

Haitham M. Alzoubi
Muhammad Turki Alshurideh
Srinidhi Vasudevan *Editors*

Technology Innovation for Business Intelligence and Analytics (TIBIA)

Techniques and Practices for Business
Intelligence Innovation

Studies in Big Data

Volume 147

Series Editor

Janusz Kacprzyk, Polish Academy of Sciences, Warsaw, Poland

The series “Studies in Big Data” (SBD) publishes new developments and advances in the various areas of Big Data- quickly and with a high quality. The intent is to cover the theory, research, development, and applications of Big Data, as embedded in the fields of engineering, computer science, physics, economics and life sciences. The books of the series refer to the analysis and understanding of large, complex, and/or distributed data sets generated from recent digital sources coming from sensors or other physical instruments as well as simulations, crowd sourcing, social networks or other internet transactions, such as emails or video click streams and other. The series contains monographs, lecture notes and edited volumes in Big Data spanning the areas of computational intelligence including neural networks, evolutionary computation, soft computing, fuzzy systems, as well as artificial intelligence, data mining, modern statistics and Operations research, as well as self-organizing systems. Of particular value to both the contributors and the readership are the short publication timeframe and the world-wide distribution, which enable both wide and rapid dissemination of research output.

The books of this series are reviewed in a single blind peer review process.

Indexed by SCOPUS, EI Compendex, SCIMAGO and zbMATH.

All books published in the series are submitted for consideration in Web of Science.

Haitham M. Alzoubi ·
Muhammad Turki Alshurideh · Srinidhi Vasudevan
Editors

Technology Innovation for Business Intelligence and Analytics (TIBIA)

Techniques and Practices for Business
Intelligence Innovation



Springer

Editors

Haitham M. Alzoubi 
School of Business
Skyline University College
Sharjah, United Arab Emirates

Srinidhi Vasudevan 
School of Business
Operations and Strategy
University of Greenwich
London, UK

Muhammad Turki Alshurideh 
Department of Marketing
School of Business
The University of Jordan
Amman, Jordan

Department of Management, College
of Business Administration
University of Sharjah
Sharjah, United Arab Emirates

ISSN 2197-6503
Studies in Big Data
ISBN 978-3-031-55220-5
<https://doi.org/10.1007/978-3-031-55221-2>

ISSN 2197-6511 (electronic)
ISBN 978-3-031-55221-2 (eBook)

© The Editor(s) (if applicable) and The Author(s), under exclusive license to Springer Nature Switzerland AG 2024

This work is subject to copyright. All rights are solely and exclusively licensed by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed.

The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

The publisher, the authors, and the editors are safe to assume that the advice and information in this book are believed to be true and accurate at the date of publication. Neither the publisher nor the authors or the editors give a warranty, expressed or implied, with respect to the material contained herein or for any errors or omissions that may have been made. The publisher remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

This Springer imprint is published by the registered company Springer Nature Switzerland AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Paper in this product is recyclable.

Contents

Social Media and Digital Transformation in Business

Impact of Social Media Usage on the Effectiveness of Higher Education Institutions: Evidence from India	3
Shanmugan Joghee and Haitham M. Alzoubi	
Using Machine Learning to Protect Users Accounts in Twitter	27
Khalifa Hussain Ali, Saif E. A. Alnawayseh, Waleed T. Al-Sit, and Haitham M. Alzoubi	

Digital Transformation and Disruptive Technologies: Effect of Cloud Computing and Devops on Managing Projects	39
Ahmad Al-Nakeeb, Mounir El Khatib, Shaima AlHarmoodi, Muaid Salami, Humaid Al Shehhi, Ahmed Al Naqbi, Mohammed Al Nuaimi, and Haitham M. Alzoubi	

Digital Transformation and Digital Disruption Technologies: The Effect of AI and Machine Learning on Managing Projects	63
Mounir El Khatib	

Systematic Literature Review and Assessment for Cyber Terrorism Communication and Recruitment Activities	83
Romil Rawat, Josefa Díaz-Álvarez, and Francisco Chávez	

Digitalization in Accounting and Auditing

Business Digitalization in Accounting and Auditing Fields	111
Sulaiman Weshah	

Accountants' Perception and Essential Skills on Blockchain Technology	125
Ibrahim Elsiddig Ahmed	

Management Accounting Systems and Data Analytics in the United States: Evidence from Apple	141
Nizar Mohammad Alsharari	
Accounting Information Systems' Control and Security: Do External Auditors Need to Set a Paragraph Within Their Report?	153
Abdelrazaq Altal, Ahmad Al Taher, Mohammad H. Alkharabsheh, Mustafa S. Qatanani, Abed Al Qader Khaddash, and Jehad Abushukhdum	
Advanced Technologies in Data Analysis and Management	
Genetic Algorithm-Based Feature Selection and Self-Organizing Auto-Encoder (Soae) for Snp Genomics Data Classifications	167
D. Karthika, M. Deepika, Neyara Radwan, and Haitham M. Alzoubi	
An Effect of Big Data Analytics on Pandemic Prevention	183
D. Karthika, E. Ramya, Maged Farouk, and Haitham M. Alzoubi	
Data Warehousing for Assisting the Decision Makers	197
Bakheet AlNaoimi, Rashed AlRaesi, Obeid AlKaboory, Abdel Aziz Alrasasi, Waleed T. Al-Sit, Saif E. A. Alnawayseh, and Haitham M. Alzoubi	
Implementing Machine Learning for the Analysis of Data	211
Ali A. Alzoubi and Haitham M. Alzoubi	
Review of Artificial Intelligence and Machine Learning Recent Advancements	223
Ali A. Alzoubi, Ibrahim Al Aqeel, and Haitham M. Alzoubi	
Digital Wallets, E-commerce, and Consumer Perspectives	
Evaluation of Purchasers Mentalities When Buying IoT Home Security Devices	239
Hussam Al Hamadi, Haitham M. Alzoubi, Mohamed Alyafei, Abdulelah Almokahel, Mohamed Alyafei, Waleed T. Al-Sit, and Saif E. A. Alnawayseh	
Digital Wallet System Development and Evaluation	259
Shaikha Omar Mubarak, Mahra Khadim Sultan, Saif E. A. Alnawayseh, Waleed T. Al-Sit, and Haitham M. Alzoubi	
Entrepreneurship and Technology Diversification: A Strategy or Desperation? FAM Case Study	271
Anil Roy Dubey, Shanmugan Joghee, and Haitham M. Alzoubi	

Internet of Things (IoT) and the Medical Field

Security Flaws in Medical Wearables Devices Used in Health Care Systems	291
Ali A. Alzoubi, Ali Al Neyadli, and Haitham M. Alzoubi	
Evaluation of Ethics and Security Challenges in Internet of Medical Things (IoMT)	301
Hamdan Alshehhi, Abdulla Almazrouei, Omar ALshehhi, and Haitham M. Alzoubi	
Data Protection and Privacy Management for Healthcare Wearable Devices	313
Abdulla AlMazrouei, Ali A. Alzoubi, and Haitham M. Alzoubi	
Privacy Violation and Information Misuse in the Internet of Medical Things (IoMT)	323
Ali A. Alzoubi, Mohammed Yousif Alzarooni, and Haitham M. Alzoubi	
IoMT Monitoring Devices: Challenges and Opportunities	333
Ali A. Alzoubi, Abdalla Alketbi, Ameen Alzarooni, and Haitham M. Alzoubi	
Analyzing the Approaches for Discovering Privacy and Security Breaches in Iomt	345
Ali A. Alzoubi, Alya AlSuwaidi, and Haitham M. Alzoubi	
Investigating E-Supply Chain Challenges in The Internet of Medical Things (IoMT)	357
Ali A. Alzoubi, Shamaa Shammas, and Haitham M. Alzoubi	
Investigating Benefits of Using IoT and Its Effect on Our Daily Life	369
Ali A. Alzoubi and Haitham M. Alzoubi	
Invistigating Benefits of Digitalized in Home Systems	381
Ali A. Alzoubi, Ibrahim Ahmed Almarzooqi, and Haitham M. Alzoubi	
Investigating Impact of Ethical Considerations on IoMT Medical Devices of UAE Healthcare System	391
Ali A. Alzoubi, Mohammed khalid Alhammadi, Khalid Abdalla Alhammadi, AbdAlla Alhammadi, and Haitham M. Alzoubi	
Analyzing Effect of Cloud Computing on IoMT Applications	403
Ali A. Alzoubi, Khalifa Al Ali, and Haitham M. Alzoubi	
Data Sharing with a Third-Party Within IoMT Environment: Challenges and Opportunities	413
Ali A. Alzoubi, Abdulrahman Alhossani, and Haitham M. Alzoubi	

Contemporary Security Concerns in IoT-Based Devices with Healthcare System	423
Ali A. Alzoubi, Reem ALKaabi, Sara ALAmeri, and Haitham M. Alzoubi	
Investigating Contemporary Ethical Issues of Using Blockchain in E-Supply Chain in Internet of Medical Things (IOMT)	437
Ali A. Alzoubi, Seyed Abdollah Nikoo, and Haitham M. Alzoubi	
Advances of Medical Internet of Things Based Patient Health Monitoring Systems	453
Ali A. Alzoubi, Mohammed Al-Wahni, and Haitham M. Alzoubi	
Investigating the Impact of Ethical Concerns on the Security and Privacy of Medical Devices in the UAE	465
Ali A. Alzoubi, Shaikha Omar Mubarak, Maher Khadim Sultan, Ayla Obaid Ali, and Haitham M. Alzoubi	
Employee Empowerment and Organizational Behavior	
The Impact of Employee Empowerment and Organizational Citizenship Behavior with Mediating Role of Job Satisfaction at Amman Private Hospitals	483
Ala'a Emad Ahmad Kharabsheh, Mohamed A. Alnuaimi, and Haitham M. Alzoubi	
Developing Rescue Mobile Application	501
Jasim Faisal Almidfa, Saif E. A. Alnawayseh, Waleed T. Al-Sit, and Haitham M. Alzoubi	

Social Media and Digital Transformation in Business

Impact of Social Media Usage on the Effectiveness of Higher Education Institutions: Evidence from India



Shanmugan Joghee and Haitham M. Alzoubi 

Abstract The advance of social media for the past few years has transformed the ways in which the internet is practiced by users. Social media is constructed on the impression of how people know and interact with each other. It gives individuals the power to share, making the world more open and associated with each other. Now-a-days, social media in education sector has become an essential part in almost all institution's progress. There are many different ways to use social media for higher education sector. Social media has numerous usages in e-learning as well as to help market and promote colleges and universities. Hence, this study aimed to analyze the impact of social media on higher educational sector with reference to Indian context. This study had been adopted on descriptive research design while it utilized both quantitative and qualitative data. The researcher has constructed an online questionnaire to collect necessary data related to this study topic from the population. This study had employed the sampling technique of convenience and the sample size had consisted of 1000 students. The sample students were chosen equally from the metropolitan and urban cities respectively in India. This study had used google form to collect the sample data during the period of 3 months between December 2020 and February 2021. The statistical analysis of this study had been achieved by the way of applying techniques such as percentage analysis, mean score, ANOVA, Correlation analysis and Multiple Regression analysis.

Keywords Social media · Higher education sector · Colleges · University and e-learning

S. Joghee · H. M. Alzoubi 

School of Business, Skyline University College, Sharjah, UAE

e-mail: haitham.alzoubi@skylineuniversity.ac.ae

S. Joghee

e-mail: jshanmugan@skylineuniversity.ac.ae

H. M. Alzoubi

Applied Science Research Center, Applied Science Private University, Amman, Jordan

1 Introduction

India has a federal set-up and the Indian Constitution places 'Education' as a concurrent responsibility of both the Centre and the State (Raut & Patil, 2016). While the Centre co-ordinates and determines standards in higher and technical education, school education is the responsibility of the State. Though a significant part of the Indian higher education system is regulated, there are certain areas that couldn't implement effectively by this the private players can be played significant part. A University can be set up only through a legislation passed by Parliament or a State Legislature. Alternately, UGC can confer 'deemed/denovo university' status to an institution which can then grant degrees. Colleges are either affiliated to a University or are independent. Only students of colleges affiliated to Universities can get degrees (Eli & Lalla Aisha Sidi Hamou, 2022). Social media has an energetic influence on live as it helps a lot in every field of life such as political field, economic field and educational field (Boateng & Amankwaa, 2016). Using of social media is not limited only to professionals or elders but also it is been widely used in educational sectors by the students. Generally, students utilized social media for numerous reasons such as study purpose, online shopping, entertainment purpose as social media offered any data they want very easily and quickly (Kurdi et al., 2022a, 2022b, 2022c). The usage of social media is varied from each student as it has positive as well as negative impact on the society (Das & Padmavathy, 2021). Social Media have become a major distraction to students, causing the overall performance of students to decline (Alshurideh et al., 2022b), especially the ones who tend to check their Facebook and twitter while studying. Students who used multi-task, checking social media sites while studying (Kurdi et al., 2022b), show reduced academic performance. Their ability to concentrate on the task at hand is significantly reduced by the distractions that are brought via such media like YouTube, Facebook or Twitter.

1.1 Problem Statement

Social media plays a crucial role among students for their education and their professional skill development. Today, it eliminates geographical and time barriers providing scope for wide connectivity to vast community sharing information and interests. The social media are way of communicating directly with other students immediately. Hence, Social media has the potentials of influencing decision-making in a very short time regardless of the distance and business approach (Alzoubi et al., 2021). Using social media by students in higher educational sector is certainly a fascinating portion of research for educationists, IT, social networkers and business innovators (Alzoubi, 2022). It also provides speedy dissemination of information and ideas and the social media like WhatsApp, Facebook, Twitter and others are now gaining more and more patronage (Kurdi et al., 2022a). Through these various platforms, faculties can connect with students and incorporate social media into their

lessons, making them more interesting, relatable and engaging. Social sites are a great tool when it comes to interacting with students since it's something they are so familiar with, using these sites frequently throughout daily life. It is also significant for researchers looking at more recent developments in the field and what it means to work in a modern higher education environment innovatively (Alnazer et al., 2017). From the collection details of this study, there are beneficial designs and styles of engaging it in educational sector have been stated. It focuses on how to communicate, interact and share course material through the social media among higher education sector. But there are no clear details about the impact of social media on higher educational sector regarding Indian context. Hence, this study aimed to determine the impact of social media on higher educational sector with reference to Indian context.

1.2 Significance of the Study

Social media plays a significant role in every student's life. It is often easier and more convenient to access information, provide information and communicate through social media. For the benefit of learning and teaching, faculties and students can be associated to each other and can make good use of these platforms. Social media have become precious tools in education sector particularly among students for their communication with other students, sharing study materials and discussion with faculties. With the traditional system of education, the social media has become that bulletin board where students can get all the information about classes, doubt clearing sessions and results at anywhere. Also, this social media also has platforms which are dedicated to students and provide all the information from book list, study material, class notes, video lectures of faculties which all the students have access to. This really helps in the preparation for any competitive examination. Social media in higher education sector is essential reading for any professional working in higher education. The outcome of the study will help to strategize and reconstruct their attitude regarding the impact of social media on higher education sector. Social media allows higher education sector students for more e-learning opportunities as well. As remote careers and online classes are becoming more popular, training students to work from a distance is an important lesson and social media can help with that.

1.3 Objectives of the Study

From the background of this study, the following objectives have been developed.

- To study the personal details of the selected students in metropolitan and urban cities.

- To identify the social media usage details and impact of social media on academic performance in the study area.
- To examine significant mean difference in impact of social media with respect to selected variables.

2 Literature Review

The study from Boateng and Amankwaa (2016) found that social media was widely used by students of higher institution also students were conversant and familiar with social media most importantly social network. Further, students were in support of the idea that social media contributed a significant quota to the development of their academic life. In case of Raut and Patil (2016) revealed that social media networks had positive and negative impact on students towards their academic performance. Also, Indian students had utilized networks like Google and Youtube for improving their academic related knowledge, moreover it has investigated by Akhtar et al., (2021), social media platforms help to make a better focus on healthcare sector that can increase the information sharing and upgrading the networking among staff and management. Results from Carey and Carey (2017) indicated that the most widely used social networks were Facebook, YouTube, Hi5, Twitter and Myspace and the main characteristics of these social networking sites related to its use in higher education (Ali et al., 2022). Accordingly, social media played a vital role in the lives of students which eventually was playing a stronger role in their academic lives and more concerned to learn innovative ideas and technological developments (Kurdi et al., 2022a). From the study of Gyenge et al., (2021) showed that positive impacts in the dimensions like support, upgrading of educational processes, co-operation and performance which indicated that the wider future use of Online Social Networks (OSNs) in higher education is quite promising. In addition, they are mostly dealing with users' learning style and personality and less with organizational issues (Hanaysha et al., 2022).

According to Deka (2015) found that most of students responded that Facebook was the most favourite social networking site whereas Tweeting, instant messaging or blogging enhanced student involvement. Also, they opined that positive impact of social networking sites on education while educational efforts were not affected by social networking (Miller, 2021). Further, students did not deny that social media may hamper educational efforts regarding negative impact of social media. The researchers (Srivastava, 2015) observed that the use of social media in higher learning enabled student interaction with content they could create individually or share with other students. Moreover, students appreciated and indeed benefit from the use of social media technologies that had positive effect on their performance and growth for example the learning can be enhanced by providing the study material through social media platforms (Alshurideh et al., 2022a). The study from Spackman and Larsen (2017) inferred that the application of social media was largely initiated by students and not so much by teachers. Thus, Facebook groups were preferred

social media for communication with colleagues and content sharing and distribution with regard to data management (Aziz & Aftab, 2021), while Wikis and Learning Management Systems (LMSs) were most used for content creation and additional learning (Alzoubi et al., 2022b). In case of Bailey et al., (2018) confirmed that the strong positive students' interest in the social platforms, especially on Facebook where all of them had an account and utilized on daily basis. Furthermore, Learning Management Systems (LMSs) used by state and private Higher Educational Sectors in Bulgaria, taught mainly in the field of Social, Business and Legal Sciences and machine learning techniques (Ali et al., n.d.).

The author Beqiri (2014) determined that there was an increase of social media usage within the students of higher education in Kosovo. Further, social media had an impact and was considered as an effective tool by students about study related activities such as subjects, research, group activities, projects, internship, and a high significance level for business to grow digitally by making e-transactions (Alzoubi et al., n.d.) and positive influence on communication and interactivity among them. The previous studies result observed that the main challenges faced by students in higher education as regards use of social media were security, unproductive behaviour or wastes time, misuse of tools (Alhamad et al., 2022) during instructional time and antisocial behaviour (Alnuaimi et al., 2021). Additionally, the students in higher education had a favourable perception towards use of social media in higher education. In case of Srivastava (2015) showed that the South African students were more dependent on using Facebook, in comparison to using Twitter. Also, University of Cape Town (UCT) students perceived towards Facebook remained positive while a less positive attitude on Twitter. Moreover, they were strong users of technology, spend time daily using technology and had positive perceptions and attitudes towards technology (Alzoubi et al., 2020) Based on argument of Deka (2015) indicated that female students' attitude had been improved than male students regarding attitude towards social media and there was significant difference existed between urban and rural students on attitude towards social media. Besides, there was a significant different existed between science, social science and literature streamed students whereas significant relationship between student academic achievement and attitude towards social media of the student.

The results from Chawinga (2017) obtained that social media technologies helped to achieve a rather more quality teaching and students' limitless presence on blogs and Twitter implied that teaching and learning continued even outside the classroom. Also, students shared and discussed course materials, posted their course reflections and interacted amongst themselves and with their lecturer 24/7. In addition, challenges faced while using social media as cost of internet data bundles, inaccessible Wi-Fi, poor bandwidths and insufficient computers that has a great impact on the learning performance and technological sources such as internet of things IoT, blockchain, big data analytics (Lee et al., 2022b). The researcher Goel (2016) proved that the relationships between positive beliefs and attitudes towards social media for exchanging academic activities and the academic performance of the students. Further, management students used social media mainly for sharing their assignments, projects and learning experiences with their colleagues in results of better

information sharing source (Alzoubi & Yanamandra, 2020). As well, suggested that the academic institutions should indorse both students and faculty to advance a positive attitude towards usage of social media. From research of Williams and Adesope (2017) indicated that social media were used for educational purposes in terms of quick growth in knowledge and information. Also, undergraduates assured with close and prospective groups for change. Furthermore, students utilized social media such as Facebook, Twitter, WhatsApp, Skype, YouTube, Opera Mini and WeChat for educational purposes.

The result from Draskovic et al., (2017) explored that students used social media frequently and had positive attitudes to integrating social media in education. Also, most of students preferred CMS for educational and communication purposes in academia (Mehmood et al., 2019). Further, there were no significant differences in social media use and preferences among Croatian and German students. In addition, students had some constrains in lecturers' engagement through social media and increased level of attraction during lectures (Alhamad et al., 2021) and they were also not very excited about voluntarily usage of social media within a course (Alzoubi et al., 2022a). In case of Kanthawongs et al. (2016) showed that there was significant difference in involvement of university undergraduate students in Social Networking based on course of study, level (year) of study and age. Also, female undergraduate students' involvement in social networking was higher than that of their male counterparts; but male undergraduate students indicated a higher positive attitude towards integration of social networking into teaching and learning (Alshurideh et al., 2020). According to Siriwardana and Mendis (2019) resulted that faculty and students differed somewhat in their current and anticipated uses of SNSs such as the currently-popular Facebook. Moreover, faculty and student responses showed that students were much more likely than faculty to use Facebook and were significantly more open to the possibility of using Facebook and similar technologies to support classroom work by using advanced method of learning (Shamout et al., 2022). Additionally, faculty members were more likely to use more "traditional" technologies such as email. The study of Brahma and Verma (2019) found that all the respondents were aware of SNSs and were using more than one Social Networking Sites (SNSs) websites while Facebook was used in large number followed by YouTube and Instagram. Likewise, mobile was the most preferred tool for accessing SNSs and students were using SNSs for entertainment purpose. Further, most of them expressed that low internet speed was the main problem and most of them were satisfied towards using SNSs. From the result of Alzoubi and Ahmed (2019) observed that higher percentage of students had mentioned these as a means of time wastage and distraction although they had also admitted their addiction to these sites. In addition, Face book, Twitter and Google+ were clearly visible as students' top admiration in most of the cases whereas WhatsApp also appeared for some positive uses by the students, it has argued by authors, the social media as a good medium of learning can enhance the student motivational level (Alsharari, 2022) and develop interest while learning. The results confirmed that difference between students answers when it's been compared on country basis (Alzoubi, 2021).

According to Balakrishnan et al., (2017) inferred that both the Australian and Malaysian students were found to place significant emphasis on academic reasons as motivation to use social media in learning. Thus, there was a significant greater emphasis on academic reasons and barriers compared to their Australian counterparts that signifies the medical students and their learning intention increased by figuring on site learning (Saad Masood Butt, 2022). Furthermore, significant effects were observed for convenience and e-learning perception among Australian students, while ease of use was found to have significant impact on Malaysian students. The researchers (Al-Mukhaini et al., 2014) revealed that the positive and negative impacts of using social networking as a way of learning whereas a high percentage of students were affected positively by using Social Networks (SNs) tools. The SNs tools provided them the chance to control their own learning environment and allowed them to share their knowledge with other students in different ways such as texting, voice and video media (Ramakrishna & Alzoubi, 2022). Moreover, Web 2.0 tools, such as blogs, Facebook, YouTube and online courses were giving students better learning opportunities to enhance their educational performance. In case of Srivastava (2015) found that female students scored highest on both scales, recording higher levels of Facebook usage and happiness than their male counterparts. Also, high age group students were more intense Facebook users (Alzoubi et al., 2022a, 2022b), more satisfied with their lives and happiest than younger age group students. In addition, positive and significant correlation was observed between Facebook usage, life satisfaction and happiness of older age group college students while integrating the students career level and corporate level (Joghee et al., 2020). Result from Kanthawongs et al. (2016) explored that there was a positive impact of perspectives on Facebook in education and relational commitment towards perceived satisfaction with Facebook, whereas the corporate level encourages the use of social media to increase the sales and marketing to become more competitive (Lee et al., 2022a). Additionally, Alzoubi and Aziz (2021) argued the relative strength of the explanatory power of perspectives on social media (Facebook) in education was higher than relational commitment towards perceived satisfaction with Facebook that has a great influence of innovation. The study of AL-Rahmi and Othman (2013) confirmed that statistically significant negative relationship between perceived usefulness and their satisfaction. Also, the results showed that engagement and perceived ease of use highly correlated with students' satisfaction for using social media for collaborative learning among students. The author Bhakta (2017) concluded that most of the students used WhatsApp and they used SNS through their mobile or tablet for entertainment purpose. Further, it was found that a negative relationship existed between duration of accessing SNS and academic achievement of the students. Moreover, Social Networking Sites had both positive and negative impacts on college students.

2.1 *Hypothesis Development*

For the purpose of study, the following null hypotheses have been developed and examined.

- There is no significant mean difference in impact of social media with respect to selected variables such as age, gender, educational status, stream of the study, place of education, location of the college/university, type of social media using more, period of using, frequency of using and type of e-Gadget using of the respondents.

3 **Methodology**

3.1 *Research Design and Technique*

This study was based on descriptive research design. For the study objective, both primary and secondary data sources have been utilized. The researcher had designed well-framed online questionnaire to collect the primary data and the secondary data were collected through internet, magazines, books, published articles related to this study, etc. The sample size has been chosen with the help of convenience sampling method. In this research, the sample size had consisted of 1000 students from higher education sector whereas equal size of respondents have been chosen from metropolitan and urban cities respectively in India. The primary data collection is undertaken through google form during the period of 3 months from December 2020 to February 2021. The collected sample data were converted into table formation and analyzed with the help of statistical tools like percentage analysis, mean score, ANOVA, Correlation analysis and Multiple Regression analysis to find mean difference and relationship between selected variables also hypothesis testing, which developed. The results are discussed in the following section.

4 **Data Analysis**

4.1 *Personal Details*

Table 1 shows the personal details of the respondents including the variables like age, gender educational status, stream of the study, place of education and location of the college/university.

- From the above table, it is explored that 30.5% of the respondents belong to 18–20 years of age group, 43.1% of the respondents belong to age category of 21–22 years and 26.4% of the respondents belong to above 22 years of age group.

Table 1 Personal details

No.	Variables	NOR	Percentage	Mean
1	<i>Age</i>			
	18–20 years	305	30.5	3.35
	21–22 years	431	43.1	3.47
	Above 22 years	264	26.4	3.38
	Total	1000	100.0	
2	<i>Gender</i>			
	Male	587	58.7	3.39
	Female	413	41.3	3.44
	Total	1000	100.0	
3	<i>Educational status</i>			
	UG	473	47.3	3.39
	PG	347	34.7	3.47
	Above PG	180	18.0	3.41
	Total	1000	100.0	
4	<i>Stream of the study</i>			
	Arts	434	43.4	3.39
	Science	245	24.5	3.44
	Engineering	321	32.1	3.41
	Total	1000	100.0	
5	<i>Place of education</i>			
	University premises	238	23.8	3.40
	College premises	762	76.2	3.44
	Total	1000	100.0	
6	<i>Location of the college/university</i>			
	Metropolitan city	500	50.0	3.42
	Urban city	500	50.0	3.41
	Total	1000	100.0	

- It is observed that 58.7% of the respondents are male and 41.3% of the respondents are female.
- It is divulged from the analysis that 47.3% of the respondents are learning UG, 34.7% of the respondents are studying PG and 18.0% of the respondents are perusing above PG.
- It is confirmed that 43.4% of the respondents are studying Arts, 24.5% of the respondents are learning Science and 32.1% of the respondents are learning Engineering.
- It is noted that 23.8% of the respondents are studying in university premises and 76.2% of the respondents are studying in college premises.

- It is concluded that equal percent of the respondents are studying in metropolitan city and urban city respectively.

4.2 Social Media Usage Details

This analysis has focused that social media usage details of the respondents consisting the variables like type of social media using more, period of using social media, frequency of using social media and type of e-Gadget using for social platform (Table 2).

- It is observed from the above analysis that 12.7% of the respondents are using you tube, 11.2% of the respondents utilize Face Book, 10.5% of the respondents using type as Google +, 8.7% as LinkedIn, 18.2% as Whatsapp, 8.5% as Yahoo, 8.6% as Byju's, 3.1% as Toppr, 4.0% as Instagram, 7.6% as Pinterest, 4.8% as Skype and 2.1% of the respondents are using other types of social media.
- It is proved that 19.3% of the respondents are using social media for 1–3 years, 41.7% of the respondents are utilizing social media for 4–5 years and 39.0% of the respondents are using social media for above 5 years.
- It is revealed that 15.5% of the respondents are using social media for 1–5 times in a day, 34.2% of the respondents are utilizing social media for 6–10 times and 50.3% of the respondents are using social media for above 10 times.
- It is examined that 39.6% of the respondents use smart phone for accessing social media, 26.1% of the respondents utilize laptop as their social platform, 10.7% as Tab, 5.4% as TV and 18.2% of the respondents as desktop computer.

4.3 Impact of Social Media on Academic Performance

In this segment, the researcher has discussed about the impact of social media on academic performance. For the purpose, twenty statements have been developed with 5 points Likert's scaling method for examining the impact of social media on academic performance. The mean of the statements is given in Table 3.

It is examined from the above table that among the fifteen categories of impact of social media, social media helps to improve academic knowledge of the respondents with the mean score of 3.69 and they are connected with fellow students by using social media with the mean score of 3.66.

4.4 Relationship Between Age and Impact of Social Media

H_0 : There is no significant mean difference in impact of social media with respect to age of the respondents (Table 4).

Table 2 Social media usage details

No.	Variables	NOR	%	Mean
1	<i>Type of social media using more</i>			
	YouTube	127	12.7	3.90
	FaceBook	112	11.2	3.48
	Google+	105	10.5	3.43
	LinkedIn	87	8.7	3.37
	Whatsapp	182	18.2	3.46
	Yahoo	85	8.5	3.34
	Byju's	86	8.6	3.31
	Toppr	31	3.1	3.42
	Instagram	40	4.0	3.33
	Pinterest	76	7.6	3.39
	Skype	48	4.8	3.34
	Others	21	2.1	3.44
	Total	1000	100.0	
2	<i>Period of using social media</i>			
	1–3 years	193	19.3	3.40
	4–5 years	417	41.7	3.41
	Above 5 years	390	39.0	3.44
	Total	1000	100.0	
3	<i>On an average, how many times each day do you open social media?</i>			
	1–5 times	155	15.5	3.41
	6–10 times	342	34.2	3.40
	Above 10 times	503	50.3	3.42
	Total	1000	100.0	
4	<i>Type of e-Gadget using for social platform</i>			
	Smart phone	396	39.6	3.39
	Laptop	261	26.1	3.61
	Tab	107	10.7	3.40
	TV	54	5.4	3.42
	Desktop computer	182	18.2	3.41
	Total	1000	100.0	

From the above table, it is proved that the null hypothesis is rejected since 'p' value is less than 0.05. So, it is found that there is a significant mean difference in impact of social media with respect to age of the respondents.

Table 3 Impact of social media on academic performance

No.	Variables	Mean
1	It helps to share voice/views in the social domine	3.45
2	To share specific subject related information with friends	3.52
3	For sharing the study/knowledge related material	3.52
4	It helps to make a better social person	3.36
5	Its helps to improve my academic knowledge	3.69
6	I have a strong background in social media for education	3.56
7	It helps to get clear information about subject/course	3.14
8	Increase academic development	3.35
9	I feel comfortable using social media for Education	3.45
10	It is very important for me to be proficient in use of social media for education	3.39
11	It helps to build my confidence regarding my subjects	3.43
12	Using social media for classroom discussions is very convenient	3.17
13	Using social media for group projects is very convenient	3.56
14	I try to think of ways to do my college work effectively using social media	3.29
15	Social media are more effective than e-Learning systems	3.24
16	I am satisfied using social media as an alternative to e-Learning systems	3.61
17	I feel more connected with fellow students by using social media	3.66
18	I can now contact my instructors more often by using social media	2.91
19	I feel social media should be used in all courses	3.57
20	My view of courses positively changed after using social media	3.57

Table 4 Relationship between age and impact of social media

	Sum of squares	df	Mean square	F	'p' value
Between groups	2.873	2	1.436	13.498	0.000*
Within groups	106.089	997	0.106		
Total	108.961	999			

Note Significant at 1% level

4.5 Relationship Between Gender and Impact of Social Media

H_0 : There is no significant mean difference in impact of social media with respect to gender of the respondents (Table 5).

It is explored that the null hypothesis is rejected as 'p' value is less than 0.05. Hence, it is showed that there is a significant mean difference in impact of social media with respect to gender of the respondents.

Table 5 Relationship between gender and impact of social media

	Sum of squares	df	Mean square	F	'p' value
Between groups	0.606	1	0.606	5.582	0.018**
Within groups	108.355	998	0.109		
Total	108.961	999			

Note Significant at 5% level

Table 6 Relationship between educational status and impact of social media

	Sum of squares	df	Mean square	F	'p' value
Between groups	0.701	2	0.350	3.226	0.040**
Within groups	108.261	997	0.109		
Total	108.961	999			

Note **Significant at 5% level

4.6 Relationship Between Educational Status and Impact of Social Media

H_0 : There is no significant mean difference in impact of social media with respect to educational status of the respondents (Table 6).

It is noted that the 'p' value is less than 0.05 consequently null hypothesis is rejected. So, it is indicated that there is a significant mean difference in impact of social media with respect to educational status of the respondents.

4.7 Relationship Between Stream of the Study and Impact of Social Media

H_0 : There is no significant mean difference in impact of social media with respect to stream of the study of the respondents (Table 7).

Table 7 Relationship between stream of the study and impact of social media

	Sum of squares	df	Mean square	F	'p' value
Between groups	0.503	2	0.251	2.310	0.100 ^{NS}
Within groups	108.459	997	0.109		
Total	108.961	999			

Note NS—Not Significant

Table 8 Relationship between place of education and impact of social media

	Sum of squares	df	Mean square	F	'p' value
Between groups	0.272	1	0.272	2.499	0.114 ^{NS}
Within groups	108.689	998	0.109		
Total	108.961	999			

Note NS—Not Significant

It is revealed that the 'p' value is greater than 0.05 therefore null hypothesis is accepted. Hence, it is confirmed that there is no significant mean difference in impact of social media with respect to stream of the study of the respondents.

4.8 Relationship Between Place of Education and Impact of Social Media

H_0 : There is no significant mean difference in impact of social media with respect to place of education of the respondents (Table 8).

It is revealed that the null hypothesis is accepted for the reason of 'p' value is greater than 0.05. So, it is indicated that there is no significant mean difference in impact of social media with respect to place of education of the respondents.

4.9 Relationship Between Location of the College/University and Impact of Social Media

H_0 : There is no significant mean difference in impact of social media with respect to location of the college/university of the respondents (Table 9).

It is obtained that the null hypothesis is accepted as the 'p' value is greater than 0.05. Hence, it is evaluated that there is no significant mean difference in impact of social media with respect to location of the college/university of the respondents.

Table 9 Relationship between location of the college/university and impact of social media

	Sum of squares	df	Mean square	F	'p' value
Between groups	0.029	1	0.029	0.262	0.609 ^{NS}
Within groups	108.933	998	0.109		
Total	108.961	999			

Note NS—Not Significant

Table 10 Relationship between type of social media using more and impact of social media

	Sum of squares	df	Mean square	F	'p' value
Between groups	9.974	11	0.907	9.050	0.000*
Within groups	98.987	988	0.100		
Total	108.961	999			

Note *—Significant at 1% level

Table 11 Relationship between period of using and impact of social media

	Sum of squares	df	Mean s	F	'p' value
Between groups	0.264	2	0.132	1.210	0.298 ^{NS}
Within groups	108.697	997	0.109		
Total	108.961	999			

Note NS—Not Significant

4.10 Relationship Between Type of Social Media Using More and Impact of Social Media

H_0 : There is no significant mean difference in impact of social media with respect to type of social media using more by the respondents (Table 10).

It is determined that the null hypothesis is rejected since the 'p' value is lesser than 0.05. So, it is stated that there is a significant mean difference in impact of social media with respect to type of social media using more by the respondents.

4.11 Relationship Between Period of Using and Impact of Social Media

H_0 : There is no significant mean difference in impact of social media with respect to period of using by the respondents (Table 11).

It is determined that the null hypothesis is accepted meanwhile the 'p' value is greater than 0.05. Henceforth, it is found that there is no significant mean difference in impact of social media with respect to period of using by the respondents.

4.12 Relationship Between Frequency of Using and Impact of Social Media

H_0 : There is no significant mean difference in impact of social media with respect to frequency of using by the respondents (Table 12).

Table 12 Relationship between frequency of using and impact of social media

	Sum of squares	df	Mean square	F	'p' value
Between groups	0.085	2	0.043	0.391	0.677 ^{NS}
Within groups	108.876	997	0.109		
Total	108.961	999			

Note NS—Not Significant

Table 13 Relationship between type of e-gadget using and impact of social media

	Sum of squares	df	Mean square	F	'p' value
Between groups	1.768	4	0.442	4.103	0.003*
Within groups	107.193	995	0.108		
Total	108.961	999			

Note *—Significant at 1% level

It is determined that the 'p' value is greater than 0.05 subsequently null hypothesis is accepted. So, it is explored that there is no significant mean difference in impact of social media with respect to frequency of using social media by the respondents.

4.13 Relationship Between Type of e-Gadget Using and Impact of Social Media

H_0 : There is no significant mean difference in impact of social media with respect to type of e-Gadget using by the respondents (Table 13).

It is revealed that the 'p' value is lesser than 0.05 then null hypothesis is rejected. Therefore, it is indicated that there is a significant mean difference in impact of social media with respect to type of e-Gadget using for accessing social media by the respondents.

4.14 Degree of Relationship Between Selected Variables and Impact of Social Media (Correlation Analysis)

The following study has been examined about the relationship between the selected variables and impact of social media by using correlation analysis. This study focused the extent of selected variables, like age, educational status, period of using and frequency of using, predict the impact of social media in higher educational sector (Table 14).

Table 14 Degree of relationship between selected variables and impact of social media (correlation analysis)

No.	Variables	'r' value	'p' value
1	Age	0.240	0.000*
2	Educational status	0.074	0.019**
3	Period of using	-0.147	0.000*
4	Frequency of using	0.016	0.605 ^{NS}

Note *—Significant at 1% level; **—Significant at 5% level; NS—Not Significant

It is confirmed that among the four selected variables, two factors like age and educational status are having positive correlation with the impact of social media. Also, period of using social media by the respondents is having negative correlation with the impact of social media. On the other hand, the variable frequency of using by the respondents is not associated with the impact of social media in the study area. It is showed that whenever the age and educational status increases their impact of social media also positively increases. Further, whenever the period of using increases their impact of social media decreases higher educational sector.

4.15 Impact of Social Media (Multiple Regression Analysis)

The relationship of impact of social media with the selected variables is discussed with the help of multiple regression analysis in Table 15.

The above table indicated that statistically fit of R^2 is 0.794 for impact of social media in higher educational sector. Also, this is statistically significant at 1 percent level. It is found from the analysis that the variables namely age and educational status are having positive association in the study area.

Table 15 Impact of social media (multiple regression analysis)

No.	Variables	Coefficient	SE	't' value	'p' value
	(Constant)	3.355			
1	Age	0.053	0.012	4.417	0.000*
2	Educational status	0.031	0.014	2.204	0.028**
3	Period of using	-0.060	0.011	-5.455	0.000*
4	Frequency of using	0.010	0.014	0.681	0.496 ^{NS}
	R value	0.794			
	R^2 value	0.630			
	F value	82.210*			

Note *—Significant at 1% level; **—Significant at 5% level; NS—Not Significant

5 Discussion

5.1 *From the Personal Details*

- It is found that majority of the respondents belong to age group of 21–22 years. In addition, maximum level impact of social media is perceived by the respondents belong to 21–22 years.
- It is showed that majority of the respondents are male. Also, high level impact of social media is perceived by the female respondents.
- It is inferred that majority of the respondents are studying UG. Further, high level impact of social media is perceived by the respondents learning PG.
- It is noted that most of the respondents are studying Arts. Moreover, maximum level impact of social media is perceived by the respondents studying Science (Hamadneh et al., 2021).
- It is revealed that utmost of the respondents are studying in college premises. Additionally, high level impact of social media is perceived by the respondents studying in college premises.
- It is concluded that equal percent of the respondents are studying in metropolitan city and urban city respectively. Furthermore, maximum level impact of social media is perceived by the respondents studying in metropolitan city.

5.2 *From the Social Media Usage Details*

- It is identified that majority of the respondents are using Whatsapp. Also, high level impact of social media is perceived by the respondents using Youtube.
- It is found that most of the respondents are using social media for 4–5 years. Further, maximum level impact of social media is perceived by the respondents using social media for above 5 years.
- It is examined that majority of the respondents are using social media for above 10 times in a day. Likewise, high level impact of social media is perceived by the respondents using social media for above 10 times daily.
- It is confirmed that most of the respondents are using smart Phone for accessing social media. Further, maximum level impact of social media is perceived by the respondents use laptop for accessing social media.

5.3 From the Impact of Social Media on Academic Performance,

- It is observed that the high impact as social media helps to improve academic knowledge of the respondents and they are connected with fellow students by using social media among the fifteen categories of impact of social media.
- It is revealed from ANOVA that there is a significant mean difference in impact of social media with respect to age of the respondents.
- It is explored from 'F' test that there is a significant mean difference in impact of social media with respect to gender of the respondents.
- It is noted from 'F' test that there is a significant mean difference in impact of social media with respect to educational status of the respondents.
- It is indicated from ANOVA that there is no significant mean difference in impact of social media with respect to stream of the study of the respondents.
- It is examined from 'F' test that there is no significant mean difference in impact of social media with respect to place of education of the respondents.
- It is showed from ANOVA that there is no significant mean difference in impact of social media with respect to location of the college/university of the respondents.
- It is inferred from 'F' test that there is a significant mean difference in impact of social media with respect to type of social media using more by the respondents.
- It is evaluated from 'F' test that there is no significant mean difference in impact of social media with respect to period of using by the respondents.
- It is confirmed from ANOVA that there is no significant mean difference in impact of social media with respect to frequency of using social media by the respondents.
- It is proved from ANOVA that there is a significant mean difference in impact of social media with respect to type of e-Gadget using for accessing social media by the respondents.
- It is assessed from Correlation analysis that whenever the age and educational status increases their impact of social media also positively increases. Further, whenever the period of using increases their impact of social media decreases higher educational sector.
- It is concluded from the multiple regression analysis that the variables namely age and educational status are having positive association in the study area.

6 Conclusion

This study aimed to analyse the impact of social media on higher educational sector with reference to Indian context. Social media like You Tube, Face Book, Google+, LinkedIn, etc. are very useful for higher education sector students for developing their academic knowledge and practical skill. Through utilizing the social media on their academic life, they can be enhanced their involvement and academic achievement. Students who would not normally participate in traditional classes are more suitable

to partake through social media utilization. Social media offers various opportunities and allows higher education sector students for easy learning and engagement in their academic study. This study revealed that students appreciate and indeed benefit from the utilization of social media that have positive effect on their academic performance. So, the higher education institutions should ensure the awareness about the benefit of using social media for academic support among students.

7 Implications/Future Recommendations

The findings indicated that high level impact of social media is perceived by the female respondents. So, female students must be given instructions and guidance about the safe utilization of personal profile forwarded on the social media. This study revealed that maximum level impact of social media is perceived by the respondents studying in metropolitan city because they well infrastructure facilities. Hence, the government should construct more facilities about the networking, internet and wi-fi to access social media in full fledge. It could be observed that high level impact of social media is perceived by the respondents using Youtube because learning as easy and quick while using this media. So, the institutions may give direction to use and develop a capacity for practical reasoning when using social media.

- It is assessed that maximum level impact of social media is perceived by the respondents studying Science. Hence, the colleges and universities should create awareness regarding serviceability of internet and social media as a source of information and its utility in academic field.
- Arrangements should be prompted for group conference and video conferences among students and faculties through social media for discussion and sharing study materials.

References

- Akhtar, A., Akhtar, S., Bakhtawar, B., Kashif, A. A., Aziz, N., & Muhammad, & , Javeid, S.,. (2021). COVID-19 detection from CBC using machine learning techniques. *International Journal of Technology Innovation Management*, 1, 65–78.
- Al-Mukhaini, E. M., Al-Qayoudhi, W. S., & Al-Badi, A. H. (2014). Adoption of social networking in education: A study of the use of social networks by higher education students in Oman. *Journal of International Education Research*, 10, 143–154.
- AL-Rahmi, W.M., Othman, M.S.,. (2013). Evaluating student's satisfaction of using social media through collaborative learning in higher education. *International Journal Advances Engineering Technology*, 6, 1541–1551.
- Alhamad, A., Alshurideh, M., Alomari, K., Al Kurdi, B., Alzoubi, H., Hamouche, S., & Al-Hawary, S. (2022). The effect of electronic human resources management on organizational health of telecommunications companies in Jordan. *International Journal of Data and Network Science*, 6, 429–438.

- Alhamad, A. Q. M., Akour, I., Alshurideh, M., Al-Hamad, A. Q., Kurdi, B. A., & Alzoubi, H. (2021). Predicting the intention to use google glass: A comparative approach using machine learning models and PLS-SEM. *International Journal of Data and Network Science*, 5, 311–320.
- Ali, N., Ahmed, A., Anum, L., Ghazal, T., Abbas, S., & A.K., M., A., H. M., A., n.d. M. (2021). Modelling supply chain information collaboration empowered with machine learning technique. *Intelligent Automation and Soft Computing*, 30, 243–257.
- Ali, N., Ghazal, T. M., Ahmed, A., Abbas, S., Khan, M. A., Alzoubi, H. M., Farooq, U., Ahmad, M., & Khan, M. A. (2022). Fusion-based supply chain collaboration using machine learning techniques. *Intelligent Automation and Soft Computing*, 31, 1671–1687.
- Alnazer, N. N., Alnuaimi, M. A., & Alzoubi, H. M. (2017). Analysing the appropriate cognitive styles and its effect on strategic innovation in Jordanian universities. *International Journal of Business Excellence*, 13, 127–140.
- Alnuaimi, M., Alzoubi, H. M., Ajelat, D., & Alzoubi, A. A. (2021). Towards intelligent organisations: An empirical investigation of learning orientation's role in technical innovation. *International Journal of Innovation and Learning*, 29, 207–221.
- Alsharari, N. (2022). The implementation of enterprise resource planning (Erp) in the United Arab Emirates: A case of Musanada corporation. *International Journal of Technology and Innovation Management*, 2, 1.
- Alshurideh, M., Gasaymeh, A., Ahmed, G., Alzoubi, H. M., & Kurd, B. A. (2020). Loyalty program effectiveness: Theoretical reviews and practical proofs. *Uncertain Supply Chain Management*, 8, 599–612.
- Alshurideh, M. T., Kurdi, A., & B., A.. (2022a). *H. M.*, 10, 1191–1202.
- Alshurideh, M. T., Kurdi, A. (2022b). Fuzzy assisted human resource management for supply chain management issues. *Annals of Operations Research*.
- Alzoubi, H., & Ahmed, G. (2019). Do total quality management (TQM) practices improve organisational success? A case study of electronics industry in the UAE. *International Journal of Economic and Business Research*, 17, 459–472.
- Alzoubi, A. (2022). Machine learning for intelligent energy consumption in smart homes. *International Journal of Computations, Information and Manufacture*, 2, 2022.
- Alzoubi, A. (2021). Renewable green hydrogen energy impact on sustainability performance. *International Journal of Computations, Information and Manufacture*, 1, 2021.
- Alzoubi, H., & A., M., A.K., B., A., n.d. K. and Ghazal, T. (2022). The effect of e-payment and online shopping on sales growth: Evidence from banking industry. *International Journal of Data and Network Science*, 6, 94–109.
- Alzoubi, H., Alshurideh, M., Kurdi, B. A., Akour, I., & Aziz, R. (2022a). Does BLE technology contribute towards improving marketing strategies, customers' satisfaction and loyalty? The role of open innovation. *International Journal of Data and Network Science*, 6, 449–460.
- Alzoubi, H. M., Ahmed, G., Al-Gasaymeh, A., & Al Kurdi, B. (2020). Empirical study on sustainable supply chain strategies and its impact on competitive priorities: The mediating role of supply chain collaboration. *Management Science Letters*, 10, 703–708.
- Alzoubi, H. M., Ahmed, G., & Alshurideh, M. (2022b). An empirical investigation into the impact of product quality dimensions on improving the order-winners and customer satisfaction. *International Journal Production Quality Management*, 36, 169–186.
- Alzoubi, H. M., & Aziz, R. (2021). Does emotional intelligence contribute to quality of strategic decisions? The mediating role of open innovation. *Journal of Open Innovation Technology Marketing Complex*, 7, 130.
- Alzoubi, H. M., & In'airat, M., Ahmed, G., (2022). Investigating the impact of total quality management practices and Six Sigma processes to enhance the quality and reduce the cost of quality: The case of Dubai. *International Journal of Business Excellence*, 27, 94–109.
- Alzoubi, H. M., Vij, M., Vij, A., & Hanaysha, J. R. (2021). What leads guests to satisfaction and loyalty in UAE five-star hotels? AHP analysis to service quality dimensions. *Enlightening Tourism a Pathmaking Journal*, 11, 102–135.

- Alzoubi, H. M., & Yanamandra, R. (2020). Investigating the mediating role of Information sharing strategy on agile supply chain in supply chain performance. *Uncertain Supply Chain Management*, 8, 273–284.
- Aziz, N., & Aftab, S. (2021). Data MIning framework for nutrition ranking: methodology: SPSS modeler. *International Journal Technological Innovation Management*, 1, 85–95.
- Bailey, M., Cao, R., Kuchler, T., & Stroebel, J. (2018). The economic effects of social networks: Evidence from the housing market. *Journal of Political Economy*, 126, 2224–2276.
- Balakrishnan, V., Teoh, K. K., Pourshafie, T., & Liew, T. K. (2017). Social media and their use in learning: A comparative analysis between Australia and Malaysia from the learners' perspectives. *Australasian Journal of Educational Technology*, 33, 81–97.
- Beqiri, G., 2014. The impact of social media on higher education in Kosovo: The student's perspective. *Academic Journal of Interdisciplinary Studies*
- Bhakta, K. (2017). Using social networking sites and its impact on college students. *International Journal of Innovative and Research Multidisciplinary Field*, 3, 12–18.
- Boateng, R. O., & Amankwaa, A. (2016). The impact of social media on student academic life in higher education. *Global Journal of Human-Social Science G Linguistic Education*, 16, 8–16.
- Brahma, K., Verma, M. K. (2019). Students' attitude towards Social Networking Sites (SNSs): A case study of Central Institute of Technology (CIT) Kokrajhar, Assam. *Library Philosophy and Practice*.
- Carey, R., & Carey, R. D. (2017). Impact of social media on higher education system and its effect on students in China. *Journal of Teacher Education*, 2017, 2017.
- Chawinga, W. D. (2017). Taking social media to a university classroom: teaching and learning using Twitter and blogs. *International Journal of Educational Technology in Higher Education*, 14.
- Das, J., & Padmavathy, R. D. (2021). Relationship between social networking addiction and academic performance of undergraduate students during Covid-19 pandemic. *Advances and Applications in Statistics*, 70, 45–67.
- Deka, P. P. (2015). A study on impact of social media on educational efforts in Guwahati City. Assam. *International Journal of Advanced Research in Education Technology*, 2, 0–4.
- Draskovic, N., Korper, A. K., Kilian-yasin, K. (2017). Student attitudes toward use of social media in the learning process : A comparative study of Croatian and German. *International Journal of Management Cases*, 53–64.
- Eli, T., & Hamou, L. A. S. (2022). Investigating the factors that influence students' choice of English studies as a major: The case of university of Nouakchott Al Aasriya, Mauritania. *International Journal of Technology and Innovation Management*, 2, 1.
- Goel, D. (2016). Impact of students attitudes towards social media use in education on their academic performance. *AIMA Journal of Management and Research*, 10.
- Gyenge, B., Máté, Z., Vida, I., Bilan, Y., & Vasa, L. (2021). A new strategic marketing management model for the specificities of E-commerce in the supply chain. *Journal of Theoretical and Applied Electronic Commerce Research*, 16, 1136–1149.
- Hamadneh, S., Pedersen, O., Alshurideh, M., Kurdi, B. A., & Alzoubi, H. M. (2021). An investigation of the role of supply chain visibility into the Scottish blood supply chain. *Journal of Legal and Ethical Regulation Issues*, 24, 1–12.
- Hanaysha, J. R., Al-Shaikh, M. E., Joghee, S., & Alzoubi, H. M. (2022). Impact of innovation capabilities on business sustainability in small and medium enterprises. *FIIB Business Review*, 11, 67–78.
- Joghee, S., Alzoubi, H. M., & Dubey, A. R. (2020). Decisions effectiveness of FDI investment biases at real estate industry: Empirical evidence from Dubai smart city projects. *International Journal of Scientific & Technology Research*, 9, 3499–3503.
- Kanthawongs, P., Kanthawongs, P., Chitcharoen, C. (2016). Factors affecting perceived satisfaction with Facebook in education. In *13th international conference on cognition and exploratory learning in digital age (CELDA 2016)* 188–194.

- Kurdi, B. A., Alshurideh, M., Akour, I., Alzoubi, H. M., Obeidat, B., & Alhamad, A. (2022a). The role of digital marketing channels on consumer buying decisions through eWOM in the Jordanian markets. *International Journal of Data and Network Science*, 6, 1175–1185.
- Kurdi, B. A., Alzoubi, H. M., Akour, I., & Alshurideh, M. T. (2022b). The effect of blockchain and smart inventory system on supply chain performance: Empirical evidence from retail industry. *Uncertain Supply Chain Management*, 10, 1111–1116.
- Kurdi, B. A., Alshurideh, M., Akour, I., Alhamad, A., Alzoubi, H. M. . (2022c). Effect of social media influencers characteristics on consumer intention and attitude towards keto production. *Purchase Intent*, 6, 1135–1146.
- Lee, K. L., Azmi, N. A. N., Hanaysha, J. R., Alzoubi, H. M., & Alshurideh, M. T. (2022a). The effect of digital supply chain on organizational performance: An empirical study in Malaysia manufacturing industry. *Uncertain Supply Chain Management*, 10, 495–510.
- Lee, K. L., Romzi, P. N., Hanaysha, J. R., Alzoubi, H. M., & Alshurideh, M. (2022b). Investigating the impact of benefits and challenges of IOT adoption on supply chain performance and organizational performance: An empirical study in Malaysia. *Uncertain Supply Chain Management*, 10, 537–550.
- Mehmood, T., Alzoubi, H., Alshurideh, M., Al-Gasaymeh, A., & Ahmed, G. (2019). Schumpeterian entrepreneurship theory: Evolution and relevance. *Academic Entrepreneurship*, 25, 1–10.
- Miller, D. (2021). The best practice of teach computer science students to use paper prototyping. *International Journal of Technology and Innovative Management*, 1, 42–63.
- Ramakrishna, Y., & Alzoubi, H. M. (2022). Empirical investigation of mediating role of six sigma approach in rationalizing the COQ in service organizations. *Operation Supply Chain Management*, 15, 122–135.
- Raut, V., & Patil, P. (2016). Use of social media in education: Positive and negative impact on the students. *International Journal of Recent Innovation Trends in Computer Communication*, 4, 281–285.
- Saad Masood Butt. (2022). Management and treatment of type 2 diabetes. *International Journal of Computation, Informations and Manufacturing*, 2, 1.
- Shamout, M., Ben-Abdallah, R., Alshurideh, M., Alzoubi, H., Kurdi, B. A., & Hamadneh, S. (2022). A conceptual model for the adoption of autonomous robots in supply chain and logistics industry. *Uncertain Supply Chain Management*, 10, 577–592.
- Siriwardana, A., & Mendis, M. (2019). *Social Media Marketing: A Conceptual Review on Applications*, 21, 54–60.
- Spackman, J. S., & Larsen, R. (2017). Evaluating the impact of social media marketing on online course registration. *The Journal of Continuing Higher Education*, 65, 151–165.
- Srivastava. A. (2015). The effect of facebook use on life satisfaction and subjective happiness of college students. *International Journal of Indian Psychology*, 2.
- Williams, C., & Adesope, R. Y. (2017). Undergraduates' attitude towards the use of social media for learning purposes. *World Journal of Education*, 7, 90.

Using Machine Learning to Protect Users Accounts in Twitter



Khalifa Hussain Ali, Saif E. A. Alnawayseh, Waleed T. Al-Sit, and Haitham M. Alzoubi 

Abstract Twitter is one of the most used social media sites where millions of people interact daily. Users perform tremendous tasks on Twitter, and it also impacts their daily lives in several ways. As social media usage is higher, the higher is the risk of spammers and attackers on social media sites and the users. Privacy and security are the most crucial aspects that every user wants, and every social media site follows. Fake and spammers accounts are the most significant issues these days. Several fake accounts on Twitter can spread phony information, make fake user following, and create several other problems. There is a spread of malicious content laying on the names of several known celebrities, which began several controversies. Machine learning is the most used technology these days as it is mainly used in predicting and classifying data. This research uses machine learning technology to detect Twitter accounts to achieve high accuracy. A support vector machine algorithm is used in this regard. First, a Twitter dataset was uploaded to the notebook. A data preprocessing was then done on the Dataset, in which attributes were distributed or extracted, stop words removed, and all other raw information was removed from the Dataset. Then, by using sci-kit, learn first a model was trained by using preprocessed data. Then

K. H. Ali

School of Information Technology, Skyline University College, Sharjah, UAE

S. E. A. Alnawayseh

Electrical Engineering Department, Faculty of Engineering, Mutah University, Mu'tah, Jordan

e-mail: saif982@mutah.edu.jo

W. T. Al-Sit

Department of Computer Engineering, Mu'tah University, Mu'tah, Jordan

Higher Colleges of Technology, Dubai, UAE

W. T. Al-Sit

e-mail: w_sitt@mutah.edu.jo

H. M. Alzoubi 

School of Business, Skyline University College, Sharjah, UAE

e-mail: haitham.alzoubi@skylineuniversity.ac.ae

Applied Science Research Center, Applied Science Private University, Amman, Jordan

fake accounts were tested accordingly. A 96.4% accuracy was achieved by using a support vector machine algorithm.

Keywords Machine learning · Twitter · Users accounts

1 Introduction

Social media is the most used intervention in the digital world (Kurdi et al., 2022b). Twitter is also one of the social networking services where multiple tweets remain connected. Everything has some issues associated with it, same as with Twitter; fake accounts are the primary issue twitter is facing these days. Almost half of the followers of famous and high-profile individuals have fake accounts (Ali et al., 2021). They sometimes use these accounts to illegally increase fan following or misuse them to attack some high-level political profiles.

Moreover, these accounts are also used to spread malicious content, resulting in controversies against well-known celebrities (Eli & Hamou, 2022). Statistical data shows that there are a total of 336 million users in 2018, of which almost 5% of the users are illegal or fake (Alzoubi et al., 2022e, 2022f). Even once, the research found that over a quarter or half of the followers of the US president is unnatural, criminal, and the same as with several other celebrities (Alzoubi et al., 2022b). Recently Twitter is more in the waters after some controversial tweets were posted in the context of US politics, so now twitter decided to clean all those fake accounts.

It is essential because it is used by all users worldwide, whether a celebrity or a typical user, to give or take the information (Ghazal et al., 2022h). Several sensitive departments or government officials also use Twitter to spread the news (Alzoubi & Yanamandra, 2020). Information provided through Twitter is considered safe and accurate by the users (Alsharari, 2022). But several cases have occurred in recent times where some fake accounts use the name of government officials or celebrities to spread malicious content or news, which created several controversies (Asem Alzoubi, 2022). Hence, twitter then decided to remove all these negative accounts to improve its security and privacy (Alzoubi et al., 2022b). Machine learning is the branch of artificial intelligence, and it is mainly used to detect intelligent human behavior (Alzoubi et al., 2021a, 2021b). This is done using algorithms trained to make decisions that result in predictions or other outcomes (Hussam Al-Hamadi et al., 2015a, 2015b; Kim et al., 2019). Twitter uses several strategies to detect fake accounts but fails to achieve the desired effect with the increasing use of machine learning to catch phony news or predict future results (Alshurideh et al., 2020). So in this assessment, machine learning is used to detect fake accounts by using machine learning (Farouk, 2021). Many Twitter users use these fake accounts for illegal purposes and attack high-profile users, which affects the privacy or reputation of users (Alzoubi et al., 2022b; Ghazal et al., 2022d).

Several works are done by using machine learning to detect fake news (Alkeem et al., 2017). Yet, by using several algorithms and models such as classification,

regression, and supervision (Islam et al., 2020; Shehada et al., 2017), each of these models is not giving the desired outcomes or accuracy (Alshurideh et al., 2022; Eli, 2021). This paper uses a support vector machine as the model, and high accuracy is expected (Alnazer et al., 2017). In this paper, first, we defined the problem statement, then all the related work done in this field which is the conclusion of several research papers already made in this context (Ghazal et al., 2021b). Then a research methodology is implemented, which is a theoretical methodology used in the assessment. Finally a conclusion is made regarding the results achieved.

1.1 Problem Statement

Fake accounts are standard these days on various social media websites such as Facebook or Twitter. Twitter is the most common social media website used by government officials, celebrities, businesses, and several departments to announce or share important information. In recent times, many fake accounts on Twitter used the name of brands and officials to spread false news. So fake accounts on Twitter are the biggest problem that needs to be addressed that has acquired by digital marketing and social media utilization (Ghazal et al., 2022g; Kurdi et al., 2022a). By using the support vector machine algorithm, fake accounts on Twitter are detected and then removed from Twitter, and it works with an accuracy of 96.4%.

1.2 Proposed Solution

A Support vector algorithm of data mining is used to detect the fake account on Twitter. This algorithm uses feature extraction and dimensional reduction techniques to decide whether the account is fake or accurate (Ghazal et al., 2022b). It is an efficient classification algorithm that works well with limited data and fasts. This algorithm is selected because of its accuracy in terms of prediction and decision-making (Ghazal et al., 2022f; Mohammad Kamrul Hasan et al., 2021a, 2021b). Several other techniques are used for fake account detection, such as feature analysis and syntax analysis. But despite using these techniques and several different machine algorithms such as regression or classification, a required accuracy is still not achieved by twitter. To solve this accuracy issue in this research, a support vector machine algorithm is used to test fake accounts on Twitter (Alshurideh et al., 2022). A support machine first makes classification by using a hyper line. A jittery line categorizes two classes, enlarges them, and then finds the closest point between two classes; these points are called support vectors. Margin is a difference between two classes and then linearly separable data is taken for the data training and then testing (Aziz & Aftab, 2021). After performing preprocessing on data, a twitter dataset is taken for data training and testing (Hanaysha et al., 2021). First, preprocessing is done in data cleaning,

data integration, data reduction, and data transformation (Lee et al., 2022a). Then a data set is spitted for training and testing. Scikit learns library is used in this regard.

2 Literature Review

In recent years, fake account identification in social networks has gotten a lot of attention, and several ways have been taken to address the issue (Mondol, 2021). At the moment, the main focus is on two approaches: machine learning and semantic modeling. Different strategies are used to distinguish between fraudulent and legitimate accounts on online social networks (Al-Hamadi et al., 2021). The typical patterns of bogus accounts are immediately identified (Al-Dmour & Teahan, 2005; Al-Hamadi et al., 2015a, 2015b; Alshurideh et al., 2022). If the method automatically applied the knowledge derived from large amounts of data. Several algorithms are used in this regard, such as classification algorithms, supervision, and regression algorithms (Alzoubi et al., 2022c, 2022g, 2022h; Farouk, 2021). The random forest algorithm was created to hypothetically analyze the suggested method on the social media site Twitter, and In terms of discrimination capacity, the results were noteworthy (Ghazal et al., 2022i; Hamadneh et al., 2021). It proposed a sophisticated methodology for detecting a fake tweet. The process, which incorporates analysis, is used in the news where the material is created of a Twitter account, cross-verification of the sources of fake information (Teahan et al., 2012) or malicious content, reverse image searching, and data mining (Aziz & Aftab, 2021; Ghazal et al., 2021c). The Twitter API was used to collect tweets.

There are four central model experiment runners used, which are feature set created, unique set fetcher, report generator, and classified content were used (Hanaysha et al., 2022). The highest accuracy achieved by using these models is 0.75. A dataset was extracted from Cresci, and the model was able to distinguish the fake account (Hasan et al., 2021a, 2021b) as created by a human or bot. a MongoDB and NoSQL database is used for unstructured information of tweets (Nada Ratkovic, 2022); moreover, data is handled by using a service-oriented architecture. The profile-based approach identified is classified as the best approach to detect fake accounts, yet however, there are several other strategies employed (Alzoubi et al., 2020). Also, a 12 million retweet dataset is used in this research, in which accuracy achieved is 96% (Vo et al., 2010).

2.1 Semantic Modeling

Nowadays, social network analysis is becoming more popular. Nonetheless, just a few scholars have detected bogus accounts using a semantic approach and ontology engineering (Akhtar et al., 2021). During instances or events where tweets are linked

to ontologies, a unique ontology-based strategy was presented to identify suspicious content (Ghazal et al., 2022k).

Social Event Detection, a new spam detection method based on ontology, has been described (Neaimi et al., 2020). The process is broken down into several parts, beginning with the establishment of the ontology, attribute extraction (Ghazal & Taleb, 2022; Joghee et al., 2020), word correlation to the current class context, and finally determining whether or not it is spam. Global ontology filters and user-customized ontology filters are the two types of ontology spam filters that have been implemented (Ghazal et al., 2022j). The user-customized ontology filter was built using the same filtering mechanism as the global ontology filter (Alzoubi et al., 2022a).

Alzoubi et al. (2022f) argued a semantic framework for identification, the ontology-based phishing approach is offered. It investigates conceptualization activity for lexical features (Ghazal et al., 2022a), with the goal of removing any ambiguity caused by superficial characteristic variation (Alzoubi et al., 2021a, 2021b). The suggested solution incorporates semantics into the extremely accurate bag-of-words and part-of-speech approaches (Zitar et al., 2021).

3 Methodology

A theoretical framework as used in this assessment; it deals with different kinds of theories and several theoretical constructs through which the whole phenomenon is explained in steps via theoretical values.

The suggested approach used classification to detect spam on Twitter. Before classification, the pre-labeled tweets should be used to train a knowledge structure model. The classification model can predict a new incoming tweet once it has learned the knowledge structure of the training data. There are two parts to the process: learning and classifying. Tweets will have their features extracted and formatted as a vector. Other methods could be used to obtain the class labels, such as fake or not fake. For training, features and class labels will be integrated into a single instance. A pair includes one feature vector, which represents a tweet, and the predicted outcome, as well as the training set and the testing set.

The classification approach is performed by SVM—Support Vector Machine, which uses the Hyperplane. The Hyperplane is the one that separates the two classes and therefore widens the gap between them (Shamout et al., 2022). The Hyperplane determines the points closest to each other in both categories, and these points are referred to as support vectors (Ghazal et al., 2021a). The distance between the classes is referred to as a margin, and SVM divides the Dataset into two categories: linearly separable and nonlinearly separable (Lee et al., 2022b). We utilized a linearly separable dataset in this example (Alzoubi et al., 2022d). The SVM parameter C specifies how far we want to keep the miss categorized training set at bay. If Hyperplane provides a finer place to get every training point to organize excellently, the greatest C will select a smaller margin Hyperplane. If the Hyperplane misclassified

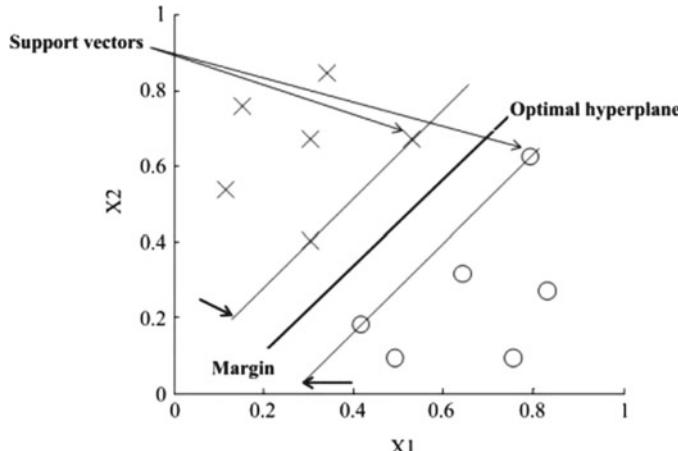


Fig. 1 Support vector machine plot with a hyperplane (Sotoudeh et al., 2019)

numerous issues, the minimum value of C would go to the larger-margin fractionation Hyperplane, even if the training was successful (Fig. 1).

4 Discussion

Machine learning algorithms will do a process of Twitter fake id detection. Following are the steps:

- First, a Twitter dataset was taken from a Cresci, were already built twitter datasets are placed. For a social media site that is so common, a user dataset can't be generated or made by a person (Saleem et al., 2022).
- Then a preprocessing was done by following multiple steps such as extracting attributes from a dataset, username, user_id, no_of_followers, tweets, language, and verified_account (Alzoubi et al., 2022a).
- Then a fake user dataset was taken and was added to the Twitter dataset; attributes of both the datasets are the same. A fake user dataset was injected into the Twitter dataset to test and train data.
- Then a dataset with both the real labels user and the fake user was extracted. The validation is done on both of the datasets by using R studio, which only accepts numerical values, so all the numerical attributes are injected.
- After the validation, a classification was made on the Dataset with a supervised learning algorithm, and the datasets are labeled as fake or not fake (Alnuaimi et al., 2021).
- After the training, tweets were passed to the trained model and are classified as fake or not fake.

A twitter dataset is one that usually comes in the form of arrays and is delivered in a tabular format. For both, there is a two-dimensional list called observation (Alzoubi, 2021) and the name of observation. R includes a class called data in it. There is a collection of flexibility in the size of data and the frames, and the frame can store mixed data (Ghazal et al., 2022c). A function called form CSV is used to load a false user dataset (Ghazal et al., 2022b). Data can be molded and processed into many values using a pivot and the cat that can be discussed with emotional intelligence (Alzoubi & Aziz, 2021).

The data is indexed properly according to the indexes using a panda's data model. The information is then appropriately aligned using a re-index function to improve the total functional quality (Alzoubi & Ahmed, 2019), and then the team and its work are aligned (Al-Nashashibi et al., n.d.). The missing data for the team and its alignment works is then handled in a data frame by eliminating all missing data from the Dataset (Ramakrishna & Alzoubi, 2022).

Several machine learning classification algorithms were utilized based on the examination of the various studies to distinguish between fake and real users (Ghazal et al., 2022e). According to some of the findings, the authentic users are separated from the rest (Al-Hamadi et al., 2021). Some of the accounts were created by bots. The SVM algorithm was used to categorize the users where most of the correct results were obtained (Mehmood et al., 2019). In this project, the data is obtained using a Support Vector Machine. In RStudio, attributes were used to identify bogus users based on followers count, genuine users count of friends, favorites, tweet, tweet frequency geolocation, and verification. The target figure had been set in advance, with the class variables 0 and 1 as res in Dataset. The accuracy achieved after testing tweets is 97.9% (Fig. 2).

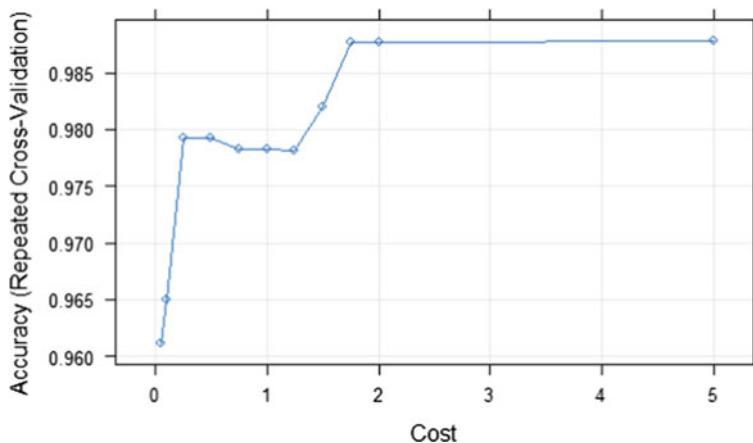


Fig. 2 Accuracy plot (Ghazal et al., 2022a)

5 Conclusion

Machine learning methods are used in artificial intelligence to naturally develop and learn from experience without being explicitly programmed. This paper examines the use of a classification algorithm to identify bogus users on Twitter. Using machine learning techniques aids in the detection of simulated Twitter users. Fake users are on the rise, and online social networks are being used to communicate massive amounts of private and personal data, which can be dangerous if shared with strangers. Machine learning approaches colliding has been utilized as an effective mechanism to combat fake profiles.

References

- Akhtar, A., Akhtar, S., Bakhtawar, B., Kashif, A. A., Aziz, N., & Javeid, M. S. (2021). COVID-19 detection from CBC using machine learning techniques. *International Journal of Technology and Innovation Management*, 1, 65–78.
- Al-Dmour, N., & Teahan, W. (2005). The blackboard resource discovery mechanism for distributed computing over P2P networks. In T. International (Ed.), *PDCN. Conference on Parallel and Distributed Computing and Networks* (pp. 15–17).
- Al-Hamadi, Hussam, Gawanmeh, A., & Al-Qutayri, M. (2015a). Formal validation of QRS wave within ECG. In *2015 International Conference on Information and Communication Technology Research, ICTRC* (Vol. 9, pp. 190–193).
- Al-Hamadi, H., Gawanmeh, A., Baek, J., & Al-Qutayri, M. (2015b). Lightweight security protocol for ECG bio-sensors. *Wireless Personal Communications*, 95, 5097–5120.
- Al-Hamadi, H., Nasir, N., Yeun, C. Y., & Damiani, E. (2021). A verified protocol for secure autonomous and cooperative public transportation in smart cities. In I. June (Ed.), *2021 IEEE International Conference on Communications Workshops (ICC Workshops)* (pp. 1–6).
- Al-Nashashibi M., Hadi, W., El-Khalili, N., Ghassan, I. (n.d.) A new two-step ensemble Learn. Model Improv. Stress Predict. Automob. Drivers. *The International Arab Journal of Information Technology*, 6 (2021).
- Ali, N., Ahmed, A., Anum, L., Ghazal, T. M., Abbas, S., Khan, M. A., Alzoubi, H. M., & Ahmad, M. (2021). Modelling supply chain information collaboration empowered with machine learning technique. *Intelligent Automation & Soft Computing*, 30, 243–257.
- Alkeem, E. A., Shehada, D., Yeun, C. Y., Zemerly, M. J., & Hu, J. (2017). New secure healthcare system using cloud of things. *Cluster Computing*, 20(3), 2211–2229.
- Alnazer, N. N., Alnuaimi, M. A., & Alzoubi, H. M. (2017). Analysing the appropriate cognitive styles and its effect on strategic innovation in Jordanian universities. *International Journal of Business Excellence*, 13, 127–140.
- Alnuaimi, M., Alzoubi, H. M., Ajelat, D., & Alzoubi, A. A. (2021). Towards intelligent organisations: An empirical investigation of learning orientation's role in technical innovation. *International Journal of Innovation and Learning*, 29, 207–221.
- Alsharari, N. (2022). The Implementation of enterprise resource planning (Erp) in the United Arab Emirates: A case of Musanada corporation. *International Journal of Technology and Innovation Management*, 2, 1.
- Alshurideh, M., Gasaymeh, A., Ahmed, G., Alzoubi, H., & Kurd, B. A. (2020). Loyalty program effectiveness: Theoretical reviews and practical proofs. *Uncertain Supply Chain Management*, 8, 599–612.

- Alshurideh, M. T., Al Kurdi, B., Alzoubi, H. M., Obeidat, B., Hamadneh, S., & Ahmad, A. (2022). The influence of supply chain partners' integrations on organizational performance: The moderating role of trust. *Uncertain Supply Chain Management*, 10, 1191–1202.
- Alzoubi, H., & Ahmed, G. (2019). Do TQM practices improve organisational success? A case study of electronics industry in the UAE. *International Journal of Economics and Business Research*, 17, 459–472.
- Alzoubi, H. M., & Yanamandra, R. (2020). Investigating the mediating role of information sharing strategy on agile supply chain. *Uncertain Supply Chain Management*, 8, 273–284.
- Alzoubi, H. M., Ahmed, G., Al-Gasaymeh, A., & Al Kurdi, B. (2020). Empirical study on sustainable supply chain strategies and its impact on competitive priorities: The mediating role of supply chain collaboration. *Managements Science Letters*, 10, 703–708.
- Alzoubi, A. (2021). Renewable Green hydrogen energy impact on sustainability performance. *International Journal of Computations, Information and Manufacturing*, 1, 94–105.
- Alzoubi, H. M., & Aziz, R. (2021). Does emotional intelligence contribute to quality of strategic decisions? The mediating role of open innovation. *Journal of Open Innovation Technology, Market, and Complex*, 7, 130.
- Alzoubi, H., Alhamad, A. Q. M., Akour, I., Alshurideh, M., Al-Hamad, A. Q., Kurdi, B. A., & Alzoubi, H. (2021a). Predicting the intention to use google glass: A comparative approach using machine learning models and PLS-SEM. *International Journal of Data and Network Science*, 5, 311–320.
- Alzoubi, H. M., Vij, M., Vij, A., & Hanaysha, J. R. (2021b). What leads guests to satisfaction and loyalty in UAE five-star hotels? AHP analysis to service quality dimensions. *Enlightening Tourism*, 11, 102–135.
- Alzoubi, A. (2022). Machine learning for intelligent energy consumption in smart homes. *International Journal of Computations, Information and Manufacturing*, 2, 1.
- Alzoubi, H., Alhamad, A., Alshurideh, M., Alomari, K., Al Kurdi, B., Hamouche, S., & Al-Hawary, S. (2022a). The effect of electronic human resources management on organizational health of telecommunications companies in Jordan. *International Journal of Data and Network Science*, 6, 429–438.
- Alzoubi, H., Alshurideh, M., Kurdi, B. A., Akour, I., & Aziz, R. (2022b). Does BLE technology contribute towards improving marketing strategies, customers' satisfaction and loyalty? The role of open innovation. *International Journal of Data and Network Science*, 6, 449–460.
- Alzoubi, H. M., Alshurideh, M. T., Al Kurdi, B., Ghazal, T. M., Said, R. A., AlHamad, A. Q., Hamadneh, S., Sahawneh, N., & Al-kassem, A. H. (2022c). Fuzzy assisted human resource management for supply chain management issues. *Annals of Operations Research*, 1–19.
- Alzoubi, H. M., Alshurideh, M. T., Kurdi, B. A., Alhyasat, K. M. K., & Ghazal, T. M. (2022d). The effect of e-payment and online shopping on sales growth: Evidence from banking industry. *International Journal of Data and Network Science*, 6, 1369–1380.
- Alzoubi, H. M., Elrehail, H., Hanaysha, J. R., Al-Gasaymeh, A., & Al-Adaileh, R. (2022e). The role of supply chain integration and agile practices in improving lead time during the COVID-19 crisis. *International Journal of Service Science, Management, Engineering, and Technology*, 13, 1–11.
- Alzoubi, H. M., In'airat, M., & Ahmed, G. (2022f). Investigating the impact of total quality management practices and six sigma processes to enhance the quality and reduce the cost of quality: The case of Dubai. *International Journal of Business Excellence*, 27, 94–109.
- Alzoubi, H. M., Ahmed, G., & Alshurideh, M. (2022g). An empirical investigation into the impact of product quality dimensions on improving the order-winners and customer satisfaction. *International Journal of Productivity and Quality Management*, 36, 169–186.
- Alzoubi, H. M., Ali, N., Ghazal, T. M., Ahmed, A., Abbas, S., Khan, M. A., Farooq, U., Ahmad, M., & Khan, M. A. (2022h). Fusion-based supply chain collaboration using machine learning techniques. *Intelligent Automation & Soft Computing*, 31, 1671–1687.
- Aziz, N., & Aftab, S. (2021). Data mining framework for nutrition ranking: Methodology: SPSS modeller. *International Journal of Technology and Innovation Management*, 1, 85–95.

- Eli, T. (2021). Students' perspectives on the use of innovative and interactive teaching methods at the University of Nouakchott Al Aasriya, Mauritania: English department as a case study. *International Journal of Technology and Innovation Management*, 1, 90–104.
- Eli, T., & Hamou, L. A. S. (2022). Investigating the factors that influence students' choice of English studies as a major: The case of University of Nouakchott Al Aasriya, Mauritania. *International Journal of Technology and Innovation Management*, 2, 1.
- Farouk, M. (2021). The universal artificial intelligence efforts to face coronavirus COVID-19. *International Journal of Computations, Information and Manufacturing*, 1, 77–93.
- Ghazal, T. M., Bibi, R., Saeed, Y., Zeb, A., Rahman, T., Said, R. A., Abbas, S., Ahmad, M., & Khan, M. A. (2021a). Edge AI-based automated detection and classification of road anomalies in VANET using deep learning. *Computational Intelligence and Neuroscience*, 2021, 1–19.
- Ghazal, T. M., Hasan, M. K., Alkhalfah, A., Abu Bakar, K. A., Omidvar, A., Nafi, N. S., & Agbinya, J. I. (2021b). Fischer linear discrimination and quadratic discrimination analysis-based data mining technique for internet of things framework for healthcare. *Frontiers in Public Health*, 9.
- Ghazal, T. M., Siddiqui, S. Y., Haider, A., Khan, M. A., Naseer, I., Abbas, S., Rahman, M., Khan, J. A., Ahmad, M., Hasan, M. K., Mohammed, A., & Ateeq, K. (2021c). IoMT cloud-based intelligent prediction of breast cancer stages empowered with deep learning. *IEEE Access*, 9, 146478–146491.
- Ghazal, T. M., & Taleb, N. (2022). Feature optimization and identification of ovarian cancer using internet of medical things. *Expert Systems*.
- Ghazal, T. M., Abbas, S., Ahmad, M., & Aftab, S. (2022a). An IoMT based ensemble classification framework to predict treatment response in hepatitis C patients. In *2022 International Conference on Business Analytics for Technology and Security, ICBATS 2022* (pp. 1–4).
- Ghazal, T. M., Abbas, S., Alhwaiti, Y., Fatima, A., Khan, M. A., Khan, M. A., Kanwal, A., Ahmad, M., & Elmitwally, N. S. (2022b). Convolutional neural network based intelligent handwritten document recognition. *Computers, Materials & Continua*, 70, 4563–4581.
- Ghazal, T. M., Abbas, S., Munir, S., Khan, M. A., Ahmad, M., Issa, G. F., Zahra, S. B., Khan, M. A., & Hasan, M. K. (2022c). Alzheimer disease detection empowered with transfer learning. *Computers, Materials & Continua*, 70, 5005–5019.
- Ghazal, T. M., Ahmed, Z. E., Hasan, M. K., Hashim, A. A., Saeed, R. A., Mokhtar, R. A., & Singh, S. P. (2022d). Optimization procedure for intelligent internet of things applications. In *2022 International Conference on Business Analytics for Technology and Security, ICBATS 2022* (pp. 1–6).
- Ghazal, T. M., Bukhari, M. M., Abbas, S., Khan, M. A., Farooq, U., Wahbah, H., Ahmad, M., & Adnan, K. M. (2022e). An intelligent proposed model for task offloading in fog-cloud collaboration using logistics regression. *Computational Intelligence and Neuroscience*.
- Ghazal, T. M., Hasan, M. K., Abdullah, S. N. H., Abubakkar, K. A., & Afifi, M. A. M. (2022f). IoMT-enabled fusion-based model to predict posture for smart healthcare systems. *Computers, Materials & Continua*, 71, 2579–2597.
- Ghazal, T. M., Hasan, M. K., Saeed, R. A., Pandey, B., Gohel, H., Eshmawi, A. A., Abdel-Khalek, S., & Alkhassawneh, H. M. (2022g). A review on security threats, vulnerabilities, and counter measures of 5G enabled internet-of-medical-things. *IET Communications*, 16, 421–432.
- Ghazal, T. M., Khan, M. A., Lee, S. W., & Rehman, A. (2022h). Data fusion-based machine learning architecture for intrusion detection. *Computers, Materials & Continua*, 70, 3399–3413.
- Ghazal, T. M., Mehmood, S., Khan, M. A., Zubair, M., Naseem, M. T., Faiz, T., & Ahmad, M. (2022i). Malignancy detection in lung and colon histopathology images using transfer learning with class selective image processing. *IEEE Access*, 10, 25657–25668.
- Ghazal, T. M., Noreen, S., Said, R. A., Khan, M. A., Siddiqui, S. Y., Abbas, S., Aftab, S., & Ahmad, M. (2022j). Energy demand forecasting using fused machine learning approaches. *Intelligent Automation and Soft Computing*.
- Ghazal, T. M., Rehman, A. U., Saleem, M., Ahmad, M., Ahmad, S., & Mehmood, F. (2022k). Intelligent model to predict early liver disease using machine learning technique. In *2022 International Conference on Business Analytics for Technology and Security, ICBATS 2022* (pp. 1–5).

- Ghazal, T. M., Zafar, S., Asif, M., Ahmad, M. B., Faiz, T., Ahmad, M., & Khan, M. A. (2022l). Assistive devices analysis for visually impaired persons: A review on taxonomy. *IEEE Access*, 10, 13354–13366.
- Hamadneh, S., Pedersen, O., Alshurideh, M., Kurdi, B. A., & Alzoubi, H. M. (2021). An investigation of the role of supply chain visibility into the Scottish blood supply chain. *Journal of Legal, Ethical and Regulatory*, (24), 1–12.
- Hanaysha, J., Al-Shaikh, M., & Alzoubi, H. M. (2021). Importance of marketing mix elements in determining consumer purchase decision in the retail market. *International Journal of Service Science, Management, Engineering, and Technology*, 12, 56–72.
- Hanaysha, J. R., Al-Shaikh, M. E., Joghee, S., & Alzoubi, H. M. (2022). Impact of innovation capabilities on business sustainability in small and medium enterprises. *FIIB Business Review*, 11, 67–78.
- Hasan, M. K., Islam, S., Sulaiman, R., Khan, S., Hashim, A. H. A., Habib, S., Islam, M., Alyahya, S., Ahmed, M. M., Kamil, S., & Hassan, M. A. (2021a). Lightweight encryption technique to enhance medical image security on internet of medical things applications. *IEEE Access*, 9, 47731–47742.
- Hasan, M. K., Ahmed, M. M., Musa, S. S., Islam, S., Abdullah, S. N., Hossain, E., Nafi, N. S., & Vo, N. (2021b) An improved dynamic thermal current rating model for PMU-based wide area measurement framework for reliability analysis utilizing sensor cloud system. *IEEE Access*, 9, 14446–14458.
- Islam, S., Khalifa, O. O., Hashim, A. H. A., Hasan, M. K., Razzaque, M. A., & Pandey, B. (2020). Design and evaluation of a multihoming-based mobility management scheme to support inter technology handoff in PNEMO. *Wireless Personal Communications*, 114, 1133–1153.
- Joghee, S., Alzoubi, H. M., & Dubey, A. R. (2020). Decisions effectiveness of FDI investment biases at real estate industry: Empirical evidence from Dubai smart city projects. *International Journal of Scientific & Technology Research*, 9, 3499–3503.
- Kim, S.-K., Yeun, C. Y., Damiani, E., & Lo, N.-W. (2019). A machine learning framework for biometric authentication using electrocardiogram. *IEEE Access*, 7, 94858–94868.
- Kurdi, B. A., Alshurideh, M., Akour, I., Alzoubi, H. M., Obeidat, B., & Alhamad, A. (2022a). The role of digital marketing channels on consumer buying decisions through eWOM in the Jordanian markets. *International Journal of Data and Network Science*, 6, 1175–1185.
- Kurdi, B. A., Alshurideh, M., Akour, I., Tariq, E., Alhamad, A., & Alzoubi, H. M. (2022b). The effect of social media influencers' characteristics on consumer intention and attitude toward Keto products purchase intention. *International Journal of Data and Network Science*, 6, 1135–1146.
- Lee, K. L., Azmi, N. A. N., Hanaysha, J. R., Alzoubi, H. M., & Alshurideh, M. T. (2022a). The effect of digital supply chain on organizational performance: An empirical study in Malaysia manufacturing industry. *Uncertain Supply Chain Management*, 10, 495–510.
- Lee, K. L., Romzi, P. N., Hanaysha, J. R., Alzoubi, H. M., & Alshurideh, M. (2022b). Investigating the impact of benefits and challenges of IOT adoption on supply chain performance and organizational performance: An empirical study in Malaysia. *Uncertain Supply Chain Management*, 10, 537–550.
- Mehmood, T., Alzoubi, H. M., Alshurideh, M., Al-Gasaymeh, A., & Ahmed, G. (2019). Schumpeterian entrepreneurship theory: Evolution and relevance. *Academy of Entrepreneurship Journal*, 25, 1–10.
- Mondol, E. P. (2021). The impact of block chain and smart inventory system on supply chain performance at retail industry. *International Journal of Computations, Information and Manufacturing*, 1, 56–76.
- Neaimi, M., Al, Hamadi, H., Al Yeun, C. Y., Jamal Zemerly, M. (2020). Digital forensic analysis of files using deep learning. In *2020 3rd International Conference on Signal Processing and Information Security, ICSPIS 2020* (pp. 1–4). IEEE.
- Ramakrishna, Y., & Alzoubi, H. M. (2022). Empirical investigation of mediating role of six sigma approach in rationalizing the COQ in service organizations. *Operations and Supply Chain Management*, 15, 122–135.

- Ratkovic, N. (2022). Improving home security using blockchain. *International Journal of Computations, Information and Manufacturing*, 2, 1.
- Saleem, M., Abbas, S., Ghazal, T. M., Adnan Khan, M., Sahawneh, N., & Ahmad, M. (2022). Smart cities: Fusion-based intelligent traffic congestion control system for vehicular networks using machine learning techniques. *Egyptian Informatics Journal*.
- Shamout, M., Ben-Abdallah, R., Alshurideh, M., Alzoubi, H., Al Kurdi, B., & Hamadneh, S. (2022). A conceptual model for the adoption of autonomous robots in supply chain and logistics industry. *Uncertain Supply Chain Management*, 10, 577–592.
- Shehada, D., Yeun, C. Y., Zemerly, M. J., Qutayri, M., Al Hammadi, Y., Al Damiani, E., & Hu, J. (2017). BROSMAP: A novel broadcast based secure mobile agent protocol for distributed service applications. In *Security and communication networks* (Vol. 2017). Wiley.
- Sotoudeh, H., Shafaat, O., Bernstock, J. D., Brooks, M. D., Elsayed, G. A., Chen, J. A., Szerip, P., Chagoya, G., Gessler, F., Sotoudeh, E., Shafaat, A., & Friedman, G. K. (2019). Artificial intelligence in the management of glioma: Era of personalized medicine. *Frontiers in Oncology*, 9, 1–11.
- Teahan, W. J., Al-Dmour, N. A., & Tuff, P. G. (2012). Knowledge distribution in multi agent systems. *Asian Journal of Information Technology*, 11, 300–311.
- Vo, D. L., Lee, H., Yeun, C. Y., & Kim, K. (2010). Enhancements of authenticated multiple key exchange protocol based on bilinear pairings. *Computers & Electrical Engineering*, 36, 155–159.
- Zitar, R. A., Al-Dmour, N., Nachouki, M., Hussain, H., & Alzboun, F. (2021). Hashing generation using recurrent neural networks for text documents. *ICIC Express Letters, Part B: Applications*, 12, 231–241.

Digital Transformation and Disruptive Technologies: Effect of Cloud Computing and Devops on Managing Projects



Ahmad Al-Nakeeb, Mounir El Khatib, Shaima AlHarmoodi, Muaid Salami, Humaid Al Shehhi, Ahmed Al Naqbi, Mohammed Al Nuaimi, and Haitham M. Alzoubi 

Abstract While a digital transformation plan begins in the C-suite, it is in the implementation that project managers must grab the reins. Project managers, as the executive muscle of any business, are in charge of putting senior leadership's vision into action and delivering the company's new digital capabilities. Cross-team communication is one of the most significant areas where new digital technology is reshaping project management. When it comes to collaboration, traditional methods like email are inconvenient because they aren't meant for real-time communication. Important information is quickly lost in long email exchanges, and email saturation saps productivity. Collaborative work management software, on the other hand, allows team members and coworkers from other departments to engage, connect, and interact in real time, drastically reducing email clutter and saving time. However, these technologies do more than just improve the efficiency of intra-work communication; they also improve its effectiveness. A good example is the viability of AI as a transformation tool in several businesses. It has been effectively used and underlined in several businesses as important. The importance of AI can be seen in its wide and seamless integration across several sectors of business that ultimately helps them in the growth and expansion of their various services. This study therefore seeks to look at the influence of digital transformations on the overall outlook of businesses from various industries.

Keywords Project management · Digital transformation · Digital disruption · Disruptive technologies · Cloud computing · DevOps

A. Al-Nakeeb · M. E. Khatib  · S. AlHarmoodi · M. Salami · H. Al Shehhi · A. Al Naqbi · M. Al Nuaimi

School of Business and Quality Management, Hamdan Bin Mohamad Smart University, Dubai, UAE

e-mail: M.Elkhatib@hbmsu.ac.ae

H. M. Alzoubi

School of Business, Skyline University College, Sharjah, UAE

Applied Science Research Center, Applied Science Private University, Amman, Jordan

1 Introduction

A new wave of disruptive technologies is compelling organizations to adapt to new methods of working, and digital transformation is gaining traction across all industry sectors. As businesses seek to capitalize on the benefits of digital disruption, the importance of more sophisticated and strategic project management methods continues to rise (Paveft, 2017). Next Practices: Maximizing the Benefits of Disruptive Technologies on Projects, a new global study from the Project Management Institute (PMI), investigates the impact of digital disruptors like cloud technology and DevOps on enterprises and project management practices. Both big difficulties and huge opportunities for company growth and competitive advantage exist as a result of digital disruption (Bongomin et al., 2020). Many organizations, however, are unaware of the relevance of this and are still yet to fully maximize the capability and the advantage that these disruptions bring to the concerned industries (Lee et al., 2022a, 2022b).

The term “disruptive technology” refers to a wide range of tools, processes, and even completed goods that provide a competitive edge. Cloud solutions, AI, and IoT were selected as the three most significant technologies by survey respondents, which is rather unsurprising (Guergov & Radwan, 2021). AI, in example, might be considered as playing a key role in increasing the strategic importance of the PM function by relieving them of mundane chores like scheduling and budgeting. The automation of these more routine aspects of project management gives the project manager additional possibilities to own all of the project’s leadership components (Alnazer et al., 2017). This is significant because, along with strategy and business management, leadership skills are a cornerstone of the PMI Talent Triangle of technical project management, which was developed in response to a growing demand for soft skills such as leadership, strategy, and human intellect creativity, which disruptive technologies are unable to provide (Utterback & Acee, 2021). These are the skillsets that will shape project management in the future and continue to be the core of the basics that are used in determining the usefulness of these technologies in the industry of project management. Blockchain, 5G mobile Internet, advanced robotics, 3D printing, and autonomous, or self-driving vehicles were among the other disruptive technologies deemed important by the PMI’s respondents (Alnuaimi et al., 2021). These and other upcoming disruptive technologies will benefit innovator businesses that see them as an opportunity to develop, focus on the value delivery landscape, and enable project managers to play a more strategic role in managing disruption (Mehmood et al., 2019).

2 Literature Review

This section covers literature relevant to the case study, looking at various project management capabilities and their amalgamation with disruptive technologies in various industries (Hanaysha et al., 2022).

2.1 Business

2.1.1 Markets

All market dynamics are shifting as a result of digital transformation. These digital transformations that are continually being driven by DevOps form a continually growing and ever-accelerating client demand on the demand side (Hanaysha et al., 2021). It has substantially cut entry barriers for suppliers, resulting in the emergence of a new breed of digital-native rivals that are upsetting established industries and aggressively stealing market share from incumbents. This has been seen in the capabilities of digital transformations to lead in the change in channels necessary for market distribution and content outreach during the market phases of the work (Erich et al., 2014).

2.1.2 Pricing

Many businesses embark on pricing changes as a means of generating value quickly and consistently. Indeed, in B2B settings, pricing excellence setting the appropriate rates and ensuring the right price is paid in each transaction is driven by precision, attention to detail, and agility, all of which are facilitated by digital pricing revolutions (Alsharari, 2021). A, shows that, when done well, such conversions can increase price by two to seven percentage points over time, with initial advantages in as short as three to six months. B2B organizations are rapidly using approaches such as end-to-end price optimization and management, configure-price-quote (CPQ) software, and business intelligence (BI) packages to enable digitally enabled pricing changes (Al Ali, 2021). Pricing reforms and technology selections are more likely to be successful if they are based on a complete rethinking of the pricing process. In this setting, decision makers such as project managers must review their current systems, build future-state systems that match their needs, and deploy the appropriate tools to support and sustain the transformation's benefits (Ali et al., 2022; Alzoubi et al., n.d.; Farouk, 2022). Companies can only hope to quickly capture the considerable margin improvements at stake if they take a more holistic strategy.

2.1.3 Delivery

Digital transformation in service delivery has been revolutionized mostly by several factions in the AI industry, mostly which come in form of drones, autonomous trucks, 3D printing among others. Drones can assist logistics businesses provide cheaper (25%), faster, and reduced deliveries by bypassing traffic congestion during the last supplies, as per the Productivity Commission (2016). Robotics, on the other end, make up just under 0.5% of all operational shipments around the world. As technology progresses and rules change, companies may benefit from fees for faster/same-day deliveries (Dillon et al., 2010; Ramakrishna & Alzoubi, 2022). We predict that it could be equivalent to a total of about \$20 billion in profitability over the next decade. Drones can be important to humans as well. It has the potential to reduce emissions by 15 million metric tons and avoid up to 4,000 deaths due to traffic accidents. Self-driving passenger vehicles have gotten a lot of attention recently, but autonomous trucks promise to reduce road accidents and carbon dioxide (CO₂) emissions while also boosting company profits. According to the International Transport Forum, the volume of freight transported by road will nearly double between 2010 and 2050. The introduction of autonomous vehicles is anticipated to take place in stages, with the benefits accruing first to B2B logistics organizations (Joghee et al., 2020). 3D printing, also known as additive layer manufacturing (ALM), manufactures three-dimensional solid items from digital blueprint files. ALM yields 5–10% waste material (which can be recycled and reused) on average, compared to 90–95% for machining processes that manufacture a product by cutting away a solid block of material rather than layering it up. At first appearance, 3D printing appears to be a major threat to the logistics business, as products may be manufactured on-site, minimizing the need for shipments. However, logistics companies might diversify their services by repurposing themselves as printers, transporters, and installers of 3D-printed goods.

2.2 *Technology*

2.2.1 Invention

Digital transformation uses technology to produce value and new services for a variety of stakeholders (customers in the broadest sense), innovate, and gain the ability to quickly adapt to changing conditions (Alshurideh et al., 2022a, 2022b; Khan, 2021). Within the regards of inventions, these transformation and disruptive process often provide new ways to change mindset of inventions and the approaches used in making these ideas come to light (Alshurideh et al., 2022a, 2022b). These transformations form the basis of these various inventions in the minds of the inventors.

2.2.2 Design

According to some scholars, various DT technologies have been created and been leveraged with the main aim of improving the design of products and services it is integrated with. These disruptive technologies have especially increased the user friendliness of website and software that increase the comfortability space that has been defined by these technologies improving the overall outlook of these business and the possibility of having site visits and clicks, depending on the nature of the business being run. Some of these disruptions include the formation of new integrated coding languages, 5th generation languages that make graphic design easy and have cause positive disruptions that many companies continue to adopting bids to increase the growth of their business (Alhamad et al., 2022; Walsh et al., 2002). The most common indicator of the efficient use of design technologies can be seen in data mining. This is the increase frequency of the data that is realized from these websites as a result of increased traffic towards these website (Al-Tahat & Moneim, 2020; Muhammad Alshurideh et al., 2022a, 2022b). As a direct result of the technologies, the use of data mining as an indicator is valid and can be confirmed in several ways as being a worthy indicator of the efficiency of disruptive transformations in the capacity of the technological industry.

2.2.3 Usage

Digital transformation is transforming the way businesses are conducted and, in some cases, spawning entirely new industries. With digital transformation, businesses are taking a step back and rethinking everything they do, from internal processes to online and in-person client interactions. We are fully ensconced in the digital age, and businesses of all kinds are inventing new and innovative ways to leverage technology. Netflix is a good illustration of this (Ali et al., n.d.). It began as a mail order service and quickly became a major competitor in the video rental industry. Then, thanks to technological advancements, large-scale streaming video became conceivable. Netflix now competes with traditional broadcast and cable television networks as well as production studios by providing a growing library of on-demand content at extremely low costs. New approaches in the usage of technologies is another sector that digital transformation seeks to cover (Alhamad et al., 2021; Paveft, 2017). Of course, using digital technology to improve the efficiency of contact centers and in-store service desks is a fantastic idea. However, true transformation occurs when you evaluate all accessible technologies and how adapting your business to them might improve the consumer experience (Alzoubi et al., 2021). Although social media was not designed to replace call centers, it has evolved into an extra channel (and opportunity) for providing superior customer support. Another fantastic example of a digital transition is adapting your service offerings to include social media (Kurdi et al., 2022a, 2022b, 2022c).

2.3 *Industry*

2.3.1 **Process**

All firms now face a shared strategic imperative: digital transformation. It improves the customer experience and provides operational efficiencies by using innovations born by developing cloud and mobile technology (Chong et al., 2021; Hamadneh et al., 2021). However, many transformation programs have yielded results to date, although not always and in all circumstances. These attempts were frequently too narrowly focused on process redesign and automation using a new generation of older business process management (BPM) software. Digital automation platforms (DAPs), which were better developed and made more efficient by DevOps, made it easier to work with business and technology professionals to optimize, automate, and modify business processes as needed (Erich et al., 2017). Process improvement, on the other hand, has broader implications that may not have been considered, such as how change affects workforce behavior and interactions with customers and suppliers, and how systems, applications, and processes must adapt and interoperate to achieve desired business outcomes (Alzoubi & Ahmed, 2019). According to Alzoubi 2022, to do so, organizations will need a new generation of planning and modeling tools that allow them to visualize and understand how their people, processes, and technologies must work together as a coordinated system in order to achieve the strategic goals of modern digital firms (Alzoubi et al., 2022a, 2022b, 2022c). These includes factors like security and data privacy that are most importantly considered in the paramount nature of company secrets among other things. Technologies in this include companies like CyberSec (pioneer DevOps companies), which have disrupted the data privacy and information security space and continue to take the fore front in the work that they do.

2.3.2 **Standard**

Disruptions have continued to occur in various levels that continue to underline the importance of raising the products standards and raising the bars of production for each of the involved companies. These necessarily need not be directly linked to product or service improvement, but can also be directly linked within organizational ranks that helps to improve various factors and elements among the employees that is ultimately used to raise service and product standards (Alzoubi et al., 2022; Radwan, 2022). Functions are well-run by good companies. Great firms excel at bridging the gaps between departments. Future commercial value is harnessed in such organizational seams, and the company achieves speed with size. This is critical to understand since bringing a product to market requires the efforts of an entire organization, including R&D, marketing, sales, supply chain, customer service, finance, legal, and partners (Walsh et al., 2002). This necessitates a shift in legacy businesses' operating models to a more modern, cohesive manner of working across the firm. Combining

new work models with complementary digital platforms, according to the study, will help. These improvements will be supported by the installation of digital tools and process upgrades, as well as the establishment of a nimbler operating model that is, the hardwiring of the organization into the improved overall being thereby effectively raising the standards set by the organization in itself (Radwan & Farouk, 2021).

2.3.3 Method

This incorporates the evolution that these businesses have to face in their quest to grow and constantly show change to the market and within as a result of direct improvement by digital transformations. Customer and employee behavior, beliefs, and expectations are the actual threat and opportunity in the face of technological change. When it comes to allocating budget and resources to current business and technology strategies (usual business) vs. the unfamiliar in regards to how such investments integrate with customer and consumer shifts, businesses face a challenge (Alzoubi, et al., 2022a, 2022b, 2022c). This is an era of technological Evolution, during which innovation and society advance at a faster rate than businesses can organically adjust. This marks the beginning of a new phase of administration, and a future model of revenue models, all governed by the slogan “adapt or perish.” Rather than responding to or being harmed by change, some foresighted firms are spending in digitalization to adapt and surpass their rivals. Capgemini, a research-based firm, produced a report in November 2012 examining the digital maturity of companies seeking digital transformation. In its study “The Smart Advantage: How innovators outclass their colleagues in every industry,” Capgemini observed that organizations that are heavily invested in both cloud-based intensity and value innovation intensity obtain more income from their own tangible assets, are much more lucrative, and seem to have significant market stock prices. These new incorporation methods formed the baseline of activities that constantly produce the evolution of the environment under which they exist in, making them to constantly improve (Alzoubi & Aziz, 2021).

2.4 Society

2.4.1 Culture

The digital transformation process is fundamentally uncertain: changes must be made provisionally and then changed, choices must be made swiftly, and people from across the company must participate. Traditional hierarchies become a hindrance as a result. It's essential to go with a flat organizational structure that's kept separate from the rest of the company. Because so many digital technologies may be tweaked, the demand for agility and prototyping is much greater than it could be in conventional change-management programs (Alzoubi & Yanamandra, 2020). Leaders must decide which vendors' apps to use and how to better incorporate Cloud and DevOps based solutions

to areas of the business which will benefit the most from the new technology, whether the transition should be done in stages, and so on. This is then the fundamental basis through which culture is changed, both in the inside and the outside of the organization by the entire processes of digital transformations (Erich et al., 2014).

2.4.2 Habits

For decades, the impact of digital technology has influenced customer choices, resulting in a considerable quantity of eCommerce, especially in the home furnishing industry. In its study “The Smart Advantage: How innovators outclass their colleagues in every industry,” Capgemini observed that organizations that are heavily invested in both cloud based intensity and value innovation intensity obtain more income from their own tangible assets, are much more lucrative, and seem to have significant market stock prices. In the purchasing sector, there is a scarcity of research on internet purchase habits. The advent of digitalization and the introduction of digital marketing platforms as opposed to offline marketing has altered purchasing habits for a variety of products. According to the report, people preferred an omnichannel approach when buying furniture, which improves competitive costs and customized designs and services. Taking full advantage of their purchases, consumers anticipate rewards both online and offline. The influence that these transformation processes especially E-commerce and Cloud based storage and computing habits have on the consumers can be seen as a direct influence on purchasing habits and be used to identify the presences (Alshurideh et al., 2020).

2.4.3 Movement

In recent years, movement through the DevOps has gained traction. To use agile business techniques, an increasing number of companies are considering making adjustments that favor production and operations collaboration specially to ensure efficient delivery and supply of goods and products. DevOps is rapidly becoming the most important tools for startups. However, before making significant changes to deploy DevOps principles, business owners must be certain that the risk and effort are worthwhile. People wait for other people and other machines in a typical IT environment, or are delayed sorting out the same issue time after time. This results in delays in customer deliveries and sluggish productivity in a business environment. Employees desire to be productive, yet churning leads to dissatisfaction and frustration. Everyone gains when individuals can spend less time on the aspects of their job that are unsatisfying and more time on the aspects of their job that bring value to the business, which is enabled by technologies that improve speedier performance and mobility to deliver to consumers. People wait for other people and other machines in a typical IT environment, or are delayed sorting out the same issue time after time. This results in delays in customer deliveries and sluggish productivity in a business environment (Ahmed & Al Amiri, 2022).

Companies face more obstacles, especially from disruptive companies which bring competition, more than ever before. However, they're also surrounded by greater opportunities. Some of the companies have to do more with less in order to prosper. The use of Artificial Intelligence to enhance development is one way to address the problem, and it may contain features that are useful to the others in the current environment (Lee et al., 2022b). The crises such as disruptive competitors cause us to return to our old habits. And we're in the midst of a global catastrophe unlike any we've seen in recent memory. As a result, many businesses are conserving capital and moving to safeguard what seems to be their 'core business.' This being done by keeping a breadth international standards and by incorporating Cloud computing and DevOps in their daily operations. At best, most people choose for little tweaks and gradual transformation. Efforts for innovation are shelved; such activities are deemed more acceptable for when the economy is doing well. However, the need for innovation persists, and those that develop now will benefit from the rebound.

Disruptive innovations, were technologically simple, comprised of off-the-shelf components assembled in a product design that's often simpler than previous techniques. They offered less of what clients in established markets wanted, thus they could only be used there as a last resort. They presented a unique set of characteristics that were only valued in emerging markets far off from, and inconsequential to, the mainstream. Some of the disruptive technology companies include (Alzoubi et al., 2020; Wang et al., 2010);

2.4.4 Microsoft

Microsoft is a thriving computer server and tools industry, which had prospered providing virtualization software as well as other tools for corporations to put in their data centers, was disrupted by AI service growth. On the disruption front, Microsoft understands. According to Brooks, Artificial Intelligence's stealth attack on the workplace is comparable to Microsoft's client-server technology, such as the Microsoft environment and Active Directory tools, which have fueled main headquarters for the past two decades. "Microsoft influenced every element of the software market," (Sotoudeh et al., 2019) says, "primarily because a lot of people had to rebuild their product to operate on Windows, much as software suppliers had to join in the AI service cloud or make their program compatible with AI resources."

2.4.5 Google

Google is a cloud native corporation, which offers it a competitive advantage over Artificial Intelligence services. While Google introduced its commercial new google Apps at about the same time as AI, the company took its time expanding its Cloud presence to the infrastructure industry, first dabbling in 2008 with the Application Servers. Since then, Google has developed its own Cloud Services, that are used by

Coca-Cola, Disney, and Best Buy, among others. The presence of Google shows the importance of Cloud Computing to the industry (Bellows et al., 2011; Shamout et al., 2022).

2.4.6 Oracle

We don't know of another software company that has had its business rocked more than Oracle. AI has added business intelligence and data-warehouse tools to its stack, posing a direct challenge to Oracle's database software business. Oracle's response to the intrusion has been to go all-in on cloud computing. (Fletcher-Watson et al., 2019) claims that Oracle has bought multiple companies and persuaded clients to switch from on-premises to cloud-based versions of Oracle software, basically switching one cash stream for another. Venturing into DevOps to secure the Cloud business model, Oracle is an example of a disruptive technology that has efficiently used the DevOps as a technology for the future.

2.4.7 Ibm

Due to difficulties in its systems division, which comprises mainframes and operating-system software, IBM's sales and profit have been continuously declining. IBM obtained SoftLayer and is already developing Bluemix cloud services as a result of the top-line fall, which is an example of how AI is driving the industry in its direction. IBM is also expecting for success with its Cognitive analytics and blockchain endeavors. "AI Services [and cloud vendors] have disrupted everybody in the hardware sector," (Bellows et al., 2011).

2.4.8 Hp

There has only been one HP until just few years ago. In 2015, HP separated into two companies: HP Inc., which sells computers and printers, and HPE, which sells enterprise IT. HPE has set off its software solutions companies this year in an effort to be nimbler and reclaim territory lost to Artificial Intelligence services and other enterprise cloud providers.

2.4.9 Dell

Dell, like HP, was once a strong vendor of servers, storage, and desktops, but it has undergone similar, if not more, changes. Dell closed it down in 2013 as AI and other cloud providers harmed its prospects, and it has since reimagined itself with a broker of the same cloud services that Amazon Web Services, Microsoft, Google,

and others supply. Later, it merged with EMC, a struggling storage company, and leased its services, software, and enterprise content divisions.

2.4.10 Verizon

Telecommunications providers with plans to enter the cloud industry have found it difficult to compete with Verizon Artificial Intelligence Services. Verizon just sold 29 server farms to co-location vendor Equinix as it concentrates on its main mobile and video operations, recognizing that AI, Amazon Web Services, Microsoft, and others are far ahead in the game.

2.4.11 IT Security Market

Companies have been trusting the data security to their cloud providers as more technology assets migrate to public clouds owned by AIs, Microsoft, Google, and a hundred other firms, which implies they have less data centers guarded by guards. Automated methods are used by cloud providers to detect hackers. Companies are increasing their investments in measures to identify social-engineering breaches via PCs, such as cybercrime and whaling schemes, as well as enhanced antivirus software and actionable insights to prevent attacks. According to (Bongomin et al., 2020), “it has flipped the data security market inside out.”

2.4.12 Compliance Market

Prior to the web, compliance was mostly a paper-intensive, manual process overseen by auditors. Companies don’t have to rely on human interaction as much now that Artificial Intelligence as well as other solution providers automate compliance capabilities. “AI is eliminating those requirements and that will be a huge change since compliance is complex and time consuming and a resource-intensive and unpleasant task for IT,” (Utterback & Acee, 2021).

2.4.13 Channel Resellers

Microsoft, as well as many of the conventional hardware manufacturers and on-premises software suppliers listed above, continue to stock warehousing with PCs, servers, and software packages. They’ve also evolved into cloud brokers, similar to what Dell considers itself to be. To adapt for the cloud shift, Ingram, CDW, Avnet, and others have changed their models. A structural upheaval from around model is yet to be seen apart from what AI services pioneered and now dominate (Alzoubi & Ahmed, et al., 2022a, 2022b).

3 Research Methodology

The research method is based on the Simplilearn approach for digital disruption and strategies for digital transformation. This approach is based on Analyzing key digital transformations across different dimensions—Business, technology, industry, Society—in specific industry. Then create own digital transformation prioritization matrix to identify the digital transformation initiatives most relevant to your industry and organization. Simplilearn investigation Questionnaire is structured in 9 steps as follows:

Step 1: List of top 10 digital transformations in the organization and a SWOT analysis.

Step 2: A list of top 10 digital initiatives by digital native disruptors most relevant to the organization. Using a what, how, and outcome framework to brainstorm the information.

Step 3: A list of top three digital disruptions across all four elements—business, technology, industry, and society—most relevant to the organization.

Step 4: A list of top three digital initiatives by the competitors.

Step 5: A list of top three digital disruptions across all the five key areas of disruption that are most relevant to the organization. We are making progress with our understanding of the digital initiatives. Now how about getting some ideas going? Let's look at each of the key areas of digital disruption one by one using the trend-benefit framework.

Step 6: A list of top three transformations across the following key technologies that are most relevant to the industry.

Step 7: Based on the previous steps, a list of all key transformations compiled.

Step 8: A list of transformations made across the impact/difficulty matrix.

Step 9: The most relevant digital transformation plans identified.

Below are the 9 steps gathered based on 30 interviews conducted with key leaders, project managers, technology specialists, and digital transformation specialists.

Step 1: List of top 10 digital transformations in the organization as shown in Table 1, and a SWOT analysis.

SWOT Analysis: A framework use to analyze the organizational strength, weaknesses, opportunities and threats to enhance the business performance as shown in Fig. 1 (Lee et al., 2022a).

Step 2: As listed in Table 2 the top 10 digital initiatives by digital native disruptors most relevant to the organization. Using a what, how, and outcome framework to brainstorm the information.

Table 1 Digital transformation

#	Key digital transformations
1	AI based processing
2	Software developments for project management
3	3D printing for project models
4	Edge processing
5	Customer experience gap
6	Blitz scaling for operations scaling
7	Logistics and operations, UPS
8	Cloud computing and devOps
9	Customer engagements via AI
10	Networking planning tools for better networking

Strengths	weaknesses
<ul style="list-style-type: none"> Popularity of the service or brand of the company. Cloud Computing makes the company stand out differently 	<ul style="list-style-type: none"> Overdependency on AI to run company programs. Non-performing sectors of the company.
Opportunities	Threats
<ul style="list-style-type: none"> Acquisitions and merger to make the brand stronger. Make better decisions using advanced technologies. Penetrate new markets. 	<ul style="list-style-type: none"> Competition from other brands. Regulatory structures like pricing of commodities and external limiting factors like tax.

Fig. 1 SWOT analysis**Table 2** Digital transformation initiatives

Sr. #	Key digital transformation initiatives
1	Transform project design
2	Autonomize projects and work
3	Transform project process
4	Reduce project time for completion
5	Increase ease of project supervision
6	Increased distribution of work among project handlers
7	Transform project outlook and results
8	Base with clientele more
9	Reduce project supervision and accountability
10	Increasing the efficiency of the project detail

Step 3: A list of top three digital disruptions across all four elements—business, technology, industry, and society—most relevant to the organization as shown in Table 3 (Alzoubi et al., 2020).

While looking at the technology dimension, the following figure is used to identify key initiatives as shown in Fig. 2 (Alzoubi & Aziz, 2021).

Step 4: List of top three digital initiatives by your competitors imposed to attain the market benefits and attract the customer on the basis of following transformation initiatives as shown in Table 4 (Hanaysha et al., 2021).

Step 5: A list of top three digital disruptions across all the five key areas of disruption that are most relevant to the industry and organizations.

We are making progress with our understanding of the digital initiatives. Now how about getting some ideas going?

Let's look at each of the key areas of digital disruption one by one using the trend-benefit framework (Lee et al., 2022b).

Trend 1: IOT Based Distribution

- Reduced cost of distribution.
- Reduced time of distribution.

Table 3 List of key Initiatives

#	Elements of digital disruption	Impact of the element relevant to your organization
1	Business	Increase the supply chain efficiency
2		Boost the product market and clientele base online
3		Revolutionize pricing mechanisms to boost competitive advantage
4	Technology	Increase the angles of approach necessary to put an invention into place
5		Making the design standards more efficient to promote resource saving
6		Give multiple frameworks for the usage of the inventions to the wide range of users
7	Industry	Making the process of service and manufacturing industries easier to promote better time saving mechanisms
8		Raising the bar of standards that are necessary to improve the quality of market products and services
9		Put in place new methods and revolutions old habits of production and processing
10	Society	Promote the intermingling of culture to create a diverse global village of culture
11		Make more efficient the habits of regular users and impacts of the digital transformations
12		To better allow and track movements of the society for safety and security reasons

<p>Technology that transforms the supply chain of workers, clients, vendors, business partners, etc.</p> <p>This includes easing the burden of time on the supply chain and maximizing the advantages it bears on the chain. Less time for delivery and increased autonomy and security of chain data.</p>	<p>Technology transformation that improves consumer experience</p> <p>The technology of consumer-based choices that includes personalized information through to them, reducing the difficulty of the process while increasing the security of the consumer data.</p>
<p>Technology transformation that gives correct details to drive efficient decision-making</p> <p>Key initiatives would be to mark the parameters used in making efficient decisions. These include reducing the amount of data and presenting it to decision makers in the most reliable of manners to increase the process of decision making and increase autonomy of decisions.</p>	<p>Technology transformation that enables accurate and stable transactions in real-time</p> <p>Stability includes the initiative securing data and making it available in real time. This DT's would have initiatives such as consistent availability of secure sockets of data to the consumer and producers.</p>

Fig. 2 Key initiatives

Table 4 Competitors digital transformation initiatives

#	Competitors	Key digital transformation initiatives
1	Competitor 1	Reduce project management costs
2		Reduce time of project completion
3		Increased output of DT towards company goals
4	Competitor 2	Improved project team coordination and communication
5		Reduce time of project completion
6		Increased outreach of company brand to the relevant market
7	Competitor 3	Reduced time for project completions
8		Reduced project management and implementation costs
9		Efficient design of company software and use in project automation
10	Competitor 4	Increased levels of project automation and DT use in various departments
11		Reduced project completion time
12		Efficient prioritizing of clientele data and digital methods that ultimately lead to efficient decision making

- Increased autonomy and clientele satisfaction on product choices and company instructiveness.

Trend 2: AI—Based Company Software

- Increased customer interactives that leads to brand trust and identification.

- Efficient automation processes that lead to increased resource output in other key areas.
- Reduced cost of company expenditure i.e. customer service.

Trend 3: 3D Delivery

- Reduced cost of distributions of goods.
- Increased environmental friendliness, safe to use printing material.
- Security of goods of the consumer.

Finally, A list of top three initiatives across all five areas of digital disruption is provided in the Table 5.

Step 6: A list of top three transformations across the following key technologies that are most relevant to the industry and implication of the following technological transformation reveals an upgraded firms operations as shown in Table 6 (Lee et al., 2022a).

Step 7: Based on the previous steps, and as listed in Table 7, all key transformations compiled that are initial to every organization's health and a successive initiative to become sustainable in business market (Meyer et al., 2018).

Table 5 Digital initiatives

Sr. #	Key areas of disruption	Digital initiatives
1	Marketing and distribution	Efficient customer outreach
2		Increased distribution chains and supply mechanisms
3		Increased brand awareness and enhanced customer experience in marketing
4	Product and service	Increased product and service standards on the market
5		Availability of product availability on customer need basis
6		Increased automation of product and service provision
7	Processes	Enhanced process automation with minimal supervision
8		Efficient working of the various processes of work
9		Decreased resource wastage on the aspects of work
10	Ecosystems	Improved protection of ecosystems i.e. 3D printings
11		Enhanced customer-based awareness through AI models on ecosystem importance
12		Enhanced and invention of new ecosystem protection mechanisms
13	Supply chains	Efficient supply chain coordination and communication
14		Increased ability of supply chain automation
15		Increased ability to identify supply chain gaps and fill them

Table 6 Digital Opportunity

Sr. #	Key technology areas	Top 3 digital opportunity for your industry
1	Platforms	Sales platforms
2		Brand marketing
3		Customer outreach
4	Customer network	Networking
5		
6		
7	Big Data	Data structuring
8		Data analysis
9		Data presentation
10	AI	
11		
12		
13	IOT	IOT distribution
14		IOT processing
15		IOT data collection
16	Drones	
17		Monitoring of smart grids
18		Accessibility of services

Step 8: A list of transformations made across the impact/difficulty matrix as shown in Fig. 3.

1*—First transformation initiative.

2*—Second transformation initiative.

3*—Third transformation initiative.

4*—Fourth transformation initiative.

Step 9: Table 8 illustrate the most relevant digital transformation plans identified that are preferred to implement within an organizational system and its strategic planning (Alzoubi & Yanamandra, 2020).

4 Discussion

Taking Platform to understand the use cases of such industries, it is being used to understand better marketing strategies to increase the overall brand awareness of most of the companies who have adopted the company platforms to work on their

Table 7 Key Transformations

Sr. #	Key transformations
1	Efficient working of the various processes of work
2	Efficient customer outreach
3	Increased product and service standards on the market
4	Availability of product availability on customer need basis
5	Increased automation of product and service provision
6	Improved protection of ecosystems i.e. 3D printings
7	Enhanced customer-based awareness through AI models on ecosystem importance
8	Enhanced and invention of new ecosystem protection mechanisms
9	Efficient supply chain coordination and communication
10	Increased ability of supply chain automation
11	Increased ability to identify supply chain gaps and fill them
12	Increase the supply chain efficiency
13	Boost the product market and clientele base online
14	Revolutionize pricing mechanisms to boost competitive advantage
15	Increase the angles of approach necessary to put an invention into place
16	Making the design standards more efficient to promote resource saving
17	Give multiple frameworks for the usage of the inventions to the wide range of users
18	Making the process of service and manufacturing industries easier to promote better time saving mechanisms
19	Raising the bar of standards that are necessary to improve the quality of market products and services
20	Put in place new methods and revolutions old habits of production and processing
21	Transform project design
22	Autotomize projects and work
23	Transform project process
24	Reduce project time for completion
25	Increase ease of project supervision
26	Increased distribution of work among project handlers
27	Transform project outlook and results
28	Base with clientele more
29	Reduce project supervision and accountability
30	Efficient working of the various processes of work

Fig. 3 Impact/difficulty matrix (Ghali et al., 2018)

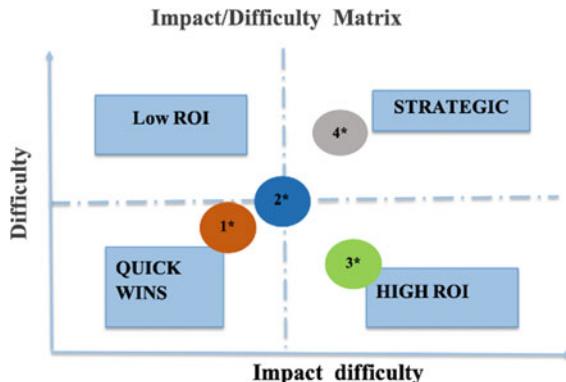


Table 8 Transformation Strategies

Sr. #	Final list of digital transformation strategies	Priority
1	Increased product output	Product
2	Reduced time of product formation	Process
3	Ecosystem protection via widespread saving mechanisms	Ecosystem
4	Increased automation of processes on the industry	Process
5	Increased security of consumer data	Consumer data
6	Autonomy of project supervision	Project supervision
7	Increased design process and investment in design	Design
8	Enhance communication between the supply chains to increase cohesiveness	Supply chain
9	Customer outreach through aggressive DT deployment	Customer
10	Supply chain efficiency through automation processes	Supply chain

various portfolio and other mechanisms of distribution of information and advertising. Reference points for the use of these platforms exist in many scenarios, most of which are companies who have since moved digital after the explosion of digital marketing and the whole industry of online influencing.

Tesla, Cyber X, are some of the companies who have improved their portfolio and increased the market share through online marketing and branding using the platform industry as a pillar. The immense benefits that stood to be realized are plain, to increase the awareness of Cloud and DevOps presence in the lives of the market and the ordinary citizen and build a better brand name from the presence of the companies and the industry on various platforms for marketing and advertising.

5 Conclusion and Recommendation

Based on the understanding of the project, it is necessary to include the multifaced technologies in the addition of digital transformations across the platforms of technology. It is variable to conclude that the understanding of these digital transformations plays an important role in the revolutionization of the project management to usher in the use of technology in these various capacities. The effect of Cloud Computing and DevOps on the technological space cannot be ignored, especially with disruptive technologies that use these aspects of technology in their being.

It is preferred to concentrate on a few roles when describing the basic changes experienced by DevOps: the guys developing the code, the ones supplying and supporting facilities, as well as the people evaluating and doing quality assurance. However, as the DevOps culture grows, so too does its effect on other parts of the company. Take project management, for example, DevOps significantly alters how IT groups approach projects, moving away from homogenous, inter (or multi-year, in certain circumstances) initiatives in light of increasing speed and quickness in the development lifecycle. This has ramifications for project managers as well.

Moreover, project managers are still useful in the DevOps era. “The requirement for operation speed—as well as cutting-edge DevOps platforms and procedures—does not eliminate the need to know what you’re going to accomplish with them,” says Josh Collins, Janeiro Digital’s technical architect. “To keep projects on track and with a clear emphasis on dependencies, a robust project management approach is essential.” However, PMs must evolve for the DevOps era, just as developers, operations professionals, security professionals, and others must abandon old habits in favor of new ones that are best suited to the digital era.

Given DevOps’ fluid nature and continuous deployment continuous integration (CD/CI) approach, the methodology may appear at variance with planning and scheduling that typically follow timeframes with a defined start and endpoint. These methods appear to be more in line with classic software delivery methods such as the waterfall method. Project management techniques, on the other hand, can be adapted to match the DevOps pipeline’s parameters. The objective is to rework the timeline to match the agile method of gradual deliveries after each sprint, rather than focusing on a single final product.

References

- Ahmed, G., & Nabeel Al Amiri. (2022). the Transformational Leadership of the Founding Leaders of the United Arab Emirates: Sheikh Zayed Bin Sultan Al Nahyan and Sheikh Rashid Bin Saeed Al Maktoum. *International Journal of Technology, Innovation and Management (IJTIM)*, 2(1), 1. <https://doi.org/10.54489/ijtim.v2i1.58>
- Al-Tahat, S., & Moneim, O. A. (2020). The impact of artificial intelligence on the correct application of cyber governance in Jordanian commercial banks. *International Journal of Scientific and Technology Research*, 9(3), 7138–7144.
- Alhamad, A., Alshurideh, M., Alomari, K., Al Kurdi, B., Alzoubi, H., Hamouche, S., & Al-Hawary, S. (2022). The effect of electronic human resources management on organizational health of telecommunications companies in Jordan. *International Journal of Data and Network Science*, 6(2), 429–438. <https://doi.org/10.5267/j.ijdns.2021.12.011>
- Alhamad, A. Q. M., Akour, I., Alshurideh, M., Al-Hamad, A. Q., Kurdi, B. A., & Alzoubi, H. (2021). Predicting the intention to use google glass: A comparative approach using machine learning models and PLS-SEM. *International Journal of Data and Network Science*, 5(3), 311–320. <https://doi.org/10.5267/j.ijdns.2021.6.002>
- Ali, A. Al. (2021). The Impact of Information Sharing and Quality Assurance on Customer Service at UAE Banking Sector. *International Journal of Technology, Innovation and Management (IJTIM)*, 1(1), 01–17. <https://doi.org/10.54489/IJTIM.V1I1.10>
- Ali, N., Ahmed, A., Anum, L., Ghazal, T., Abbas, S., & A. K., M., A., & H. M., A. (n.d.). M. (2021). Modelling supply chain information collaboration empowered with machine learning technique. *Intelligent Automation and Soft Computing*, 30(1), 243–257.
- Ali, Naeem, Ghazal, T. M., Ahmed, A., Abbas, S., Khan, M. A., Alzoubi, H. M., Farooq, U., Ahmad, M., & Khan, M. A. (2022). Fusion-based supply chain collaboration using machine learning techniques. *Intelligent Automation and Soft Computing*, 31(3), 1671–1687. <https://doi.org/10.32604/IASC.2022.019892>
- Alnazer, N. N., Alnuaimi, M. A., & Alzoubi, H. M. (2017). Analysing the appropriate cognitive styles and its effect on strategic innovation in Jordanian universities. *International Journal of Business Excellence*, 13(1), 127–140.
- Alnuaimi, M., Alzoubi, H. M., Ajelat, D., & Alzoubi, A. A. (2021). Towards intelligent organisations: An empirical investigation of learning orientation's role in technical innovation. *International Journal of Innovation and Learning*, 29(2), 207–221.
- Alsharari, N. (2021). Integrating Blockchain Technology with Internet of things to Efficiency. *International Journal of Technology, Innovation and Management (IJTIM)*, 1(2), 01–13. <https://doi.org/10.54489/IJTIM.V1I2.25>
- Alshurideh, M. T., Al Kurdi, B., Alzoubi, H. M., Obeidat, B., Hamadneh, S., & Ahmad, A. (2022a). The influence of supply chain partners' integrations on organizational performance: The moderating role of trust. *Uncertain Supply Chain Management*, 10(4), 1191–1202. <https://doi.org/10.5267/J.USCM.2022.8.009>
- Alshurideh, M., Gasaymeh, A., Ahmed, G., Alzoubi, H. M., & Kurd, B. A. (2020). Loyalty program effectiveness: Theoretical reviews and practical proofs. *Uncertain Supply Chain Management*, 8(3), 599–612.
- Alshurideh, M., Al Kurdi, B., Alzoubi, H. M., Ghazal, T. M., Said, R. A., AlHamad, A. Q., Hamadneh, S., Sahawneh, N., & Al-kassem, A. H. (2022b). Fuzzy assisted human resource management for supply chain management issues. *Annals of Operations Research*, 1–19. <https://doi.org/10.1007/s10479-021-04472-8>
- Alzoubi, H., & Ahmed, G. (2019). Do Total Quality Management (TQM) Practices Improve Organisational Success? A case study of electronics industry in the UAE. *International Journal of Economics and Business Research*, 17(4), 459–472.
- Alzoubi, H., Alshurideh, M., Kurdi, B. A., Alhyasat, K., & Ghazal, T. (2022a). The effect of e-payment and online shopping on sales growth: Evidence from banking industry. *International Journal of Data and Network Science*, 6(4), 94–109.

- Alzoubi, H., Alshurideh, M., Kurdi, B. A., Akour, I., & Aziz, R. (2022b). Does BLE technology contribute towards improving marketing strategies, customers' satisfaction and loyalty? The role of open innovation. *International Journal of Data and Network Science*, 6(2), 449–460. <https://doi.org/10.5267/j.ijdns.2021.12.009>
- Alzoubi, H. M., Vij, M., Vij, A., & Hanaysha, J. R. (2021). What Leads Guests to Satisfaction and Loyalty in UAE Five-Star Hotels? AHP Analysis to Service Quality Dimensions. *ENLIGHTENING TOURISM. A PATHMAKING JOURNAL*, 11(1), 102–135.
- Alzoubi, H. M., Ahmed, G., Al-Gasaymeh, A., & Al Kurdi, B. (2020a). Empirical study on sustainable supply chain strategies and its impact on competitive priorities: The mediating role of supply chain collaboration. *Management Science Letters*, 10(3), 703–708. <https://doi.org/10.5267/j.msl.2019.9.008>
- Alzoubi, H. M., Ahmed, G., & Alshurideh, M. (2022b). An empirical investigation into the impact of product quality dimensions on improving the order-winners and customer satisfaction. *International Journal of Productivity and Quality Management*, 36(2), 169–186. <https://doi.org/10.1504/IJPQM.2021.10037887>
- Alzoubi, H. M., Elrehaile, H., Hanaysha, J. R., Al-Gasaymeh, A., & Al-Adaleh, R. (2022c). The Role of Supply Chain Integration and Agile Practices in Improving Lead Time During the COVID-19 Crisis. *International Journal of Service Science, Management, Engineering, and Technology*, 13(1), 1–11. <https://doi.org/10.4018/IJSSMET.290348>
- Alzoubi, H. M., & Aziz, R. (2021). Does Emotional intelligence contribute to quality of strategic decisions? the mediating role of open innovation. *Journal of Open Innovation: Technology, Market, and Complexity*, 7(2), 130. <https://doi.org/10.3390/joitmc7020130>
- Alzoubi, H. M., & Yanamandra, R. (2020). Investigating the mediating role of Information Sharing Strategy on Agile Supply Chain in Supply Chain Performance. *Uncertain Supply Chain Management*, 8(2), 273–284.
- Bellows, B., Bhandari, A., Ibrahim, M., & Sandhu, J. S. (2011). Peering into the Black Box. *Information Communication Technologies*, January, 1–6. <https://doi.org/10.4018/9781599049496.ch067>
- Bongomin, O., Gilibrays Ocen, G., Oyondi Nganyi, E., Musinguzi, A., & Omara, T. (2020). Exponential Disruptive Technologies and the Required Skills of Industry 4.0. *Journal of Engineering (United Kingdom)*, 2020. <https://doi.org/10.1155/2020/4280156>
- Chong, C., Lee, K., & Ahmed, G. (2021). Improving IoT privacy, data protection and security concerns. *International Journal of Technology, Innovation and Management (IJTIM)*, 1(1), 18–33. <https://doi.org/10.54489/IJTIM.V1I1.12>
- Dillon, T., Wu, C., & Chang, E. (2010). Cloud computing: Issues and challenges. *Proceedings - International Conference on Advanced Information Networking and Applications*, AINA, 27–33. <https://doi.org/10.1109/AINA.2010.187>
- Erich, F., Amrit, C., & Daneva, M. (2014). Report: DevOps Literature Review. Https://Www.Researchgate.Net/Publication/267330992_Report_DevOps_Literature_Review, October, 1–27. <https://doi.org/10.13140/2.1.5125.1201>
- Erich, F. M. A., Amrit, C., & Daneva, M. (2017). A qualitative study of DevOps usage in practice. *Journal of Software: Evolution and Process*, 29(6), 1–20. <https://doi.org/10.1002/sm.1885>
- Fletcher-Watson, S., Adams, J., Brook, K., Charman, T., Crane, L., Cusack, J., Leekam, S., Milton, D., Parr, J. R., & Pellicano, E. (2019). Making the future together: Shaping autism research through meaningful participation. *Autism*, 23(4), 943–953. <https://doi.org/10.1177/1362361318786721>
- Ghali, M., Tlija, M., & Aifaoui, N. (2018). Optimal tolerance allocation based on Difficulty matrix using FMEA tool. *Procedia CIRP*, 70, 132–137. <https://doi.org/10.1016/j.procir.2018.03.005>
- Guergov, S., & Radwan, N. (2021). Blockchain convergence: analysis of issues affecting IoT, AI and Blockchain. *International Journal of Computations, Information and Manufacturing (IJCIM)*, 1(1), 1–17. <https://doi.org/10.54489/ijcim.v1i1.48>

- Hamadneh, S., Pedersen, O., Alshurideh, M., Kurdi, B. A., & Alzoubi, H. M. (2021). An investigation of the role of supply chain visibility into the scottish blood supply chain. *Journal of Legal Ethical and Regulatory Issues*, 24(1), 1–12.
- Hanaysha, J. R., Al Shaikh, M. E., & Alzoubi, H. M. (2021). Importance of marketing mix elements in determining consumer purchase decision in the retail market. *International Journal of Service Science, Management, Engineering, and Technology (IJSSMET)*, 12(6), 56–72.
- Hanaysha, J. R., Al-Shaikh, M. E., Joghee, S., & Alzoubi, H. M. (2022). Impact of innovation capabilities on business sustainability in small and medium enterprises. *FIIB Business Review*, 11(1), 67–78. <https://doi.org/10.1177/23197145211042232>
- Joghee, S., Alzoubi, H. M., & Dubey, A. R. (2020). Decisions effectiveness of FDI investment biases at real estate industry: Empirical evidence from Dubai smart city projects. *International Journal of Scientific and Technology Research*, 9(3), 3499–3503.
- Khan, M. A. (2021). Challenges Facing the Application of IoT in Medicine and Healthcare. *International Journal of Computations, Information and Manufacturing (IJCIM)*, 1(1), 39–55. <https://doi.org/10.54489/ijcim.v1i1.32>
- Kurdi, B. A., Alshurideh, M., Akour, I., Alzoubi, H. M., Obeidat, B., & Alhamad, A. (2022a). The role of digital marketing channels on consumer buying decisions through eWOM in the Jordanian markets. *International Journal of Data and Network Science*, 6(4), 1175–1185. <https://doi.org/10.5267/ijdns.2022.7.002>
- Kurdi, B. A., Alzoubi, H. M., Akour, I., & Alshurideh, M. T. (2022b). The effect of blockchain and smart inventory system on supply chain performance: Empirical evidence from retail industry. *Uncertain Supply Chain Management*, 10(4), 1111–1116. <https://doi.org/10.5267/j.uscm.2022.9.001>
- Kurdi, B. A., Alshurideh, M., Akour, I., Alhamad, A., & Alzoubi, H. M. (2022c). *The Effect of Social Media Influencers' Characteristics on Consumer Intention and Attitude toward Keto Products Purchase Intention*, 6(4), 1135–1146.
- Lee, K. L., Azmi, N. A. N., Hanaysha, J. R., Alzoubi, H. M., & Alshurideh, M. T. (2022a). The effect of digital supply chain on organizational performance: An empirical study in Malaysia manufacturing industry. *Uncertain Supply Chain Management*, 10(2), 495–510. <https://doi.org/10.5267/j.uscm.2021.12.002>
- Lee, K. L., Romzi, P. N., Hanaysha, J. R., Alzoubi, H. M., & Alshurideh, M. (2022b). Investigating the impact of benefits and challenges of IOT adoption on supply chain performance and organizational performance: An empirical study in Malaysia. *Uncertain Supply Chain Management*, 10(2), 537–550. <https://doi.org/10.5267/J.USCM.2021.11.009>
- Maged Farouk. (2022). Studying human robot interaction and its characteristics. *International Journal of Computations, Information and Manufacturing (IJCIM)*, 2(1), 1. <https://doi.org/10.54489/ijcim.v2i1.73>
- Mehmood, T., Alzoubi, H., Alshurideh, M., Al-Gasaymeh, A., & Ahmed, G. (2019). Schumpeterian entrepreneurship theory: evolution and relevance. *Academy of Entrepreneurship*, 25(4), 1–10.
- Meyer, M., Helmholz, P., & Robra-Bissantz, S. (2018). Digital transformation in retail: Can customer value services enhance the experience? In *31st Bled EConference: Digital Transformation: Meeting the Challenges, BLED 2018* (pp. 291–300). <https://doi.org/10.18690/978-961-286-170-4.19>
- Neyara Radwan. (2022). the Internet's role in undermining the credibility of the healthcare industry. *International Journal of Computations, Information and Manufacturing (IJCIM)*, 2(1), 1. <https://doi.org/10.54489/ijcim.v2i1.74>
- Paveft, K. (2017). Disruptive technologies. *Flexo*, 42(2), 28–30. https://doi.org/10.1057/978-1-349-95968-6_3
- Radwan, N., & Farouk, M. (2021). The Growth of Internet of Things (IoT) In The Management of Healthcare Issues and Healthcare Policy Development. *International Journal of Technology, Innovation and Management (IJTIM)*, 1(1), 69–84. <https://doi.org/10.54489/IJTIM.VII1.8>

- Ramakrishna, Y., & Alzoubi, H. M. (2022). Empirical investigation of mediating role of six sigma approach in rationalizing the COQ in Service Organizations. *Operations and Supply Chain Management*, 15(1), 122–135. <https://doi.org/10.31387/OSCM0480335>
- Shamout, M., Ben-Abdallah, R., Alshurideh, M., Alzoubi, H., Kurdi, B. A., & Hamadneh, S. (2022). A conceptual model for the adoption of autonomous robots in supply chain and logistics industry. *Uncertain Supply Chain Management*, 10(2), 577–592. <https://doi.org/10.5267/J.USCM.2021.11.006>
- Sotoudeh, H., Shafaat, O., Bernstock, J. D., Brooks, M. D., Elsayed, G. A., Chen, J. A., Szerip, P., Chagoya, G., Gessler, F., Sotoudeh, E., Shafaat, A., & Friedman, G. K. (2019). Artificial intelligence in the management of glioma: Era of personalized medicine. *Frontiers in Oncology*, 9(AUG), 1–11. <https://doi.org/10.3389/fonc.2019.00768>
- Utterback, J. M., & Acee, H. J. (2021). Disruptive technologies: An expanded view. *Digital Disruptive Innovation*, 9(1), 3–23. <https://doi.org/10.1142/s1363919605001162>
- Walsh, S. T., Kirchhoff, B. A., & Newbert, S. (2002). Differentiating market strategies for disruptive technologies. *IEEE Transactions on Engineering Management*, 49(4), 341–351. <https://doi.org/10.1109/TEM.2002.806718>
- Wang, L., Von Laszewski, G., Younge, A., He, X., Kunze, M., Tao, J., & Fu, C. (2010). Cloud computing: A perspective study. *New Generation Computing*, 28(2), 137–146. <https://doi.org/10.1007/s00354-008-0081-5>

Digital Transformation and Digital Disruption Technologies: The Effect of AI and Machine Learning on Managing Projects



Mounir El Khatib

Abstract It is without a doubt that the impact of digital transformation and disruptive technologies has impacted all industries globally. There is hardly any sector that is left untouched by this form of innovation. This is also true for the power sector, which is the industry targeted for this study. The power sector is crucial for human existence, and hence, it is the use of different kinds of technology that must be employed at the helm of its operations. These different kinds of technology are related to AI, Robotics, IoT, and Big Data. The major intention behind these technologies should be to pace up different projects managed in the industry. Therefore, the company selected for this project is Dubai Electricity and Water Authority (DEWA). It is a company that is involved with various technological projects ranging from smart grids to digital meters to managing customer data. By interviewing thirteen key people from the company, the study highlights the current status of technology and how it is being employed by different power sector companies. In the end, it has been deduced that the future of the power industry relies on its adaption of green energy generation, and hence, all the efforts of the companies should be directed toward producing green energy with the help of modern technology. Also, it was found that the use of AI can enhance the efficiency of the projects, making them less risky. Therefore, the use of AI ensures that the projects are less prone to risks and have a higher chance of success.

Keywords Project management · Digital transformation · Digital disruption · Disruptive technologies · Machine learning · Artificial Intelligence

M. El Khatib (✉)
Hamdan Bin Mohamad Smart University, Dubai, UAE
e-mail: M.Elkhatib@hbmsu.ac.ae

1 Introduction

Digital transformation is gaining momentum across industries, driven by a wave of disruptive technologies influencing companies and businesses to get used to innovative working (Zubizarreta et al., 2021). As organizations strive to secure the benefits of digital disruption, the importance of strategic and robust practices of project management continues to increase. In the field of project management, disruptive technology is significantly evolving, forcing project managers to be proactive in honing and developing technical skills to meet future, increasing demands (Alzoubi et al., 2021; Gupta & Antony, 2017). Disruptive technologies are being used by innovation to enhance the role of project management within the organization by boosting automation and higher efficiency. Cloud technology, for instance, provides flexibility and speed, IoT connects to data more efficiently, AI drives intelligence, and the resulting technological trio can make a significant transformation in project management (Ali et al., 2021).

It is anticipated that organizations are planning to adopt or have adopted a digital-first strategy with key technologies like APIs, cloud, mobile, and big data/analytics driving their digital transformation (Saleh et al., 2021). Likewise, non-IT companies are changing their services and products around digital capabilities bringing new technologies, undergoing cultural changes, and adapting agile workforce to excel in new changing digital reality (Shamout et al., 2022). Besides, digital transformation through collaborative work management software is aiding teams across departments to interact, connect and engage in real-time, reducing email clutter and time needed in the process. It is automating workflows and increasing coordination of project management tasks such as scheduling, helping project managers to focus on project delivery and strategy optimization. Lastly, it provides managers with the analytical techniques for making data-driven decisions to improve project outcomes (Alnazer et al., 2017; Cozzolino et al., 2018). Overall, the focus of this study is on the effects of AI and machine learning and other digital technologies in managing project risks and analyzes key digital transformations across different dimensions, with a focus on the project management industry.

2 Literature Review

The focus of this section is on the following key factors, business, technology, society, and industry, discussing how digital transformation initiatives have an effect on improving organization efficiency, and help in the management of the project (Lee et al., 2022a).

At present, digital transformation is taking place across the industry, and disruptive innovations, including the internet of things (IoT), artificial intelligence (AI), and cloud solutions, are emerging in business sectors while displacing other technologies. This significant change in business stimulates innovation in project management

(Alsharari, 2021; Saleh et al., 2021). AI is found to aid digital channels helping both consumers and companies and is playing an important role in project management. In the context of pricing models, fixed pricing contracts estimate the amount of pending work to be completed (Hanaysha et al., 2022). Emphasizing changing technology can help project managers predict the pricing planned beforehand, as it is convenient for managers to predict if assigned work is completed on a set deadline (Mehmood et al., 2019). Likewise, the milestone model of pricing help in reducing the chances of fraud between the client and service provider. However, with digital transformation, a milestone in project management can help to measure the progress toward the final goal and is used for signaling posts for the start or end of the project date (Ageron et al., 2020). In project management, it is found that digitalization has helped businesses to create products and services using innovation and effective management of resources, which help to unnecessary product costs (Alnuaimi et al., 2021). Moreover, it has been discussed that efficient project management, including tools, tactics, and strategies supported by technologies, is significant in the delivery mechanisms of products and services (Miller, 2021).

Likewise, technology is also an important construct in the business world and provides the organization with a much-needed competitive advantage. Project management has a significant link in aligning business strategy with technology management (Alzoubi et al., 2022a). In project management, the application of technology can help ensure success and may reduce risk related to the project (Alzoubi & Yanamandra, 2020; Sadiq et al., 2016). A study showed that the use of technology in managing projects has been positive for the project managers with respect to cost management, scheduling, project strategy, and project structure (Zubizarreta et al., 2021). Additionally, technological innovation helps in projects with new processes and services and makes improvements and necessary adjustments. Similarly, the use of technology is found to be linked with quick access and friendly user experiences providing convenience for both client and the user (Alzoubi & Aziz, 2021). For instance, software like Proofhub is a scalable solution for managing the activities of a project, as it is simple and easy to use. With the help of this software, the project team can log in to the single tool of project management for their project needs (Kurdi et al., 2022c; Xinxian & Jianhui, 2022). Moreover, it is significantly helpful in terms of project planning and timeline to measure the planning process of the project. Besides using technological tools, the management of tasks can be made easy in a more organized and detailed way (Cruz, 2021). In a similar context, it is found that collaboration tools, project tracking, information-gathering tools, software scheduling, and workflow automation are viewed to be useful in improving project management (Alzoubi et al., 2022d), lowering risks, bringing efficiency to work, and helping improve project development with synchronicity, making it simpler for project managers to manage their tasks (Sadiq et al., 2016). Moreover, with increased automation and the transformation of technology, together with the introduction of cloud and AI, managing projects will be easy, efficient, quicker, and risk-free (Alshurideh et al., 2020). Nevertheless, new technologies bring new risks; hence managers will need understanding and knowledge on dealing with those issues (Ibrahim, 2019; Lee et al., 2022b).

Relating to the challenges, it is observed that project leaders need awareness and sensitivity to multicultural preferences (Mehmood, 2021). Globally, distributed and diverse teams usually work on complex projects with different time zones, geography, and strict deadlines and therefore need resources and time, along with a collaborative culture to perform efficiently (Kurdi et al., 2022a; Müller & Turner, 2010). A supportive culture and interactive environment boost the morale of the project team, thus helping to ensure project success (Hamadneh et al., 2021). Moreover, closed groups and connecting team members are pivotal in developing a sound collaborative working environment that may help ensure the tracking, record, and scheduling of the project and may help to identify the risk factors and challenges that may arise in the projects (Fernandes Rodrigues Alves et al., 2018). Moreover, it will also help in reducing the chances of project delay if team members and groups are well connected through communicative technological tools (Alshurideh et al., 2022a, 2022b; Farouk, 2021). Likewise, it is noted that the role of project leaders or managers is transforming significantly, and the traditional role of a team leader is changing to project influencer (Aziz & Aftab, 2021; Yanamandra & Alzoubi, 2022). The organizations are early adopters and forward-thinking of new technologies, and thus project managers are increasingly playing a role in influencing people to adapt to new ideas and technologies and bring easiness and flexibility in managing projects (Alzoubi, 2021). In project management, people leveraging on leadership skills can significantly develop professional networks beyond and within their organization can be persuaded and influence others. (Alhamad et al., 2021; Alshurideh et al., 2022a, 2022b; Alzoubi, 2022) Although influencer as a term is linked with digital media and marketing, however in projects, it can now be becoming popular, where leadership with skills in influencing team members in the management of tasks, service delivery, and outperform (Alzoubi et al., 2020). Overall, the organizational culture, environment, team cohesiveness, collaboration, and communication, along with leadership influence, can play an important role in the management of the project and thus contribute to organizational success (Müller & Turner, 2010).

In terms of industries, the reliance on the management of the project is linked with new technologies, which can aid in the production, supplies, and management of complex tasks (Akhtar et al., 2021). Disruptive technologies are also pivotal in relation to privacy and security and help ensure that there are minimal risks involved in project failure or delays (Alshurideh et al., 2022a; 2022b; Kurdi et al., 2022b). Moreover, the transformation of technologies is revolutionizing industries, like cloud computing, IoT, robotics, AI, and other cutting-edge technologies developing opportunities to work, employees to manage projects, and business to thrive more differently (Kashif et al., 2021). It is noted that in an industrial setting where there are increased concerns related to safety, security, and privacy, project leaders will require a thorough combination of project management, and technical skills, along with business management, strategic, and leadership skills, which are key element project management triangle (Alzoubi et al., 2022b). People who have skills in managing projects usually support and embrace quick changes and position themselves to compete and excel in disruptive and fast-paced business environments (Alzoubi et al., 2022a, b, c; Cozzolino et al., 2018; Hanaysha et al., 2021). Besides, there is a need

for continuous changes considering the increasing development and changes in technology (Ali et al., 2022). It is found that organizations are upgrading the skills and technical knowledge of their people to adapt to increasingly growing demand from clients, efficiently in addressing challenges related to project failures, disruptions, etc., and find ways for reducing the gap between the clients and the organization (Saad Masood Butt, 2022). It is identified that project management is changing together with technologies and increasing demand of industries, and therefore, more trained, skilled project managers are required to deal with forthcoming challenges (Gupta & Antony, 2017).

3 Methodology

In order to identify the research findings a research questionnaire developed that consists of the below 9 steps and sequence:

Step 1: List of top 10 digital transformations in the organization as shown in Table 1, used to transform the organizational setup and a SWOT analysis used to identify the strength, weaknesses, opportunities and threats in the firm.

3.1 SWOT Analysis:

As shown in Fig. 1, a specified method used to identify an organization's strengths, weaknesses, opportunities and threats in an organization to remain sustainable and achieve organizational performance (Alhamad et al., 2022).

Step 2: A list of top 10 digital initiatives by digital native disruptors most relevant to the organization as shown in Table 2. Using a what, how, and outcome framework to brainstorm the information.

Table 1 Key digital transformations

Sr. #	Key digital transformations
1	Digital bill payment
2	Digital management of electricity and water
3	Customer data service
4	Consumption verification
5	Customer account service
6	Green charger cards
7	Customer dashboards
8	Smart consumption
9	Internet of things
10	Digital bills

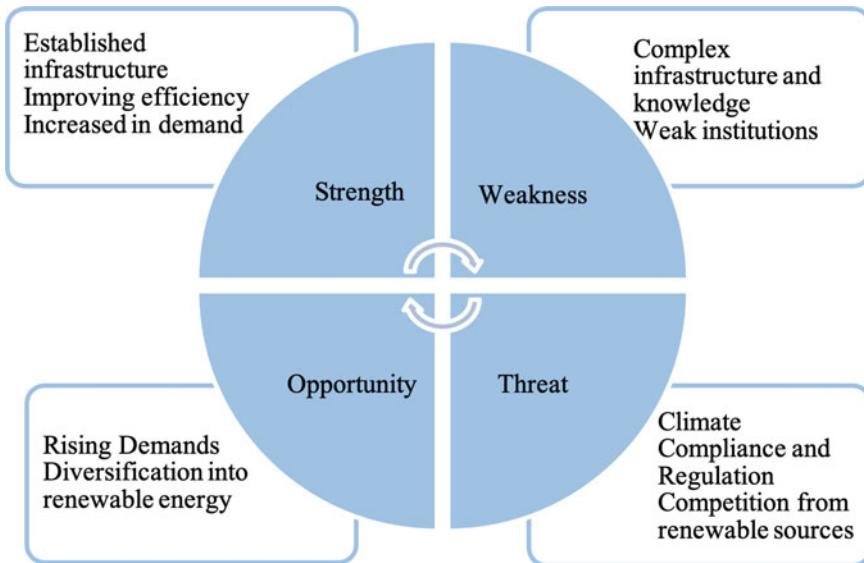


Fig. 1 SWOT Analysis (developed by authors)

Table 2 Key digital transformation initiatives

#	Key digital transformation initiatives
1	Smart meters
2	Digital billing
3	Payment gateways
4	Customer dashboards
5	Robotics in power plants
6	Interconnectedness
7	Reskilling employees
8	Consumer awareness
9	Grid optimization
10	Integrated customer services

Step 3: A list of top three digital disruptions across all four elements—business, technology, industry, and society—most relevant to the organization as shown in Table 3.

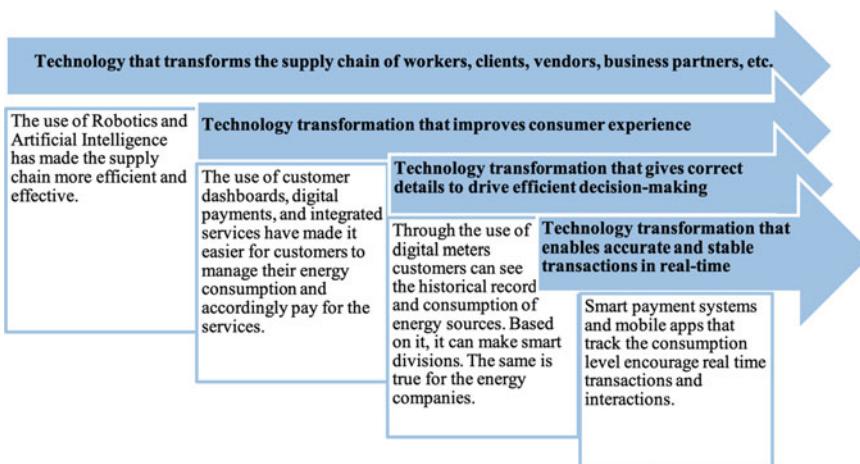
While looking at the technology dimension, the following framework used to identify key initiatives as shown in Fig. 2 (Mehmood, 2021).

Step 4: Create a list of top three digital initiatives by your competitors. A list of top three digital initiatives by the competitors shown in Table 4.

Step 5: A list of top three digital disruptions across all the five key areas of disruption that are most relevant to the organization.

Table 3 Elements of digital disruptions (Fosso Wamba et al., 2020)

#	Elements of digital disruption	Impact of the element relevant to your organization
1	Business	Digital marketing
2		Upgradation of employee skills
3		Service integration
4	Technology	Grid optimization
5		Waste reduction
6		Cybersecurity
7	Industry	Cloud computing
8		Big data
9		Robotics in grids
10	Society	Investment in renewable energy
11		Awareness on energy waste
12		Batteries for energy storage

**Fig. 2** Technology dimensions (developed by authors)

We are making progress with our understanding of the digital initiatives. Now how about getting some ideas going?

Let's look at each of the key areas of digital disruption one by one using the trend-benefit framework (Fig. 3).

List the top three initiatives across all five areas of digital disruption is provided in the Table 5 below (Xinxian & Jianhui, 2022).

Step 6: A list of top three transformations across the following key technologies as shown in Table 6, that are most relevant to the industry to attain the competitive advantage of the industry (Alzoubi et al., 2020).

Table 4 Competitors implementation on digital transformation initiatives

#	Competitors	Key digital transformation initiatives
1	Dubai Electricity and Water Authority (DEWA)	Smart apps
2		Digital marketing for consumer awareness
3		Digital bill payment
4	Total energies	Customer data service
5		Consumption verification
6		Digital factory
7	ExxonMobil	New payment options
8		Detecting methane emissions
9		Quantum computing
10	Schneider electric	Edge computing
11		Cybersecurity protocols
12		Pay as you go subscription-based model

Trend 1**Smart Meters**

Smart meters help the users to track their energy consumption.

Trend 2**Payment Options**

This helps users to pay for the bills in any payment option such as debit cards, paypal, cryptocurrency, etc.

Trend 3**Robotics**

Installation of robotic technology helps in reducing the energy waste

Fig. 3 Key Areas of Digital Disruptions (developed by authors)

Step 7: Based on the previous steps, a list of all key transformations compiled as shown in Table 7, that can be implemented through an organizational strategic system to enhance the performance (Müller & Turner, 2010).

Step 8: A list of transformations made across the impact/difficulty matrix as shown in Fig. 4 and Table 8 (Wagner et al., 2017).

Step 9: The most relevant digital transformation plans identified in Table 9, that can improve the firms market stability to earn competitive edge as well as integration of advanced technology can assist to maintain competitive edge of the organization (Khan et al., 2019).

Table 5 Digital initiatives

#	Key areas of disruption	Digital initiatives
1	Marketing and distribution	Marketing on social media platforms
2		CSR activities related to environment
3		Distribution based on data
4	Product and service	Robotics in smart grid
5		Smart energy
6		Smart meters
7	Processes	Payment models
8		Lowering energy consumption
9		Cloud computing
10	Ecosystems	Renewable energy
11		Investment in green initiatives
12		Employee capacity
13	Supply chains	Detecting methane emissions
14		Quantum computing
15		Edge computing

4 Empirical Analysis

The questionnaire was asked to several respondents who had a working experience in the power sector. The template was very helpful in determining the direction taken by the industry as a whole. For instance, the first question pertained to the key digital transformations that were underway in the power sector. One of the responses that were received is as follows:

“In my opinion, the key digital transformation that is currently underway is related to Digital Bill Payment. We are working on a technology that allows customers to pay the bills through the use of mobile apps.”

Such a system would be a breakthrough for the consumers as well as for the companies. This is further explained by (Kumaresan & Baskaran, 2010), where it is highlighted that electricity consumers are often faced with problems of delayed billing, and this is primarily because of the sheer size of the consumers. Therefore, with the use of a base programming language, web services are being developed where users will be given a unique identification number, and this will help in retrieving digital bills. It will be extremely helpful for both the company and consumer as it would reduce the cost of paper billing from the end of the consumer and customer. They can access the bill whenever they need it. Similar to this, another respondent noted the use of digital apps for the use of electricity and other utility services. These apps would help track the consumption level of the consumers, and they could keep a real-time track of the consumption patterns. These apps will also be able to alert the

Table 6 Industrial digital opportunities

#	Key technology areas	Top 3 digital opportunity for your industry
1	Platforms	Customer dashboards
2		Supplier dashboards
3		Consumption database
4	Customer network	Customer data network
5		Integrated customer channels
6		Data centers
7	Big Data	Smart consumption
8		Consumer data base
9		Reduction in energy wastage
10	AI	Efficiency
11		Connectivity
12		Smart payment systems
13	IOT	Centralized mobile connection
14		Cybersecurity
15		Connectivity
16	RPA	Improvement in supply chain
17		Improvement in distribution
18		Automated distribution
19	XR	Virtual experience
20		Zero carbon future
21		Increased efficiency
22	Edge computing	Higher computation
23		Increase in speed
24		Reduction in cost
25	Drones	Short time to repair power damages
26		Monitoring of smart grids
27		Accessibility of services

users if the consumption increases the specified target, and hence, this would be the first time customers would be alerted of their usage. Consider the below response:

“The development of Digital Apps would bring the entire services into one centralized hub. This would enable customers to access their consumption patterns, past billing history, and lots of other services. This is truly an innovation as it had never been carried out before in the power industry.”

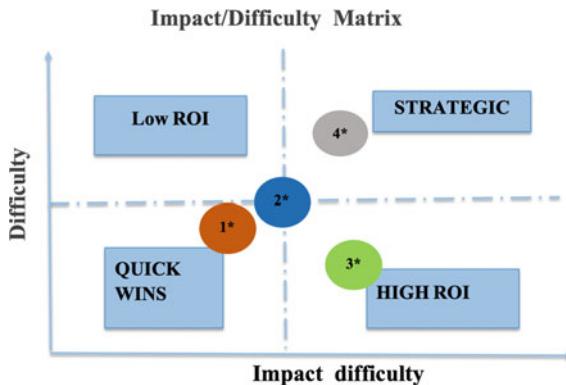
Regarding the strengths and weaknesses of the power sector, respondents were quick to note the importance of infrastructure. This makes sense because, without infrastructure, there is hardly any use of electricity, and all the companies rely on infrastructure as it is their biggest strength for the provision of services. However,

Table 7 First Key transformations

Sr. #	Key transformations
1	Service integration
2	Customer dashboards
3	Supplier dashboards
4	Consumption database
5	Customer data network
6	Integrated customer channels
7	Data centers
8	Smart consumption
9	Consumer data base
10	Reduction in energy wastage
11	Efficiency
12	Connectivity
13	Smart payment systems
14	Centralized mobile connection
15	Cybersecurity
16	Connectivity
17	Improvement in supply chain
18	Improvement in distribution
19	Automated distribution
20	Virtual experience
21	Zero carbon future
22	Increased efficiency
23	Higher computation
24	Increase in speed
25	Reduction in cost
26	Short time to repair power damages
27	Monitoring of smart grids
28	Accessibility of services
29	Digital marketing
30	Upgradation of employee skills

the complexity and lack of knowledge regarding the same infrastructure is also a shortcoming as not every employee in the team is aware of these technicalities, and often these companies have to rely on a third-party agency if there is a problem related to infrastructure quality. Furthermore, rising demands and consumption was quoted as the biggest opportunity for power sector company. It is also stated by (Müller & Turner, 2010) where the authors have mentioned that due to urbanization and globalization, the power demand has increased ten folds, and hence, there is a great opportunity for the power sector companies to meet these demands and increase

Fig. 4 Difficulty matrix (developed by authors). 1*—First transformation initiative. 2*—Second transformation initiative. 3*—Third transformation initiative. 4*—Fourth transformation initiative



their revenues. On the contrary, the biggest threat was recorded to be renewable energy. For this factor to understand, consider the below response:

“It is without a doubt that the biggest threat to the power sector companies comes in the form of the environment. The climate is degrading, and there must be a clean and renewable source that must be developed which is in the interest of everyone on this planet. Otherwise, it is possible that the power companies may be sanctioned soon and are replaced by companies that provide energy through environmentally safe solutions.”

From the above response, it is clear that the future of power sector companies lies in the direction of renewable sources. If they are not able to switch to a renewable form of energy, then they may fall out of favor with the government as well as with the consumers who are looking forward to a greener solution.

Further to this, when the respondents were asked about the key digital transformations initiatives observed in the industry, the option of smart meters was prioritized. As per the study by (Ibrahim, 2019), smart meters in the power sector that are installed in place of analog meters have the capability of reducing energy consumption and, at the same time, can be useful for policymakers in devising energy efficiency policies for the future. Smart meters also offer a viable alternative for a cost-effective, stable, and reliable form of electricity metering. However, as one of the respondents noted, such a type of installation requires a change in the approach of both consumers and the companies. Concerns for the environment may be very valid in the west but not in Asian or middle eastern societies. Therefore, a large-scale installation of smart meters lacks the pull factors, and there is a bigger role from the government that should intervene and encourages smart metering of the households. Similarly, another breakthrough is installing robotics in power plants and electricity-generating farms. This was also a response that was gathered from all the respondents, and hence, it can be noted that the use of modern robotics is a game-changing technology. This is because the installation of robots at the power plants can increase the efficiency of the plants and prevent the wastage of energy which is the prime concern of the industry. A further explanation is provided by (Joghee et al., 2020). As per the researchers, the foremost challenge facing the power sector is related to sustainability, and this is

Table 8 Second Key transformations

#	Key transformations	
1	Service integration	3rd
2	Customer dashboards	3rd
3	Supplier dashboards	3rd
4	Consumption database	4th
5	Customer data network	1st
6	Integrated customer channels	1st
7	Data centers	2nd
8	Smart consumption	3rd
9	Consumer data base	1st
10	Reduction in energy wastage	2nd
11	Efficiency	4th
12	Connectivity	3rd
13	Smart payment systems	1st
14	Centralized mobile connection	1st
15	Cybersecurity	2nd
16	Connectivity	3rd
17	Improvement in supply chain	4th
18	Improvement in distribution	3rd
19	Automated distribution	2nd
20	Virtual experience	1st
21	Zero carbon future	3rd
22	Increased efficiency	1st
23	Higher computation	3rd
24	Increase in speed	1st
25	Reduction in cost	1st
26	Short time to repair power damages	3rd
27	Monitoring of smart grids	4th
28	Accessibility of services	2nd
29	Digital marketing	3rd
30	Upgradation of employee skills	3rd

adequately addressed by the use of robotics at power facilities. It can also be able to reduce dependency on labor and subsequently reduce the labor cost. On the contrary, customer dashboards for power usage and consumption are also considered to be a great new service that can provide customers with the history of their consumption. This will rely on IoT that will see the users connect their mobile phone apps with electrical appliances in the household. This dashboard can then not only be used to check the power consumption status but also used to control the electrical appliances.

Table 9 List of digital transformation strategies

#	Final list of digital transformation strategies	Priority
1	Installation of digital meters	1
2	Digital payment systems	2
3	Integration into mobile app	3
4	Dashboards for customers	4
5	Robotics in grid system	5
6	Use of VR for marketing	6
7	Service integration	7
8	Green energy awareness	8
9	Smart consumption	9
10	Cybersecurity	10

Related to technology, there is grid optimization, waste reduction and cybersecurity that would play a key role in the shaping of the industry. Grid optimization is related to having robotics in power generating facilities. This is also illustrated in the below quote from the respondent:

“Optimization of the gridding system has become a top priority not only in Dubai or UAE but around the world. This is because a huge percentage of electricity is wasted due to inferior infrastructure and technology. This can be averted if there is the use of robotics that are equipped with AI and machine learning. This means that the current technology and equipment are replaced with more intelligent machines capable of sending and receiving signals.”

From the above quote, it is clear that the installation of robotics-based on AI is of huge importance to power companies. The study of (Sadiq et al., 2016), which is quoted in the literature review section, provides unique insights. As per the researchers, the use of AI makes a project quicker, reliable, and easier. These benefits are exactly the benefits that the power grids aim to realize through the installation of AI-driven robotics. Furthermore, the study of (Durowoju et al., 2020) is also important to mention as the authors bring into consideration the importance of cloud computing and robotics to thrive in the modern world. Cloud computing is also listed as an impact that will affect the entire industry. This is because energy management, like project management, requires a flexible and scalable environment. Before cloud computing, companies were relying on huge data centers that were unacceptable for the current environment and, at the same time, were physically redundant. With cloud computing, this can be reduced and can provide a greater synergy between different stakeholders of a project, such as employees, managers, and customers. Hence, in this sense, the findings of the literature and the opinion of the respondent are coherent.

5 Discussion

The respondents were asked to classify technology that is able to increase the supply chain process, improve customer experiences, help inefficient decision-making, and encourage accurate and stable transactions. Within the power sector, it was noted that all these four key areas of project management are being alleviated by a different kind of technology. For instance, robotics and AI are used in the supply chain, Big Data for customer experiences, digital meters for efficient decision making, and smart payment systems for reliable information. This means that the application of technology in the power sector is multidimensional and can impact each and every stage of project management. This is also in line with the findings of (Cozzolino et al., 2018) mentioned in the prior section, which state the importance of a dynamic and fluid environment which can only be achieved with the use of technology. Gupta and Antony (2017) have based their study on how can the gap between customer and organization can be reduced in project management, which is discussed in the literature section. And it seems that in the power sector, this can be reduced through the integration of technology such as smart payment systems, customer dashboards, digital meters, etc. This would empower the customers and remove their dependency of customers on the organization.

Similar themes emerged when the respondents were asked about the underlying trends in the industry. These trends are related to smart meters, adding payment options, and the use of robotics and AI for increasing efficiency in the supply section. Once again, the concept of smart grids is important to discuss as it is a recurring theme in the responses from the respondents. In this griding system, there are a variety of options and energy measurements units that can provide a foundation for both the company and customer regarding their habit of energy consumption. This is optimized through the use of robotics and AI. This type of innovation is also among the most prioritized digital transformation plan affecting all the players in the industry.

Within the transformation plan, there is also the aspect of installing digital meters instead of the current meter system. Based on the information gathered from the respondents, this is a very important aspect of the industry and is in line with the needs and preferences of customers. These digital meters can then have the ability to connect with the mobile app on the user's smartphone giving access to the consumer's energy consumption, payment history, and other details on one centralized hub. Lastly, the investment in green and renewable sources of energy is also prioritized and constantly referred to by the respondents. This should also be communicated to the users in the form of digital marketing. This is because companies are actively investing in creating an awareness regarding the need for green electricity, which would be the future of the power sector. To this end, the industry is also tapping into the sources that can help in creating clean energy which will be effective using digital technology.

6 Conclusion

Subjected to the above discussion, it can be stated that one of the most important industries for the survival of humanity is deeply embedded with technological progress. There are multiple sources of technology, such as Robotics, AI, Big Data, Mobile apps, etc., that are the key trends for the power sector and would be guiding the future of the companies. The provided analysis examined different aspects of technology use, including benefits, advantages, and changes in the industry that was introduced by the integration of disruptive technologies. The digital transformation shift improved all project management processes specifically risk management. In addition, digitalization provides a better environment and an enhanced experience for managers, employees, and customers.

7 Summary

The key findings of this paper are listed below:

- Digital transformation utilizes the use of digital technologies including artificial intelligence, the internet of things, big data, robotics, digital marketing, and other advanced technologies.
- Digital technologies have significantly impacted all sectors including business, society, industry, and technology. Leading to enhanced operations, experiences, and improved efficiency. It also creates new risks.
- Projects managers, engineers, and employees require to develop the appropriate level of skills to eliminate the risks associated with the implementation of new technologies.
- Dubai Electricity and Water Authority (DEWA) the organization subjected to this study, has effectively adopted digital initiatives across different areas of disruption such as marketing, distribution, process, products, and services.
- New strategies, applications, solutions, and services evolved across the various digital transformation initiatives.
- Power industry companies are competing in the process of implementing the latest technologies in alternative initiatives and projects.
- Promoting innovation by utilizing digital disruptive in managing projects delivers advanced solutions to deal with risks, threats, and opportunities. Specifically, the use of Artificial Intelligence (AI) which leads to an enhanced planning, execution, improved quality, and better decision making of projects.
- Integration of technologies in managing projects introduces numerous advantages of eliminating errors, reducing costs, effective management, customer satisfaction, enhanced operations, and project delivery.
- Interview results conclude that an effective risk management plan established by managers to deal with the digital environment risks is an optimal approach to benefit from the evolving technologies.

8 Recommendations

Following a thorough review of the literature and addressing a questionnaire to several employees dealing with projects at Dubai Electricity and Water Authority, the paper presents a number of suggestions.

- Organizations must provide training sessions and workshops addressing the current evolving digital technologies for their employees to teach them how to incorporate digital transformations in managing projects and risks associated with them.
- Development of professional skills is required to support the use of digital transformations in projects.
- Industries should embrace change by adopting the use of digital technologies company-wide to open up opportunities for all departments including IT, marketing, and customer services to enhance their processes.
- Introducing regulations and reforms on implementing digital transformations for the successful management of projects.
- Corporation between organizations and industries will improve the process of adopting the latest digital transformations in managing project risks.
- Proper research is required before integration with projects to unlock the benefits of using digital technologies.
- Organizations should focus on continuous innovation in managing projects to compete in the digitalized world.

References

- Ageron, B., Bentahar, O., & Gunasekaran, A. (2020). Digital supply chain: Challenges and future directions. *Supply Chain Forum*, 21, 133–138.
- Akhtar, A., Akhtar, S., Bakhtawar, B., Kashif, A. A., Aziz, N., & Javeid, M. S. (2021). COVID-19 detection from CBC using machine learning techniques. *International Journal of Innovation and Technology Management*, 1, 65–78.
- Alhamad, A., Alshurideh, M., Alomari, K., Al Kurdi, B., Alzoubi, H., Hamouche, S., & Al-Hawary, S. (2022). The effect of electronic human resources management on organizational health of telecommunications companies in Jordan. *International Journal of Data and Network Science*, 6, 429–438.
- Alhamad, A. Q. M., Akour, I., Alshurideh, M., Al-Hamad, A. Q., Kurdi, B. A., & Alzoubi, H. (2021). Predicting the intention to use google glass: A comparative approach using machine learning models and PLS-SEM. *International Journal of Data and Network Science*, 5, 311–320.
- Ali, N., Ahmed, A., Anum, L., Ghazal, T. M., Abbas, S., Khan, M. A., Alzoubi, H. M., & Ahmad, M. (2021). Modelling supply chain information collaboration empowered with machine learning technique. *Intelligent Automation & Soft Computing*, 30, 243–257.
- Ali, N., Ghazal, T. M., Ahmed, A., Abbas, S., Khan, M. A., Alzoubi, H. M., Farooq, U., Ahmad, M., & Khan, M. A. (2022). Fusion-based supply chain collaboration using machine learning techniques. *Intelligent Automation & Soft Computing*, 31, 1671–1687.

- Alnazer, N. N., Alnuaimi, M. A., & Alzoubi, H. M. (2017). Analysing the appropriate cognitive styles and its effect on strategic innovation in Jordanian universities. *International Journal of Business Excellence*, 13, 127–140.
- Alnuaimi, M., Alzoubi, H. M., Ajelat, D., & Alzoubi, A. A. (2021). Towards intelligent organisations: An empirical investigation of learning orientation's role in technical innovation. *International Journal of Innovation and Learning*, 29, 207–221.
- Alsharari, N. (2021). Integrating blockchain technology with internet of things to efficiency. *International Journal of Innovation and Technology Management*, 1, 01–13.
- Alshurideh, M., Al Kurdi, B., Alzoubi, H.M., Ghazal, T.M., Said, R.A., AlHamad, A.Q., Hamadneh, S., Sahawneh, N., & Al-kassem, A.H. (2022a). Fuzzy assisted human resource management for supply chain management issues. *Annals of Operations Research* 1–19.
- Alshurideh, M., Gasaymeh, A., Ahmed, G., Alzoubi, H. M., & Kurd, B. A. (2020). Loyalty program effectiveness: Theoretical reviews and practical proofs. *Uncertain Supply Chain Management*, 8, 599–612.
- Alshurideh, M. T., Al Kurdi, B., Alzoubi, H. M., Obeidat, B., Hamadneh, S., & Ahmad, A. (2022b). The influence of supply chain partners' integrations on organizational performance: The moderating role of trust. *Uncertain Supply Chain Management*, 10, 1191–1202.
- Alzoubi, A. (2021). The impact of process quality and quality control on organizational competitiveness at 5-star hotels in Dubai. *International Journal of Innovation and Technology Management*, 1, 54–68.
- Alzoubi, A. (2022). Machine learning for intelligent energy consumption in smart homes. *International Journal of Computations, Information and Manufacturing*, 2, 2022.
- Alzoubi, H. M., Ahmed, G., Al-Gasaymeh, A., & Al Kurdi, B. (2020). Empirical study on sustainable supply chain strategies and its impact on competitive priorities: The mediating role of supply chain collaboration. *Management Science Letters*, 10, 703–708.
- Alzoubi, H., Alshurideh, M., Kurdi, B. A., Akour, I., & Aziz, R. (2022a). Does BLE technology contribute towards improving marketing strategies, customers' satisfaction and loyalty? The role of open innovation. *International Journal of Data and Network Science*, 6, 449–460.
- Alzoubi, H. M., Ahmed, G., & Alshurideh, M. (2022b). An empirical investigation into the impact of product quality dimensions on improving the order-winners and customer satisfaction. *International Journal of Productivity and Quality Management*, 36, 169–186.
- Alzoubi, H. M., Elrehaeil, H., Hanaysha, J. R., Al-Gasaymeh, A., & Al-Adaileh, R. (2022c). The role of supply chain integration and agile practices in improving lead time during the COVID-19 crisis. *The International Journal of Service Science, Management, Engineering, and Technology*, 13, 1–11.
- Alzoubi, H., Alshurideh, M., Kurdi, B., Alhysasat, K., & Ghazal, T. (2022d). The effect of e-payment and online shopping on sales growth: Evidence from banking industry. *International Journal of Data and Network Science*, 6, 94–109.
- Alzoubi, H. M., & Aziz, R. (2021). Does emotional intelligence contribute to quality of strategic decisions? The mediating role of open innovation. *Journal of Open Innovation: Technology, Market, and Complexity*, 7, 130.
- Alzoubi, H. M., Vij, M., Vij, A., & Hanaysha, J. R. (2021). What leads guests to satisfaction and loyalty in UAE five-star hotels? AHP analysis to service quality dimensions. *Enlightening Tourism. A Pathmaking Journal*, 11, 102–135.
- Alzoubi, H. M., & Yanamandra, R. (2020). Investigating the mediating role of Information sharing strategy on agile supply chain in supply chain performance. *Uncertain Supply Chain Management*, 8, 273–284.
- Aziz, N., & Aftab, S. (2021). Data mining framework for nutrition ranking: Methodology: SPSS modeller. *International Journal of Innovation and Technology Management*, 1, 85–95.
- Butt, S. M. (2022). Management and treatment of type 2 diabetes. *International Journal of Computations, Information and Manufacturing*, 2, 1.

- Cozzolino, A., Verona, G., & Rothaermel, F. T. (2018). Unpacking the disruption process: New technology, business models, and incumbent adaptation. *Journal of Management Studies*, 55, 1166–1202.
- Cruz, A. (2021). Convergence between blockchain and the internet of things. *International Journal of Innovation and Technology Management*, 1, 34–53.
- Durowoju, O., Chan, H. K., & Wang, X. (2020). Investigation of the effect of e-platform information security breaches: A small and medium enterprise supply chain perspective. *IEEE Transactions on Engineering Management*, 1–16.
- Farouk, M. (2021). The universal artificial intelligence efforts to face coronavirus COVID-19. *International Journal of Computer Integrated Manufacturing*, 1, 77–93.
- Fernandes Rodrigues Allves, M., Vasconcelos Ribeiro Galina, S., & Dobelin, S. (2018). Literature on organizational innovation: Past and future. *Innovation & Management Review*, 15, 2–19.
- Fosso Wamba, S., Queiroz, M. M., & Trinchera, L. (2020). Dynamics between blockchain adoption determinants and supply chain performance: An empirical investigation. *International Journal of Production Economics*, 229, 107791.
- Gupta, S., & Antony, J. (2017). Top ten reasons for process improvement project failures. *International Journal Lean Six Sigma*, 10.
- Hamadneh, S., Pedersen, O., Alshurideh, M., Kurdi, B. A., & Alzoubi, H. M. (2021). An investigation of the role of supply chain visibility into the Scottish blood supply chain. *The Journal of Legal, Ethical and Regulatory Issues*, 24, 1–12.
- Hanaysha, J. R., Al-Shaikh, M. E., Joghee, S., & Alzoubi, H. M. (2022). Impact of innovation capabilities on business sustainability in small and medium enterprises. *FIIB Business Review*, 11, 67–78.
- Hanaysha, J. R., Al Shaikh, M. E., & Alzoubi, H. M. (2021). Importance of marketing mix elements in determining consumer purchase decision in the retail market. *International Journal of Service Science Management Engineering and Technology*, 2, 56–72.
- Ibrahim, B. (2019). Modeling impact of project management performance with among roles of project risk management and organizational culture on project success. *European Journal of Business Management*, 11, 44–48.
- Joghee, S., Alzoubi, H. M., & Dubey, A. R. (2020). Decisions effectiveness of FDI investment biases at real estate industry: Empirical evidence from Dubai smart city projects. *International Journal of Scientific & Technology Research*, 9, 3499–3503.
- Kashif, A. A., Bakhtawar, B., Akhtar, A., Akhtar, S., Aziz, N., & Javeid, M. S. (2021). Treatment response prediction in hepatitis c patients using machine learning techniques. *International Journal of Innovation and Technology Management*, 1, 79–89.
- Khan, S. N., Shael, M., & Majdalawieh, M. (2019). Blockchain technology as a support infrastructure in E-Government evolution at Dubai economic department. In *ACM International Conference Proceeding Series* (pp. 124–130).
- Kumares, S., & Baskaran, R. (2010). Defect analysis and prevention for software process quality improvement. *International Journal of Computers and Applications*, 8, 42–47.
- Kurdi, B. A., Alshurideh, M., Akour, I., Alzoubi, H. M., Obeidat, B., & Alhamad, A. (2022a). The role of digital marketing channels on consumer buying decisions through eWOM in the Jordanian markets. *International Journal of Data and Network Science*, 6, 1175–1185.
- Kurdi, B. A., Alzoubi, H. M., Akour, I., & Alshurideh, M. T. (2022b). The effect of blockchain and smart inventory system on supply chain performance: Empirical evidence from retail industry. *Uncertain Supply Chain Management*, 10, 1111–1116.
- Kurdi, B. A., Alshurideh, M., Akour, I. (2022). The effect of social media influencers' characteristics on consumer intention and attitude toward Keto products purchase intention. *International Journal of Data and Network Science*, 6, 1135–1146.
- Lee, K. L., Azmi, N. A. N., Hanaysha, J. R., Alzoubi, H. M., & Alshurideh, M. T. (2022a). The effect of digital supply chain on organizational performance: An empirical study in Malaysia manufacturing industry. *Uncertain Supply Chain Management*, 10, 495–510.

- Lee, K. L., Romzi, P. N., Hanaysha, J. R., Alzoubi, H. M., & Alshurideh, M. (2022b). Investigating the impact of benefits and challenges of IOT adoption on supply chain performance and organizational performance: An empirical study in Malaysia. *Uncertain Supply Chain Management*, 10, 537–550.
- Mehmood, T., Alzoubi, H., Alshurideh, M., Al-Gasaymeh, A., & Ahmed, G. (2019). Schumpeterian entrepreneurship theory: Evolution and relevance. *Academic Entrepreneur*, 25, 1–10.
- Mehmood, T. (2021). Does information technology competencies and fleet management practices lead to effective service delivery? Empirical evidence from e-commerce industry. *International Journal of Innovation and Technology Management*, 1, 14–41.
- Miller, D. (2021). The best practice of teach computer science students to use paper prototyping. *International Journal of Innovation and Technology Management*, 1, 42–63.
- Müller, R., & Turner, R. (2010). Leadership competency profiles of successful project managers. *International Journal of Project Management*, 28, 437–448.
- Sadiq, M., Shahid Iqbal, M., Sajad, M., & Naveed, K. (2016). Software project management: Tools assessment, comparison and suggestions for future development cloud computing security threats & security guidelines view project bioenergy production prediction view project software project management: Tools assessment. *IJCSNS International Journal of Computer Science and Network Security*, 16, 31–42.
- Saleh, M. M. A., Jawabreh, O. A. A., Al Om, R., & Shniekat, N. (2021). Artificial intelligence (AI) and the impact of enhancing the consistency and interpretation of financial statement in the classified hotels in Aqaba, Jordan. *Academy of Strategic Management Journal*, 20, 1–18.
- Shamout, M., Ben-Abdallah, R., Alshurideh, M., Alzoubi, H., Al Kurdi, B., & Hamadneh, S. (2022). A conceptual model for the adoption of autonomous robots in supply chain and logistics industry. *Uncertain Supply Chain Management*, 10, 577–592.
- Wagner, T., Herrmann, C., & Thiede, S. (2017). Industry 4.0 impacts on lean production systems. *Procedia CIRP*, 63, 125–131.
- Xinxian, C., & Jianhui, C. (2022). Digital transformation and financial risk prediction of listed companies. *Computational Intelligence and Neuroscience*, 2022, 7211033.
- Yanamandra, R., & Alzoubi, H. M. (2022). Empirical investigation of mediating role of six sigma approach in rationalizing the COQ in service organizations. *Operations and Supply Chain Management: an International Journal*, 15, 2579–9363.
- Zubizarreta, M., Ganzarain, J., Cuadrado, J., & Lizarralde, R. (2021). Evaluating disruptive innovation project management capabilities. *Sustainable*, 13, 1–22.

Systematic Literature Review and Assessment for Cyber Terrorism Communication and Recruitment Activities



Romil Rawat, Josefa Díaz-Álvarez, and Francisco Chávez

Abstract Terrorist Network Analysis has been one of the most commonly discussed ways for safeguarding Online Social Network accessing and transmission through decentralized, trustless, peer-to-peer networks since Gabriel Weimann's research paper on *Cyberterrorism* published in 2005. This study analyzes peer-reviewed literature attempting to use Terrorist Network Analysis for Cybercrime and gives a comprehensive analysis of the most often used Terrorist Network Analysis Security applications. The Proposed Finding recommends Malicious activities (Messages and Post relating to Terrorist events on Social Networking) for alerting users, so that they could cut away his/her communication from Malicious Actors and also help Security Agencies to identify possible Attacks and Vulnerabilities on modern Online Social Network, their main reasons and countermeasures. This systematic study also offers light on future directions in Terrorist Network Analysis and Cybercrime research, education, and practices, such as Terrorist Network Analysis security in Online Social Network, Security for Machine Learning and automated techniques.

Keywords Cyber attack · OSN · Cyber terrorist · Propaganda · Terrorist communication · Terrorist network analysis

R. Rawat
University of Extremadura, Badajoz, Spain

J. Díaz-Álvarez (✉)
Computer Architecture and Communications Department, University of Extremadura,
Centro Universitario de Mérida, Mérida, Spain
e-mail: mjdiaz@unex.es

F. Chávez
Computer and Telematics Systems Department, University of Extremadura. Centro Universitario de Mérida, Mérida, Spain

1 Introduction

Terrorist network analysis (TNA) technology is an advance Security procedures to identify Terrorist activities (Weimann, 2005; Yarlagadda et al., 2018) on Dark Web (DW) in terms of functionality and design patterns. The OSN (Online Social Network) is traced by Security agencies to track shared contents used by Terrorist for Recruitment and Drug Supply on Social Network, so that alert can be generated to Security agencies with account details and locations. The main finding focused towards:

- Analysis of Code-Words used for Communication.
- Methods of Communication at DN.
- Process of Drug Order and delivery at international location.
- Response on interested youth for joining the Terrorist camp.
- How the Terrorist organization generates Post, Mail and Messages on DW.
- Why Terrorist feels safe on DW and succeeds in their Message transfer and Recruitment.
- Automatic mail sent to Police when, Terrorist or Drug Related mail, Message or Post appeared on browser.

The main activities conducted by Cyber terrorist aim to cause heavy human loss and damage critical infrastructures (Aitkin et al., 2017) like—human injury, Cyber Ex- plosions, Plane Crashes, the Water Contamination, Nuclear Plant Hacking (Mishra et al., 2020), Antique Trafficking, Illicit Trafficking for Cultural Goods, Antiquities and Art- Works (Alzoubi et al., 2022). As terrorists use the most advanced techniques, LEAs are persistently evaluating new ways to provide robust evidence to detect and block terrorist activities (Alzoubi & Aziz, 2021). In this light, large dataset on terrorist recruitment and the OSN environment related to drug trafficking are needed to be evaluated. Since the launch of the first Fundraising by Virtual Currency (FVC) TNA (Malm et al., 2016), new TNA systems have evolved with Open accessibility outside of existing fiat currencies and electronic systems, such as Bitcoin (Rehman et al., 2022) for anonymous transaction at online channels (Gutfraind & Genkin, 2017). Recently, a rising number of scientific studies (Choudhary & Singh, 2018) have concentrated on TNA technique, and the distinctive trust and reliability properties caught the attention of investigators, programmers, and business professionals. Without a doubt, TNA has become more and more prominent all across the world. Instead of only gaining popularity, it has had a long-lasting effect on the world (Burcher & Whelan, 2018). For instance, it has been used extensively, affected world monetary marketplaces (Farooq et al., 2018), and promoted the growth of illicit DW marketplaces (Hanaysha et al., 2021a). It has also contributed to the growth of financially motivated cyber attacks (CA) like cryptolocker threat against retailers and other digital enterprises.

The industries have realized the use and value of a trust-less, decentralized digital currency and latest events don't help to be generally adopted the system historical immutability (McMillan et al., 2020), and are attempting to adapt the key concepts to

their present business processes (Zafar et al., 2022). The TNA technology's unique qualities make its application appealing in a variety of fields, including banking, logistics, the pharmaceutical and, most crucially in Cybercrime Terrorist events (Auer et al., 2022). Beyond digital currency payments used for cyber Terrorist Recruitment, there is a developing trend. The TNA could enable a newer set of decentralized apps without intercessor and serving the foundation for important components of Digital infrastructures Security. As a result, it's critical to find existing research on the application of TNA to the problem of cybercrime in order to understand how developing technologies can help minimize emerging dangers (Yanamandra & Alzoubi, 2022). It is crucial to map out pertinent manuscripts and scholarly working, to determine the existing research in relation to TNA and Cybercrime (Alzoubi & Ahmed, 2019).

This study focuses on the available literature on the use of TNA as a assisting technology for Cybercrime applications, such as domains of business linked to Data Privacy, Integrity, Security, and Accountability with its usage in Networked Channels like the OSN (Ali et al., 2022a). Our main purpose is to create a community- driven initiative to promote a better understanding of TNA and Cybercrime by examining the relationship between the two commonly discussed disciplines. To do this, review on existing models and studies on TNA Cybercrime is to be done and apply findings to newer areas.

1.1 Available Research and Findings

Based on the review, there appear to be few Systematic Literature Review (SLR) in regard to the application of TNA to the problem of Cybercrime.

Hanaysha et al., 2021a) published research article for tracing terrorist activities and behaviors at Social Media Network(SMN) (Ali et al., 2022a). The authors of this paper discuss the challenges and issues that come with using security frameworks in a centralized systems in the domains of OSN channels Authentication (Ali et al., 2021; Gundabathula & Vaidhehi, 2018). This study, in our opinion, provides a good starting point for other researchers that are concerned in TNA-based, Network handling Security. Beside from that, a less number of reviews on TNA and its larger influence have been published, which we will review below to compare and contrast the topics chosen by the writers with our research. (Berlusconi, 2017) ran a SLR to see what research findings have been published on the general notion of TNA technology (Zuberi, 2018). They didn't look at legal, economic, or regulatory research, instead focusing on publications about TNA technology (Hanaysha et al., 2021b). They discovered around 80% of research publications are about FVC initiatives, with a frequent topic of system Security & Privacy. Since 2016, the applications for TNA widened, thus our study will look into what research has been done specifically on Cybercrime and TNA applications.

Kadoguchi et al., 2020) administered an SLR on the usage and tractability of TNA, particularly in connection to OSN and other peer-to-peer communicative

Table 1 Research questions

Request question	Description
RQ1: Which applications for online social networks (OSNs) are security-focused?	TNA's has been the most discussed topic among Security agencies to detect their activities and channels used by Criminals and Recruiters at Online Platform
RQ2: What are the different terrorist communication techniques and methods?	OSN is the collection of multiple platform (Whatsapp, Facebook, Twitter, Instagram etc.), where Cyber offenders searches for target(users) to isolate from his relatives, in this way Criminals encourages target to follow Terrorist Ideologies
RQ3: What is List of Datasets covering Cyber Terrorism related information?	Millions of contents(Audio, Video, Text, Images) are continuously generating at OSN Platform, the researchers and Security agencies are Tracking Vulnerable contents and creating automated system to detect Malicious activities when matched with data collected from OSN Criminal Channels

modes (McElreath et al., 2018). The study not considered TNA's broader influence on Cybercrime. They suggested that future study include an evaluation of real-world applications, the foundation of our investigation of how TNA can affect Cybercrime issues (Alshurideh, et al., 2022). Existing preceding studies addressing the questions about the wider usage of TNA technology among all none of them focused for improving and proposing Cybercrime solutions. TNA research has a relatively brief history about for rapidly progressing. To lead new research activities, a fresh summary of modern exploration about works in the realms of TNA and Cybercrime is prerequisite.

1.2 *Research Objectives*

An objective of this evaluation is to review available findings to outline assessment task in TNA applications for Cybercrime. We generated three study questions, as indicated in Table 1, to help focus our efforts.

1.3 *Design and Contributions*

The SLR adds to existing research by providing the contributions for anyone interested in TNA and Cybercrime to advance their research:

- Till early 2022, we found 53 elementary studies on TNA and Cybercrime. This list of studies can be used by other Researchers and security agencies to expand their investigation in this area.
- 30 elementary studies that match the quality standards we established were identified (Kadoguchi et al., 2020). These reviews could serve as crucial metrics for contrasting research of a comparable work to explain.
- We administered a detailed assessment of data included at subset of 30 elementary exploration and offer the findings in order to studies TNA and Cybercrime model design considerations.
- We give a Meta-Analysis in terms of TNA implementation approaches for improving the Security of existing and OSN analysis technologies. To encourage future work in this area, we make representations and develop guidelines.

The manuscript is structured as follows: Results related to the previously mentioned study objectives are described in Sects. 2; 3 abridges the results of all of the elementary studies that were chosen; The procedures used to systematically select the elementary studies for analysis are mentioned in Sects. 4; 5 wraps up the study and makes some recommendations for further research.

2 Related Work

Yli-Huumo et al. (2016) created a Vulnerability Detection Framework based on the Artificial Fish Swarming Algorithm (AFSA) and a Back Propagation NN (BPNN). The approach enhances classification Accuracy by optimizing the weights of the BPNN, reducing sample training time and improving classification accuracy.

Broadhurst et al. (2017) proposed a hybrid classifiers that combines Kernel Principal Component Analysis (KPCA), Radial Basis Function NN (RBFNN), & PSO. The KPCA is also applied to reduce the data dimensionality. The Radial Basis Function (RBF) NN's fundamental classifier is the PSO technique, which is used for optimizing the RBFNN's parameters.

Taylor et al. (2020) introduced "Query Probing", an automated Deep-Web categorization approach that extracts information from DeepWeb data origins, which is frequently applied in Supervised Learning Algorithms (SLA) & Visible Form Features. (Arora et al., 2019) administered an empirical investigation on the Web of several worldwide extremist organizations to see how sophisticatedly they spread their ideology. Sentiment analysis, the Opinion Mining (Tian & Liu, 2010), and influence analysis of user postings on Web forums have all been studied, as well as the finding of user roles and their ties (Alnuaimi et al., 2021).

Xu et al. (2011) devised a technique using the Particle Swarm Optimization (PSO) algorithm to enhance BPNN in a IDS. The preprocessing phase carries out the feature selection process applying the Principal Components Analysis (PCA) method to reduce the dimensionality on the original Dataset.

Ghazal et al. (2022) presented a strategy for MLP-based IDS that may be employed in an offline mode for vulnerabilities perception. A Multilayer Perceptron (MLP), and Neural classifier is utilized in this work to discriminate between Benign & Malicious Traffic in the flow-based NIDS. The connectivity weights for neural anomaly detector are optimized using a modified gravity search method, a recent heuristic technique.

Alshurideh et al. (2020) used real-time Incident data to create a risk Framework that evaluated the level of Terrorism danger in various areas. Along with the risk Framework, a set of guidelines was provided for predicting future Terrorist operations. The paper claimed to have a 96% accuracy rate. Using an ELA, (Noor et al., 2011) predicted Threats categories, Weapon types utilized, and target types, i.e., the sort of people on whom an Attack is made. The accuracy of the document is reported to be in the range of 79 to 86%.

Qin et al. (2011) focused on using DM techniques to forecast Terrorist occurrences from the GTD (Global Terrorism Database). The Support Vector Machine (SVM), NB, and Logistic Regression(LR) were utilized, and they showed up to 78% accuracy. To Model the risk of TAI, (Nunes et al., 2016) applied ML Algorithms (NNET, SVM, and Random Forest(RF)). With a success rate of 96%, the programme was able to forecast the locations where TAI may occur. (Shi et al., 2015) analyzed the attitudes and persistence of Tweets preceding the TAI on Security personnel on 2016(18—September) by four separate Attackers. Different aspects of tweets were considered, such as the most recent Retweet, the numbers of Retweets, and favorites, to investigate the sentiments of Tweets.

Yarlagadda et al. (2018) used five different ML Models, including SVM, ANN, NB, RF, and Decision Trees(DT), to predict threat type, Attack range, and Weapon type, with an accuracy of over 90%. (Sheikhan & Jadidi, 2014) anticipated Terrorist unit activity by proposing a comprehensive framework that incorporates Social Network Analysis(SNA), Wavelet Transform and the Pattern Recognition Methodologies to understand terrorist unit dynamics and predict attack conduct. The methodology, according to the report, has generated authentic predictions about terrorist unit behavior.

Using data from TAI in Southeast Asia from 1970 to 2016, (Toure & Gangopadhyay, 2016) refined the site selection algorithm having multisource elements and spatial characteristics. The Framework was used to create a TAI spatial risk assessment Framework. According to the paper, it can attain an accuracy of up to 88%.

Saha et al. (2017) employed geospatial statistics to evaluate the spatio-temporal evolution of Terrorist Incidents in Indo-China in another study. Using 15 driving factors, RF is utilized to estimate the danger of Terrorist acts. (Mo et al., 2017) focused on studying the GTD Dataset and making predictions on several aspects that may have contributed to the defeat of Terrorism (Joghee et al., 2020). To understand the Dataset with predicting divergent factors in the success of the TAI, the unit that was involved, and the effect of different external factors, DM and ML algorithms such as SVM, RF, and LR were used (Ding et al., 2017) to established a system that analyses Terrorist units' development or decay over time, location, types of Attack, Target Motives, Weapon category, and availability (Ali et al., 2021).

Based on Sentiment Analysis, (Garg et al., 2017) developed a system for detecting and classifying SMN-based Extremist associations. The goal was to categories Tweets into two classifications: extreme and non-extremist. To categories the Tweets, the system use Deep Learning(DL)-based Sentiment Analysis.

Li et al. (2018) had utilized and analyzed compared with previous surveyed research, gave analytical metrics that were more authentic in profiling the genuine attribute of Criminal Networks (Alnazer, et al. 2017). The Authors recommended that future study may be undertaken by utilizing LR, RF, SVM and NN to generate various comparative findings.

Trends in DNN (Deep Neural Networks) designs and their influence on parallelization tactics for Cybercrime analysis were described by Zhang et al. (2018). They examined and modelled a variety of concurrencies in DNNs, including distributed DL, single operators, and concurrent network interpretation and training (Mehmood et al., 2019). Additionally taken into consideration were distributed configurations, neural design search, and nonsynchronous stochastic optimization. Furthering their research on the potential for parallel processing in DL, they found that speeding up DNN training is a big issue. They tested a variety of Methods, including distributed algorithms and low-level circuit designs (Rehman et al., 2022).

The Latent Dirichlet Analysis (LDA) (Hao et al., 2019) approach was used to find latent themes in the content of a DW Page. LDA is a generative Framework for detecting themes in a text corpus by calculating the likelihoods of each document and then capturing words and documents that are exchangeable (Ghazal et al., 2022). Detecting com-munity key-members might be aided by locating Threatened subjects. A study was administered to extract essential members of a group using LDA to discover Terrorized themes by incorporating LDA into DW sites to improve SNA. Using the strategy, you may determine a member's radical and put them into expert or important categories according on the issue. This study is confined to DW sites that utilize English as a communication language and is carried out on a single forum (El Khatib et al., 2022).

The University of Hong Kong's CISC (Agarwal et al., 2019), published the Framework for Dark Net(DN) Threat Intelligence by highlighting the concept of Hidden Threat Intelligence review to identify the techniques used for identifying vulnerable activities.

Maniraj et al. (2019) developed a coherence-based spectral clustering technique to detect DW clusters taking into account the temporal coherence of user activity rather by contents or connections as the core data. They portrayed a set of users for multivariate, m-dimensional process, which was used to produce the spectral density matrix, which was then used to compute the spectral coherence score, which was then used to identify the clusters (Ali et al., 2022b).

Tian and Liu (2010) looked for Cyber Threat Intelligence on the DW and English Deep-Web forums and markets. They shown its feasible to identify zero-day vulnerabilities, map user/vendor connections, and undertake subject categorization, Authors uncovered 16 zero-day vulnerabilities by monitoring forum discussions in DN markets. Their binomial classification approach integrated supervised and

semi-supervised classifiers to decrease training data labeling needs (Label Propagation & Co-Training). The Unsupervised k-Means Clustering was used to divide DW marketplace goods into 34 clusters using character level N-Gram characteristics (Ahmad et al., 2019).

Bellemare et al. (2017) demonstrated a web-text content-based categorization pipeline that identified illicit TOR (The Onion Router) and DN platform activities. They used three separate Supervised Classifiers with two well-identified text representation approaches (Frequency Inverse Document Frequency(TFIDF) and Bag-of-Words) (LR, SVM, and NB).

Bellemare et al. (2017) devised a system for automatically labeling threads that are likely for triggering private messages in order to evaluate private interactions. this study were used to investigate the underground forum economy and members' social interactions.

A light-weight system for detecting was described in Morshed (2020) with new threats termed deep-full-range (DFR). The system used DL for encrypted Traffic categorization and vulnerabilities perception.

Bellemare et al. (2017) suggested an IDS for real-time data processing and analysis based on a distributed DL Framework with DNNs. They employed the suggested with open available dataset DNN Framework to detect threats and intrusions by collecting host and network-based information in real time. Authors compared this framework to other traditional ML approaches using several tests. Open available datasets such as NSL-KDD and UNSW-NB15 were used. The DNN outrun other models in the binary classification scenario, according to the results.

Bellemare et al. (2017) proposed an approach for intrusion detection using PCA and information gain (IG). Multilayer perceptrons (MLPs), Instance-Based Learning Algorithms (IBKs), and SVM were used to classify Cyber vulnerabilities associated by OSN platforms. To test their Framework, they used Kyoto 2006+ , NSL-KDD, and ISCX 2012.

Several jurisdictions authorized frameworks given by Rawat et al. (2021) characterize the threats banned criminal offences. The job of combating licit events relating to crime- offender is entrusted to Law Enforcement Agencies (LEA). Analyst shows multiple analysis & prediction tactics to the organizations undertaking the research.

Using crime data collected by Al Nabki et al. (2017), Overdorf et al. (2018) from SMN, a big data and ML architecture was created. Volunteered Geographical Information, online, and mobile offence reporting techniques were utilized. The NB was utilized to cause crime predictions from the gathered data. The purpose of forecasts is to spot the location of inherent crimes so that they might be avoided. A demographic and the geographical data from past years' occurrences was used to forecast TAI (McElreath et al., 2018) in India.

Terrorism (Vinayakumar et al., 2019) may devastate a society and have a significant impact on its citizens. Over the last few decades, substantial expedition has been administered to better understand the causes of Terrorism and how to establish an efficient Counter-Terrorism system to lower the likelihood of Terrorist Attacks and Infringement(TAI).

Salo et al. (2019) created a Classification Framework, which could be prone to being Terrorist targets and comprises illicit events (internal, exterior, natural, unnatural events, and man-made). They've created a new approach of Security analysis that forecasts vulnerable event uncertainty. On the basis of a 2D arrangement, created a visual analytical approach for successfully identifying connected entities like Terrorist units, events, and coordinates.

Vinayakumar et al. (2019) introduced an ELA(Ensemble Learning Algorithm) that uses four different classifiers to categories and predict Terrorist units: NB, K- Nearest Neighbors(KNN), Iterative Dichotomiser 3(ID3), and the Decision Stump(ML Model). The authors showed the prediction of Illicit Events associated Terrorism Activities. Garg et al. (2017) created a neural network(NN)-based Counter Terrorism system. The researchers used a game created by Criminologists and Psychologists to collect data that might be used to examine the applicability of Artificial Intelligence (AI) techniques application for Counter-Terrorism occurrence. Researchers looked into NN and found that they could detect Illicit behavior with a 60% success rate to test.

The data used by McElreath et al. (2018) to assess cybercrime was publicly obtainable information from SMN sites such as Facebook, Instagram and Twitter. The F-measure value were utilized to collate the algorithms and design. The RF algorithm proved the best match in the circumstance, having an accuracy of 80%. Using the Models described previously the Cyber-threats were identified automatically to analyze cybercrime Through the screening programme given by Shi et al. (2015), real-time offence information from the Online social network news and classification algorithms the SVM, Multinomial NB, and RF are used. Values were categorized into Criminal and the Non-Criminal for delivering news review.

Jha et al. (2019) introduced a Hybrid Anomaly Detection approach, an platform for filtering network traffic and detecting malicious network activity. The platform employs a protocol analyzer and a association of linear & learning algorithms filter and extract characteristic CA qualities and features, while the learning algorithms employ these attributes and features to detect new forms of threats.

Jha et al. (2019) used ML as an "active defence" against CA to efficiently gather threat intelligence from the DW.

Jha et al. (2019) discusses the usage of a hybrid HAD algorithm technique for NN training in the context of intrusion detection system (IDS). It provided related studies using Swarm Intelligence approach to train NN for the goal of vulnerabilities perception to put this usage in context and emphasize the position of the introduced approach in the literature.

Using data about real Cybercrime incidents in India, Holt et al. (2022) applied SVM algorithms to classify data from Cybercrime. The accuracy was 99% in predicting Crimes, split down on time consumed on analysis & manual reporting.

The Holt et al. (2022), Uddin et al. (2020) analysis used 39 different categories of crime census from San Francisco. Gradient Boosted Trees (GBT) and SVMs were used to create a paradigm that divides offenses into two categories: violent and non-violent crimes and blue-white collar offences. Blue-collar and white-collar violations were categorized with excellent accuracy.

Corallo et al. (2022) proposed an Invasion Internet Traffic Framework for the IDS based on a DL mechanism using a 1-Dimensional Convolutional NN (1DCNN). Used for vulnerable system Traffic Management. Experimental tests were carried out using the open available UNSW-NB15 Dataset obtaining a detection accuracy of 0.9091. The 1D-CNN outrun other Frameworks in binary classification, according to the findings.

Corallo et al. (2022) utilized a ML system to examine and predict the likelihood of threats in different places. The analysis attempted to link the unidentified terrorist act to known Terrorist organizations.

According to the article, the approach exposes links between different OSN channels that are difficult to discover with traditional methods (Monshizadeh et al., 2019) comparison that has been adjusted to include the Criminal's activities of time. Furthermore, malicious attack software (viruses, worms, Trojan horses, spyware, as well as espionage) that is installed on a user's machine without that user's consent has been used by assailants more frequently. Threats from social engineering are the most challenging to combat. They are carried out by taking advantage of the victim's system design flaw and are based on technical knowledge, cunning, and persuasion.

3 Research Techniques

This SLR, following the guidelines presented by Ghanem et al. (2020), try to answer the questions stated in Table 1. The strategy for evaluation of SLR, projecting, directing and reporting phases of reviews in iterations is followed.

3.1 *Selection of Elementary Studies*

This section details the methodology followed to select the elementary studies. Firstly, keywords were entered into Search Engine's searching function to emphasize elementary studies. Table 2 shows the Digital Library platforms accessed in this study. The keywords were identify to aid in the discovery of study findings. "AND" and "OR" were the exclusive Boolean operators obtainable. The search terms were as follows: ("Terrorist Recruitment" OR "Hate Speech" OR "Fundraising") AND "Cybercrime" ("Terrorist Networks" OR "Fundraising" OR "Terrorist Communication") AND ("Cyber Crime" OR "Cyber Threat" OR "Darkweb Crime" OR "Dark-Web Crime" OR "Online Social Network Threat").

Based on the searching platforms, the probe were administered using the title, keyword, or abstract. On March 25th, 2022, we did the reviews and processed all work that had been published up to that point. These searches produced refined results based on inclusion/exclusion constraints. The criterion permitted to generate

Table 2 Digital library platforms accessed in the search engine phase

Digital library
ScienceDirect
ACM
Google scholar
IEEE Xplore
Springer search

a collection of findings using snowballing process (Ch et al., 2020) based on process using forward and backward iterations search is done until no more manuscript meeting the criteria for inclusion.

3.2 Criteria for Article (Inclusion and Exclusion) Analysis

Existing technological TNA applications, and commentary on the development of current cyber vulnerability analysis measures through TNA integration are examples of studies that could be included in this SLR. They must have undergone peer review and be written in English. The Article associated with Cyber Terrorism Communication and Recruitment Activities, events and processes, related to online activities are first taken into consideration. The Article only dealt with general information were excluded from the research. Because Google Scholar has the potential to generate underneath-grade publications, results associating with Google Scholar will be evaluated for concurrence with the criteria. This SLR will only feature the recent version of a review.

Elementary Studies Filtering Technique are shown in Table 3 and *Review Criteria* in Table 4 listed the main criteria for paper inclusion and exclusion.

Table 3 Elementary Studies Filtering Technique. General inclusion and exclusion criteria in this review are presented

Inclusion	Exclusion
Paper need to include Empirical Data on the deployment and use of TNA	Papers focusing on general discussion or relating to business promotion
Information about TNA or Online Social Network Crime, Extremism and Propaganda Analysis	An Grey literature containing Blogs, Posts, News and Government Documents
Must be the peer-reviewed work that has been found in a reputed journal and conference proceedings	Papers—Non-English

Table 4 Review criteria. The specific review criteria for TNA research are described

Review Process	Details
TNA	The paper must be focused on the application of TNA domains to a defined problem that is well-addressed
Context	To enable for authentic research interpretation. study aims and findings is to be placed in perspective
TNA application	For addressing the research-questions RQ1 and RQ2, enough specifics is required for offering an authentic presentation
Security context	In order to aid in answering RQ3, the manuscript should provide an elucidation for the cyber threats security concern
TNA performance	Comparisons of different TNA applications for evaluating the performance
Data acquisition	To determine precision, specifics regarding how the details was collected, measured, presented and reported must be provided

3.3 Outcome Identification

At the initial keyword searching on the indicated library, around 799 studies were identified. After deleting duplicate research, the total count was shortened to 693. After reviewing the research against the Inclusion–Exclusion criteria, there were 83 papers left to read. The 83 papers were read, and the Inclusion/Exclusion criteria were reapplied, yielding 41 Manuscripts. The snow- balling process, Forward (7) and backward (5) revealed an additional outcomes, bringing the total count included to 53.

3.4 Qualitative Assessment

The quality of elementary research was assessed using the guidelines laid forth by Ghanem et al. (2020). This acknowledged for an evaluation of the manuscripts relevance to the issues with indicators of evaluation bias and the reliability of exploration data. The evaluation action was based on that of Singh et al. (2020). To examine their effectiveness, six papers were chosen at random process:

This quality-control checklist was then applied to all other elementary studies found. As demonstrated *Review Criteria* Table 4, 11 studies failed to meeting the checklist requirements and were consequently deleted from the SLR.

3.5 Data Extraction Process

The Contents was taken from articles passing the quality assessment (QA) to analyze the entirety of data and to test the authentic recording of details included within

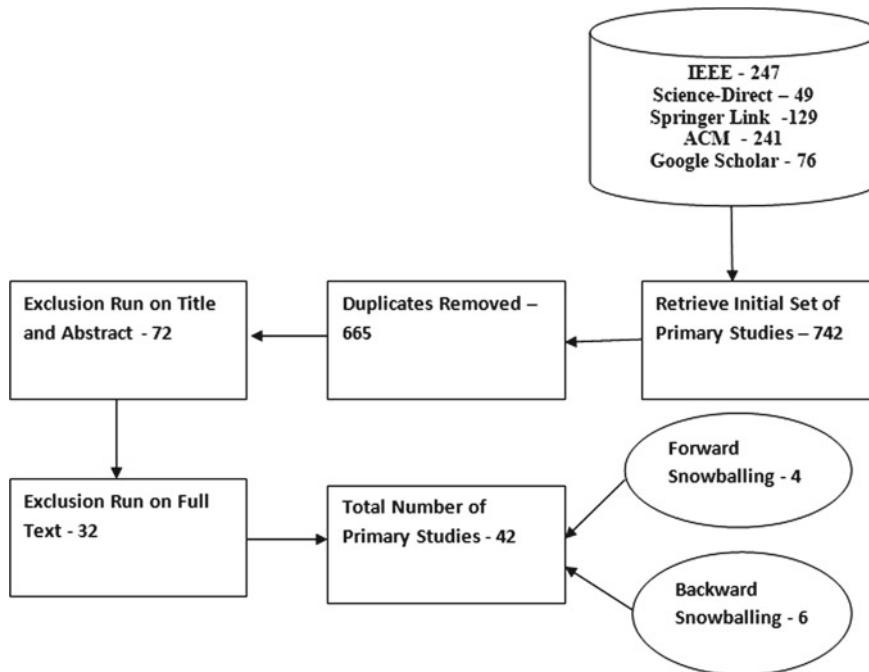


Fig. 1 General schema for paper processing and categorization

the papers. The data extraction procedure was tested on six research in the beginning before being enlarged to encompass the entire collection of reviews passing the quality evaluation step. Each Data is formulated in spreadsheet, then data was bifurcated into the following classes: Data relating the study's goal is known as context data. Findings with conclusions referring as qualitative information refers to data association through testing and analysis. By the first keyword probe on all libraries through the final selection of elementary studies. Figure 1 displays the count of papers collected during the process, as well as the Categorization rate of manuscripts.

3.6 Data Analysis

The details are compiled containing the information of qualitative and quantitative (QQ) information classes to satisfy the purpose of representing the review questions. We also performed a meta-analysis on the reviews related to the final information releasing procedure.

Table 5 Research publications distribution in analysis

Year	Publications
2017	10
2018	11
2019	11
2020	25
2021	22
2022	8

3.6.1 Research Publications

Although the notion of TNA, which is linked to Cyber Terrorism (Zhang et al., 2018), was first established in 90 s, no elementary study papers were released until 2018. This could draw attention to the novelty of TNA's Cybercrime applications (Choudhary & Singh, 2018). Table 5 shows the number of elementary studies published each year. There is a growing trend in the use of TNA in the cybercrime environment (Ali et al., 2022b). We anticipate that a considerable count of research reviews on the use of TNA in real-world models will be published in the future. This Assumption is given by the count of publications up to March 2022 is only the half of total count of publications in 2021.

The examination of keywords is done at all 53 studies to describe the usual themes among the selected elementary studies. Regarding the keywords in analysis, Table 6 illustrates the count of times certain words found in each at elementary studies. Except for the keyword chosen by the author, *Terrorist Recruitment* and *Fundraising*, *Cybercrime* is the third most common term in our Dataset, after *Dark-Web Crime* and *Hate Speech* as shown in Table 6. This demonstrates a growing interest in TNA adoption in the context of OSN (Alzoubi & Aziz, 2021).

Table 6 Keywords distribution in analysis

Keywords	Number
Online social network (OSN)	2575
Hate Speech	1632
Propaganda	1287
Fundraising	1034
Recruitment	984
Terrorist communication	845
Terrorist network analysis	796
Illicit trafficking	712
Extremism	612
Cyber terrorist	598

4 Outcomes

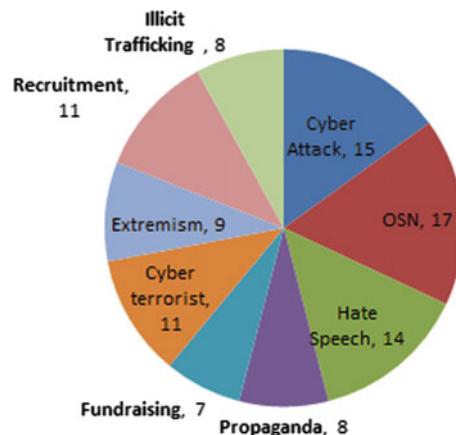
Each elementary research paper was read in its complete, with pertinent QQ data retrieved and summarized in above Tables. All of the elementary studies had a topic or theme that related to how TNA dealt with a certain issue. Table 7 listed the most recent assessments security-focused TNA applications. The emphasis of each study had further divided by wider classifications to permit for a more straightforward description of the elementary research' domains. An networks class (Kim et al., 2020) was generated for collecting the work focused on *Hate Speech* (Shandler & Gomez, 2022), *Propaganda*, *Fundraising*, *Cyber Terrorist*, *Extremism*, *Recruitment*, *Funding*, *Terrorist Communication* and *Terrorist Network Analysis* (Nukusheva et al., 2022). The percentages of distinct themes in the 30 main observation that passed the quality evaluation to be added in the data perusal are shown in Fig. 2.

About half studies (45%) on Cyber crime attributes of TNA concerning by the Security of OSN, according to the themes found in the elementary studies. With a percentage of 16, *Hate Speech* is the second most followed domain. *Propaganda* is the third most popular theme, accounting for 10% of the total. *Fundraising* is the fifth themes, each accounting for 7% of the total. The End users can utilize the TNA

Table 7 Most recent assessments security-Focused TNA applications

Mode	Details
OSN	Content Filtering and Suspicious Activity Alerting Deployment is required to guide users
Unidentified Communication	Communication with unknown or unrelated user must be firstly verified for authenticity of his/her identity
OSN Channel Automation	Suspicious and offensive related account and Propaganda based content should be identified and blocked

Fig. 2 Elementary studies theme chart



applications to authenticate with another entity or service, rather than relying on a susceptible central source of data. The fifth most popular issue concerns recruitment and how TNA can successfully record in a dispersed environment in order to intercept malicious alterations and cyber threat contents (Hao et al., 2019). *Terrorist Communication, Terrorist Network Analysis, Illicit Trafficking Extremism, Cyber Terrorist* are the last three popular themes or keywords (Başaranel, 2017; Holt et al., 2019; Hosseini et al., 2017; Jalali & Wohlin, 2012; Maniraj et al., 2019; Tierney, 2018; Turner et al., 2010) on our list, each accounting for 3% of the total.

5 Analysis and Discussion

Initial keyword searches reveal that TNA is the subject of a large number of papers. TNA are definitely still in their infancy, having barely been established for fifteen years. A remarkable count of the elementary reviews chosen are experimental hypotheses for answering the today's issues, with quality information and few actual applications. In the remaining elementary reviews, most of the practical cyber security outcomes demonstrate unique techniques for managing the wider range of problems found in Cyber Terrorism and Propaganda (Habibi Lashkari et al., 2020) sharing at OSN. The feasible solutions usually require a substantial moderation to the system's architecture, such as a vulnerable (Rewari & Singh, 2017) content identification engines.

Because of the time and effort required to upgrade the system into automated Terrorist event detection (Vinayakumar et al., 2019) change into an available systems, it is hard to test practical principles by traditional Security. OSN design concerns and their experimentation with other consensus procedures were notable outliers. To undertake their generation and experimental reviews, they used the well-known Social Network Analytics (SNA) platform. The solutions that had been appeared to be the most feasible and ready-to-deploy. SNA enables for highly flexible analytics of content links and their influence (Stevanovic et al., 2017) and centralized person for identification and Mapping or Malicious (Alshurideh et al., 2020) content origin.

The Credibility Checklist By assigning a value to individual connecting nodes (Noor et al., 2011), TNA was able to reach a consensus. The hypothesized that a hybridized TNA using both proof-of-stake and (Qin et al., 2011) proof-of-credibility proved to be resistant to Cybercrime and threat than by Proof-of-Work TNA (PoW). It shows that PoW procedures aren't the only way to ensure Crime Detection. A TNA's democratic approach gives it strength, sturdiness, and unwavering appeal. As a result, elementary investigations in general have indicated about the utilization of existing TNAs attributes is a must. Additional count of associating nodes and the finer the system for regulating mining node conduct, the greater the de-centralization and demand for individual node trust, leading towards the gains in TNA Security, sustainability and dependability.

5.1 RQ1: Which applications for online social networks (OSNs) are security-focused?

It's vital to note that the scope of this SLR is limited to Cybercrime applications of TNA, with no consideration given to other possible or present uses like Business, Health informatics or Logistics. It's worth noting that the researchers found that papers on finance and healthcare were prevalent during the categorization process used to pick the key studies. Yet each of these reviews might have showed Security threats and challenges, the identification process targeted on research that has Security at their core (Tellez Gaytan et al., 2022; Yanamandra & Alzoubi, 2022). When you consider that OSN was involved in about half of all published Cybercrime TNA applications, there are plenty of chances to improve its Security. This could be due to the widespread usage of OSN for sharing personal details and communicative medium of thought expression as well as the growing demand for OSN solutions (Nunes et al., 2016). Similarly, well-publicized media stories of threats coordinated by exploiting such communicating channels and apps may have sparked demand for remedies to Security concerns for OSN (Shi et al., 2015).

5.2 RQ2: What are the Different Terrorist Communication Techniques and Methods? [Dead Dropping (Saving in Draft) and Quiz are the most popular ones.] TNA and related technologies aren't a panacea for Cybercrime problems (Turk et al., 2020). They only reinforce existing efforts in the areas of secure communicative (Toure & Gangopadhyay, 2016) and code languages (Gundabathula & Vaidhehi, 2018).

- Patterns of Communication (Garg et al., 2017).
- Location of User activity.
- User behavior.
- Terrorist Recruitment, Funding and Propaganda related contents (Mo et al., 2017).
- Banned organization by Security agencies related account keywords and hashtags (Vinayakumar et al., 2019).
- Identification of Code Name used in OSN.
- Triggering and Violent words (Ding et al., 2017).

To maintain immutable records, TNA use filtering techniques, and many other Cybercrime solutions employ similar technology. To verify information, the most of cyber Security approaches relying on single reliable command. The system is stretched for vulnerability, and a huge count of bad actors/users could focus their attempts on a single spot to launch CA and Trigger Malware (Saha et al., 2017), inject suspicious information, or extort data through blackmail or theft.

TNAs are decentralized not relying on the authority or confidence of a single organization or network member, which gives the edge over the current security methods. Trust is not required by the system because every node/member having the complete copy of all the historical details available, and more information is only required to be added among the chain of existing knowledge by reaching bulk consent. This can be realized in a number of ways, highlighted in another portion of manuscript, but the base line is a category comprised of multiple persons having access to that details will be far more secured than a batch created by one leader with a extent of members relying at leader for details, mainly when bad actors is

group members or leaders itself. Relating towards most security-focused TNA apps revealed in RQ1, it is demonstrated how TNA used for improving the Cybercrime in OSN.

5.3 RQ3: What is List of Datasets covering Cyber Terrorism related information? the dataset details mentioned in Table 8 Huge amount of main studies agrees that actors (Criminals) influence users by understanding his personal details and contact by creating multiple chain of mind wash techniques and luring for the hidden world with unchecked powers (Terrorist activities) (Ghosh et al., 2017). That is, novel approaches for signature, fingerprinting and pattern verification of Malicious actors working at OSN (Filshtinskiy, 2013), having communicative behavior suspicious as marked by security agencies. The channel suggest that there are alternatives for relocating in that they allow recipient nodes to have wider selecting/voting power, node contributes to mining, will have over the strong faith and chain's procedure for future.

One study even looking towards the focus of depending on numerous TNA levels for trust (Albishre et al., 2015; Morgia et al., 2018), authorization and authentication among connecting layers. Few studies recommend TNA as a security based solution, yet they don't specify if a current TNA should be used or whether a new one should be built. Similarly, other study completely ignores the use of content blocking justifying

Table 8 Cybercrime datasets

Cybercrime dataset	Details
ISCXTor2016 and ISCXVPN2016 (Shandler & Gomez, 2022)	Traffic detection of Tor application
Anonymized data for the AlphaBay Online Marketplace (2014–2017). (Torres & Tranchita, 2004)	Drug and cybercrime related data
DTU (Darknet-Usage-Text-Addresses)(Pilley & Sikchi, 2014)	10 K [25 classifications of legal and illicit activities]
CIC-Darknet2020 (JSPM, W., & Tirwa, K., 2018)	Darknet traffic dataset
Darknet Market (Hasan & Zaki, 2011)	Drug database
AZSecure-Data (Borgatti et al., 2002)	Dark web, terrorist recruitment cyber attack dataset
CAIDA – UCSD (Wegberg et al., 2018)	Network telescope darknet scanners dataset
20 Newsgroups data set (20 NG Dataset) (Al-Nabki et al., 2019)	Collection of approximately 20,000 Newsgroup documents
Twitter-Dataset (Iliadis & Kaifas, 2021)	Containing time-zone (Geolocation of Crowds)
Global Terrorism Database (Bogensperger et al., 2021)	Information having around 200,000 Terrorist Attacks
Spam Assassin Corpus Dataset (Saini & Bansal, 2021)	Containing 4150 non-spam with 1897 spam emails
Ling-Spam Dataset (Dainotti et al., 2013)	Consists of 2412 Linguist emails, and 481 of the spam emails

the document that suggests some intriguing security methods without elaborating on the TNA itself (LaFree, 2010). Major studies has not justified about any method other than a PoW consent procedure that rewards recruiter able for scaling securely by levels of connected user traffic (Alzoubi et al., 2022; Kumar et al., 2012; Naksomboon et al., 2010).

Table 8 provides the detail about different Datasets relating to Cybercrime (DW) used for research and analysis and also keeps updated.

6 TNA Cybercrime Future Scope

By the findings of evaluation and our insights, it is recommend for the available TNA cyber crime reviews directions for future investigation:

With respect to TNA for OSN Security, despite current research showing that about each Manuscript on TNA Cybercrime in the SLR points towards the Security attributes for OSN, is to be strengthen if supported by TNA. The Security in OSN claimed as a crucial requirement for the by achieving the priority for enhancement and implementation (Hanaysha et al., 2021b; Zafar et al., 2022). Still fewer is communicated about the features that influence outcomes the feasibility of adopting this methodology and OSN Policing, as well as how and where it can be comprehensively used to address recent OSN risks and threats in a clear lexicon, permitting for the generation of future vectors for security domain. Proposing lightweight TNA- based solutions might also be a future study topic (Alshurideh et al., 2020; Tellez Gaytan et al., 2022; Yanamandra & Alzoubi, 2022). Millions of Users are active at OSN channels and data is collected from a variety of sources and shared through multiple countries and unknown users. AI and its variants approaches for analyzing and processing collected information allow researchers for obtaining functional reasoning in Security threat challenges (Al Nabki et al., 2017). Deceptive analysis created when illicit data is intentionally assimilated by a suspicious third-party based on adversarial inputs, despite the fact that AI may be used with distributed Channels (Alshurideh et al., 2022; Alzoubi & Ahmed, 2019). TNA, being a widely used technique, has the capability to be used for cyberspace tools and models. TNA aims to eliminate monetary system risks and Financial trickery by assuring the authenticity, trustworthiness, and integrity of data through qualities like as decentralization, verifiability, and immutability.

The answers to these problems are critical for future inquiries into TNA Cybercrime over OSN channels research (Alnazer et al., 2017; Alnuaimi et al., 2021; Joghé et al., 2020; Khatib et al., 2022; Mehmood et al., 2019). Making open-source software and datasets available to the public, as well as participating with the community: Between academics and the developer community, TNA Cybercrime research is divided. Academic must work to bridge this gap by releasing additional opensource programmes, tools, and Datasets that may be used by the industrial centers and start-ups. Indeed, because a significant groups focused in TNA analysis, academics could

actively incorporate in the creation, authorization, and perpetuation of their review findings.

7 Concluding Remark and Future Work

The study uncovered recent research on how TNA solutions may aid in the resolution of Cybercrime issues. TNA carries an absurd variety of viable features for Banking, Logistics operations, Health informatics, and Cybercrime, Terrorists' Recruitment, Fundraising, Hate Speech, Propaganda escalation according to the first keyword probe for this reviews and media sources. The emphasis of this study was primarily on assessment for Cyber Terrorism communication and Recruitment activities. The Terrorist activity identification and alerting address all challenges in the realm of Cybercrime on its alone. TNA Cybercrime solutions have grown and augmented previous attempts to improve Security and repel Criminal attackers. This study identifies potential topics for future Cybercrime research outside of the sphere of OSN. As the World Wide Web progresses toward widespread use of increasingly employ encryption and security models implementation for routinely communication, an growing need for safeguarding the cryptography surrounds it. OSN security study employing TNA apps frequently made remarks on diversity of available Online communicative modes in order to sustain the dispersed network. By the variety in available solutions used by all unit of researchers, it was not possible to quantify such data for the purposes of this work. Future study might include a comparison of OSN Channels mode vulnerability analysis and automated malicious activity blocking mechanism in TNA-based OSN Networks, as well as the standardization of data from elementary investigations.

- Funding- Not Applicable
- Ethics approval and Consent to participate-Not applicable
- Consent for publication-Not applicable
- Availability of data and materials and Code Availability-Not applicable.

Acknowledgements This work is supported by Spanish Ministry of Science and Innovation under project PID2020-115570GB-C21 funded by MCIN/AEI/<https://doi.org/10.13039/501100011033> and Junta de Extremadura, project GR15068.

Author Contributions Romil Rawat, Josefa Díaz-Alvarez and Francisco Chávez: Conceptualization, Methodology, Writing original draft preparation, Writing review and editing, Formal analysis and investigation; Josefa Díaz-Alvarez and Francisco Chávez: Funding acquisition and Supervision.

References

- Agarwal, P., Sharma, M., & Chandra, S. (2019, August). Comparison of machine learning approaches in the prediction of terrorist attacks. In *2019 Twelfth International Conference on Contemporary Computing (IC3)* (pp. 1–7). IEEE.
- Ahmad, S., Asghar, M. Z., Alotaibi, F. M., & Awan, I. (2019). Detection and classification of social media-based extremist affiliations using sentiment analysis techniques. *Human-Centric Computing and Information Sciences*, 9(1), 1–23.
- Aitkin, M., Vu, D., & Francis, B. (2017). Statistical modelling of a terrorist network. *Journal of the Royal Statistical Society: Series A (statistics in Society)*, 180(3), 751–768.
- Al Nabki, M. W., Fidalgo, E., Alegre, E., & De Paz, I. (2017, April). Classifying illegal activities on tor network based on web textual contents. In *Proceedings of the 15th Conference of the European Chapter of the Association for Computational Linguistics: Volume 1, Long Papers* (pp. 35–43).
- Albshire, K., Albatan, M., & Li, Y. (2015, December). Effective 20 newsgroups dataset cleaning. In *2015 IEEE/WIC/ACM International Conference on Web Intelligence and Intelligent Agent Technology (WI-IAT)* (Vol. 3, pp. 98–101). IEEE.
- Ali, N., Ghazal, T. M., Ahmed, A., Ahmad, M., Khan, M. A., & Alzoubi, H. M. (2022a). Fusion-based supply chain collaboration using machine learning techniques. *Intelligent Automation and Soft Computing*, 31(3), 1671–1687.
- Ali, A., Septyanto, A. W., Chaudhary, I., Hamadi, H. A., Alzoubi, H. M., & Khan, Z. F. (2022b). Applied artificial intelligence as event horizon of cyber security. In *International Conference on Business Analytics for Technology and Security (ICBATS)* (pp. 1–7). <https://doi.org/10.1109/ICBATS54253.2022.9759076>
- Ali, N., Ahmed, A., Anum, L., Ghazal, T., Abbas, S., Adnan Khan, M., Alzoubi, H. M., & Ahmad, M. (2021). Modelling supply chain information collaboration empowered with machine learning technique. *Intelligent Automation and Soft Computing*, 30(1), 243–257.
- Al-Nabki, M. W., Fidalgo, E., Alegre, E., & Fernández-Robles, L. (2019). Torank: Identifying the most influential suspicious domains in the tor network. *Expert Systems with Applications*, 123, 212–226.
- Alnazer, N. N., Alnuaimi, M. A., & Alzoubi, H. M. (2017). Analysing the appropriate cognitive styles and its effect on strategic innovation in Jordanian universities. *International Journal of Business Excellence*, 13(1), 127–140.
- Alnuaimi, M., Alzoubi, H. M., Ajelat, D., & Alzoubi, A. A. (2021). Towards intelligent organisations: An empirical investigation of learning orientation's role in technical innovation. *International Journal of Innovation and Learning*, 29(2), 207–221.
- Alshurideh, M., Gasaymeh, A., Ahmed, G., Alzoubi, H. M., & Kurd, B. A. (2020). Loyalty program effectiveness: Theoretical reviews and practical proofs. *Uncertain Supply Chain Management*, 8(3), 599–612.
- Alshurideh, M. T., Al Kurdi, B., Alzoubi, H. M., Ghazal, M., Al-kassem, A. H. (2022). Fuzzy assisted human resource management for supply chain management issues. *Annals of Operations Research*, 308(2), 617–629.
- Alzoubi, H., & Ahmed, G. (2019). Do TQM practices improve organisational success? A case study of electronics industry in the UAE. *International Journal of Economics and Business Research*, 17(4), 459–472.
- Alzoubi, H. M., & Aziz, R. (2021). Does emotional intelligence contribute to quality of strategic decisions? The mediating role of open innovation. *Journal of Open Innovation: Technology, Market, and Complexity*, 7(2), 130.
- Alzoubi, H., Inairat, M., & Ahmed, G. (2022). Investigating the impact of total quality management practices and Six Sigma processes to enhance the quality and reduce the cost of quality: The case of Dubai. *International Journal of Business Excellence*, 27(1), 94–109.
- Arora, T., Sharma, M., & Khatri, S. K. (2019, October). Detection of cyber crime on social media using random forest algorithm. In *2019 2nd International Conference on Power Energy, Environment and Intelligent Control (PEEIC)* (pp. 47–51). IEEE.

- Auer, R., Böhme, R., Clark, J., & Demirag, D. (2022). Mapping the privacy landscape for central bank digital currencies: Now is the time to shape what future payment flows will reveal about you. *Queue*, 20(4), 16–38.
- Başaranel, B. U. (2017). Online Terrorist Financing. In M. Conway, L. Jarvis, O. Lehane, S. Macdonal ve L. Nouri (Eds.) *Terrorist's Use of the Internet: Assessment and Response*, 136, 95–108.
- Bellemare, M. G., Dabney, W., & Munos, R. (2017, July). A distributional perspective on reinforcement learning. In *International Conference on Machine Learning* (pp. 449–458). PMLR.
- Berlusconi, G. (2017). Social network analysis and crime prevention. In *Crime Prevention in the 21st Century* (pp. 129–141). Springer, Cham.
- Bogensperger, J., Schlarb, S., Hanbury, A., & Recski, G. (2021, November). DreamDrug-A crowd-sourced NER dataset for detecting drugs in darknet markets. In *Proceedings of the Seventh Workshop on Noisy User-generated Text (W-NUT 2021)* (pp. 137–157).
- Borgatti, S. P., Everett, M. G., & Freeman, L. C. (2002). *Ucinet for windows: Software for social network analysis* (Vol. 6, pp. 12–15). Analytic Technologies.
- Broadhurst, R., Woodford-Smith, H., Maxim, D., Sabol, B., Orlando, S., Chapman-Schmidt, B., & Alazab, M. (2017). Cyber terrorism: Research review: research report of the Australian national university cybercrime observatory for the Korean institute of criminology. SSRN 2984101.
- Burcher, M., & Whelan, C. (2018). Social network analysis as a tool for criminal intelligence: Understanding its potential from the perspectives of intelligence analysts. *Trends in Organized Crime*, 21, 278–294.
- Ch, R., Gadekallu, T. R., Abidi, M. H., & Al-Ahmari, A. (2020). Computational system to classify cyber crime offenses using machine learning. *Sustainability*, 12(10), 4087.
- Choudhary, P., & Singh, U. (2018). Ranking terrorist organizations network in India using combined Sna-Ahp approach. *International Journal of Recent Technology and Engineering, Article*, 7(4), 168–172.
- Corallo, A., Lazoi, M., Lezzi, M., & Luperto, A. (2022). Cybersecurity awareness in the context of the Industrial Internet of Things: A systematic literature review. *Computers in Industry*, 137, 103614.
- Dainotti, A., Benson, K., King, A., Claffy, K. C., Kallitsis, M., Glatz, E., & Dimitropoulos, X. (2013). Estimating internet address space usage through passive measurements. *ACM SIGCOMM Computer Communication Review*, 44(1), 42–49.
- Ding, F., Ge, Q., Jiang, D., Fu, J., & Hao, M. (2017). Understanding the dynamics of terrorism events with multiple-discipline datasets and machine learning approach. *PLoS ONE*, 12(6), e0179057.
- Farooq, A., Joyia, G. J., Uzair, M., & Akram, U. (2018, March). Detection of influential nodes using social networks analysis based on network metrics. In *2018 International Conference on Computing, Mathematics and Engineering Technologies (iCoMET)* (pp. 1–6). IEEE.
- Filshtinskyi, S. (2013). Cybercrime, cyberweapons, cyber wars: Is there too much of it in the air? *Communications of the ACM*, 56(6), 28–30.
- Garg, P., Garg, H., & Ranga, V. (2017, May). Sentiment analysis of the Uri terror attack using Twitter. In *2017 International Conference on Computing, Communication and Automation (ICCCA)* (pp. 17–20). IEEE.
- Ghanem, W. A. H., Jantan, A., Ghaleb, S. A. A., & Nasser, A. B. (2020). An efficient intrusion detection model based on hybridization of artificial bee colony and dragonfly algorithms for training multilayer perceptrons. *IEEE Access*, 8, 130452–130475.
- Ghazal, T. M., Hasan, M. K., Alzoubi, H. M., AlHammadi, M., Al-Dmour, N. A., Islam, S., Kamran, R., & Mago, B. (2022). Securing smart cities using blockchain technology. In *2022 1st International Conference on AI in Cybersecurity (ICAIC)*, 2022 (pp. 1–4). <https://doi.org/10.1109/ICAIC53>
- Ghosh, S., Das, A., Porras, P., Yegneswaran, V., & Gehani, A. (2017, August). Automated categorization of onion sites for analyzing the darkweb ecosystem. In *Proceedings of the 23rd ACM SIGKDD International Conference on Knowledge Discovery and Data Mining* (pp. 1793–1802).

- Gundabathula, V. T., & Vaidhehi, V. (2018). An efficient modelling of terrorist groups in India using machine learning algorithms. *Indian Journal of Science and Technology*, 11(15), 1–10.
- Gutfraind, A., & Genkin, M. (2017). A graph database framework for covert network analysis: An application to the Islamic State network in Europe. *Social Networks*, 51, 178–188.
- Habibi Lashkari, A., Kaur, G., & Rahali, A. (2020, November). DIDarknet: A contemporary approach to detect and characterize the darknet traffic using deep image learning. In *2020 the 10th International Conference on Communication and Network Security* (pp. 1–13).
- Hanaysha, J. R., Al Shaikh, M. E., & Alzoubi, H. M. (2021a). Importance of marketing mix elements in determining consumer purchase decision in the retail market. *International Journal of Service Science, Management, Engineering, and Technology*, 2(6), 56–72.
- Hanaysha, J. R., Al-Shaikh, M. E., Joghee, S., & Alzoubi, H. M. (2021b). Impact of innovation capabilities on business sustainability in small and medium enterprises. *FIIB Business Review*, 11(1), 67–78.
- Hao, M., Jiang, D., Ding, F., Fu, J., & Chen, S. (2019). Simulating spatio-temporal patterns of terrorism incidents on the Indochina Peninsula with GIS and the random forest method. *ISPRS International Journal of Geo-Information*, 8(3), 133.
- Hasan, M. A., & Zaki, M. J. (2011). A survey of link prediction in social networks. In *Social network data analytics* (pp. 243–275). Springer.
- Holt, T. J., Freilich, J. D., & Chermak, S. M. (2019). Legislation specifically targeting the use of the internet to recruit terrorists. In *Online terrorist propaganda, recruitment, and radicalization* (pp. 125–136). CRC Press.
- Holt, T. J., Chermak, S. M., Freilich, J. D., Turner, N., & Greene-Colozzi, E. (2022). Introducing and exploring the extremist cybercrime database (ECCD). *Crime & Delinquency*, 00111287221083899.
- Hosseini, S., Turhan, B., & Gunarathna, D. (2017). A systematic literature review and meta-analysis on cross project defect prediction. *IEEE Transactions on Software Engineering*, 45(2), 111–147.
- Iliadis, L. A., & Kaifas, T. (2021, July). Darknet traffic classification using machine learning techniques. In *2021 10th International Conference on Modern Circuits and Systems Technologies (MOCAST)* (pp. 1–4). IEEE.
- Jalali, S., & Wohlin, C. (2012, September). Systematic literature studies: Database searches vs. backward snowballing. In *Proceedings of the ACM-IEEE International Symposium on Empirical Software Engineering and Measurement* (pp. 29–38).
- Jha, P., Jha, R., & Sharma, A. (2019). Behavior analysis and crime prediction using big data and machine learning. *International Journal of Recent Technology and Engineering*, 8(1), 1.
- Joghee, S., Alzoubi, H. M., & Dubey, A. R. (2020). Decisions effectiveness of FDI investment biases at real estate industry: Empirical evidence from Dubai smart city projects. *International Journal of Scientific and Technology Research*, 9(3), 3499–3503.
- Jspm, W., & Tirwa, K. (2018). Predictive modeling of terrorist attacks using machine learning. *International Journal of Pure and Applied Mathematics*, 119, 49–61.
- Kadoguchi, M., Kobayashi, H., Hayashi, S., Otsuka, A., & Hashimoto, M. (2020, November). Deep self-supervised clustering of the dark web for Cyber Threat Intelligence. In *2020 IEEE International Conference on Intelligence and Security Informatics (ISI)* (pp. 1–6). IEEE.
- El Khatib, M. M., Alzoubi, H. M., Ahmed, G., Kazim, H. H., AlFalasi, Salama Al A., Mohammed, F., & AlMulla, M. (2022). Digital Transformation and SMART-the analytics factor. In *2022 International Conference on Business Analytics for Technology and Security (ICBATS)*, 2022 (pp. 1–11). <https://doi.org/10.1109/ICBATS54253.2022.9759084>.
- Kim, J., Kim, J., Kim, H., Shim, M., & Choi, E. (2020). CNN-based network intrusion detection against denial-of-service attacks. *Electronics*, 9(6), 916.
- Kumar, N. S., Rana, D. P., & Mehta, R. G. (2012). Detecting e-mail spam using spam word associations. *International Journal of Emerging Technology and Advanced Engineering*, 2(4), 222–226.
- LaFree, G. (2010). The global terrorism database (GTD) accomplishments and challenges. *Perspectives on Terrorism*, 4(1), 24–46.

- Li, Z., Sun, D., Li, B., Li, Z., & Li, A. (2018). Terrorist group behavior prediction by wavelet transform-based pattern recognition. *Discrete Dynamics in Nature and Society*.
- Malm, A., Nash, R., & Moghadam, R. (2016). Social network analysis and terrorism. In *The handbook of the criminology of terrorism* (pp. 221–231).
- Maniraj, S. P., Chaudhary, D., Deep, V. H., & Singh, V. P. (2019). Data aggregation and terror group prediction using machine learning algorithms. *International Journal of Recent Technology and Engineering*, 8(4), 1467–1469.
- McElreath, D. H., Doss, D. A., McElreath, L., Lindsley, A., Lusk, G., Skinner, J., & Wellman, A. (2018). The communicating and marketing of radicalism: A case study of ISIS and cyber recruitment. *International Journal of Cyber Warfare and Terrorism (IJCWT)*, 8(3), 26–45.
- McMillan, C., Felmlee, D., & Braines, D. (2020). Dynamic patterns of terrorist networks: Efficiency and security in the evolution of eleven islamic extremist attack networks. *Journal of Quantitative Criminology*, 36(3), 559–581.
- Mehmood, T., Alzoubi, H. M., Alshurideh, M., Al-Gasaymeh, A., & Ahmed, G. (2019). Schumpeterian entrepreneurship theory: Evolution and relevance. *Academy of Entrepreneurship Journal*, 25(4), 1–10.
- Mishra, A. K., Joshi, N., & Mathur, I. (2020). An efficient concept generation approach to identifying most influential node in a Terrorist Network using Weighted Formal Concept Analysis. *Materials Today: Proceedings*, 29, 427–439.
- Mo, H., Meng, X., Li, J., & Zhao, S. (2017, March). Terrorist event prediction based on revealing data. In *2017 IEEE 2nd International Conference on Big Data Analysis (ICBDA)* (pp. 239–244). IEEE.
- Monshizadeh, M., Khatri, V., Atli, B. G., Kantola, R., & Yan, Z. (2019). Performance evaluation of a combined anomaly detection platform. *IEEE Access*, 7, 100964–100978.
- La Morgia, M., Mei, A., Raponi, S., & Stefa, J. (2018, July). Time-zone geolocation of crowds in the dark web. In *2018 IEEE 38th International Conference on Distributed Computing Systems (ICDCS)* (pp. 445–455). IEEE.
- Morshed, M. M. (2020). An empirical study of deep web based on graph analysis. SSRN 3720454.
- Naksomboon, S., Charnsripinyo, C., & Wattanapongsakorn, N. (2010, May). Considering behavior of sender in spam mail detection. In *INC2010: 6th International Conference on Networked Computing* (pp. 1–5). IEEE.
- Noor, U., Rashid, Z., & Rauf, A. (2011). A survey of automatic deep web classification techniques. *International Journal of Computer Applications*, 19(6), 43–50.
- Nukusheva, A., Zhamiyeva, R., Shestak, V., & Rustembekova, D. (2022). Formation of a legislative framework in the field of combating cybercrime and strategic directions of its development. *Security Journal*, 35(3), 893–912.
- Nunes, E., Diab, A., Gunn, A., Marin, E., Mishra, V., Paliath, V., & Shakarian, P. (2016, September). Darknet and deepnet mining for proactive cybersecurity threat intelligence. In *2016 IEEE Conference on Intelligence and Security Informatics (ISI)* (pp. 7–12). IEEE.
- Overdorf, R., Troncoso, C., Greenstadt, R., & McCoy, D. (2018). Under the underground: Predicting private interactions in underground forums. [arXiv:1805.04494](https://arxiv.org/abs/1805.04494).
- Pilley, P. H., & Sikchi, S. S. (2014). Review of group prediction model for counter terrorism using clope algorithm. *International Journal of Advance Research in Computer Science and Management Studies*, 2(1), 96–100.
- Qin, J., Zhou, Y., & Chen, H. (2011). A multi-region empirical study on the internet presence of global extremist organizations. *Information Systems Frontiers*, 13(1), 75–88.
- Rawat, R., Rajawat, A. S., Mahor, V., Shaw, R. N., & Ghosh, A. (2021). Dark web—onion hidden service discovery and crawling for profiling morphing, unstructured crime and vulnerabilities prediction. In *Innovations in electrical and electronic engineering* (pp. 717–734). Springer.
- Rehman, A. U., Saleem, R. M., Shafiq, Z., Imran, M., Pradhan, M., & Alzoubi, H. M. (2022). Analysis of income on the basis of occupation using data mining. In *International Conference on Business Analytics for Technology and Security (ICBATS)*, 2022 (pp. 1–4). <https://doi.org/10.1109/ICBATS54253.2022.9759040>

- Rewari, S., & Singh, W. (2017, September). Systematic review of crime data analytics. In *2017 IEEE International Conference on Power, Control, Signals and Instrumentation Engineering (ICPSI)* (pp. 3042–3045). IEEE.
- Saha, S., Aladi, H., Kurian, A., & Basu, A. (2017). Future terrorist attack prediction using machine learning techniques. *PESIT South Campus: Bengaluru, India*.
- Saini, J. K., & Bansal, D. (2021). Detecting online recruitment of terrorists: Towards smarter solutions to counter terrorism. *International Journal of Information Technology*, 13(2), 697–702.
- Salo, F., Nassif, A. B., & Essex, A. (2019). Dimensionality reduction with IG-PCA and ensemble classifier for network intrusion detection. *Computer Networks*, 148, 164–175.
- Shandler, R., & Gomez, M. A. (2022). The hidden threat of cyber-attacks—undermining public confidence in government. *Journal of Information Technology & Politics*, 1–16.
- Sheikhan, M., & Jadidi, Z. (2014). Flow-based anomaly detection in high-speed links using modified GSA-optimized neural network. *Neural Computing and Applications*, 24(3), 599–611.
- Shi, L., Yang, Y., & Lv, J. (2015, May). PCA-PSO-BP neural network application in IDS. In *2015 International Power, Electronics and Materials Engineering Conference* (pp. 145–150). Atlantis Press.
- Singh, S., Verma, S. K., & Tiwari, A. (2020). A novel method for destabilization of terrorist network. *Modern Physics Letters B*, 34(27), 2050298.
- Stevanovic, M., Pedersen, J. M., D'Alconzo, A., & Ruehrup, S. (2017). A method for identifying compromised clients based on DNS traffic analysis. *International Journal of Information Security*, 16(2), 115–132.
- Taylor, P. J., Dargahi, T., Dehghanianha, A., Parizi, R. M., & Choo, K. K. R. (2020). A systematic literature review of blockchain cyber security. *Digital Communications and Networks*, 6(2), 147–156.
- Tellez Gaytan, J. C., Ateeq, K., Rafiuddin, A., Alzoubi, H., Chaudhary, S., & Viju, G. K. (2022). AI-based prediction of capital structure: Performance comparison of ANN SVM and LR models. *Computational Intelligence and Neuroscience*, 2022, 8334927.
- Tian, W., & Liu, J. (2010, May). Network intrusion detection analysis with neural network and particle swarm optimization algorithm. In *2010 Chinese Control and Decision Conference* (pp. 1749–1752). IEEE.
- Tierney, M. (2018). # TerroristFinancing: An examination of terrorism financing via the internet. *International Journal of Cyber Warfare and Terrorism (IJCWT)*, 8(1), 1–11.
- Torres, A., & Tranchita, C. (2004, October). Events classification and operation states considering terrorism in security analysis. In *IEEE PES Power Systems Conference and Exposition* (pp. 1265–1271). IEEE.
- Toure, I., & Gangopadhyay, A. (2016, May). Real time big data analytics for predicting terrorist incidents. In *2016 IEEE Symposium on Technologies for Homeland Security (HST)* (pp. 1–6). IEEE.
- Turk, K., Pastrana, S., & Collier, B. (2020, September). A tight scrape: Methodological approaches to cybercrime research data collection in adversarial environments. In *2020 IEEE European Symposium on Security and Privacy Workshops (EuroS&PW)* (pp. 428–437). IEEE.
- Turner, M., Kitchenham, B., Brereton, P., Charters, S., & Budgen, D. (2010). Does the technology acceptance model predict actual use? A systematic literature review. *Information and Software Technology*, 52(5), 463–479.
- Uddin, M. I., Zada, N., Aziz, F., Saeed, Y., Zeb, A., Ali Shah, S. A., & Mahmoud, M. (2020). Prediction of future terrorist activities using deep neural networks. *Complexity*.
- Vinayakumar, R., Alazab, M., Soman, K. P., Poornachandran, P., Al-Nemrat, A., & Venkatraman, S. (2019). Deep learning approach for intelligent intrusion detection system. *Ieee Access*, 7, 41525–41550.
- Van Wegberg, R., Tajalizadehkhooob, S., Soska, K., Akyazi, U., Ganan, C. H., Klievink, B., & Van Eeten, M. (2018). Plug and prey? Measuring the commoditization of cybercrime via online anonymous markets. In *27th USENIX Security Symposium (USENIX Security 18)* (pp. 1009–1026).

- Weimann, G. (2005). Cyberterrorism: The sum of all fears? *Studies in Conflict & Terrorism*, 28(2), 129–149.
- Xu, R., An, R., & Geng, X. (2011, July). Research intrusion detection based PSO-RBF classifier. In *2011 IEEE 2nd International Conference on Software Engineering and Service Science* (pp. 104–107). IEEE.
- Yanamandra, R. & Alzoubi, H. M. (2022). Empirical investigation of mediating role of six sigma approach in rationalizing the COQ in service organizations. *Operations and Supply Chain Management: An International Journal*, 15(1), 122–135. ISSN 2579–9363
- Yarlagadda, R., Felmlee, D., Verma, D., & Gartner, S. (2018, July). Implicit terrorist networks: A two-mode social network analysis of terrorism in india. In *International Conference on Social Computing, Behavioral-Cultural Modeling and Prediction and Behavior Representation in Modeling and Simulation* (pp. 340–347). Springer.
- Yli-Huumo, J., Ko, D., Choi, S., Park, S., & Smolander, K. (2016). Where is current research on blockchain technology? A systematic review. *PLoS ONE*, 11(10), e0163477.
- Zafar, S. Z., Zhilin, Q., Mabrouk, F., Alzoubi, H., Hishan, S. S., & Michel, M. (2022). Empirical linkages between ICT, tourism, and trade towards sustainable environment: Evidence from BRICS countries. *Economic Research-Ekonomska Istrazivanja*, 37(1), 850–862.
- Zhang, X., Jin, M., Fu, J., Hao, M., Yu, C., & Xie, X. (2018). On the risk assessment of terrorist attacks coupled with multi-source factors. *ISPRS International Journal of Geo-Information*, 7(9), 354.
- Zuberi, K. J. Z. K. J. (2018). Use of cyber space by terrorist organizations. *International Journal for Electronic Crime Investigation*, 2(1), 6–6.

Digitalization in Accounting and Auditing

Business Digitalization in Accounting and Auditing Fields



Sulaiman Weshah

Abstract Improving the quality of accounting reporting and audit may be considered an opportunity within the current technological and digital era. The current research, based on theoretical review, proves that eXtensible Business Reporting Language (XBRL), Big Data, and blockchain reduce tax evasion and provide solution for real-time reporting, reducing the risk of doubtful debts, and obtaining digital confirmation as audit evidence.

Keywords XBRL · Big Data · Blockchain · Accounting · Audit

1 Introduction

The accounting sector is undergoing a huge transition as a result of conventional ways of evolution as technology advances in nearly every business today. Therefore, in order Experts in the sector must keep up with cutting-edge technologies to stay ahead of their competitors in the financial market. To do this, many accounting firms have already started integrating Big Data, robotics, and artificial intelligence (AI) technologies into their business models (Alzoubi et al., 2022b). Out of all the current hot topics, big data has the most impact on the accounting industry. It improves data-driven audits, which are advantageous to both clients and auditors (Kroon et al., 2021).

The concern surrounding this contemporary disclosure method is whether it is possible to execute continuous auditing within eXtensible Business Reporting Language (XBRL) as a digital financial report (CA). In addition, a distributed data base is created using blocks of connected data that are decentralized, secure, and hashed via block chain technology (Kurdi et al., 2022b). By tokenizing assets and employing digital or crypto currency, a block chain is referred to as a distributed

S. Weshah (✉)
Al-Balqa Applied University, Salt, Jordan
e-mail: Sulaiman.weshah@bau.edu.jo

ledger from a financial perspective (Agrawal et al., 2021). These are the most important technology for accountants and auditors need to include into their operations and their business processes.

2 Literature Review

2.1 *eXtensible Business Reporting Language (XBRL)*

2.1.1 Is Adopting (XBRL) Representing an Opportunity to Reduce Tax Evasion?

Organizations may tend to provide two kinds of financial reports; one is heading to lenders such as banks which almost contain the real numbers about net income (Tian, 2015). The other is heading to tax agencies that may contain fake net income aiming to reduce the income tax they have to pay. Nowadays, interest in XBRL is increasing, as mentioned by La Rosa and Caserio (2013) that researchers interested in the XBRL format have concentrated their attention on how it affects various stakeholder groups that may gain from its adoption (Farouk, 2021). Thus, lenders and banks are also interested in this adoption of XBRL and can use provided information within their decision-making process (Alzoubi et al., 2022d).

Countries depend on income tax funds as one of the most important funds sources. So, tax evasion may have the priority of how to reduce and get the real income tax should be provided (Eli & Hamou, 2022). Although the (XBRL) is still growing, it perhaps will be the only station for financial reports users such as lenders (banks) and tax agencies. The different users are going to use the same financial reports for making their decisions; this will be through using one source of financial reports representing the use of (XBRL) (Abreu et al., 2018).

2.1.2 Is (XBRL) a Solution for Real-Time Reporting?

The goal of XBRL, which has been around for more than ten years, was to improve the efficacy and efficiency of the use of information. A language called XBRL uses Internet technology to communicate corporate information together with the metadata (data about data) that goes with it (Alzoubi & Yanamandra, 2020). Using XBRL, information providers may send a wide range of data kinds to consumers, including text blocks or fragments, numeric facts contained in text blocks, reports on transaction flows, performance reports, and data tables and data cubes (Liu et al., 2019).

Islam et al. (2017) Mentioned that future implementation of accounting information system will face many challenges such as financial reporting, nowadays Extensible Business Reporting Language (XBRL) is used as a solution to new challenges of financial reporting (Islam et al., 2017). Real-time reporting is meant to “limit the

chances for deceit and manipulation" and "allow for speedier and more effective disclosure," according to the SEC. However, if managers can timing information occurrences, this goal might not be met. Tian (2015). Cloud computing helps in implementing real-time reporting (Mehmood et al., 2019), by allowing the instant information sharing across all users within and outside the company who require it to make educated decisions (Trigo et al., 2014) and via integration between cloud computing and (XBRL) this supports the real-time reporting.

2.2 Big Data and Enterprise Resource Planning (ERP)

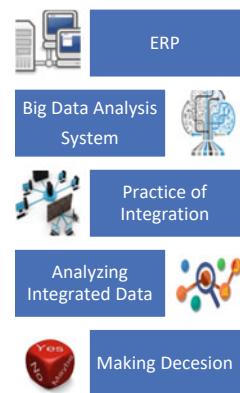
2.2.1 The Impact on Doubtful Debts

ERP standardizes internal data processing operations, merges operational data, and serves as an integrated information system for all business activities and working processes that comes from different functions (Miller, 2021), and without ERP systems it is impossible to achieve an effective integration for supply chain (Alzoubi et al., 2020). In addition Weshah et al. (2022) revealed that ERP system integration with the ABC (activity-based costing system) improves operations effectiveness. These are forming the motivations for ERP implementation and integration.

As Petter et al. (2008) mentioned, businesses from more than a decade ago still face the fears approximately financial conditions and expanding competition making weights to cut costs (Ramakrishna & Alzoubi, 2022), which requires organizations to degree and look at the benefits and costs of technology and it is innovation (Alzoubi et al., 2022a, 2022b, 2022c, 2022d). Digitalization is progressively and broadly affecting companies all through all businesses (Kasem & Al-Gasaymeh, 2022). The integration between ERP systems and Big Data analysis systems will lead to an efficient path of avoiding facing a bad debt by dealing with customers based on related detailed information concluded from the designed integration between ERP systems and the output of Big Data analysis systems (Agrawal et al., 2021) (Fig. 1).

During the Covid-19 pandemic (Weshah & Alzoubi, n.d.) recommend managers to develop and enhance their present systems by hiring software experts to assist create the integration between information systems (Alzoubi et al., 2022c). Particularly in the food, supply (Alsharari, 2022), and agricultural sectors, the integration of the activity-based-costing system (Alzoubi et al., 2021), with the enterprise resource planning system plays a significant role in increasing the efficacy of operations (Alshurideh et al., 2020).

Fig. 1 ERP systems integration with big data



2.3 *Blockchain Technology, XBRL, and Audit Confirmations*

2.3.1 **Digital Confirmation as Audit Evidence Within Block Chains Technology: A Step Forward to Implement Continuous Audit Required by Implementing (XBRL)**

As ISAs set out, the purpose of the external audit process is to provide an independent report that contains an opinion based on different types of evidence. One example of important evidence is confirmations (Alshurideh et al., 2022), which are used by external auditors to check balances that are related to third-party account balances, such as account receivable and account payable (Hang et al., 2022).

In 2008, blockchain technology was adopted by Satoshi Nakamoto in parallel with Bitcoin as a cryptocurrency to be used in secured digital business transactions (Monti & Rasmussen, 2017) “Blockchain is an information recording (Alhamad et al., 2022) technology that uses encryption to prevent forgery or manipulation of information. A Study on the Transformation of Accounting Based on New Technologies: (Evidence from Korea, n.d.) But blockchain still needs the acceptance of legal authorities (Hughes et al., 2019). Figure 2 illustrates the concept of a blockchain:

Blockchain technology is a set of decentralized, secured, and hashed blocks that contain connected data to form a distributed database (Alzoubi & Ahmed,

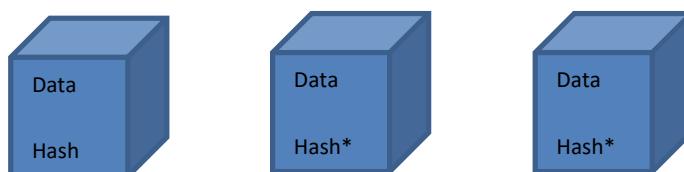


Fig. 2 Concept of Block chain

2019). Financially, a blockchain is called a distributed ledger by digitalizing assets (tokenization) and using digital or cryptocurrencies.

Data

Any type of data such as name, address, amount, etc., is saved inside every block for any transaction.

Hash

Digital fingerprint, where every block contains a hash connected to the hash of the previous block, except the first block because there is no previous block.

Security

A copy of detailed data is saved inside every block, which means it is too hard to manipulate or change saved data because of the need to change the data inside all blocks.

Simplification

Decentralized database.

Privacy

Open (public) blockchain is one of the blockchain types that anyone can enter. The other type is called closed (private) blockchain, and permission is required, so here privacy can be protected (Alnazer et al., 2017). Therefore, users within a distributed ledger in a blockchain need permission. Figure 4 illustrates this issue as follows:

Based on Fig. 3, it could be concluded that the blockchain is forming an open journal entry for all parties who have permission to enter. Described as a “digital ledger of economic activities that can be configured to record not just financial transactions but basically anything of value (Joghee et al., 2020),” a blockchain is a distributed ledger technology (Hughes et al., 2019).

Fig. 3 Decentralized DB within Blockchain

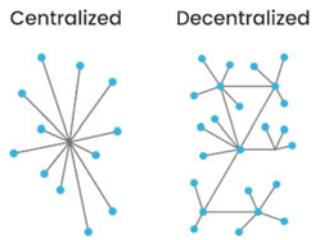
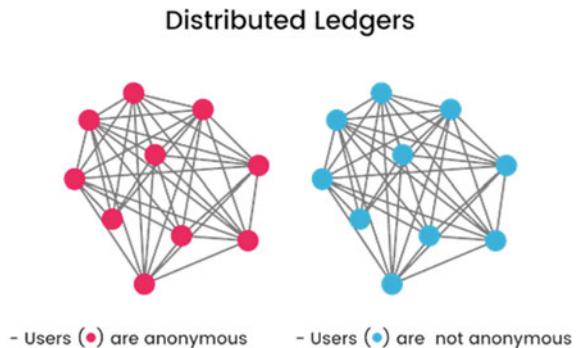


Fig. 4 Closed (private) blockchain need permission



Traceability

Blockchain can be used to create technological trust among supply chain partners, and transactions can be saved within a distributed ledger, resulting in a transparent and sustainable supply chain (Agrawal et al., 2021).

Transparency

Near real-time access to information and efficient information flow and communication [4], intermediate verification, and improving the efficiency of the market while reducing uncertainty in exchanges (Rozario & Vasarhelyi, 2018).

Trust in financial transactions will be based on blockchain technology (Abreu et al., 2018). This is based on the upcoming global network for real-time payments. Banks are building a real-time global payment network using blockchain technology (Ali et al., n.d.). Also, there is a fundamental change in the landscape of the auditing and accounting professions and reshaping the business ecosystem (Liu et al., 2019). Therefore, educational institutions must modify their academic programs and curricula to give students the abilities that employers expect of them (Farouk, 2022) and (Weshah & Alzoubi, n.d.) Block chain effectively changes the effects on accounting and all of its subfields, including auditing. It will soon be able to combine

and communicate with new technologies (Alnuaimi et al., 2021) like artificial intelligence (AI), the internet of things (IoT), and others to deliver higher-quality services (Ali et al., 2022) to society (Lu, 2018) and (Demirkan et al., 2020).

3 Methodology

A qualitative approach demonstrates how blockchain, big data, and eXtensible Business Reporting Language (XBRL) help to prevent tax evasion, offer a solution for real-time reporting, lower the danger of financial loans, and acquire digital confirmation as audit evidence. In this study, systematic and theoretical literature review method was followed, as it is the appropriate method to achieve its objectives.

4 Empirical Discussion

4.1 *Big Data and Enterprise Resource Planning (ERP) Implementation*

Enterprise resource planning, software that helps plan, budget, anticipate, and report on an organization's financial results, is also a component of a full ERP package (Akkermans & van Helden, 2002). Accounting information systems (AISs) collect, store, and process accounting and financial data that is then used by internal users to disclose data to creditors, investors, and tax authorities (Eli & Hamou, 2022). External confirmations are one of the most significant forms of audit evidence for the technologies listed here based on the third parties' preparation of such evidence. There are three main categories of such evidence that could be illustrated and made the comparison like the following within Table 1.

Confirmations as audit evidence are divided into three main categories: negative external confirmation, positive external confirmation, and blind external confirmation. Each one has advantages and disadvantages (ISA 505). In 2017, the American Institute of Certified Public Accountants (AICPA) and Chartered Professional Accountants (Canada) declared that there is a potential impact of blockchain on the audit and assurance professions (Hanaysha et al., 2021).

4.2 *Blockchain Technology, XBRL, and Audit Confirmations*

Within eXtensible Business Reporting Language (XBRL) as a digital financial report, the question related to this modern disclosure technique is about the possibility of implementing continuous auditing (CA) (Alzoubi & Aziz, 2021; Cheung et al., 2020).

Table 1 External audit confirmations types

Key	Negative confirmation	Positive confirmation	Blind confirmation
Who provides the account balance?	Auditor	Auditor	Third-party
Responding from the third party	Only when there is a discrepancy in recorded balances	Responding anyway	Responding anyway
Risks	It may be lost or not received, which may indicate that a third party agrees with the presented balances	Low response rate due to the need for respondents to exert more effort	Low response rate due to the need for respondents to exert more effort
Prefer the ability of the auditor	The most preferable is because of the least needed time	Low level of preferability because of the more needed time	The highest level of preferability because of the most needed time depends on the needed effort to be done by the respondent

Thus, Shan and Troshani (2014) answered partially and found that (XBRL) reduced audit fees and had important implications for auditors. Silva et al. (2021) concluded that there is an effective and potential implication of blockchain on auditing with new possibilities of real-time auditing. Blockchain is supplying a safe setting for commercial transactions and this will change the audit process and strategy (Al-Tahat & Moneim, 2020) and the use of Blockchain as a tool for auditors to enhance company information systems (Hanaysha et al., 2022) to reduce time and stop fraud (Mondol, 2021). Thus, we investigate the concept of blockchain technology and its impacts on confirmations as one of the important audit evidence.

5 Discussion

Blockchains make third parties' balances available and under the use by distributed ledgers and by utilizing software that can perform transactions and produce associated ledger entries, smart contracts may make information about third parties (Hamadneh et al., 2021), such as clients or suppliers, more transparent (Liu et al., 2019). Moreover, external confirmations from consumers (Kurdi et al., 2022a) are not required as the blockchain reconciles each payment that clients receive (Alzoubi et al., 2022a) especially within the use of digitalizing assets (tokenization) and taxonomies as a universal account dictionary for electronic reporting in XBRL.

The use of blockchains as decentralized databases and distributed ledger will make external confirmations with third parties automated, easier, faster, and more effective as one digital conformation type without the need to depend on classic external

confirmation types (Kurdi et al., 2022a, 2022b, 2022c). Therefore, digital confirmation within blockchain technology could be considered a step up in achieving a continuous audit process (Lee et al., 2022; Shamout et al., 2022). It has been determined that blockchain will play an important role in continuous audit/hybrid audit as an intelligent smart audit procedure, also known as Smart Contracts as a digitized accounting system.

6 Conclusions

Using of electronic information systems increasing and wild spreading within all types of companies and is main tool to introduce financial statements. Although it is still developing, (XBRL) may end up being the only platform for users of financial reporting like lenders (banks) and tax authorities. The many users will each utilize the identical financial data to inform their decisions, and this will be accomplished by employing a single source of financial information that represents the usage of (XBRL).

The standard (computer) language for the electronic exchange of commercial and financial data is called XBRL, facilitates the creation of management reports using a range of data, including financial reports, by businesses. The SECs are starting to implement XBRL in many countries for certain financial filings, this is a base step for real-time reporting by the increasing in machine-readability. By dealing with customers based on the related detailed information derived from the designed integration between ERP systems and the output of Big Data analysis systems, the integration between ERP systems and Big Data analysis systems will lead to an effective path of avoiding having to deal with a bad debt. This also depicts the academic path needs to improve syllabuses to be in parallel with the new technological changes and it is needed security procedures.

7 Recommendations

Within the great potential effect of blockchain on the audit profession, this study suggest the better implementation of blockchain, ERP, XBRL in purpose of tax evasion can assist the financial institutions to overcome the technological challenges efficiently. Moreover, this will support the continuous audit process and will be integrated with instant documents related to XBRL as an electronic method to disclose financial statements. Additionally, it is recommended for future studies to incorporate an empirical analysis from financial institutions; for instance, banking sector to evaluate the extent of technological development.

References

- Abreu, P. W., Aparicio, M., & Costa, C. J. (2018). Blockchain technology in the auditing environment. In *Iberian conference on information systems and technologies, CISTI* (pp. 1–6).
- Agrawal, T. K., Kumar, V., Pal, R., Wang, L., & Chen, Y. (2021). Blockchain-based framework for supply chain traceability: A case example of textile and clothing industry. *Computers & Industrial Engineering*, 154, 10713.
- Akkermans, H., & van Helden, K. (2002). Vicious and virtuous cycles in ERP implementation: A case study of interrelations between critical success factors. *European Journal of Information Systems*, 11, 35–46.
- Al-Tahat, S., & Moneim, O. A. (2020). The impact of artificial intelligence on the correct application of cyber governance in Jordanian commercial banks. *International Journal of Scientific & Technology Research*, 9, 7138–7144.
- Alhamad, A., Alshurideh, M., Alomari, K., Al Kurdi, B., Alzoubi, H., Hamouche, S., & Al-Hawary, S. (2022). The effect of electronic human resources management on organizational health of telecommunications companies in Jordan. *International Journal of Data and Network Science*, 6, 429–438.
- Ali, N., Ahmed, A., Anum, L., Ghazal, T., Abbas, S., Khan, M. A., Alzoubi, H. M., & Ahmad, M. (2021). Modelling supply chain information collaboration empowered with machine learning technique. *Intelligent Automation and Soft Computing*, 30, 243–257.
- Ali, N., Ghazal, T. M., Ahmed, A., Abbas, S., Khan, M. A., Alzoubi, H. M., Farooq, U., Ahmad, M., & Khan, M. A. (2022). Fusion-based supply chain collaboration using machine learning techniques. *Intelligent Automation and Soft Computing*, 31, 1671–1687.
- Alnazer, N. N., Alnuaimi, M. A., & Alzoubi, H. M. (2017). Analysing the appropriate cognitive styles and its effect on strategic innovation in Jordanian universities. *International Journal of Business Excellence*, 13, 127–140.
- Alnuaimi, M., Alzoubi, H. M., Ajelat, D., & Alzoubi, A. A. (2021). Towards intelligent organisations: An empirical investigation of learning orientation's role in technical innovation. *International Journal of Innovation and Learning*, 29, 207–221.
- Alsharari, N. (2022). The implementation of enterprise resource planning (Erp) in the United Arab Emirates: A case of Musanada Corporation. *International Journal of Innovation, Management and Technology*, 2, 1.
- Alshurideh, M., Al Kurdi, B., Alzoubi, H. M., Ghazal, T. M., Said, R. A., AlHamad, A. Q., Hamadneh, S., Sahawneh, N., & Al-kassem, A. H. (2022). Fuzzy assisted human resource management for supply chain management issues. *Annals of Operations Research*, 1–19.
- Alshurideh, M., Gasaymeh, A., Ahmed, G., Alzoubi, H. M., & Kurd, B. A. (2020). Loyalty program effectiveness: Theoretical reviews and practical proofs. *Uncertainty in Supply Chain Management*, 8, 599–612.
- Alzoubi, H., & Ahmed, G. (2019). Do total quality management (TQM) practices improve organisational success? A case study of electronics industry in the UAE. *International Journal of Economics and Business*, 17, 459–472.
- Alzoubi, H. M., Ahmed, G., Al-Gasaymeh, A., & Al Kurdi, B. (2020). Empirical study on sustainable supply chain strategies and its impact on competitive priorities: The mediating role of supply chain collaboration. *Management Science Letters*, 10, 703–708.
- Alzoubi, H. M., & Aziz, R. (2021). Does emotional intelligence contribute to quality of strategic decisions? The mediating role of open innovation. *Journal of Open Innovation: Technology, Market, and Complexity*, 7, 130.
- Alzoubi, H., Alshurideh, M., Kurdi, B. A., Akour, I., & Aziz, R. (2022a). Does BLE technology contribute towards improving marketing strategies, customers' satisfaction and loyalty? The role of open innovation. *International Journal of Data and Network Science*, 6, 449–460.
- Alzoubi, H. M., Ahmed, G., & Alshurideh, M. (2022b). An empirical investigation into the impact of product quality dimensions on improving the order-winners and customer satisfaction. *International Journal of Productivity and Quality Management*, 36, 169–186.

- Alzoubi, H. M., Alshurideh, M. T., Kurdi, B. A., Alhyasat, K. M. K., & Ghazal, T. M. (2022c). The effect of e-payment and online shopping on sales growth: Evidence from banking industry. *International Journal of Data and Network Science*, 6, 1369–1380.
- Alzoubi, H. M., Elrehail, H., Hanaysha, J. R., Al-Gasaymeh, A., & Al-Adaileh, R. (2022d). The role of supply chain integration and agile practices in improving lead time during the COVID-19 crisis. *The International Journal of Service Science, Management, Engineering, and Technology*, 13, 1–11.
- Alzoubi, H. M., & In'airat, M., Ahmed, G. (2022e). Investigating the impact of total quality management practices and Six Sigma processes to enhance the quality and reduce the cost of quality: The case of Dubai. *International Journal of Business Excellence*, 27, 94–109.
- Alzoubi, H. M., Vij, M., Vij, A., & Hanaysha, J. R. (2021). What leads guests to satisfaction and loyalty in UAE five-star hotels? AHP analysis to service quality dimensions. *Enlightening Tourism. A Pathmaking Journal*, 11, 102–135.
- Alzoubi, H. M., & Yanamandra, R. (2020). Investigating the mediating role of information sharing strategy on agile supply chain in supply chain performance. *Uncertainty in Supply Chain Management*, 8, 273–284.
- Cheung, M. L., Pires, G., & Rosenberger, P. J. (2020). The influence of perceived social media marketing elements on consumer–brand engagement and brand knowledge. *Asia Pacific Journal of Marketing and Logistics*, 32, 695–720.
- Demirkan, S., Demirkan, I., & McKee, A. (2020). Blockchain technology in the future of business cyber security and accounting. *Journal of Management Analysis*, 7, 189–208.
- Eli, T., & Hamou, L. A. S. (2022). Investigating the factors that influence students' choice of English studies as a major: The case of university of Nouakchott Al Aasriya. *Mauritania. International Journal of Innovation, Management and Technology*, 2, 1.
- Farouk, M. (2021). The universal artificial intelligence efforts to face coronavirus COVID-19. *International Journal of Computations, Information and Manufacturing*, 1, 77–93.
- Farouk, M. (2022). Studying human robot interaction and its characteristics. *International Journal of Computations, Information and Manufacturing*, 2, 1.
- Hamadneh, S., Pedersen, O., Alshurideh, M., Kurdi, B. A., & Alzoubi, H. M. (2021). An investigation of the role of supply chain visibility into the Scottish blood supply chain. *Journal of Legal, Ethical and Regulatory Issues*, 24, 1–12.
- Hanaysha, J. R., Al-Shaikh, M. E., Joghee, S., & Alzoubi, H. M. (2022). Impact of innovation capabilities on business sustainability in small and medium enterprises. *FIIB Business Review*, 11, 67–78.
- Hanaysha, J. R., Shaikh, A., & M. E., & Alzoubi, H. M. (2021). Importance of marketing mix elements in determining consumer purchase decision in the retail market. 2, 56–72.
- Hang, Y., Sarfraz, M., Khalid, R., Ozturk, I., & Tariq, J. (2022). Does corporate social responsibility and green product innovation boost organizational performance? a moderated mediation model of competitive advantage and green trust. *Economic Research-Ekonomska Istrazivanja*, 0, 1–21.
- Hughes, L., Dwivedi, Y. K., Misra, S. K., Rana, N. P., Raghavan, V., & Akella, V. (2019). Blockchain research, practice and policy: Applications, benefits, limitations, emerging research themes and research agenda. *International Journal of Information Management*, 49, 114–129.
- Islam, K. M., Ch, A. R., Bilal, A. R., & Ilyas, M. (2017). Accounting information systems: Traditions and future directions (by using AIS in traditional organizations). *Journal of Internet Banking and Commerce*, 22, 1–13.
- Joghee, S., Alzoubi, H. M., & Dubey, A. R. (2020). Decisions effectiveness of FDI investment biases at real estate industry: Empirical evidence from Dubai smart city projects. *International Journal of Scientific & Technology Research*, 9, 3499–3503.
- Kasem, J., & Al-Gasaymeh, A. (2022). A cointegration analysis for the validity of purchasing power parity: Evidence from middle east countries. *International Journal of Innovation, Management and Technology*, 2, 1.

- Kroon, N., Alves, D. C., & M., Martins, I. (2021). The impacts of emerging technologies on accountants' role and skills: Connecting to open innovation-a systematic literature review. *Journal of Open Innovation: Technology, Market, and Complexity*, 7, 3.
- Kurdi, B. A., Alshurideh, M., Akour, I., Alzoubi, H. M., Obeidat, B., & Alhamad, A. (2022a). The role of digital marketing channels on consumer buying decisions through eWOM in the Jordanian markets. *International Journal of Data and Network Science*, 6, 1175–1185.
- Kurdi, B. A., Alzoubi, H. M., Akour, I., & Alshurideh, M. T. (2022b). The effect of blockchain and smart inventory system on supply chain performance: Empirical evidence from retail industry. *Uncertainty in Supply Chain Management*, 10, 1111–1116.
- Kurdi, B. A., Alshurideh, M., & Akour, I., Alhamad, A., & Alzoubi, H. M. (2022c). Eff. Soc. media Influ. Charact. Consum. Intent. attitude Towar. Keto Prod. Purch. Intent. 6, 1135–1146.
- La Rosa, F., & Caserio, C. (2013). Are auditors interested in XBRL? A qualitative survey of big auditing firms in Italy. *Lecture Notes in Information Systems and Organisation*, 3, 13–45.
- Lee, K. L., Romzi, P. N., Hanaysha, J. R., Alzoubi, H. M., & Alshurideh, M. (2022). Investigating the impact of benefits and challenges of IOT adoption on supply chain performance and organizational performance: An empirical study in Malaysia. *Uncertainty in Supply Chain Management*, 10, 537–550.
- Liu, M., Wu, K., & Xu, J. J. (2019). How will blockchain technology impact auditing and accounting: Permissionless versus permissioned blockchain. *Current Issues in Auditing*, 13, A19–A29.
- Lu, Y. (2018). Blockchain and the related issues: A review of current research topics. *Journal of Management Analysis*, 5, 231–255.
- Mehmood, T., Alzoubi, H., Alshurideh, M., Al-Gasaymeh, A., & Ahmed, G. (2019). Schumpeterian entrepreneurship theory: Evolution and relevance. *Academic Entrepreneur*, 25, 1–10.
- Miller, D. (2021). The best practice of teach computer science students to use paper prototyping. *International Journal of Innovation, Management and Technology*, 1, 42–63.
- Mondol, E. P. (2021). The impact of block chain and smart inventory system on supply chain performance at retail industry. *International Journal of Computations, Information and Manufacturing*, 1, 56–76.
- Monti, M., & Rasmussen, S. (2017). RAIN: A bio-inspired communication and data storage infrastructure. *Artificial Life*, 23, 552–557.
- Petter, S., DeLone, W., & McLean, E. (2008). Measuring information systems success: Models, dimensions, measures, and interrelationships. *European Journal of Information Systems*, 17, 236–263.
- Ramakrishna, Y., & Alzoubi, H. M. (2022). Empirical investigation of mediating role of six sigma approach in rationalizing the COQ in service organizations. *Operations and Supply Chain Management*, 15, 122–135.
- Rozario, A. M., & Vasarhelyi, M. A. (2018). Auditing with smart contracts. *International Journal of Digital Accounting Research*, 18, 1–27.
- Shamout, M., Ben-Abdallah, R., Alshurideh, M., Alzoubi, H., Kurdi, B. A., & Hamadneh, S. (2022). A conceptual model for the adoption of autonomous robots in supply chain and logistics industry. *Uncertainty in Supply Chain Management*, 10, 577–592.
- Shan, Y. G., & Troshani, I. (2014). Does XBRL benefit financial statement auditing? *The Journal of Computer Information Systems*, 54, 11–21.
- Silva, R., Inácio, H., & Marques, R. P. (2021). Effective and potential implications of blockchain technology for auditing. In A., A., H., D., G., M., F., R.C. (Eds.), *Advances in intelligent systems and computing. Trends and applications in information systems and technologies. WorldCIST 2021. Advances in Intelligent Systems and Computing* (vol. 1368, pp. 435–451). Springer.
- Tian, X. S. (2015). Does real-time reporting deter strategic disclosures by management? The impact of real-time reporting and event controllability on disclosure bunching. *The Accounting Review*, 90, 2107–2139.
- Trigo, A., Belfo, F., & Estébanez, R. P. (2014). Accounting information systems: The challenge of the real-time reporting. *Procedia Technology*, 16, 118–127.

- Weshah, S., Almari, M., Bader, A., Abughniem, M., Aishat, M., & Humeedat. (2022). Harmonizing ABC system with ERP system for operational effectiveness improvement during Covid-19 pandemic. *International Conference on Business Analytics for Technology and Security (ICBATS)*, 2022, 1–5.
- Weshah, S., & Alzoubi, H. M. (n.d.). *Business Digitalization in Accounting and Auditing*, 1–11.

Accountants' Perception and Essential Skills on Blockchain Technology



Ibrahim Elsiddig Ahmed

Abstract Purpose: The expanded use of blockchain in accounting provides clarity over ownership of assets, the existence of obligations, recording transactions, transparency, and significantly improves efficiency. Therefore, Blockchain has the potential to enhance the accounting profession and may replace accountants' main functions in the near future. The study aims to assess the awareness of accountants in the Middle East and North Africa (MENA) and investigate their application of BC.

Methodology: A questionnaire composed of more than 20 questions, categorized into six areas of concern was distributed and 300 responded to it. A descriptive, correlation, and regression analysis has been conducted to assess whether accountants are familiar with BC technology and testes three hypotheses related to the objectives of the study. **Findings:** The main findings are; accountants are highly aware of the BC technology, they face difficulty in understanding the way it is applied, and there is a real gap between accountants and IT professionals. **Originality:** Very few studies investigated or asked accountants about their perception of the application of BC and what is its impact BC application on the future of the accounting profession. Therefore, the main justification of this study is to fill in this gap and ask a wide range of accountants in the MENA about their perception of BC application in the field of accounting. This will contribute to the literature as a new dimension of accounting and blockchain will be addressed and open the door for future research in this field.

Keywords Blockchain · Accountants perception · Usefulness of BC · Future trends of BC

I. E. Ahmed (✉)
Ajman University, Ajman, UAE
e-mail: i.alsiddiqe@ajman.ac.ae

1 Introduction

Blockchain revolution has a very significant impact on recording, updating, and safely keeping transactions and accounting data. Instead of having one single owner, blockchain records are fairly distributed among the different users. The blockchain system uses a complex system of consensus and verification to ensure that all the users are part of a permanent record. The blockchain (BC) facilitates the creation of a global entry bookkeeping, where every single entry is shared identically among all the participants (Al Kurdi et al., 2022b). All transactions are merged together into a block and added to a chain of all previous transactions, by a complex cryptographic process to confirm that the history of all transactions is genuine. Using blockchain in accounting provides clarity over ownership of assets, existence of obligations, and significantly improve efficiency (Kokina et al., 2017). Therefore, Blockchain has the potential to enhance the accounting profession by reducing the costs of maintaining and reconciling ledgers, and providing absolute certainty over the ownership and history of assets. BC was first started as cryptographically, then applied in its current version by Satoshi Nakamoto as a payment system for encrypted digital currencies. It was used as a security technology for transactions of the cryptocurrency Bitcoin developed in 2009 (Dai & Vasarhelyi, 2017). Consequently, there is a tendency to misinterpret Blockchain technology as a cryptocurrency, perceiving it with a negative image because of cryptocurrency's speculative nature. Binance Academy (2020), provide highlights on Bitcoin is the first blockchain application, which introduced the cryptocurrencies, as a digital cash that enables individuals to transmit value in a digital setting.

Accounting activities were manually processed or with the limited uses of computer for just book-keeping. However, new technologies such as AI, Big Data, and BC have been actively applied in accounting processes the always require a big system for information sharing to enhance organizational effectiveness (Alzoubi & Yanamandra, 2020). This revolution enhances transparency and reduced efforts and time through the processing of huge data and transactions at a time (Alzoubi & Aziz, 2021).

Many previous studies were concerned with the dilemma of artificial versus human intelligence that may assist to reduce the work stress by human (Victoria, 2022). This debate raised controversial views among academics and practitioners, raised many of the concerns on the future prospects of many occupations, the required new skill set and competences needed, how humans and machines, autonomous robots (Shamout et al., 2022) can work together by incorporating IT, education, banking and healthcare sector (Neyara Radwan, 2022). Accounting profession is on its way to make a great change of the role it plays in the organization and the functions it currently performs (Mehmood et al., 2019).

Previous studies identified the new accounting technologies into Cloud, Artificial Intelligence, Big Data, and Blockchain, and introduces the case of Korean companies applying new technologies to their accounting process (Lee et al., 2019). Big data analytics and AI in the field of management accounting has significance that can

transform the organizational leadership in order to maintain financial security and effective team management (Ahmed and Al Amiri, 2022). Most of the work done in this area is taking a report form such as the “Digital Darwinism” report (2013) that was conducted by The Association of Chartered Certified Accountants (ACCA) and the Institute of Management Accounts (IMA) on the future of accounting. This report discussed ten technology trends with the potential of significantly reshaping the business and professional environment. Also, the Institute of Chartered Accountants in England and Wales identified AI, Big Data, Blockchain, and Cybersecurity as technologies transforming the accounting industry (Mehmood, 2021). BC technology has described as an internet-based peer-to-peer network that uses cryptography. P2P networks use a distributed application that allocates and shares tasks among peers participating in the network. Due to this chain-shaped link, BC can overcome the limits of double-entry recording such as the need for external assurance on companies' financial statements and the potential for fraud. One of the greatest benefits of BC application is the removal of intermediaries, which reduces costs as stated by (Hughes et al., 2019).

Although BC offers these benefits, it has a number of limitations that need to be factored into any business case for adoption. (Hughes et al., 2019) Identified the following limitations with Blockchain technology: lack of privacy, high costs, security model, flexibility limitations, latency, and governance. Besides, they mention that non-technical limitations including lack of acceptance from legal and regulatory authorities (Alshurideh et al., 2020), and lack of user acceptance are also present (Radwan & Farouk, 2021). However, recently, Blockchain has been adopted in various ways (Bossert, 2018), transforming transactions throughout the industry. (Alzoubi et al., 2022a, 2022b, 2022c, 2022d) Claimed that Blockchain would significantly impact financial services because of its anti-corruption and information validity characteristics.

All the previous studies are either very technical in nature and discuss how to apply technologies in accounting, highlighting the benefits of the different types of technologies, writing general reports on the technology application on accounting, healthcare, real estate, education, graphical techniques and others (Edward Probir Mondol, 2022). None of the previous studies investigated or asked accountants about their perception on the application of BC and what is its impact BC application on the future of accounting profession. Therefore, the main justification of this study is fill in this gap and ask a wide range of accountants in the Middle East and North Africa on their perception on BC application in the field of accounting, auditing, and finance in general. This will contribute to the literature as a new dimension of accounting and blockchain will be addressed and open the door for future research in this field. In addition, it helps practitioners as it guides managers to plan for their needs of human resources and accountants to think of the required future skills to cope with the BC application (Alhamad et al., 2022).

The study is organized as follows: The first section is about introduction, justification, and significance of the study. The second section covers the objectives and the methodology of the study. The third is a review of the literatures that discusses the adoption of BC technology, benefits, and challenges, then ends up with the

hypotheses. The fourth section analyzes the questionnaire and discusses the results and findings. The last section includes the conclusion, limitations of this study, and future implications.

2 Literature Review

Most of the previous studies were just introducing the BC technology and the expected benefits Such as; who concentrated on the current practice and future difficulties that may face application of BC (Rozario & Thomas, 2019). BC is classified into three stages and levels of Blockchain: First-generation is Blockchain 1.0, which first started with Bitcoin's operating system. Second is Blockchain 2.0 that enables smart contracts. Third, Blockchain 3.0, in which smart contracts are used in different areas and sectors. As per accessibility and availability to readers and users BC has been classified into three major types moving from the most open to the most restricted; public, consortium, and private. Public BC and other cryptocurrencies distribute entire through a permission-less consensus mechanism that anyone can participate in them. Whereas, in a private BC system designer can introduce some type of centralization or control over who can participate in the blockchain (Ducas & Wilner, 2017). A comparison among the three types is given.

2.1 *Types of Blockchain*

Properties	Public blockchain	Private blockchain	Consortium blockchain
Consensus process	Permission-less	Permissioned	Permissioned
Consensus determination	All miners	One organization	Selected set of nodes
Efficiency	Low	High	High
Read permission	Public	Public or restricted	Public or restricted
Write permission	Public	Network operator	Authorized participants
Committed users	Anyone	Network operator	All or authorized
Centralized	No	Yes	Partially
Immutability	Impossible tamper	Possible tamper	Possible tamper

The lack of a Quality-led perspective indicates (Alnazer et al., 2017) that the technologists rather than other experts are making the decisions that will affect the way we think about accounting and finance in the future having a huge impact of financial department in any industry to keep efficient supply chain procedure (Alzoubi et al., 2022c). It has been argued that it is hard to find studies on the impact of technologies on management practices, and that new perspectives (Ramakrishna &

Alzoubi, 2022), when existing, do not transition into practice. BC verifies, clears, and stores transactions conducted every ten minutes and links them to the preceding block to create a chain (Rikhardsson & Yigitbasioglu, 2018). Each block confirms the validity of the previous one. Expected future of BC in business and education to be directed to four main areas: blockchain testing, stop the tendency to centralization, big data analytics and blockchain application (Obaid, 2021).

Bitcoin and cryptocurrencies are the most well-known applications of BC. The main benefit of BC is to allow payments to be completed without any intermediary (Alhamad et al., 2021), and can be used in various financial services such as digital assets, remittance and online payment (Alzoubi et al., 2022b). Over and above, BC is becoming one of the most promising technologies for the next generation of internet interaction systems, such as smart contracts, public services, internet of things (IoT), reputation systems, security services, and record keeping in financial and medical areas to detect and keep the patients record (Saad Masood Butt, 2022). (Rennock et al., 2018) state that BC technology has been used in valuation and resource planning plus the book recording. This type of innovative use of BC increases efficiency of accounting through the development of cost strategy and human resource development (Alshurideh et al., 2022b). Overall, BC has remarkable contribution in increasing value of digital assets (Alshurideh et al., 2022a) and reducing the associated expenses in production and manufacturing sector (Lee et al., 2022b). Many other benefits can be derived from the application of BC such as; reliability, transparency, trust, speed, and security (Hanaysha et al., 2021a). As usual, with any new technology the challenges are there. Some of the main challenges and disadvantages of BC technology are; the high cost of acquiring the technology (Alzoubi et al., 2020), complexity in online buying and transactional decisions (Hanaysha et al., 2021b), growing size of BC (Rennock et al., 2018), energy consumption (O'Leary, 2018), and human understanding and errors (Alzoubi et al., 2022a).

Given the above benefits of BC and the current and expected future expansion of its application, open a door for many worries regarding the future of accountants, auditors, estate markets, retailing and healthcare jobs (Khan, 2021). The applications of this technology may have great negative or even positive impact on organizations and humans by enhancing the work quality with technology preference (Alzoubi et al., 2022d). The increase of unemployment is considered as one of the expected impacts (Dirican, 2015) and accountants should be prepared for all the challenges of this revolution to improve the organizational performance (Lee et al., 2022a). At least future expectations are to have a major change in the role of accountants and how they can benefit or cope with BC to satisfy the interest of their organizations. At the World Government Summit in Dubai, explained one of the threads of technology domination, saying that "Humans have already started losing their jobs to machines" and new roles for those people should be figured out (Gunasekaran et al., 2019). In his opinion, the real problem is that the process of labor displacement is very quick and disruptive to maintain the quality management in any organization (Alzoubi & Ahmed, 2019). It has noted that accountants will become more than preparers of historical financial data (Yoon, 2020). One of the shifts in accountants' roles is a response to their intensive work with data analytics. Accountants may change their

role to data analytics and financial modelling, to have more strategic and proactive roles in their organizations, whereas the medical practitioners have to deal with challenges while maintaining the data and security concerns (Akhtar et al., 2021). Enhancement of awareness and understanding, and strong numeracy skills, accountants' capabilities are well placing the profession across organization boundaries (Fanning & Centers, 2016). Accountants' competences in ML and data analytics will be valuable as they can provide support to the employees in understanding the complex models and deriving the right meaning of data.

It is expected that more than 20 billion internet of things (IOT) devices would be existed by 2020 (Coyne & McMickle, 2017). This technology would provide reliable and secure mechanism to IOT devices for making transactions effectively (Ali et al., 2022). BC help to provide unique identity to virtual assets while making online transaction, shopping, and retailing (Kurdi et al., 2022a, 2022b, 2022c). This is because; technology has the power to maintain virtual and physical assets separately (Joghee et al., 2020) that has a great impact on online transactions (Al Kurdi et al., 2022a). (Ducas & Wilner, 2017) mentioned that international trade would be conducted through blockchain by 2030 (Alnuaimi et al., 2021). Accountants may have more valuable roles as a result of BC application that may increase their participation in the decision-making process, internal consultancy, building strategies and problem solving (Hamadneh et al., 2021).

Hypotheses Development

H1: Accountants and auditors in the MENA region are quite aware of the BC technology and its applications.

H2: Accountants and auditors are highly concerned about their future positions as a result of the expansion of BC technology.

H3: BC technology has a significant positive impact on the accounting profession and the development of new skills.

H4: There is a significant gap between accountants and IT professionals.

2.2 Problem Statement and Research Contribution

The paper main objective is to investigate the perception of accountants on the usefulness of Blockchain, highlight the challenges facing the accounting profession nowadays and to shed light on possible trends of the future development of accounting profession in the era of blockchain. It aims also identifying the gap between accountants and IT technicians and professionals (Yeoh, 2017). Most importantly, this paper aims to provide recommendations for the future of accounting and auditing practice as well future directions of research and identify where academicians and practitioners can cooperate to deal with the challenges, provide solutions, and apply the accounting and auditing best practices.

3 Methodology

In order to achieve the research objectives and test the stated hypotheses, an online questionnaire was developed to capture accountants' and auditors' perception of the impacts of BC on their profession. The questionnaire is a closed-ended question that cover two major parts. The first part is about the demographic profile and second part focuses on accountants' experience and perception, which address independent variable and dependent variable. A list of items representing benefits and challenges of BC implementation was developed from a comprehensive industry research on perception of AI in general tested in in many countries. The list consists of 21 questions representing benefits and challenges of BC. The questions have been categorized into 6 main areas of BC understanding and applications, namely; (awareness, usefulness, ease of application, concerns, future changes, and gap identification). The questions were presented in a 5-point Likert-type scale, ranged from 1 (strongly disagree) to 5 (strongly agree). To assess the predictive validity, respondents were asked to state how likely they are to follow recommendations from BC system application. The questionnaire also includes some basic backgrounds and prior use of BC in accounting and auditing jobs. A total of 300 responses were collected from accountants working in 14 countries located in the Middle East and North Africa (MENA). To explore their perception of impacts of BC, exploratory factor analysis (principal component analysis/PCA), cluster analysis, discriminant function analysis, and one-way analysis of variance (ANOVA) were implemented to analyze the data.

4 Empirical Analysis

To achieve the objective of the perception assessment, the study adopts two stages of analysis. Stage 1, is about the descriptive analysis that describe the frequency and percentage extracted from the respondents to the questionnaire about age, education, job. Stage 2, uses SPSS and conducts Analysis of validity and reliability of the variables have been conducted. The study used the Pearson correlation to see the degree of correlation between the responses of the two groups. Lastly, multiple regressions were used to test the hypotheses; that is, to analyze the statistical significance of the variables.

4.1 Demographic and Descriptive Analysis

The descriptive and general demographic analysis shows that the respondents are relatively older and experienced employees (62% of respondents are 40 years and over), mostly college-educated (86% have at least a Bachelor's Degree and exactly

Table 1 Descriptive analysis

	Frequency	Percent (%)
<i>Education</i>		
Post Graduate	70	23
Bachelor	182	61
School	20	7
Other	28	9
	300	
<i>Job</i>		
Accountants	185	62
Auditors	42	14
IT	73	24
	300	
<i>Age</i>		
Above 50	74	25
40–50	115	38
30–39	90	30
20–29	18	6
Less than 20	3	1
	300	

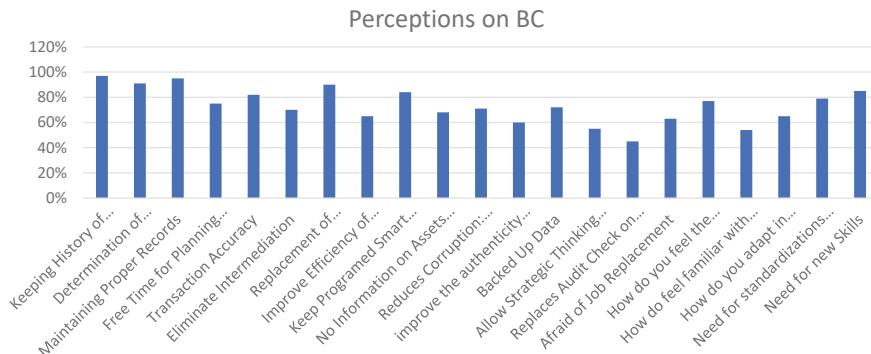
70% are Bachelor holders), and majority are working in accounting position (61%) with 23% have additional IT skills, and 16% have auditing experience. Table 1 shows the findings of the main descriptive information about the respondents.

The overall scores of the respondents on the asked questions are presented in Fig. 1. It is noticed that keeping records, replacement of some basic functions, identifications, and accuracy attain high score and agreed on by majority of the respondents. On the other hand, the respondents see that BC can't replace of auditors' work and they don't confirm the ease of application.

4.2 Reliability and Validity

This study measures discriminant validity through both Fornell-Lacker method. This is to ensure that the latent constructs used for measuring the causal relationships are different and not measuring the same thing that would arise the issue of multicollinearity. Fornell Lacker method computes the correlation coefficients of latent constructs as shown by Table 2. Output from the analysis revealed the composite reliability and the average variance extracted (AVE) are summarized as in Table 2.

Assessment of the reliability of each item measured by the cross-loadings and it is found that the values of composite reliability were high on their respective constructs,

**Fig. 1** Respondents' scores**Table 2** Reliability and validity

	Cronbach's alpha	Rho A	Composite reliability	Average Variance Extracted (AVE)
Awareness	0.775	0.858	0.832	0.594
Usefulness of BC	0.835	0.756	0.756	0.600
Ease of application	0.796	0.656	0.849	0.511
Concerns	0.845	0.750	0.883	0.587
Future change	0.807	0.856	0.884	0.562
Gap	0.743	0.654	0.742	0.540

which means that each factor loading is greater than the cut-off value of 0.70. This also proves that the reliability of each variable is good and gives reinforcement to the allocation for each item on the specified latent construct. The study compares the square root of each Average Variance Extracted (AVE) and their values are within 0.51 and 0.60, which indicates very small differences. It is acceptable validity score that all the AVE values are above 0.50.

The Cronbach alpha is applied to measure internal consistency and composite reliability based on the interrelationship of the observed items. The internal consistency among the 6 variables is achieved and acceptable once the values of Cronbach alpha is between 0.60 to 0.70 as in Table 2.

4.3 Discriminant Validity

Fornell Lacker method computes the correlation coefficients of latent constructs as shown by Table 3. When comparing Tables 3 and 4 results, one of the main results is that the square root of each construct's AVE should be greater than the correlations

Table 3 Discriminant validity: Fornell-lacker

	Awareness	Usefulness of BC	Ease of application	Concerns	Future change	Gap
Awareness	0.730					
Usefulness of BC	0.473	0.657	0.806			
Ease of application	0.708	0.753	0.430	0.808		
Concerns	0.421	0.548	0.681	0.469	0.810	
Future change	0.534	0.496	0.487	0.483	0.379	0.749
Gap	0.006	0.273	0.351	0.236	0.287	0.194

Table 4 Correlation and descriptive statistics

Variables	Mean	St. deviation	1	2	3	4	5	6
Awareness	3.950	0.755	1					
Usefulness of BC	3.449	0.952	0.472**	1				
Ease of application	1.094	3.100	0.400**	0.340**	1			
BC concerns	0.992	3.763	0.437**	0.427**	0.451**	1		
Future change	0.854	3.898	0.552**	0.405**	0.355**	0.331**	1	
Gap	1.110	3.383	0.338**	0.342**	0.541**	0.403**	0.362**	1

with other latent constructs. Therefore, discriminant validity can be accepted for this measurement model and supports the discriminant validity between the constructs.

One of the main findings on awareness is the negative relationship between the age and the familiarity and awareness with BC. This may be due to the high familiarity of the new generation with BC technology and the education system has been changed to equip them with enough skills in BC. Figure 2 highlights this relationship.

4.4 Correlation Analysis

Table 4 shows that the awareness on BC is the highest (mean = 3.95, standard deviation = 0.755), and the lowest variable is the future change (mean = 854, standard deviation = 0.952). It also illustrates the zero-order correlation for all categories of the constructs using bivariate correlations. These bivariate correlations permit the

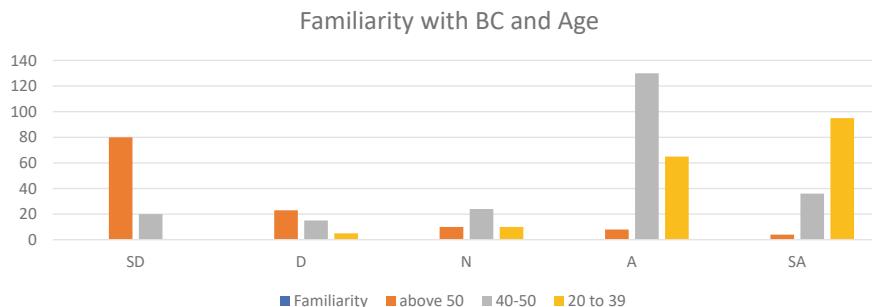


Fig. 2 BC awareness and age

initial investigation on the hypothesized relationships. All the relationships have significant positive correlations.

4.5 Test of Hypotheses: The Regression Analysis

Table 5, explains that there a positive significant relationship between awareness and application of BC. Therefore, H1 will be accepted as (F statistic = **57.044**; p < 0.001).

The second hypothesis is to test the relationship between expansion in BC and the worries of accountants about their future positions. As per the results of Table 6, this hypothesis was not supported (F statistic = **38.15**; p = 0.067).

The third hypothesis is investigating whether there is a gap between accountants and auditors on one hand and the IT professionals on the other hand with regard to perceptions on the BC.

Table 5 ANOVA analysis for awareness on application of BC

Model	Sum of squares	Df	Mean square	F	Sig
Regression	5270.8	4	128,427	57.044	0.000 ^b
Residual	3383.5	179	235.757		
Total	8654.3	183			

Table 6 ANOVA analysis for expansion in BC on worries of accountants

Model	Sum of squares	Df	Mean square	F	Sig
Regression	4270.0	4	14,223	38.15	0.067
Residual	2252.5	112	125.52		
Total	6522.5	138			

Table 7 ANOVA analysis for gap between accountants and auditors

Model	Sum of squares	Df	Mean square	F	Sig
Regression	3367.20	6	234,675	77.54	0.002
Residual	4562.62	122	1268.5		
Total	7929.82	170			

Table 7 shows that there is a significant gap between the perceptions of the two groups of respondents as indicated by the p-value of less than 0.05.

5 Discussion

In this study, the Fornell-Lacker technique and discriminant validity are both measured. This is done to prevent multi-collinearity by ensuring that the latent constructs used to measure the causal links are distinct and not measuring the same thing. After the analysis the study investigation came to find the significance of blockchain for the accountants to manage the financial tasks. The data management and data security accommodate the management and customer trust that ultimately builds up the business performance. Additionally, the results demonstrate that while accountants are aware of the blockchain and its uses, they have some trouble comprehending its technical details and programming components.

6 Conclusion

This study investigates the perception of accountants on the usefulness of Blockchain, highlight the challenges facing the accounting profession nowadays and sheds light on possible trends of the future development of accounting profession in the era of blockchain. It also tries to identify the gap between accountants and IT. A 5-Likert questionnaire was conducted and data was collected from 500 of accountants, auditors, and IT professionals working in 15 countries in the MENA region. The findings show that accountants are aware of the BC and its applications but they face some difficulties in understanding the technical aspects and programming parts of it. There is a significant gap between accountants and IT employees.

7 Future Implications and Recommendations

- Accounting professionals are currently required to have programming skills and to be proficient in data analysis. They must be capable of understanding emergent tools, interfacing with reporting techniques, and interpreting reports to answer questions from authorities.
- The introduction of advanced technology into the accounting profession is likely to reduce the number of employment opportunities for accountants without programming and analysis skills. It may be necessary (and desirable) for companies to provide adequate re-training for existing staff.
- Create new academic programs that combine technical and accounting skills.
- Standardize the practice and application of blockchain and AI technology.
- Enhance on job training.

The future implications are related to both researchers and practitioners. They have to collaborate together to conduct more research and provide technical training on BC to bridge the gap and make use of the expansion in BC technology.

References

- Ahmed, G., & Amiri, N. A. (2022). The transformational leadership of the founding leaders of the United Arab Emirates: Sheikh Zayed Bin Sultan Al Nahyan and Sheikh Rashid Bin Saeed Al Maktoum. *International Journal of Technology, Innovation and Management.*, 2, 1.
- Akhtar, A., Akhtar, S., Bakhtawar, B., Kashif, A. A., & AzizMuhammad, & , Javeid, S., N. (2021). COVID-19 Detection from CBC using Machine Learning Techniques. *International Journal of Technology, Innovation and Management.*, 1, 65–78.
- Alhamad, A., Alshurideh, M., Alomari, K., Al Kurdi, B., Alzoubi, H., Hamouche, S., & Al-Hawary, S. (2022). The effect of electronic human resources management on organizational health of telecommunications companies in Jordan. *International Journal of Data and Network Science.*, 6, 429–438.
- Alhamad, A. Q. M., Akour, I., Alshurideh, M., Al-Hamad, A. Q., Kurdi, B. A., & Alzoubi, H. (2021). Predicting the intention to use google glass: A comparative approach using machine learning models and PLS-SEM. *International Journal of Data and Network Science.*, 5, 311–320.
- Ali, N., Ghazal, T. M., Ahmed, A., Abbas, S., Khan, M. A., Alzoubi, H. M., Farooq, U., Ahmad, M., & Khan, M. A. (2022). Fusion-based supply chain collaboration using machine learning techniques. *Intelligent Automation and Soft Computing.*, 31, 1671–1687.
- Alnazer, N. N., Alnuaimi, M. A., & Alzoubi, H. M. (2017). Analysing the appropriate cognitive styles and its effect on strategic innovation in Jordanian universities. *International Journal of Business Excellence*, 13, 127–140.
- Alnuaimi, M., Alzoubi, H. M., Ajelat, D., & Alzoubi, A. A. (2021). Towards intelligent organisations: An empirical investigation of learning orientation's role in technical innovation. *International Journal of Innovation and Learning.*, 29, 207–221.
- Alshurideh, M., Gasaymeh, A., Ahmed, G., Alzoubi, H. M., & Kurd, B. A. (2020). Loyalty program effectiveness: Theoretical reviews and practical proofs. *Uncertain Supply Chain Manag.*, 8, 599–612.
- Alshurideh, M. T., Kurdi, A., & B., A., (2022a). *H. m.*, 10, 1191–1202.

- Alshurideh, M., Kurdi, B., Alzoubi, H., Obeidat, B., Hamadneh, S., & Ahmad, A. (2022b). Fuzzy assisted human resource management for supply chain management issues. *Annals of Operations Research*.
- Alzoubi, H., & Ahmed, G. (2019). Do Total Quality Management (TQM) practices improve organisational success? A case study of electronics industry in the UAE. *International Journal of Economics and Business Research*, 17, 459–472.
- Alzoubi, H., Alshurideh, M., Kurdi, B. A., Akour, I., & Aziz, R. (2022a). Does BLE technology contribute towards improving marketing strategies, customers' satisfaction and loyalty? The role of open innovation. *International Journal of Data and Network Science*, 6, 449–460.
- Alzoubi, H. M., Ahmed, G., Al-Gasaymeh, A., & Al Kurdi, B. (2020b). Empirical study on sustainable supply chain strategies and its impact on competitive priorities: The mediating role of supply chain collaboration. *Manag Sci Lett*, 10, 703–708.
- Alzoubi, H. M., Ahmed, G., & Alshurideh, M. (2022c). An empirical investigation into the impact of product quality dimensions on improving the order-winners and customer satisfaction. *International Journal of Productivity and Quality Management*, 36, 169–186.
- Alzoubi, H. M., Alshurideh, M. T., Kurdi, B. A., Alhyasat, K. M. K., & Ghazal, T. M. (2022d). The effect of e-payment and online shopping on sales growth: Evidence from banking industry. *International Journal of Data and Network Science*, 6, 1369–1380.
- Alzoubi, H. M., & Aziz, R. (2021). Does emotional intelligence contribute to quality of strategic decisions? the mediating role of open innovation. *Journal of Open Innovation: Technology, Market, and Complexity*, 7, 130.
- Alzoubi, H. M., Elreħail, H., Hanaysha, J. R., Al-Gasaymeh, A., & Al-Adaileh, R. (2022d). The role of supply chain integration and agile practices in improving lead time during the COVID-19 crisis. *International Journal of Service Science, Management, Engineering, and Technology*, 13, 1–11.
- Alzoubi, H. M., & In'airat, M., Ahmed, G., (2022). Investigating the impact of total quality management practices and Six Sigma processes to enhance the quality and reduce the cost of quality: The case of Dubai. *International Journal of Business Excellence*, 27, 94–109.
- Alzoubi, H. M., & Yanamandra, R. (2020). Investigating the mediating role of Information Sharing Strategy on Agile supply chain in supply chain performance. *Uncertain Supply Chain Manag.*, 8, 273–284.
- Bossert, J. L. (2018). Is quality 4.0 the end of six sigma? *Lean Six Sigma Rev.*, 17, 4–19.
- Coyne, J. G., & McMickle, P. L. (2017). Can blockchains serve an accounting purpose? *Journal of Emerging Technologies in Accounting*, 14, 101–111.
- Dai, J., & Vasarhelyi, M. A. (2017). Toward blockchain-based accounting and assurance. *Journal of Information Systems*, 31, 5–21.
- Dirican, C. (2015). The impacts of robotics, artificial intelligence on business and economics. *Procedia—Soc. Behavioral Science*, 195, 564–573.
- Ducas, E., & Wilner, A. (2017). The security and financial implications of blockchain technologies: Regulating emerging technologies in Canada. *International Journal*, 72, 538–562.
- Edward Probir Mondol. (2022). The role of Vr games to minimize the obesity of video gamers. *International Journal of Computations, Information and Manufacturing*, 2, 1.
- Fanning, K., & Centers, D. P. (2016). Blockchain and its coming impact on financial services. *J Corp*, 27, 53–57.
- Gunasekaran, A., Subramanian, N., & Ngai, W. T. E. (2019). Quality management in the 21st century enterprises: Research pathway towards Industry 4.0. *International Journal of Production Economics*, 27, 125–129.
- Hamadneh, S., Pedersen, O., Alshurideh, M., Kurdi, B. A., & Alzoubi, H. M. (2021). An investigation of the role of supply chain visibility into the scottish blood supply chain. *J Legal Ethical Regul Issues*, 24, 1–12.
- Hanaysha, J. R., Al-Shaikh, M. E., Joghee, S., & Alzoubi, H. M. (2021a). Impact of innovation capabilities on business sustainability in small and medium enterprises. *FIIB Business Review*, 12, 55–68.

- Hanaysha, J. R., Shaikh, A., & M. E., A. (2021b). H. M. Importance Mark. Mix Elel. *Determ Consum Purch Decis Retail Mark.*, 2, 56–72.
- Hughes, L., Dwivedi, Y. K., Misra, S. K., Rana, N. P., Raghavan, V., & Akella, V. (2019). Blockchain research, practice and policy: Applications, benefits, limitations, emerging research themes and research agenda. *International Journal of Information Management*, 49, 114–129.
- Joghee, S., Alzoubi, H. M., & Dubey, A. R. (2020). Decisions effectiveness of FDI investment biases at real estate industry: Empirical evidence from Dubai smart city projects. *International Journal of Scientific & Technology Research*, 9, 3499–3503.
- Khan, M. A. (2021). Challenges facing the application of IoT in medicine and healthcare. *International Journal of Computations, Information and Manufacturing*, 1, 39–55.
- Kokina, J., Mancha, R., & Pachamanova, D. (2017). Blockchain: Emergent industry adoption and implications for accounting. *Journal of Emerging Technologies in Accounting.*, 14, 91–100.
- Kurdi, B. A., Alshurideh, M., Akour, I., Alzoubi, H. M., Obeidat, B., & Alhamad, A. (2022a). The role of digital marketing channels on consumer buying decisions through eWOM in the Jordanian markets. *International Journal of Data and Network Science.*, 6, 1175–1185.
- Kurdi, B. A., Alzoubi, H. M., Akour, I., & Alshurideh, M. T. (2022b). The effect of blockchain and smart inventory system on supply chain performance: Empirical evidence from retail industry. *Uncertain Supply Chain Manag.*, 10, 1111–1116.
- Kurdi, B. A., Alshurideh, M., & Akour, I. (2022c). Alhamad, A., Alzoubi, H M Eff Soc media Influ Charact Consum Intent attitude Towar. *Keto Prod Purch Intent.*, 6, 1135–1146.
- Lee, H., Yoon, N., Park, S., Lee, C., & Hwang, S. A. (2019). Study on the accounting information system based on Blockchain. *Korean Acc.*, 28, 273–300.
- Lee, K. L., Azmi, N. A. N., Hanaysha, J. R., Alzoubi, H. M., & Alshurideh, M. T. (2022a). The effect of digital supply chain on organizational performance: An empirical study in Malaysia manufacturing industry. *Uncertain Supply Chain Manag.*, 10, 495–510.
- Lee, K. L., Romzi, P. N., Hanaysha, J. R., Alzoubi, H. M., & Alshurideh, M. (2022b). Investigating the impact of benefits and challenges of IOT adoption on supply chain performance and organizational performance: An empirical study in Malaysia. *Uncertain Supply Chain Manag.*, 10, 537–550.
- Mehmood, T., Alzoubi, H., Alshurideh, M., Al-Gasaymeh, A., & Ahmed, G. (2019). Schumpeterian entrepreneurship theory: evolution and relevance. *Academy of Entrepreneurship.*, 25, 1–10.
- Mehmood, T. (2021). Does information technology competencies and fleet management practices lead to effective service delivery? empirical evidence from e-commerce industry. *International Journal of Technology, Innovation and Management.*, 1, 14–41.
- O'Leary, D. E. (2018). Open information enterprise transactions: Business intelligence and wash and spoof transactions in blockchain and social commerce. *Intelligent Systems in Accounting, Finance and Management*, 25, 148–158.
- Obaid, A. J. (2021). Assessment of smart home assistants as an IoT. *International Journal of Computations, Information and Manufacturing*, 1, 18–38.
- Radwan, N. (2022). The internet's role in undermining the credibility of the healthcare industry. *International Journal of Computations, Information and Manufacturing*, 2, 1.
- Radwan, N., & Farouk, M. (2021). The Growth of Internet of Things (IoT) in the management of healthcare issues and healthcare policy development. *International Journal of Technology, Innovation and Management*, 1, 69–84.
- Ramakrishna, Y., & Alzoubi, H. M. (2022). Empirical investigation of mediating role of six sigma approach in rationalizing the COQ in service organizations. *Oper Supply Chain Manag.*, 15, 122–135.
- Rennock, M. J., Cohn, A., Butcher, J. R. (2018). Blockchain technology and regulatory investigations. *Journal 1*, 35–45.
- Rikhardsson, P., & Yigitbasioglu, O. (2018). Business intelligence & analytics in management accounting research: Status and future focus. *International Journal of Accounting.*, 29, 37–58.
- Rozario, A. M., & Thomas, C. (2019). Reengineering the audit with blockchain and smart contracts. *Journal of Emerging Technologies in Accounting*, 16, 21–35.

- Saad Masood Butt. (2022). Management and treatment of type 2 diabetes. *International Journal of Computations, Information and Manufacturing.*, 2, 1.
- Shamout, M., Ben-Abdallah, R., Alshurideh, M., Alzoubi, H., Kurdi, B. A., & Hamadneh, S. (2022). A conceptual model for the adoption of autonomous robots in supply chain and logistics industry. *Uncertain Supply Chain Manag.*, 10, 577–592.
- Victoria, V. (2022). Impact of process visibility and work stress to improve service quality: empirical evidence from dubai retail industryimpact of process visibility and work stress to improve service quality: empirical evidence from dubai retail industry. *International Journal of Technology, Innovation and Management*. 2.
- Yeoh, P. (2017). Regulatory issues in blockchain technology. *Journal of Financial Regulation and Compliance*, 25, 196–208.
- Yoon, S. (2020). A study on the transformation of accounting based on new technologies: evidence from Korea. *Sustain MDPI, Open Access J.*, 12, 1–22.

Management Accounting Systems and Data Analytics in the United States: Evidence from Apple



Nizar Mohammad Alsharari

Abstract Management accounting is the process of making goals and objectives of the company by identifying and analyzing the available and its communication to the managers. Advanced management accounting systems can be used to make decisions, including Job Costing System, Process Costing System, Budgeting, Activity Costing System etc. The United States of America has undergone many phases to get to the advanced management accounting system. The first elaborate management accounting system was seen in New England Textile Industry and Springfield armory in the eighteenth century. The railroads' management gave another push to management accounting and auditing. The scientific management theory of Frederick Taylor was a significant development that framed the current scenario of Management accounting. The pre-war and post-war eras had seen many ups and downs in these fields. With the 1950s and 1960s came the period of responsible reporting, and the advanced management system was given rise from that era. Data Analytic techniques also play an essential role in analyzing and visualizing data, enabling managers to make better decisions. Apple Inc. is a global leader in the field of IT and computers. It uses several techniques and systems to manage its costs and expenses. This study discusses the use of Activity-based costing and Cost volume analysis on Apple Inc. operations.

Keywords Management accounting · Data analytics · Accounting systems · Apple

1 Introduction

Management accounting is formulating organizational goals by identifying, measuring, analyzing, interpreting, and communicating information to managers (Ahrens & Chapman, 2007). The focus of management accounting is on all the

N. M. Alsharari (✉)

Department of Accounting, Finance, and Entrepreneurship, College of Business, Jackson State University, Jackson, USA

e-mail: nizar.m.alsharari@jsums.edu

accounting that provides information to the management regarding operational business metrics with innovational procedures (Hanaysha et al., 2022). It deals with the information about the cost of products or services purchased by the company (Ali, 2021). To quantify the decisions made in operational planning, budgets are used with the help of AI and technological factors (Al-Tahat & Moneim, 2020). Management accountants use performance reports to note the variance between the real-time results and the budgets (Chichan et al., 2021).

The significant difference between management and financial accounting is that financial accounting aims at creating financial reports, improved working system to lessen the work pressure (Victoria, 2022) by using accounting data to make financial reports using advanced technology like IoT, AI, Big Data (Radwan & Farouk, 2021); on the other hand, management accounting is the internal processing of an organization, internal processing includes the manufacturing, supply chain, product cycle and employee management (Hamadneh et al., 2021) that a company uses to account for business dealings (Quesado & Silva, 2021). There are several types of management accounting systems that managers use to collect data and make decisions; (Gosselin, 2006) such as.

- Job costing systems
- Process costing systems
- Hybrid costing system
- Activity-based costing systems
- Traditional costing system
- Budgeting system
- Marginal costing system
- Lean accounting system
- Standard costing system.

1.1 Job Costing System

This costing system allows the firm to accumulate the costs of different jobs separately. This can be used by companies that create unique products and special orders. This can be used by an event management company, costly surveillance company, and service organizations that provide services as well as manufacturing to maintain the product cycle (Ramakrishna & Alzoubi, 2022).

1.2 Process Costing Systems

This type of costing system can be used to accumulate separate manufacturing costs for each process. It can be used for products whose manufacturing occurs in different departments, and the cost flows from one department to another during supply chain process (Alzoubi et al., 2022c).

1.3 Hybrid Costing System

In some unique situations, firms use job and process accounting systems. Such a system is called a Hybrid Costing system (Gosselin, 2006).

1.4 Traditional Costing System

This system uses a single overhead rate and applies it to every company department (Quesado & Silva, 2021).

1.5 Activity-Based Accounting System

This system calculates the activity rate of each product and provides relevant information that applies the overhead rate based on their respective activity usage (Alzoubi & Yanamandra, 2020).

1.6 Budgeting System

The process of financial and non-financial planning for the satisfaction of organizational goals of the company (Gosselin, 2006).

The current study analyzes the management accounting systems used in Apple as an evidence from United States of America. The company selected for this case study is Apple Inc. This study consists of a brief history of management accounting in the USA, the relationship between management accounting and data analytics, methodology for data collection for the case study, description of the case, analysis, discussion, and arguments on the subject conclusions at the end.

2 Literature Review

2.1 Management Accounting in the USA

2.1.1 History of Management Accounting in the USA

The term cost accounting information was broadly interpreted and used in managerial fashion in New England textile Industry in the early 1800s. This was a large-scale industry that employed hundreds of employees along with professional managers

(Ahrens & Chapman, 2007). Large production in this industry reflected the change from mercantile to industrial accounting in the U.S. Springfield armory was the first and most significant prototype of a modern factory institution in the late eighteenth century. It was an integrated manufacturing facility where detailed and formal reports were made to control and coordinate the flow of products in the armory (Schaltegger et al., 2022; Fleischman & Tyson, 2006).

The nineteenth century brought the emergence of railroad accounting. By the 1860s', railroads were involved in more accounting and auditing than the state and national governments. The basic unit to measure unit cost on the railroads was the ton-mile. This was also used as a primary control to measure managers' performance and net incomes in advanced way (Lee et al., 2022a). After the civil war, there was significant growth in American businesses. This growth was due to technological advancement in the business world (Alsharari, 2021). Accounting in this era was highly centralized with a top-down managerial environment (Fleischman & Tyson, 2006).

Then came the scientific management theory of Fredrick Taylor in 1909. He believed the firm's productivity could increase if we worked scientifically (Joghee et al., 2020). He thought the managers must first find an efficient way of doing the tasks. And then train a set of workers on a specific task up to first class (Alshurideh et al., 2020). Then introduce incentives for optimum performance and loss of earnings on poor performance. He also stated that work should be divided among workers and utilize proper methods of learning (Eli, 2021), with one type of worker working on a specific task and the other working on the other for better efficiency (Mehmood et al., 2019).

By 1925, multidivisional firms such as Du Point and General Motors were on the rise, and most of the management accounting in that era was to develop accounting innovations to support them with technology and big data analytics (Alnuaimi et al., 2021). In the 1930s, Security Exchange Commission was created to monitor the US capital markets and implement the Security Act. This event glamorized the accounting profession (Alshurideh et al., 2022b), and more prestige was given to those accountants who worked for top well-known firms (Fleischman & Tyson, 2006).

The nation went to war in the late 1940s, so the cost of accountancy expertise faced a low ebb. The National Association of Cost Accountants reported many standard costing and variance articles in their bulletins and yearbooks. However, as the country moved toward war, any notion of standard costing quickly disappeared as the government preferred contracts over actual rather than the standard cost (Alzoubi & Aziz, 2021). Other factors that caused this decline include high labor turnover, inexperienced workforce, unfamiliar products, shortage of materials, numerous artificial controls (Fleischman & Tyson, 2006).

The era of responsible accounting in the 1950 and 1960s emphasized cost controls through standard costs. Several notable accountants came into emergence in this era. They focused on the cost management side of accounting and the need for budgetary and cost control that might be possible by implication of blockchain and data management (Al Kurdi et al., 2022b). The modern methods of costing, such

as value-added cost analysis to make sustainable supply chain that directly effects accounts and financial operations (Alzoubi et al., 2020), activity-based costing, and target, cycle, and strategic costing, were all found on the concept that information regarding the cost must help the managers in decision making (Alhamad et al., 2022), especially in their efforts to reduce the cost concerning relentless global market competition and employees retention (Fleischman & Tyson, 2006).

2.2 Management Accounting and Data Analytics in the USA

Data analytics has a vital role in management accounting. It enables the managers to analyze a much larger pool of data that is available for financial accounting in innovative way that ultimately upgrade an organizational operations with technology (Ali et al., 2022). A broader opportunity for data analysis is known as the data is not just restricted to financial information reported to the US SEC 10 K fillings (Trong NGUYEN, 2021). Management accountants can use both financial and non-financial data to provide a customized creative analysis to support their organizations' better decision-making (Mehmood, 2021). This analysis provides an insight into sources of operational efficiencies and inefficiencies (Lee et al., 2022b). Having access to such data allows a company to gain more profits and operational efficiency with the use of IoT in today's hypercompetitive business world (Cruz, 2021).

After the analysis, the data needs to be presented in a meaningful and explicit mode that may require strategic innovation (Alnazer et al., 2017). This can be done using data visualization softwares such as DataViz. DataViz presents the information in a pictorial and graphical way using interactive boards, reports, and presentations. It grabs the attention of the user through the production of data and graphs. It allows the viewer to perceive a large amount of multifaceted information (Ali, 2021) in pictorial graphical format more efficiently (Alzoubi et al., 2021) than that by reading a spreadsheet. Data differences can be highlighted with the help of colors. The advance technology softwares make working efficient, cost effective and time effective (Alzoubi & Ahmed, 2019).

2.3 Challenges in Data Analytics

The use of reliable and accurate data is a significant challenge in data analytics that assist in improving the quality management (Alzoubi et al., 2022d). Data may be corrupt, inaccurate or cracks that requires advances robotics data management operations to detect and rectify (Shamout et al., 2022). Therefore, it may need identified and correcting before performing data analysis. Management accountants need to be a part of data cleansing as they are well versed in data of the firm (Chu et al., 2020). If this task is delegated to the IT department, it will be hazardous as the they do

not understand the data's nuances as that of the management accountants (Ali et al., 2022).

Another challenge in data analytics is the chance of drawing the conclusion from it. That's why there is a need to plan the analysis, identify the objectives and then carefully review the results that has an external impact on product market and competition (Hanaysha et al., 2021). Also, some kind of internal controls and governance procedures should be employed to protect the data (Chong et al., 2021). Equipping management accountants with data analytics skills returns enormous dividends for the firms. As accountants equipped with such skills turn out to be trusted advisors for the companies (Alzoubi et al., 2022b).

3 Methodology

The current study aims to provide an analysis of management accounting system employed in one of the top companies of United States of America known as Apple Inc. The data for the study is taken from reports and articles available online on websites, journal articles, and blogs. Financial information is taken from annual reports of Apple Inc. Scholarly articles about management accounting practices of the various companies all over the world to compare and analyze the effectiveness of the rules in Apple Inc.

4 Research Description

4.1 *History of Apple*

The company chosen for this analysis is Apple Inc. Apple Inc, was established in 1976, by college dropouts Steve Jobs and Steve Wozniak. They brought a vision to make user friendly, small companies that people can use at home. Apple introduced the first-ever color graphics and revolutionized the computer industry. Apples' sales sky rocketed from \$7.8 million to \$117 million after that. By 1985 both Wozniak and Jobs had left Apple for the want of more exciting and more significant opportunities. Apple was still doing through the 1980s and made its highest profit in 1990. This was by the efforts already made by Jobs by making an alliance with Adobe, and together these two companies launched a phenomenon known as desktop publishing (Kirk, 2015).

Over the next couple of years, the company's shares started to suffer slowly until 1996 when they bought Steve Jobs' new company called NEXT and asked for his help. Jobs made several changes in the company. He made a deal with Microsoft to create a MAC version of the office program. This proved to be the turning point for

the company. He then revamped the computer s and launched iBook and iPod which received an immensely positive response from the market (Chen et al., 2022).

Then came the iPhone in 2007, which became one of the most successful products of the world. Several new versions of it have been released ever since. Other popular products of Apple are the tablet version of the computer called, the iPad and the Apple watch. Apple has further expanded its services in the recent times and launched Apple card (a credit card, Apple arcade, Apple new and Apple TV+ . Steve Jobs died in 2011, but Tim Cook continued his legacy as the CEO of Apple. The company closed at one trillion dollars valuation in 2018 and in 2 years, it has doubled that number (Kirk, 2015).

4.2 Management Accounting in Apple Incorporation

Many management decisions of a company are dependent upon the Cost Volume Profit (CVP) analysis. Apple also uses the similar system. Apples uses a fixed cost structure due to which generates huge number of profits in the holiday season when their products are selling like hot cakes but in the average period it may suffer from operational losses which is quite a normal phenomenon (Al Kurdi et al., 2022a). Apple makes several assumptions in the CVP analysis that includes the assumption they have fix sales mix as they have a variety of products. If one product goes down, other supplements it. Also, that they have a linear product cost which is divided to fix and variable cost. They have constant variable element per one unit, whereas the fixed part are consistent throughout the relevant range (Ahrens & Chapman, 2007).

Apple Inc. makes another assumption that is their product's selling price does not change as the price is not dependent upon the volume changes. They do not change their inventories as well and keep producing the same number of units as the number of their sales. Their number of sales never increase from their highest ever sales. If the company wants increase their revenue, they just change the model of their product and increase its selling price which intern increase the sales mix and the fix costs as well (Alzoubi et al., 2022a, 2022b, 2022c, 2022d; Chen et al., 2022).

Apple determines the production cost of its products using Activity Based Costing system (ABC). For example; if the revenue generated from making one iPhone is \$645, then in order to calculate the gross margins of the product it needs to be subtracted from overall margins. In order to make an iPhone Apple has to incur 4 types of cost which include; material cost, production cost (labor), transport and warehousing costs, warranty expenses to make effective production by maintaining the product quality (Alzoubi et al., 2022a).

It takes about 34 h to build one iPhone and 6–7 h for the installation of the software along with testing. The workers are paid \$1.78 per hour for a single iPhone will be \$30rhowever it is tough to find out the cost of a single phone. The cost of R & D and the administrative fee are not included in the cost structure of Apple Inc. These are fixed costs which are implemented for the manufacturing of the production. A

“clock cycle” is present in the company, which is used to time each worker to ensure they all spend some time in the work place.

5 Empirical Analysis

In the above section we have discussed two management accounting systems being implemented in Apple inc. in order to make managerial decisions. One is Activity-based costing and other is cost volume profit analysis (Alshurideh et al., 2022a). There are thousands of companies that have adopted or looked into the chances of adopting Activity-based costing, but almost 90% of them have given it up as it is complicated to implement. It is a huge responsibility to pinpoint the all the data regarding direct and indirect costs of the company and also to set up a system to keep track of such data and present it to the employees so they can use it in their day-to-day decision-making process. It is a difficult task to convince the employee to lose their old ways and take up this new system (Chen et al., 2022).

However, taking up this system will transform the company and make it a company that everyone copies. If we take the example of the two companies, Safety Kleen and Crysler that have adopted this approach in its early era and they are now making booming profits and creating consumer purchase retention can enhance the market strategical implication to attain competitive advantage (Kurdi et al., 2022a, 2022b, 2022c). Crysler reports that ever since it has implemented ABC in its system, they have generated hundreds of dollars of revenue by simplifying product design and by eliminating inefficient, unproductive and redundant activities (Margulis and Galli, 2018). Similarly, Safety Kleen has reaped an income of \$12.7 million through cost avoidance and cost saving. This is fourteen times more than that of the original investment (Aljafari, 2016).

Similarly, a technique of cost volume profit analysis is used by Apple to find out the cost incurred, volume of activity, value of sale and profits generated. Three variables were taken to analyze the profits, i.e., Costs, sales volume and sales price. Several assumptions are made to predict the performance of the company in the longer run. This system however has its disadvantages if the assumptions of CVP analysis are violated (Reyhanoglu, 2011).

6 Discussion

There are several advantages and disadvantages of ABC implementation in Apple Inc. One of the advantages is that ABC provides the actual cost of production for specific products. It also allocated accurate overhead costs on its product based on their activity (Alhamad et al., 2021). Using this system inefficient processes are identified and improvements are made. The products profit margins can be identified more precisely. However, there may be some disadvantages linked to ABC, such as

collection and preparation of data is very time taking and it is costly to analyze the data as well. Sometimes the ABC reports may not conform to the general principles of accounting and cannot be used for reporting externally (Quesado & Silva, 2021).

Similarly, there are many advantages and disadvantages of CVP analysis implementation in Apple Inc (Reyhanoglu, 2011). One of the advantages is that it helps in the decision making process by making the manager equipped with answers to some problems in a business environment. For example, if the manager knows the breakeven point of the company, he can predict how future spending and production can lead to success or failure of the company's initiatives. Therefore, he can make decisions accordingly to avoid the failure. It also provides a clear perspective of the all of the company's activities from the cost of the products to the amount of the product being manufactured. CVP also has its disadvantages for example it is prone to human error, results can change drastically if estimates are used than that of the exact number. CVP is also not very applicable to multi product industries and works well with one product at a time. CVP requires an immense attention to detail, but still, it provides approximate results that that of exact figures. Therefore, managers need to work with great caution to make decision based on the inaccurate results.

7 Conclusions

The current study analyzed the management accounting system of US. First the general terms in the management accounting and some popular management accounting systems were discussed. Then the history of management accounting in the US was studies to go through the phases that the management accountancy went through to reach its current face. Then a case study of management accounting systems in Apple Inc. was discussed. Apple Inc. uses the Activity-based costing for collecting the information regarding its cost and them making decisions. Furthermore, it employs the model of Cost Volume Profit analysis to make assumption about the future trends in the company and make decisions accordingly. Both of these systems have their advantages and disadvantages. However, looking at the current profit trends of the company it is making huge turnovers. Therefore, it can be said that these systems are working for it.

References

- Ahrens, T., & Chapman, C. S. (2007). *Management accounting as practice*, 32, 1–27.
- Alhamad, A. Q. M., Akour, I., Alshurideh, M., Al-Hamad, A. Q., Kurdi, B. A., & Alzoubi, H. (2021). Predicting the intention to use google glass: A comparative approach using machine learning models and PLS-SEM. *International Journal of Data and Network Science.*, 5, 311–320.

- Alhamad, A., Alshurideh, M., Alomari, K., Al Kurdi, B., Alzoubi, H., Hamouche, S., & Al-Hawary, S. (2022). The effect of electronic human resources management on organizational health of telecommunications companies in Jordan. *International Journal of Data and Network Science*, 6, 429–438.
- Ali, A. A. (2021). The impact of information sharing and quality assurance on customer service at UAE banking sector. *International Journal of Technology, Innovation and Management*, 1, 01–17.
- Ali, N., Ghazal, T. M., Ahmed, A., Abbas, S., Khan, M. A., Alzoubi, H. M., Farooq, U., Ahmad, M., & Khan, M. A. (2022). Fusion-based supply chain collaboration using machine learning techniques. *Intelligent Automation and Soft Computing*, 31, 1671–1687.
- Aljafari, A. (2016). Apple Inc., Industry Analysis–business policy and strategy. *International Journal of Scientific and Engineering Research*, 7, 406–441.
- Alnazer, N. N., Alnuaimi, M. A., & Alzoubi, H. M. (2017). Analysing the appropriate cognitive styles and its effect on strategic innovation in Jordanian universities. *International Journal of Business Excellence*, 13, 127–140.
- Alnuaimi, M., Alzoubi, H. M., Ajelat, D., & Alzoubi, A. A. (2021). Towards intelligent organisations: An empirical investigation of learning orientation's role in technical innovation. *International Journal of Innovation and Learning*, 29, 207–221.
- Alsharari, N. (2021). Integrating blockchain technology with internet of things to efficiency. *International Journal of Technology, Innovation and Management*, 1, 01–13.
- Alshurideh, M., Gasaymeh, A., Ahmed, G., Alzoubi, H. M., & Kurd, B. A. (2020). Loyalty program effectiveness: Theoretical reviews and practical proofs. *Uncertain Supply Chain Manag.*, 8, 599–612.
- Alshurideh, M. T., Kurdi, A., & B., A. (2022a). *H. m.*, 10, 1191–1202.
- Alshurideh, M. T., Kurdi, A., B., A., H. M., S., N., A. (2022b). A. H. Fuzzy assisted human resource management for supply chain management issues. *Annals of Operations Research*.
- Al-Tahat, S., & Moneim, O. A. (2020). The impact of artificial intelligence on the correct application of cyber governance in Jordanian commercial banks. *International Journal of Scientific & Technology Research*, 9, 7138–7144.
- Alzoubi, H., & Ahmed, G. (2019). Do Total Quality Management (TQM) Practices Improve Organisational Success? A case study of electronics industry in the UAE. *International Journal of Economics and Business Research*, 17, 459–472.
- Alzoubi, H. M., & Aziz, R. (2021). Does emotional intelligence contribute to quality of strategic decisions? the mediating role of open innovation. *Journal of Open Innovation: Technology, Market, and Complexity*, 7, 130.
- Alzoubi, H. M., & In'airat, M., Ahmed, G., (2022). Investigating the impact of total quality management practices and Six Sigma processes to enhance the quality and reduce the cost of quality: The case of Dubai. *International Journal of Business Excellence*, 27, 94–109.
- Alzoubi, H. M., & Yanamandra, R. (2020). Investigating the mediating role of Information Sharing Strategy on Agile Supply Chain in Supply Chain Performance. *Uncertain Supply Chain Manag.*, 8, 273–284.
- Alzoubi, H. M., Ahmed, G., Al-Gasaymeh, A., & Al Kurd, B. (2020). Empirical study on sustainable supply chain strategies and its impact on competitive priorities: The mediating role of supply chain collaboration. *Management Science Letters*, 10, 703–708.
- Alzoubi, H. M., Vij, M., Vij, A., & Hanaysha, J. R. (2021). What leads guests to satisfaction and loyalty in UAE five-star hotels? AHP analysis to service quality dimensions. *ENLIGHTENING Tour A PATHMAKING J.*, 11, 102–135.
- Alzoubi, H., Alshurideh, M., Kurdi, B. A., Akour, I., & Aziz, R. (2022a). Does BLE technology contribute towards improving marketing strategies, customers' satisfaction and loyalty? The role of open innovation. *International Journal of Data and Network Science*, 6, 449–460.
- Alzoubi, H. M., Ahmed, G., & Alshurideh, M. (2022b). An empirical investigation into the impact of product quality dimensions on improving the order-winners and customer satisfaction. *International Journal of Productivity and Quality Management*, 36, 169–186.

- Alzoubi, H. M., Alshurideh, M. T., Kurdi, B. A., Alhyasat, K. M. K., & Ghazal, T. M. (2022c). The effect of e-payment and online shopping on sales growth: Evidence from banking industry. *International Journal of Data and Network Science*, 6, 1369–1380.
- Alzoubi, H. M., Elrehail, H., Hanaysha, J. R., Al-Gasaymeh, A., & Al-Adaileh, R. (2022d). The role of supply chain integration and agile practices in improving lead time during the COVID-19 crisis. *International Journal of Service Science, Management, Engineering, and Technology*, 13, 1–11.
- Chen, X., Liu, Y., & Gong, H. (2022). Apple Inc. strategic marketing analysis and evaluation. In *Proc 2021 3rd Int Conf Econ Manag Cult Ind (ICEMCI 2021)* (Vol. 203, pp. 3053–3061).
- Chichan, H. F., Tawfeeq, T., & Alabdullah, Y. (2021). Does environmental management accounting matter in promoting sustainable development? *A Study in Iraq*, 5, 110–122.
- Chong, C., Lee, K., & Ahmed, G. (2021). Improving IoT privacy, data protection and security concerns. *International Journal of Technology, Innovation and Management*, 1, 18–33.
- Chu, C. Y., Park, K., & Kremer, G. E. (2020). A global supply chain risk management framework: An application of text-mining to identify region-specific supply chain risks. *Adv Eng Informatics*, 45, 101053.
- Cruz, A. (2021). Convergence between blockchain and the internet of things. *International Journal of Technology, Innovation and Management*, 1, 34–53.
- Eli, T. (2021). Students' perspectives on the use of innovative and interactive teaching methods at the university of nouakchott al aasriya, mauritania: english department as a case study. *International Journal of Technology, Innovation and Management*, 1, 90–104.
- Fleischman, R., & Tyson, T. (2006). The History of management accounting in the U.S. *Handbooks of Management Accounting Research*, 2, 1071–1089.
- Gosselin, M. (2006). A review of activity-based costing: technique, implementation, and consequences. *Handbooks of Management Accounting Research*, 2, 641–671.
- Hamadneh, S., Pedersen, O., Alshurideh, M., Kurdi, B. A., & Alzoubi, H. M. (2021). An investigation of the role of supply chain visibility into the scottish blood supply chain. *J Leg Ethical Regul Issues*, 24, 1–12.
- Hanaysha, J. R., Shaikh, A., & M. E., A. (2021). H. M. Importance Mark. Mix Elem. *Determ Consum Purch Decis Retail Mark.*, 2, 56–72.
- Hanaysha, J. R., Al-Shaikh, M. E., Joghee, S., & Alzoubi, H. M. (2022). Impact of Innovation Capabilities on Business Sustainability in Small and Medium Enterprises. *FIIB Business Review*, 11, 67–78.
- Joghee, S., Alzoubi, H. M., & Dubey, A. R. (2020). Decisions effectiveness of FDI investment biases at real estate industry: Empirical evidence from Dubai smart city projects. *International Journal of Scientific & Technology Research*, 9, 3499–3503.
- Kirk, R. (2015). Cars of the future: The Internet of Things in the automotive industry. *Network Security*, 2015, 16–18.
- Kurdi, B. A., Alshurideh, M., Akour, I., Alzoubi, H. M., Obeidat, B., & Alhamad, A. (2022a). The role of digital marketing channels on consumer buying decisions through eWOM in the Jordanian markets. *International Journal of Data and Network Science*, 6, 1175–1185.
- Kurdi, B. A., Alzoubi, H. M., Akour, I., & Alshurideh, M. T. (2022b). The effect of blockchain and smart inventory system on supply chain performance: Empirical evidence from retail industry. *Uncertain Supply Chain Manag.*, 10, 1111–1116.
- Kurdi, B. A., Alshurideh, M., & Akour, I. (2022c). Alhamad, A., Alzoubi, H. M. Eff Soc media Influ Charact Consum Intent attitude Towar. *Keto Prod Purch Intent.*, 6, 1135–1146.
- Lee, K. L., Azmi, N. A. N., Hanaysha, J. R., Alzoubi, H. M., & Alshurideh, M. T. (2022a). The effect of digital supply chain on organizational performance: An empirical study in Malaysia manufacturing industry. *Uncertain Supply Chain Manag.*, 10, 495–510.
- Lee, K. L., Romzi, P. N., Hanaysha, J. R., Alzoubi, H. M., & Alshurideh, M. (2022b). Investigating the impact of benefits and challenges of IOT adoption on supply chain performance and organizational performance: An empirical study in Malaysia. *Uncertain Supply Chain Manag.*, 10, 537–550.

- Margulis, C. S., Galli, B. J. (2018). A case study of Apple v. Samsung and how big data analytics might have changed the outcome. *International Journal of Qualitative Research in Services*, 3, 21.
- Mehmood, T. (2021). Does information technology competencies and fleet management practices lead to effective service delivery? Empirical evidence from e-commerce industry. *International Journal of Technology, Innovation and Management*, 1, 14–41.
- Mehmood, T., Alzoubi, H., Alshurideh, M., Al-Gasaymeh, A., & Ahmed, G. (2019). Schumpeterian entrepreneurship theory: evolution and relevance. *Academy of Entrepreneurship*, 25, 1–10.
- NGUYEN, C. T. (2021). Factors affecting the application of managerial accounting in small and medium-sized enterprises in Vietnam. *The Journal of Asian Finance, Economics and Business*, 8(9), 313-0319.
- Quesado, P., & Silva, R. (2021). Activity-based costing (ABC) and its implication for open innovation. *Journal of Open Innovation: Technology, Market, and Complexity*, 7, 1–20.
- Radwan, N., & Farouk, M. (2021). The Growth of Internet of Things (IoT) in the management of healthcare issues and healthcare policy development. *International Journal of Technology, Innovation and Management*, 1, 69–84.
- Ramakrishna, Y., & Alzoubi, H. M. (2022). Empirical investigation of mediating role of six sigma approach in rationalizing the COQ in service organizations. *Operations and Supply Chain Management*, 15, 122–135.
- Reyhanoglu, M. (2011). Activity-based costing system advantages and disadvantages. *SSRN Electron J.*
- Schaltegger, S., Christ, K. L., Wenzig, J., & Burritt, R. L. (2022). Corporate sustainability management accounting and multi-level links for sustainability—A systematic review. *International Journal of Management Reviews*, 1–21.
- Shamout, M., Ben-Abdallah, R., Alshurideh, M., Alzoubi, H., Kurdi, B. A., & Hamadneh, S. (2022). A conceptual model for the adoption of autonomous robots in supply chain and logistics industry. *Uncertain Supply Chain Manag.*, 10, 577–592.
- Victoria, V. (2022). Impact of process visibility and work stress to improve service quality: empirical evidence from dubai retail industry impact of process visibility and work stress to improve service quality: empirical evidence from dubai retail industry. *International Journal of Technology, Innovation and Management* 2.

Accounting Information Systems' Control and Security: Do External Auditors Need to Set a Paragraph Within Their Report?



Abdelrazaq Altal, Ahmad Al Taher, Mohammad H. Alkharabsheh, Mustafa S. Qatanani, Abed Al Qader Khaddash, and Jihad Abushukhdum

Abstract Within the contemporary technology and digital era, it may be thought of as a chance to improve the caliber of audit process and auditors reports. Based on a survey of the literature, the current study establishes that and may provide opportunities to increase quality of external audit reports. This study discusses the theoretical and practical issues related to external audit report and its contents, discussing the audit of accounting information systems and if there is needs to set a paragraph within external audit's report discussing the auditing and assessing done by the external auditor for computerized accounting information system. Specifically, issues related to system control and security. Respondents are users of external auditors' report in Jordanian public sector. The results include using of information systems increasing and wild spreading within all kinds of companies, it is a main tool to introduce financial statements. Users of external auditors' report needs to highlight and to know what the auditor opinion is related to accounting information system security and control through paragraph within external auditors' report assessing the control and security of information systems enhancing users' decision-making process.

Keywords Accounting Information System (AIS) · External audit report · AIS controls and security · IT audit

A. Altal (✉)

The World Islamic sciences & Education University, Amman, Jordan

e-mail: abdrzaq.altal@wise.edu.jo

A. Al Taher

Group CFO, HAKA Group, Al Khobar, Saudi Arabia

M. H. Alkharabsheh · M. S. Qatanani · A. Al Qader Khaddash · J. Abushukhdum
Al-Balqa Applied University, Salt, Jordan

1 Introduction

Information system risk assessment increases by accelerating development in information systems themselves and the gap between auditor's knowledge and the ability to assess these modern technologies. Information System Audit and Control Association (ISACA) set many standards and control procedures to guide users related to information systems (IS). According to (Abreu et al., 2018), audit has lost some of its credibility. Most organizations under audit are using (IS) to process their activities, which the external auditor needs for assessment to get the final judgment and write the final opinion annotated at the end of the report regarding business supply chain (Ali et al., 2022), financial activities and HRD (Mondol, 2021). The external auditor's report is classified into many paragraphs depending on International Audit Standards (IAS)'s requirements, which aimed to serve the users of the external auditor's report (Paunescu, 2015) by using technological sources in the business management (Alhamad et al., 2021).

These users need to know about the stability and security of information systems received (Nada Ratkovic, 2022), processed data, and produced the financial information audited by external auditors. Therefore, to specify the need of exist standard(s) to guide external auditors regarding adding paragraphs within their report to assess accounting information system's controls and security (Alzoubi et al., 2022c). The qualities of the auditor's report suffer. It is said that the most common way for customers to get correct information is to have an independent audit done (decreasing the information risk) (Alzoubi et al., 2020). To boost the trust of the intended users in the financial statements (Shamout et al., 2022), an audit of the financial statements will be performed. The premise that the audited data is fairly full, accurate, and unbiased guides how decision-makers use it to make better quality of the business management (Alzoubi & Ahmed, 2019). The reputation of the company benefits from the auditor's independence as a value that has significance by using internet of things, blockchain and technological practices in financial management (Alsharari, 2021).

Paragraphs included within auditors' report steted by institutes and organizations related to IAS (International Audit Standards) which control and manage the usefulness of auditors' report and its contents to the users benefit from auditors' services that can be settled with the help of blockchain and data security (Cruz, 2021). In addition, in a decision-making process, it may be crucial to communicate clearly about the audit process (Mehmood et al., 2019), the auditor's duties, the nature of the assurances the auditor provides, and other topics such as business trends, and financial statement (Khan, 2021). A type of attestation service is an audit of historical financial statements, where the auditor expresses an opinion on whether the financial statements are fairly presented in accordance with the applicable accounting standards in a written report this process of statement is referred to cognition that is differentiated (Alnazer et al., 2017). Users of financial statements recognize the auditor's assurance because of the auditor's independence from the client and proficiency in financial statement reporting.

2 Literature Review

An assurance service is the audit or review of historical financial accounts, in which an auditor makes a judgement on the accuracy of a written assertion that is the duty of a third parties (Hamadneh et al., 2021) People who are in charge of making economic choices look for assurance services to assist increase the accuracy and applicability of the data that forms the foundation of such judgments (Alzoubi et al., 2021). The attestation of internal control over financial reporting and assurance services for information technology are two further areas of assurance services (Alzoubi & Yanamandra, 2020).

Decision-makers rely on data and financial statements that have been generated and presented by an entity's management when making decisions (Joghee et al., 2020). The term "information risk" refers to the potential for the information chosen to be erroneous (Weshah, 2021). An audit report will be produced based on the audit (Ramakrishna & Alzoubi, 2022). Users of financial statements receive the auditor's findings through the audit report. The audit report includes details on the audit, such as its scope, and a conclusion about the financial statements' fair presentation (Kasem & Al-Gasaymeh, 2022).

2.1 *Introductory Paragraph*

The opening sentence of the auditor report:

- Financial statements related to which entity;
- Indicates the financial statements have undergone an audit;
- Clearly states the name of each statement that makes up the financial statements, such as the balance sheet, income statement, statement of changes in equity, and cash flow statement;
- Refers to the overview of material accounting policies and other supporting data; and
- Specifies the time period covered for financial statement.

2.2 *Management's Responsibility*

The duties of people in the organization who are in charge of creating financial statements are described in this section of the audit report that helps to maintain business sustainability and performance (Hanaysha et al., 2021a). The phrase "management" or "those entrusted with governance", is used in the audit report and is suitable in the context of a legal framework (Alhamad et al., 2022). "The production (Hanaysha et al., 2022) and fair presentation of financial statements" is under management responsible and connection to the producing of financial statements, according to the

audit report (Radwan & Farouk, 2021). The description clarifies that management is responsible for both the internal controls necessary to ensure that the financial statements are free of material misstatements and for the financial statement preparation in compliance with the relevant reporting structure.

2.3 Auditor's Responsibility

Explains the auditor's obligation to provide an opinion on the financial statements in conformity with the audit and to certify that the audit was carried out (ISA). According to the audit report, in order to get a reasonable level of assurance (Alshurideh et al., 2020) that the financial statements are accurate and devoid of substantial misstatement, the auditor must adhere to ethical standards, plan, and carry out the audit (Suffield, 2018). Also, According to the audit report, an audit entails carrying out processes to gather the financial statements' amounts and disclosures have been audited (Alzoubi & Aziz, 2021). The auditor's judgment, which includes an assessment of the risks of significant financial statement misstatements, determines the procedures that are used (Alzoubi et al., 2022b). While developing audit procedures, the auditor takes internal control into consideration to ensure they are situation-appropriate and do not express an opinion on how effectively the entity's internal controls are performing. According to the audit report, part of an audit is determining whether the accounting principles applied are suitable and if management's accounting estimations are reasonable (Alshurideh et al., 2022). If the auditor considers that the audit evidence as it was collected by the auditor is adequate and suitable to serve as a foundation for the auditor's view, it will be stated in the final sentence of this part of the audit report.

2.4 Auditor's Opinion

The auditor clarify that the financial statements are prepared in compliance with International Financial Reporting Standards (IFRS).

2.5 Signature of the Auditor

Depending on what is suitable for the specific jurisdiction, the auditor's signature may be in the name of the audit company, the auditor's given name, or both.

2.6 Date of the Audit Report

The audit report is only dated as of the time the auditor has gathered enough relevant audit evidence to support their conclusion about the financial accounts and employee retention to increase the performance of the organization (Kurdi et al., 2022a, 2022b, 2022c).

2.7 Auditor's Address

The jurisdiction in which the auditor conducts business is identified in the audit report. The unqualified audit report means that the audited financial statements offer an accurate and fair assessment of the company's financial situation as of December 31, 20X1, as well as of its financial performances and cash flows for the year then ended, according to the audit report's key conclusion (Lee et al., 2022b).

2.8 Audit Expectation Gap

This gap relates to discrepancies between the publics and the auditor's conceptions of the functions and responsibilities of the auditor, and it pertains to: The role and responsibilities of auditors (Victoria, 2022).

- The audit function's quality;
- The profession's organization and rules;
- The content and significance of audit report messages; and
- The auditor's capacity to convey various degrees of confidence.

The audit exception gap causes the parties to be quite concerned (Guergov & Radwan, 2021), also auditors will decrease the audit expectation gap and boost stakeholder confidence concurrently by retaining their perceived independence and increasing engagement with users (Akther & Xu, 2020).

2.9 Accounting Information Systems

In all types of businesses, accounting information systems are regarded as one of the primary information sources that attempt to assist decision-makers in all industries and at all levels from an accounting perspective (Alnuaimi et al., 2021). With the development of technology such as sophisticated manufacturing technologies used to manage factories, businesses expanded with more complicated transactions, and control systems also evolved and became highly automated (Olojede et al., 2020).

2.9.1 IT Audit Process

The fundamental phases in carrying out the information technology audit process are as follows:

- Audit planning
- Internal controls' evaluation
- Procedures of the audit
- Audit completing.

The growth of the audit profession, ensuring that it keeps up with modern trends, equips it to meet current difficulties (Hanaysha et al., 2021b), and narrows the expectations gap (Ali Kamil & Majeed Nashat, 2017). Auditors use modern technologies to analyze risks and better understand their audit clients (Bauer et al., 2019).

Auditor Functions considering accounting information systems—only if the consumers of the financial statements have confidence in the auditor's objectivity (Alzoubi et al., 2022a) and impartiality will the audit's goal—to increase the credibility of the financial statements—be fulfilled. Independence is essential to the audit report's dependability. The most popular “hot issue” is still cyber, maintaining a decade-long trend.

3 Methodology

This study used a theoretical literature review approach since it was the best way to accomplish its goals. Auditor's Report Paragraphs Through the implementation of IAS 700 'Forming an Opinion and Reporting on Financial Statements' (IFAC) the form and content of an audit report is as follows:

Title: The title of the audit report makes it obvious that it is the work of the independent auditor.

Addressee: Indicates that the auditor report has been handled based on the engagement's conditions.

4 Empirical Analysis

The quality of the review process is negatively impacted by the use of information technology in the process of increasing audit efficiency. However, there are benefits to using modern approaches (Al Kurdi et al., 2022a). Auditing in the area of real efficiency is mostly devoted to the disposal of outdated techniques and procedures that are more closely tied to outdated methodologies than to new methodologies' methods and processes. It also leads to another conclusion, which is that the use of information technology in a variety of auditing fields will contribute to enhancing the effectiveness and efficiency of the review process (Al Kurdi et al., 2022b), despite obstacles that

prevent taking action to fully utilize information technology (Najmatuzzahrah et al., 2021).

Performance Expectancy outlines the benefits and incentives that are crucial and play a significant role in the auditor's intentions with regard to the use and adoption of Computer Assisted Audit Techniques—CAATs. This suggests that these two primary drivers may increase the effect of IT on the evolution of the audit process (Alheet et al., 2021). The audit function encompasses all of the personnel, technology, software, and databases that make up an electronic information system (Alzoubi et al., 2022a, 2022b, 2022c) under the accounting information systems of electronic checking. To accomplish the review's goals, these elements work in tandem with one another.

5 Discussion

When faced with technological issues, external auditors must increase their expertise of the ERP environment and according to ISA 610; external auditors primarily rely on internal auditors' work conducted as part of ERP continuous auditing (Weshah et al., 2022) The risks associated with cloud accounting systems, including intrusion, disruption, and secrecy (Al-Nsour et al., 2021). The auditor is required to do the audit to get reasonable certainty about whether the financial statements are free from significant misstatement and to offer an opinion on the financial statements in addition to performing the audit to do so. The results of the study show that respondents understood this audit report statement pretty clearly that can enhance the organizational effectiveness and performance (Alzoubi et al., 2022a). However, the audit report clearance and significance adheres the businesses development to get proper understanding of financial reports and financial concerns.

6 Conclusions

Electronic information systems are increasingly being used by all kinds of businesses as the primary instrument for introducing financial statements. Using of information systems increasing and wild spreading within all kinds of companies and is main tool to introduce financial statements. Users of external auditors' reports need to understand the auditor's position on the security and management of accounting information systems and need to know what the auditor opinion is related to accounting information system security and control. Therefore, the presence of a paragraph in an external auditor's report evaluating the security and control of information systems improves users' ability to make decisions. For the purpose of ensuring their efficacy, developing the procedures and techniques employed by the control, and identifying their flaws in order to work on strengthening them, auditors are interested in researching and assessing computerized information systems. The planning, organizing, and control responsibilities are assisted by the auditor's consulting

role on behalf of management. Existing of a paragraph within external auditors' report assessing the control and security of information systems enhancing users' decision-making process.

7 Recommendations

It will have a positive impact if IAS take into consideration and form a new paragraph within external auditor's report evaluating the IS to give more confidence for users of external audit reports. Furthermore, educational institutes also take into consideration enhancing audit subjects and researches because audit education significantly reduces expectation gap (Siddiqi & Qureshi, 2016) and specifically (Weshah, 2021) concluded that practice field need students with IS knowledge.

Furthermore, a new technology area such as big data analysis and it is impact on audit process should be taken into consideration to have deep understanding for clients' environment (Korpela et al., 2017) and as (Al Kurdi et al., 2022b) concluded that utilizing big data analysis (Lee et al., 2022a) to gather audit evidence will reduce the auditor's obligations.

References

- Abreu, P.W., Aparicio, M., & Costa, C.J. (2018). Blockchain technology in the auditing environment. In *Iberian conference on information systems and technologies, CISTI* (pp. 1–6). CISTI
- Akther, T., & Xu, F. (2020). Existence of the audit expectation gap and its impact on stakeholders' confidence: The moderating role of the financial reporting council. *International Journal of Financial Studies*, 8.
- Alhamad, A. Q. M., Akour, I., Alshurideh, M., Al-Hamad, A. Q., Kurdi, B. A., & Alzoubi, H. (2021). Predicting the intention to use google glass: A comparative approach using machine learning models and PLS-SEM. *International Journal of Data and Network Science*, 5, 311–320.
- Alhamad, A., Alshurideh, M., Alomari, K., Al Kurdi, B., Alzoubi, H., Hamouche, S., & Al-Hawary, S. (2022). The effect of electronic human resources management on organizational health of telecommunications companies in Jordan. *International Journal of Data and Network Science*, 6, 429–438.
- Alheet, A., Adwan, A. A., Areiqat, A. Y., & Zamil, A. M. A. (2021). Impact of strategic planning and continuous improvement on the effectiveness of administrative decisions. *Journal of Management Information and Decision Science*, 24, 1–14.
- Ali, N., Ghazal, T. M., Ahmed, A., Abbas, S., Khan, M. A., Alzoubi, H. M., Farooq, U., Ahmad, M., & Khan, M. A. (2022). Fusion-based supply chain collaboration using machine learning techniques. *Intell Autom Soft Comput*, 31, 1671–1687.
- Ali Kamil, O., & Majeed Nashat, N. (2017). The impact of information technology on the auditing profession-analytical study. *International Review of Management and Business Research*, 6, 1330–1342.
- Alnazer, N. N., Alnuaimi, M. A., & Alzoubi, H. M. (2017). Analysing the appropriate cognitive styles and its effect on strategic innovation in Jordanian universities. *International Journal of Business Excellence*, 13, 127–140.

- Al-Nsour, E., Weshah, S., & Dahiyat, A. (2021). Cloud accounting information systems: Threats and advantages. *Accounting*, 7, 875–882.
- Alnuaimi, M., Alzoubi, H. M., Ajelat, D., & Alzoubi, A. A. (2021). Towards intelligent organisations: An empirical investigation of learning orientation's role in technical innovation. *International Journal of Innovation and Learning*, 29, 207–221.
- Alsharari, N. (2021). Integrating blockchain technology with internet of things to efficiency. *International Journal of Technology, Innovation and Management*, 1, 01–13.
- Alshurideh, M., Gasaymeh, A., Ahmed, G., Alzoubi, H. M., & Kurd, B. A. (2020). Loyalty program effectiveness: Theoretical reviews and practical proofs. *Uncertain Supply Chain Manag.*, 8, 599–612.
- Alshurideh, M. T., Kurdi, A., & B., A., (2022). *H. m.*, 10, 1191–1202.
- Alzoubi, H., & Ahmed, G. (2019). Do Total Quality Management (TQM) practices improve organisational success? A case study of electronics industry in the UAE. *International Journal of Economics and Business Research*, 17, 459–472.
- Alzoubi, H. M., & Aziz, R. (2021). Does emotional intelligence contribute to quality of strategic decisions? the mediating role of open innovation. *Journal of Open Innovation: Technology, Market, and Complexity*, 7, 130.
- Alzoubi, H. M., & Yanamandra, R. (2020). Investigating the mediating role of information sharing strategy on agile supply chain in supply chain performance. *Uncertain Supply Chain Manag.*, 8, 273–284.
- Alzoubi, H. M., Ahmed, G., Al-Gasaymeh, A., & Al Kurdi, B. (2020). Empirical study on sustainable supply chain strategies and its impact on competitive priorities: The mediating role of supply chain collaboration. *Management Science Letters*, 10, 703–708.
- Alzoubi, H. M., Vij, M., Vij, A., & Hanaysha, J. R. (2021). What leads guests to satisfaction and loyalty in UAE five-star hotels? AHP analysis to service quality dimensions. *ENLIGHTENING Tour: A PATHMAKING J.*, 11, 102–135.
- Alzoubi, H., Alshurideh, M., Kurdi, B. A., Akour, I., & Aziz, R. (2022a). Does BLE technology contribute towards improving marketing strategies, customers' satisfaction and loyalty? The role of open innovation. *International Journal of Data and Network Science*, 6, 449–460.
- Alzoubi, H. M., Ahmed, G., & Alshurideh, M. (2022b). An empirical investigation into the impact of product quality dimensions on improving the order-winners and customer satisfaction. *International Journal of Productivity and Quality Management*, 36, 169–186.
- Alzoubi, H. M., Alshurideh, M. T., Kurdi, B. A., Alhyasat, K. M. K., & Ghazal, T. M. (2022c). The effect of e-payment and online shopping on sales growth: Evidence from banking industry. *International Journal of Data and Network Science*, 6, 1369–1380.
- Alzoubi, H. M., In'airat, M., Ahmed, G. (2022c). Investigating the impact of total quality management practices and Six Sigma processes to enhance the quality and reduce the cost of quality: the case of Dubai. *International Journal of Business Excellence*, 27, 94–109.
- Bauer, T. D., Estep, C., & Malsch, B. (2019). One team or two? Investigating relationship quality between auditors and it specialists: implications for audit team identity and the audit process. *Contemporary Accounting Research*, 36, 2142–2177.
- Cruz, A. (2021). Convergence between Blockchain and the Internet of Things. *International Journal of Technology, Innovation and Management*, 1, 34–53.
- Guergov, S., & Radwan, N. (2021). Blockchain convergence: Analysis of issues affecting IoT, AI and blockchain. *International Journal of Computations, Information and Manufacturing*, 1, 1–17.
- Hamadneh, S., Pedersen, O., Alshurideh, M., Kurdi, B. A., & Alzoubi, H. M. (2021). An investigation of the role of supply chain visibility into the scottish blood supply chain. *J Legal Ethical Regul Issues*, 24, 1–12.
- Hanaysha, J. R., Al-Shaikh, M. E., Joghee, S., & Alzoubi, H. M. (2021a). Impact of innovation capabilities on business sustainability in small and medium enterprises. *FIIB Business Review*, 12, 55–68.

- Hanaysha, J. R., Shaikh, A., & M. E., A. (2021b). H. M. Importance Mark. Mix Elel. *Determ Consum Purch Decis Retail Mark.*, 2, 56–72.
- Hanaysha, J. R., Al-Shaikh, M. E., Joghee, S., & Alzoubi, H. M. (2022). Impact of innovation capabilities on business sustainability in small and medium enterprises. *FIIB Business Review*, 11, 67–78.
- Joghee, S., Alzoubi, H. M., & Dubey, A. R. (2020). Decisions effectiveness of FDI investment biases at real estate industry: Empirical evidence from Dubai smart city projects. *International Journal of Scientific & Technology Research*, 9, 3499–3503.
- Kasem, J., & Al-Gasaymeh, A. (2022). A Cointegration analysis for the validity of purchasing power parity: evidence from Middle East Countries. *International Journal of Technology, Innovation and Management*, 2, 1.
- Khan, M. A. (2021). Challenges facing the application of IoT in medicine and healthcare. *International Journal of Computations, Information and Manufacturing*, 1, 39–55.
- Korpela, K., Hallikas, J., & Dahlberg, T. (2017). Digital supply chain transformation toward blockchain integration. In *Proceedings of annual hawaii international conference system and science* (pp. 4182–4191).
- Kurdi, B. A., Alshurideh, M., Akour, I., Alzoubi, H. M., Obeidat, B., & Alhamad, A. (2022a). The role of digital marketing channels on consumer buying decisions through eWOM in the Jordanian markets. *International Journal of Data and Network Science*, 6, 1175–1185.
- Kurdi, B. A., Alzoubi, H. M., Akour, I., & Alshurideh, M. T. (2022b). The effect of blockchain and smart inventory system on supply chain performance: Empirical evidence from retail industry. *Uncertain Supply Chain Manag*, 10, 1111–1116.
- Kurdi, B. A., Alshurideh, M., Akour, I., Alhamad, A., & Alzoubi, H. M. (2022c). Eff Soc media Influ Charact Consum Intent attitude Towar. *Keto Prod Purch Intent*, 6, 1135–1146.
- Lee, K. L., Azmi, N. A. N., Hanaysha, J. R., Alzoubi, H. M., & Alshurideh, M. T. (2022a). The effect of digital supply chain on organizational performance: An empirical study in Malaysia manufacturing industry. *Uncertain Supply Chain Manag*, 10, 495–510.
- Lee, K. L., Romzi, P. N., Hanaysha, J. R., Alzoubi, H. M., & Alshurideh, M. (2022b). Investigating the impact of benefits and challenges of IOT adoption on supply chain performance and organizational performance: An empirical study in Malaysia. *Uncertain Supply Chain Manag*, 10, 537–550.
- Mehmood, T., Alzoubi, H., Alshurideh, M., Al-Gasaymeh, A., & Ahmed, G. (2019). Schumpeterian entrepreneurship theory: evolution and relevance. *Academy of Entrepreneurship Journal*, 25, 1–10.
- Mondol, E. P. (2021). The impact of block chain and smart inventory system on supply chain performance at retail industry. *International Journal of Computations, Information and Manufacturing*, 1, 56–76.
- Najmatuzzahrah, Mulyani, S., Wiraningsih, S., & Akbar, B. (2021). Research audit quality and its impact on an organization's reputation. *Utop y Prax Latinoam* 26, 207–221.
- Olojede, P., Erin, O., Asiriwu, O., & Usman, M. (2020). Audit expectation gap: An empirical analysis. *Future Business Journal*, 6, 1–12.
- Paunescu, M. (2015). *The quality of independent auditor's report—does the size matter? The Romanian case*, pp. 195–198.
- Radwan, N., & Farouk, M. (2021). The growth of Internet of Things (IoT) in the management of healthcare issues and healthcare policy development. *International Journal of Technology, Innovation and Management*, 1, 69–84.
- Ramakrishna, Y., & Alzoubi, H. M. (2022). Empirical investigation of mediating role of six sigma approach in rationalizing the COQ in service organizations. *Operations and Supply Chain Management*, 15, 122–135.
- Ratkovic, N. (2022). Improving home security using blockchain. *International Journal of Computations, Information and Manufacturing*, 2, 1.

- Shamout, M., Ben-Abdallah, R., Alshurideh, M., Alzoubi, H., Kurdi, B. A., & Hamadneh, S. (2022). A conceptual model for the adoption of autonomous robots in supply chain and logistics industry. *Uncertain Supply Chain Manag*, 10, 577–592.
- Siddiqi, H., & Qureshi, M. (2016). The impact of employees' creativity on the performance of the firm. *Research Issues in Social Sciences*, 1, 1–12.
- Suffield, M. (2018). *Stephen Haddrill CEO*. Financial Reporting Council Developments in Audit 2018 Thursday 18 October 1–5.
- Victoria, V. (2022). Impact of process visibility and work stress to improve service quality: empirical evidence from Dubai retail industry impact of process visibility and work stress to improve service quality: empirical evidence from Dubai retail industry. *International Journal of Technology, Innovation and Management (IJTIM)*, 2.
- Weshah, S. (2021). Adopting modern IT systems is vital in employing accountants and internal auditors (educational perspective): a case study in Jordan cement company—Lafarge. *Jordan Journal of Business Administration*, 17, 555–565.
- Weshah, S., Almari, M., Bader, A., Abughniem, M., Aishat, M. al, & Humeedat, M. (2022). Harmonizing ABC system with ERP system for operational effectiveness improvement during Covid-19 Pandemic. In *2022 International Conference on Business Analytics for Technology and Security (ICBATS)* (pp. 1–5).

Advanced Technologies in Data Analysis and Management

Genetic Algorithm-Based Feature Selection and Self-Organizing Auto-Encoder (Soae) for Snp Genomics Data Classifications



D. Karthika, M. Deepika, Neyara Radwan, and Haitham M. Alzoubi

Abstract SNPs (single nucleotide polymorphisms) are the most common biomarkers, and they have a wide range of applications, especially in human genetics. The high cost of genotyping many SNPs is one of the most significant obstacles in SNP analysis. Selection and classification of characteristics are particularly tough due to these challenges. Therefore, a method for detecting significant SNPs and distinguishing healthy and ill samples has been developed. Finding the (sub) optimal subset of attributes is a Nondeterministic Polynomial Time (NP) hard problem. To begin, the nominal SNP data is transformed to numeric using an intelligence method called Mean Encoding. After that, a Genetic Algorithm (GA)-based feature selection is applied, which selects the important traits while discarding the redundant ones. Finally, the recommended Self-organizing Auto-Encoder (SOAE) is utilized to categorize, allowing it to create its structure autonomously based on the input thyroid cancer. The proposed strategy is applied to a thyroid cancer dataset from the Gene Expression Omnibus (GEO) database to see how well it works. When compared to other methodologies using measurements like accuracy, recall, and F-measure, the results suggest that it performed well.

D. Karthika
Patrician College of Art and Science, Chennai, India

M. Deepika
Crescent University, Chennai, India
e-mail: deepika.ca@crescent.education

N. Radwan
Industrial Engineering Department, College of Applied Sciences, AlMaarefa University, Ad Diriyah, Saudi Arabia

Mechanical Department, Faculty of Engineering, Suez Canal University, Ismailia, Egypt

N. Radwan
e-mail: nradwan@um.edu.sa

H. M. Alzoubi (✉)
School of Business, Skyline University College, Sharjah, UAE
e-mail: haitham_zubi@yahoo.com

Applied Science Research Center, Applied Science Private University, Amman, Jordan

Keywords Single Nucleotide Polymorphism (SNP) · Feature selection · Complex diseases · Genetic Algorithm (GA) · Deep learning · Self-Organizing Auto-Encoder (SOAE)

1 Introduction

Because of the combined effect of environmental and genetic variables, risk prediction of complex illnesses such as asthma is difficult. A variety of technologies and research approaches have been used (Farouk, 2022) to enhance biological studies that utilize genetic data to evaluate illness risk. A single-base pair variation in the DNA sequence known as a single-nucleotide polymorphism (SNP) is used as a biomarker in genome-wide association studies (GWAS) to identify genetic areas linked with a certain trait. SNPs linked with candidate genes implicated in asthma were discovered in recent GWAS. However, GWAS only accounts for a tiny proportion of individual features, leaving the “problem of missing heritability” unanswered in the case of complex illnesses (Power et al., 2016).

In any case, there are some critical obstacles within the field of SNP recognizable proof (Gaudillo et al., 2019). Since SNP information has such a tremendous number of measurements, dimensionality could be a critical challenge (up to one million). Numerous properties in high-dimensional information (Alzoubi & Yanamandra, 2020) are regularly repetitive or unessential, diminishing the viability of the classifier and expanding the computation fetched that only happens with the use of new software (Mondol, 2022). Creating an effective procedure that incorporates includes choice and classification is complex (Alzoubi et al., 2021) and time-consuming given all these concerns (Ali et al., 2022). Include determination is significant in machine learning. Its significance is emphasized in a recently distributed survey think about highlights determination calculations for classification issue (Alnazer et al., 2017).

These techniques were classified into three types in this study: filter, wrapper, and embedding approaches (Batnyam et al., 2013). A statistical measure is used to assign a score to each feature in a filter feature selection strategy (Alshurideh et al., 2022a). The qualities are scored, and their scores determine whether they are retained or eliminated from the data collection (Alnuaimi et al., 2021). The attributes with the highest scores will be chosen in the next categorization phase. One of the benefits of this strategy is the ability to apply this methodology to a data collection (Hanaysha et al., 2021a) with a high number of characteristics clearly and quickly that is independent of machine learning methods (Alzoubi et al., 2017). It also has a reduced possibility of overfitting than the wrapper technique, which has a larger chance of this problem (Al-Tahat & Moneim, 2020). The downside of this strategy is that it generates a feature set that is not suited to a certain type of prediction model. However, the effectiveness can be measured electronic learning and assessment growth (Alzoubi et al., 2022). As a result, a filter technique may fail to determine the optimum subset of attributes for a given predictive model in many cases (Alzoubi, 2021). In contrast, a wrapper method is based on machine learning

techniques (Alzubi et al., 2017). Method selection is a Nondeterministic Polynomial Time (NP) hard optimization issue. Its best answer can only be identified after a thorough examination (Alshurideh et al., 2022b; Nguyen et al., 2015).

This inquiries about points to address the challenge of deciding a subset of unique highlights and decision effectiveness (Joghee et al., 2020) that might make strides SNP recognizable proof exactness in thyroid datasets (Alzoubi et al., 2022a). Since machine learning calculations work with a subset of the highlights advertised by a GA, chosen highlights are the ones that surrender the leading comes about (Alshurideh et al., 2020). Even though a wrapper strategy takes a long time to calculate owing to the different procedural steps it must do (Miller, 2021), it ordinarily produces the most excellent subset of highlights that can be managed through the innovative techniques and improving quality (Alzoubi et al., 2022b). Center on the Self-organizing Auto-Encoder whereas categorizing sicknesses (Singh & Singh, 2019). It's a subsection of the representation learning method that looks for different layers of representation (Al Kurdi et al., 2022a). The high-level representation (or highlights) appears subtler elements approximately the information (Alhamad et al., 2022). In complicated ailments, the SOAE classifier is utilized to classify (case and control) tests. At last, the recommended strategy is connected to the SNP dataset (Batnyam et al., 2013), and the discoveries appear that the SOAE procedure has performed way better in this locale.

2 Literature Review

Molina-Azorín et al. (2015) offered an Irregular Timberland (RF) and k-Nearest Neighbor (KNN) demonstration for Single Nucleotide Polymorphism (SNPs) in Type 2 diabetes risk prediction. The RF method was used to identify the most important fundamental characteristics (SNPs) related to diabetes, assigning a weight (degree of pertinence) to each quality ranging from 1. Because they are two of the most well-known machine learning algorithms (Ali, 2021) in the therapeutic area, Support Vector Machine (SVM) and Logistic Regression (LR) was overused. It is about were compared to the results obtained by RF (Alshurideh et al., 2022a).

In Random Forests (ts-RF), (Nguyen et al., 2015) proposed a two-stage quality-based looking at a strategy for Single Nucleotide Polymorphism (SNPs) in subspace assurance and Genome-wide connection (GWAS). The technique begins by utilizing p-value examination to choose a cut-off point that separates profitable (Kurdi et al., 2022) and unessential SNPs into two categories (Pirmoradi et al., 2020). Because it is where SNPs from the two sub-groups are taken into thought when assessing the SNP subspace for creating trees for the timberland. When utilized to confine a center in a tree, they incorporate subspaces ceaselessly consolidating significantly teacher SNPs (Eli, 2021).

Made strides standard Insect Colony Clustering (ACC) for SNP data planning was displayed by Zheng et al. (2006). Moved forward classical ACC utilized to data examination of salt tricky hypertension SNPs in organize to investigate tall throughout

SNPs quantifiable examination and deliver unused considerations (Alzoubi & Aziz, 2021). The LF calculation was overhauled, and the Tangle 1ab8.0 program was utilized to program the present-day methodology. The computer program interface and the LF calculation were both effectively overhauled (Pirmoradi et al., 2020). All tests are divided into two categories utilizing the advanced calculation, the essential of which contains 169 tests and the minute of which contains 166 tests of consistency test and sit out of gear lesson examination comes approximately, the Kappa regard, and two sorts of contrasts in masses SNPs probability scattering truthful test. Curiously considering, mechanized computation, and ease of upgrade are all highlights of the ACC calculation. For SNP data categorization, (Alzoubi et al., 2017) proposed Conditional Common Data Maximization, Support Vector Machine (SVM), and Recursive Incorporate Conclusion. The calculation for finding the first educator SNPs and selecting a reasonable SNP subset utilizing a correct half breed incorporates a choice technique (Gaudillo et al., 2019).

3 Methodology

The proposed study was compared to four state-of-the-art incorporate assurance methodologies: unimportant Redundancy most noteworthy Congruity, Fast Relationship-based Incorporate Assurance, and Fast Relationship-based Incorporate Assurance. The exploratory revelations show up that the chosen highlight assurance method outflanks all other highlight choice calculations and accomplishes the most noteworthy classification accuracy for the proposed paper.

There are three phases to the suggested procedure: (A) A pre-processing step in which nominal SNP data is encoded and missing values in SNP data are removed or replaced. (B) A feature selection step, in which an appropriate FS algorithm selects relevant SNPs. (C) A classification step in which SNP data is classified using self-organizing auto-encoders (Alzoubi et al., 2022). The sequenced feature helps to retain the processes quality measures in the supply chain process (Hamadneh et al., 2021). Additionally, various categorization measures like Precision, Recall, and F-measure are applied to chosen SNPs. Figure 1 depicts the entire procedure.

3.1 SNP Dataset

The SNP data used in this investigation were obtained from the Gene Expression Omnibus (GEO) webpage of the National Center for Biotechnology Information (NCBI) (Pirmoradi et al., 2020). The proposed technique is evaluated using GSE67047, a difficult illness with 1 million SNPs and 226 samples, 97 of whom are case samples and 129 of those are comparison sample sizes. The data is provided

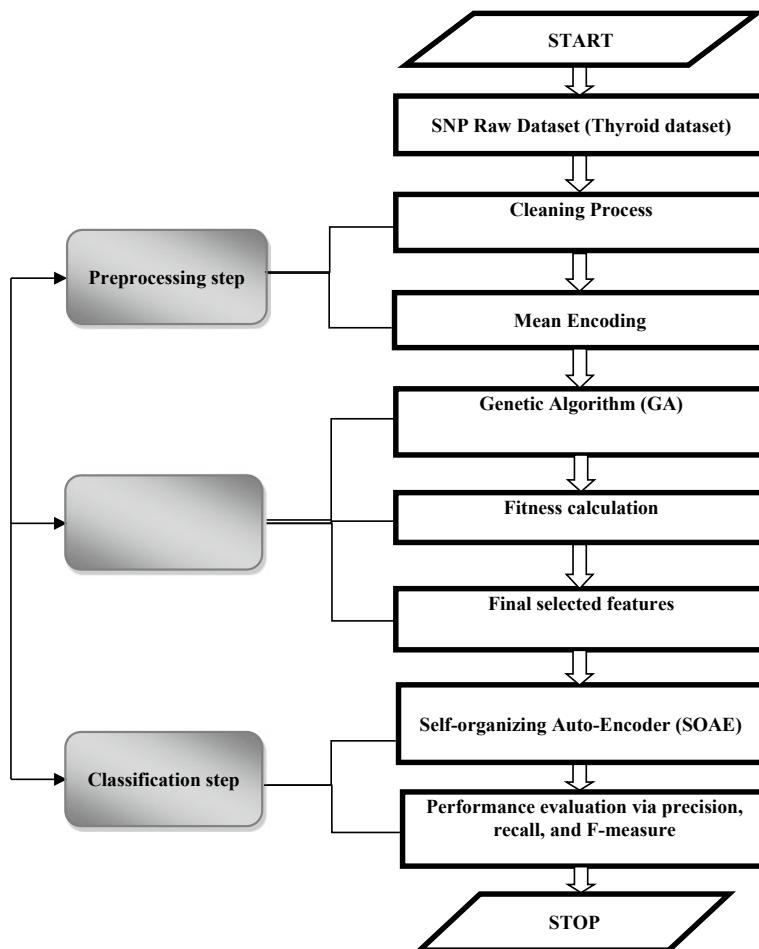


Fig. 1 The overall flow of the proposed system (developed by authors)

through GEO, which itself is managed either by the National Center for Biotechnology Information and is one of the world's largest most well-known biological datasets (Aziz & Aftab, 2021; Lee et al., 2022a).

3.2 Pre-Processing

The step of pre-processing is attributed to two main factors. During the first step, redundant SNPs (or characteristics) are found and deleted, and No Request or null values are corrected with sufficient quantities in the second step (Al Kurdi et al., 2022b).

Duplicate features: are SNPs that get the same values in all patients and control samples, indicating that these characteristics or SNPs will be unable to distinguish between the two groups (case and control). For feature selection and classification, for example, storing a BB value for a specific SNP in all samples is pointless and technically applied through innovation and improved performance (Alzoubi et al., 2022c).

Missing value: Every SNP with so much more than 10% No Call numbers is excluded; generally, the No Call value is updated by an assessed cost (Ramakrishna & Alzoubi, 2022), which in some SNP databases is the mode of feature (the most frequent value for a single program across all samples) or a new app type in many others. That is the reason to utilize updated and advanced technological system (Alzoubi et al., 2020).

3.3 *Encoding Method*

The mean encoding is used to encode the SNP data in this work. The mean encoding approach is ingenious because it considers the target label throughout the encoding process, whereas other encoding methods do not. For example the data assessment requires different criteria for different departments according to the nature of data assessment (Alzoubi & Ahmed, 2019). In the case of many attributes, mean encoding may also be a much simpler approach. Mean encoding, according to the equation, computes the numerical quantity for the unique nominal feature (1).

$$\text{mean encoding of feature } i = \frac{\text{Number of true targets under the feature } i}{\text{Total number of targets under the feature } i} \quad (1)$$

In overall average encoding, the strategy allocates a quantity to each category (BB, Bb, and bb) based on the independent possibility of each classification in each batch of data. Consensus encoding can aid in the selection and categorization of features. Conversely, mean encoding provides different answers to BB and Bb, suggesting that the i th feature, whether BB or Bb, is significant in complicated illnesses.

3.4 *Feature Selection (FS) by Genetic Algorithm (GA)*

Feature selection (FS) is significant in machine image processing and pattern discovery because it may increase the f-measure of a classifier by eliminating unnecessary and repeated data (Hanaysha et al., 2021b). The goal of the FS technique is to choose a subset of features from input information that can economically explain the data while also still generating high classification tasks results while avoiding noise effects (irrelevant and redundant features) (Lee et al., 2022a). The suggested method employs GA to choose unsupervised features, and the classification results

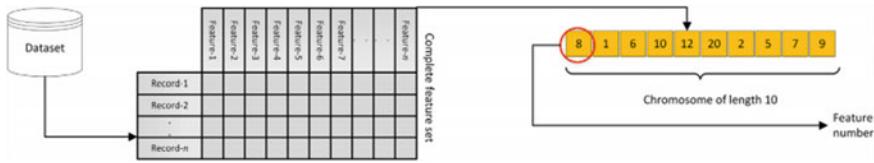


Fig. 2 Chromosome structure for GA (developed by authors)

are improved. The current approach optimizes using GA relying on the previously defined fitness function. The serious learning module, which again is based on GA, includes an attribute selection component. This paper employs a GA for unstructured optimum feature selection as a solution to the challenge at the discussion. The GA is tested under a variety of situations described in the test design (Al-Tahat & Moneim, 2020). The GA consists of the following steps: (a) estimated sample generation, (b) establishment of fitness functions, (c) choosing a strategy for partners who generate offspring for the next source, (d) cross-over, (e) mutations, and (f) ultimate upcoming development.

3.4.1 Initial Inhabitant's Generation and Gene Structure:

A first step in implementing the GA is to build a study sample. The initial population in this case is produced at randomness. A chromosome contains several chromosomes that have been randomly chosen. To minimize gene duplication, genomes are picked at random from the actual data characteristics depending on the needed specific gene in each chromosome. Similarly, the area of autonomous robots and machine learning assist in maintaining gene structure (Al-Tahat & Moneim, 2020; Shamout et al., 2022). As seen in Fig. 2, each gene in the symbols has one solution to the select issue.

The chromosome is made up of N cells that are organized in a one-dimensional array. Throughout this work, the number N is set to 10. Following that, many tests involving varying the level of N were carried out. Each chromosomal cell holds the algebraic integer V , with a feature of size V_0 . The component number is represented by the numeric value in each gene. If the chromosome at index 0 has a value of 8, it reflects the eighth aspect of the data. As a result, each chromosome preserves 10 attributes from the feature set, resulting in a subset that is subsequently improved to produce the best answer.

3.4.2 Fitness Role

This work proposes new objective functions based on the computing of the relationship between the supplied characteristics without the usage of class labels (Alhamad et al., 2021). The optimization algorithm may be used to discover characteristics with

a low degree of similarity. This enables a broader range of attributes to be gathered, as well as the ability to express most of the data in the collection. The suggested fitness method calculates the association average after computing the association of the provided characteristics. After obtaining the mean correlation's resulting value, the quantities of both the acquired f-measure and average correlation must be maximized by elevating them across the GA iterations. Using the converted average correlation value and the chromosome's f-measure (Kashif et al., 2021), weight values may be derived. We are using the f-measure and the average of the modified data.

3.4.3 Selection Method

In this study, the random initial approach is used for the peer selection operation to develop offspring. The roulette wheel selection methodology, when done in parallel, has the advantage of lowering execution time and needing no scaling or sorting, unlike other selection methods. The fitness values supplied by the fitness function are proportional to the parents chosen. It denotes that the greater the fitness grade, the better the chances of getting selected. The concept of linear search is used in function f , with the rear wheels, slots weighted based on the fitness values of the individual chromosomes. The chromosome with the greatest fitness values spans a bigger area on the random variable, improving its chances of being selected. Additionally, the evolution based technology processes the data and method according to the technological need in any disease diagnostic (Mehmood et al., 2019).

3.4.4 Crossover and Mutation

Diversification is important in EAs, and reproduction operators play a key role that we can relate with digitization and its influence (Lee et al., 2022b). This project employs both mutation and crossover techniques. Crossover and mutation procedures are undertaken after all the chromosomes in the population have been examined for fitness. To find the best crossover rate, researchers examined three different rates: 0.25, 0.5, and 0.75. Simulations showed that using 0.5 as the crossover probability resulted in higher performance.

For crossover, two parents are chosen using the roulette wheel approach.

- The other half of the first parent's genome is directly transferred to the child's genome and the additional genes are reproduced in almost the same order from the parental figure to the kid genome but they were from the stepparent.
- The above two stages are continued until the population has reached the desired number of persons.
- Using the chosen parent pair, just one kid is created.

The GA's mutation operation is employed to give exploration methods, with the mutation rate influencing the search space width. The GA convergence is influenced by the mutation rate. In most circumstances, a high mutation rate will result in poor

convergence since GA will lose significant pieces of the solution before convergence. The following is the procedure for mutation.

- As with crossover, three distinct mutation rates, 0.25, 0.5, and 0.75, are examined to discover the best one. The mutation rate has been set at 0.5 based on simulations.
- The change is not applied to every recently formed child chromosome, as is the case with classical mutations. Therefore, the mutation rate is greater. A parent is chosen for mutation using the roulette wheel procedure.
- Even the parent's genes are immediately passed to the adolescent after mutation.
- On the mode to improve the diversity, the left behind genes is chosen at random in the sort [1–n] to prevent feature unemployment.

3.4.5 Stopping Criteria

There is a general ending criterion in the suggested solution, and when it is met, the entire number of generations is ended. During the GA iterations, the generation's maximum fitness values are saved. In the first generation, the greatest value V_i is kept as the maximum fitness value V_f . If any value is greater than V_f . appears during the second-generation chromosomal evaluation, it should replace the existing value, and the new fitness value is considered as the V_f . If the highest fitness value of any n iterations is less than the V_f , the GA stopping conditions are met, and the fitness value stops increasing. However, during calculations, the proposed approach was also evaluated by running it for a predetermined number of iterations. The best chromosome denotes the optimal feature collection that is expected to produce greater results when combined with a traditional classifier just once the GA implementation is ended.

3.5 Deep Self-Organizing Auto-Encoder (SOAE)

The self-organizing deep auto-encoder constructs its layout in two steps: first, it estimates the number of sensor nodes and layers, and then it constructs them. AE encodes attribute values into large feature space in the first stage, where the encoded spatial dimensions are bigger than the real vector dimension and the number of sensors in the encoding layers is linked to the attributes of instances. In the second phase, add the AE layer by layer, following the structure of each AE indicated in step one. Attach the work great to each architecture and compare the first one with one AE to the later with two AEs (Pirmoradi et al., 2020). While the first design outperforms the next, avoid contributing AEs and select the first architecture; alternatively, add additional AEs and key stage 2. To predict the quality of architecture, train the perfect algorithm and use the test data (Pravin & Palanivelan, 2021).

4 Data Analysis

As shown in Table 1, measures such as F-measure, Precision, and Recall have demonstrated the suggested method's potential to predict occurrences.

For feature selection comparison, approaches such as Conditional Mutual Information Maximin (CMIM) (Alzubi et al., 2017) and Relief-F (Alzubi et al., 2017) are applied. The accuracy, recall, and f-measure of the chosen SNPs were assessed using classification techniques such as SVM, Support SVM-RFE, and SOAE.

Figure 3 shows the values of a precision comparison of FS techniques and classifiers. The suggested classifier with GA algorithm has a precision of 88.71%, whereas approaches such as Relief-F and CMIM with the proposed classifier have precisions of 85.65% and 87.66%, respectively (Table 1).

Figure 4 depicts the recall comparison of FS techniques and classifiers. The suggested classifier with GA algorithm has a recall of 88.38%, whereas techniques

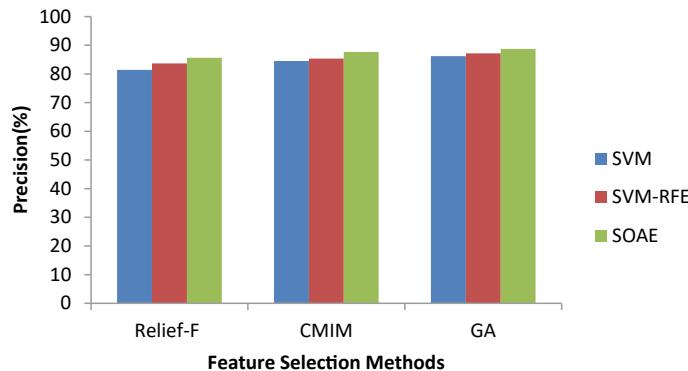


Fig. 3 Precision results concerning Fs methods and classifiers (developed by authors)

Table 1 Evaluation results comparison of thyroid cancer dataset

Metrics (%)	Feature selection	SVM	SVM-RFE	SOAE
Precision	Relief-F	81.42	83.69	85.65
	CMIM	84.54	85.38	87.66
	GA	86.21	87.19	88.71
Recall	Relief-F	80.71	82.47	84.52
	CMIM	82.45	84.17	86.79
	GA	84.51	86.92	88.38
F-measure	Relief-F	81.06	83.08	85.08
	CMIM	83.49	84.77	87.22
	GA	85.36	87.05	88.54

such as Relief-F and CMIM with the proposed classifier have recalls of 84.51% and 86.92%, respectively (Table 1).

Figure 5, shows the results comparison of both FS techniques and classifiers. The suggested classifier with GA algorithm produces greater F-measure results of 88.54%, whereas Relief-F and CMIM with the proposed classifier provide higher F-measure results of 85.36% and 87.05%, respectively (Table 1).

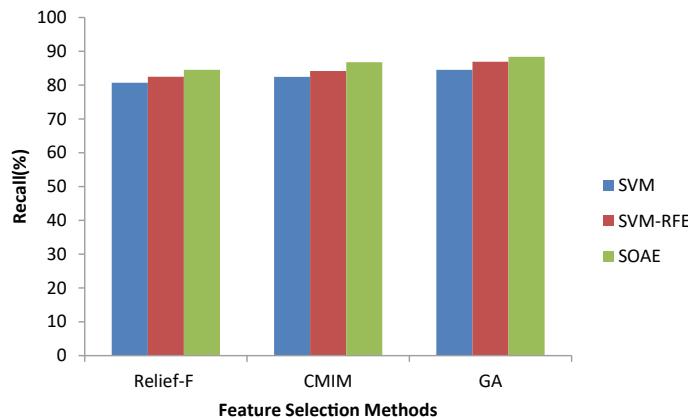


Fig. 4 Recall results concerning FS methods and classifiers (developed by authors)

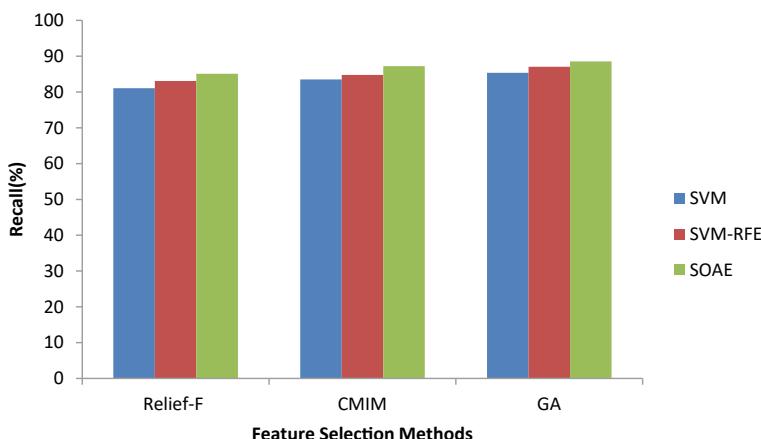


Fig. 5 F-measure results concerning Fs methods and classifiers (developed by authors)

5 Results and Discussion

The procedures below were performed with each SNP data obtained, and the simulated results are provided in this paragraph. The proposed method and existing algorithms are implemented using MATLAB software (Pirmoradi et al., 2020). 1–Pre-processed SNP data 2–The SNP data is divided into three sections: instruction, validation, and testing, with each section containing 50, 20, and 30% of the information. 3–Before converting SNP data to numerical information, the Mean Encoding approach was used. 4–Before picking the top 500 features from the dataset, the FS algorithm examines each feature's relevance to the aim. Finally, the top 50 traits were determined. 5–A classifier is used to evaluate specific qualities.

GSE67047 is a complicated disease with 1,000,000 SNPs and 225 specimens, 96 of which would be case specimens and 129 of which would be comparison sample size. The dataset includes a variable sample size (case and control), a variable number of characteristics (SNPs), and a range of discovered certain variables. The outputs of the classifications were assessed using precision, recall, and F-measure metrics.

6 Conclusion and Future Recomendations

The goal of this study is to find a subset of unique characteristics that have a good impact on SNP detection performance in thyroid datasets. Because machine learning algorithms work with a subset of the features offered by a Genetic Algorithm, chosen features are the ones that yield the best results (GA). The Self-Organizing Auto-Encoder (SOAE) is a tool for classifying illnesses based on GA features. An SOAE classifier is a representation learning technique subset that identifies many points of representation. The high-level description (or characteristics) of the data gives further information. In complicated illnesses, the SOAE classifier is used to categorize (case and control) samples. This benefit has reduced the amount of time spent learning and managing, as well as the cost of computing. Finally, the suggested method is used for the SNP dataset, and the findings show that the SOAE technique was effective, with better accuracy, recall, and f-measure outcomes. In the future study, the suggested model for illness categorization will include a regularisation mechanism.

References

- Al Kurdi, B., Alzoubi, H. M., Akour, I., & Alshurideh, M. T. (2022). The effect of blockchain and smart inventory system on supply chain performance: Empirical evidence from retail industry. *Uncertain Supply Chain Manag.*, 10(4), 1111–1116. <https://doi.org/10.5267/j.uscm.2022.9.001>
- Al Kurdi, B., Alshurideh, M., Akour, I., Alzoubi, H. M., Obeidat, B., & Alhamad, A. (2022). The role of digital marketing channels on consumer buying decisions through eWOM in the Jordanian

- markets. *International Journal of Data and Network Science*, 6(4), 1175–1185. <https://doi.org/10.5267/j.ijdns.2022.7.002>.
- Alhamad, A., et al. (2022). The effect of electronic human resources management on organizational health of telecommunications companies in Jordan. *International Journal of Data and Network Science*, 6(2), 429–438. <https://doi.org/10.5267/j.ijdns.2021.12.011>
- Alhamad, A. Q. M., Akour, I., Alshurideh, M., Al-Hamad, A. Q., Al Kurdi, B., Alzoubi, H. (2021). Predicting the intention to use google glass: A comparative approach using machine learning models and PLS-SEM,” *International Journal of Data and Network Science*, 5(3), 311–320. <https://doi.org/10.5267/j.ijdns.2021.6.002>
- Ali, N., et al. (2021). Modelling supply chain information collaboration empowered with machine learning technique. *Intelligent Automation & Soft Computing*, 30(1), 243–257.
- Ali, N., et al. (2022). Fusion-based supply chain collaboration using machine learning techniques. *Intell Autom Soft Comput*, 31(3), 1671–1687. <https://doi.org/10.32604/IASC.2022.019892>
- Alnazer, N. N., Alnuaimi, M. A., & Alzoubi, H. M. (2017). Analysing the appropriate cognitive styles and its effect on strategic innovation in Jordanian universities. *International Journal of Business Excellence*, 13(1), 127–140.
- Alnuaimi, M., Alzoubi, H. M., Ajelat, D., & Alzoubi, A. A. (2021). Towards intelligent organisations: An empirical investigation of learning orientation’s role in technical innovation. *International Journal of Innovation and Learning*, 29(2), 207–221.
- Alshurideh, M., Gasaymeh, A., Ahmed, G., Alzoubi, H. M., & Kurd, B. A. (2020). Loyalty program effectiveness: Theoretical reviews and practical proofs. *Uncertain Supply Chain Manag*, 8(3), 599–612.
- Alshurideh, M. T., et al. (2022a). Fuzzy assisted human resource management for supply chain management issues. *Annals of Operations Research*. <https://doi.org/10.1007/s10479-021-04472-8>
- Alshurideh, M. T., Al Kurdi, B., Alzoubi, H. M., Obeidat, B., Hamadneh, S., & Ahmad, A.: The influence of supply chain partners’ integrations on organizational performance: The moderating role of trust. *Uncertain Supply Chain Manag*, 10(4), 1191–1202. <https://doi.org/10.5267/j.uscm.2022.8.009>
- Al-Tahat, S., & Moneim, O. A. (2020). The impact of artificial intelligence on the correct application of cyber governance in Jordanian commercial banks. *International Journal of Scientific & Technology Research*, 9(3), 7138–7144.
- Alzoubi, A. (2021). The impact of process quality and quality control on organizational competitiveness at 5-star hotels in Dubai. *International Journal of Technology, Innovation and Management*, 1(1), 54–68. <https://doi.org/10.54489/ijtim.v1i1.14>
- Alzoubi, H., & Ahmed, G. (2019). Do TQM practices improve organisational success? A case study of electronics industry in the UAE. *International Journal of Economics and Business Research*, 17(4), 459–472.
- Alzoubi, H. M., & Aziz, R. (2021). Does emotional intelligence contribute to quality of strategic decisions? The mediating role of open innovation. *J Open Innov Technol Mark Complex*, 7(2), 130. <https://doi.org/10.3390/joitmc7020130>
- Alzoubi, H. M., & Yanamandra, R. (2020). Investigating the mediating role of information sharing strategy on agile supply chain. *Uncertain Supply Chain Manag*, 8(2), 273–284. <https://doi.org/10.5267/j.uscm.2019.12.004>
- Alzoubi, H. M., Vij, M., Vij, A., & Hanaysha, J. R. (2021). What leads guests to satisfaction and loyalty in UAE five-star hotels? AHP analysis to service quality dimensions. *Enlightening Tour*, 11(1), 102–135.
- Alzoubi, H. M., Elrehail, H., Hanaysha, J. R., Al-Gasaymeh, A., & Al-Adaileh, R. (2022a). The role of supply chain integration and agile practices in improving lead time during the COVID-19 Crisis. *International Journal of Service Science, Management, Engineering, and Technology*, 13(1), 1–11. <https://doi.org/10.4018/IJSSMET.290348>

- Alzoubi, H. M., Ahmed, G., & Alshurideh, M. (2022b). An empirical investigation into the impact of product quality dimensions on improving the order-winners and customer satisfaction. *International Journal of Productivity and Quality Management*, 36(2), 169–186. <https://doi.org/10.1504/IJPQM.2021.10037887>
- Alzoubi, H. M., Ahmed, G., Al-Gasaymeh, A., & Al Kurdi, B. (2020). Empirical study on sustainable supply chain strategies and its impact on competitive priorities: The mediating role of supply chain collaboration. *Management Science Letters*, 10(3), 703–708. <https://doi.org/10.5267/j.msl.2019.9.008>
- Alzoubi, H., Alshurideh, M., Al Kurdi, B., Akour, I., Aziz, R. (2022). Does BLE technology contribute towards improving marketing strategies, customers' satisfaction and loyalty? The role of open innovation. *International Journal of Data and Network Science*, 6(2), 449–460. <https://doi.org/10.5267/j.ijdns.2021.12.009>
- Alzoubi, H. M., In'airat, M., & Ahmed, G. (2022). Investigating the impact of total quality management practices and Six Sigma processes to enhance the quality and reduce the cost of quality: the case of Dubai. *International Journal of Business Excellence*, 27(1), 94–109. <https://doi.org/10.1504/IJBE.2022.123036>
- Alzoubi, H., Alshurideh, M., Kurdi, B. A., Alhyasat, K., & Ghazal, T. (2022). The effect of e-payment and online shopping on sales growth: Evidence from banking industry. *International Journal of Data and Network Science*, 6(4), 94–109
- Alzoubi, R., Ramzan, N., Alzoubi, H., & Amira, A. (2017). A hybrid feature selection method for complex diseases SNPs. *IEEE Access*, 6, 1292–1301. <https://doi.org/10.1109/ACCESS.2017.2778268>
- Aziz, N., & Aftab, S. (2021). Data mining framework for nutrition ranking: methodology: SPSS modeller. *International Journal of Technology, Innovation and Management*, 1(1), 85–95. <https://doi.org/10.54489/ijtim.v1i1.16>
- Batnyam, N., Gantulga, A., & Oh, S. (2013). An efficient classification for single nucleotide polymorphism (SNP) dataset. *Stud Comput Intell*, 493, 171–185. https://doi.org/10.1007/978-3-319-00804-2_13
- Eli, T. (2021). Students' perspectives on the use of innovative and interactive teaching methods at the university of nouakchott al aasriya, mauritania: English department as a case study. *International Journal of Technology, Innovation and Management*, 1(2), 90–104. <https://doi.org/10.54489/ijtim.v1i2.21>
- Farouk, M. (2022). Studying human robot interaction and its characteristics. *International Journal of Computations, Information and Manufacturing (IJCIM)*, 2(1), 1. <https://doi.org/10.54489/ijcim.v2i1.73>
- Gaudillo, J., et al. (2019). Machine learning approach to single nucleotide polymorphism-based asthma prediction. *PLoS ONE*, 14(12), 1–12. <https://doi.org/10.1371/journal.pone.0225574>
- Hamadneh, S., Pedersen, O., Alshurideh, M., Kurdi, B. A., & Alzoubi, H. M. (2021). An investigation of the role of supply chain visibility into the Scottish blood supply chain. *J Leg Ethical Regul Issues*, 24, 1–12.
- Hanaysha, J. R., Al-Shaikh, M. E., Joghee, S., & Alzoubi, H. M. (2021b). Impact of innovation capabilities on business sustainability in small and medium enterprises. *FIIB Business Review*, 11(1), 67–78.
- Hanaysha, J. R., Shaikh, A., & A. M. E. (2021). "H," M Importance Mark Mix Elem Determ Consum Purch Decis. *Retail Mark.*, 2(6), 56–72
- Joghee, S., Alzoubi, H. M., & Dubey, A. R. (2020). Decisions effectiveness of FDI investment biases at real estate industry: Empirical evidence from Dubai smart city projects. *International Journal of Scientific & Technology Research*, 9(3), 3499–3503.
- Kashif, A. A., Bakhtawar, B., Akhtar, A., Akhtar, S., Aziz, N., & Javeid, M. S. (2021). Treatment response prediction in hepatitis C patients using machine learning techniques. *International Journal of Technology, Innovation and Management*, 1(2), 79–89. <https://doi.org/10.54489/ijtim.v1i2.24>

- Kurdi, B. A., Alshurideh, M., & Akour, I., Alhamad, A., Alzoubi, H. (2022). M Eff Soc media Influ Charact Consum Intent attitude Towards. *Keto Prod Purch Intent.*, 6(4), 1135–1146
- Lee, K. L., Romzi, P. N., Hanaysha, J. R., Alzoubi, H. M., & Alshurideh, M. (2022a). Investigating the impact of benefits and challenges of IOT adoption on supply chain performance and organizational performance: An empirical study in Malaysia. *Uncertain Supply Chain Manag.*, 10(2), 537–550. <https://doi.org/10.5267/j.uscm.2021.11.009>
- Lee, K. L., Azmi, N. A. N., Hanaysha, J. R., Alzoubi, H. M., & Alshurideh, M. T. (2022b). The effect of digital supply chain on organizational performance: An empirical study in Malaysia manufacturing industry. *Uncertain Supply Chain Manag.*, 10(2), 495–510. <https://doi.org/10.5267/j.uscm.2021.12.002>
- Mehmood, T., Alzoubi, H. M., Alshurideh, M., Al-Gasaymeh, A., & Ahmed, G. (2019). Schumpeterian entrepreneurship theory: Evolution and relevance. *Academy of Entrepreneurship Journal*, 25(4), 1–10.
- Miller, D. (2021). The best practice of teach computer science students to use paper prototyping. *International Journal of Technology, Innovation and Management*, 1(2), 42–63. <https://doi.org/10.54489/ijtim.v1i2.17>
- Molina-Azorín, J. F., Tarí, J. J., Pereira-Moliner, J., López-Gamero, M. D., & Pertusa-Ortega, E. M. (2015). The effects of quality and environmental management on competitive advantage: A mixed methods study in the hotel industry. *Tourism Management*, 50, 41–54. <https://doi.org/10.1016/j.tourman.2015.01.008>
- Mondol, E. P. (2022). The role of Vr games to minimize the obesity of video gamers. *International Journal of Computations, Information and Manufacturing (IJCIM)*, 2(1), 1. <https://doi.org/10.54489/ijcim.v2i1.70>
- Nguyen, T. T., Huang, J. Z., Wu, Q., Nguyen, T. T., & Li, M. J. (2015). Genome-wide association data classification and SNPs selection using two-stage quality-based random forests. *BMC Genomics*, 16(Suppl 2), 1–11. <https://doi.org/10.1186/1471-2164-16-S2-S5>
- Pirmoradi, S., Teshnehab, M., Zarghami, N., & Sharifi, A. (2020). A self-organizing deep auto-encoder approach for classification of complex diseases using SNP genomics data. *Applied Soft Computing*, 97, 106718. <https://doi.org/10.1016/j.asoc.2020.106718>
- Power, R. A., Parkhill, J., & De Oliveira, T. (2016). Microbial genome-wide association studies: Lessons from human GWAS. *Nature Reviews Genetics*, 18(1), 41–50. <https://doi.org/10.1038/nrg.2016.132>
- Pravin, S. C., & Palanivelan, M. (2021). Regularized deep LSTM autoencoder for phonological deviation assessment. *International Journal of Pattern Recognition and Artificial Intelligence*, 35(4). <https://doi.org/10.1142/S0218001421520029>
- Ramakrishna, Y., & Alzoubi, H. M. (2022). Empirical investigation of mediating role of six sigma approach in rationalizing the COQ in service organizations. *Operation Supply Chain Manag.*, 15(1), 122–135. <https://doi.org/10.31387/oscm0480335>
- Shamout, M., Ben-Abdallah, R., Alshurideh, M., Alzoubi, H., Al Kurdi, B., Hamadneh, S. (2022). A conceptual model for the adoption of autonomous robots in supply chain and logistics industry. *Uncertain Supply Chain Manag.*, 10(2), 577–592. <https://doi.org/10.5267/j.uscm.2021.11.006>
- Singh, D., & Singh, B. (2019). Hybridization of feature selection and feature weighting for high dimensional data. *Applied Intelligence*, 49(4), 1580–1596. <https://doi.org/10.1007/s10489-018-1348-2>
- Zheng, J., Bakker, E., Knight, L., Gilhespy, H., Harland, C., & Walker, H. (2006). A strategic case for e-adoption in healthcare supply chains. *International Journal of Information Management*, 26(4), 290–301. <https://doi.org/10.1016/j.ijinfomgt.2006.03.010>

An Effect of Big Data Analytics on Pandemic Prevention



D. Karthika, E. Ramya, Maged Farouk, and Haitham M. Alzoubi 

Abstract Several countries have been afflicted by a novel disease that first emerged in China at the beginning of December. The disease has been classified as a pandemic. Several deaths have been reported worldwide. At least 124 nations and territories have reported clinical signs of the disease, including deaths. However, the disease may cause enough severe disease to affect the entire globe, although this is unlikely. It may be impossible to comprehend an epidemic's characteristics in this situation to control it. There have been numerous deaths and havoc caused by the Covid-19 outbreak, including in the social, economic, and health spheres. Researchers examined massive amounts of data to determine what effect massive data analysis can have on containing and monitoring the increase of Covid-19, as well as examining data from various other sources. An objective of this research is to evaluate the current big data analytics methods, such as deep learning and machine learning, to facilitate the application of future Covid-19 analytical research. A massive amount of data was gathered through categorization approaches, the epidemic risk was broken down, widespread tracking has been validated, prevention level tracking has been validated, and an evaluation of Covid-19 prevention and control has been completed.

D. Karthika
Patrician College of Art and Science, Chennai, India

E. Ramya
SDNB Vaishnav College for Women, Chennai, India
e-mail: ramya.e@sdnbvc.edu.in

M. Farouk
Business Administration Department, College of Humanities and Administrative Studies, Onaizah Colleges, Onaizah, Saudi Arabia

Industrial Relations Department, Workers University, Cairo, Egypt

H. M. Alzoubi 
School of Business, Skyline University College, Sharjah, UAE
e-mail: haitham.alzoubi@skylineuniversity.ac.ae

Applied Science Research Center, Applied Science Private University, Amman, Jordan

Keywords Covid-19 · Big data analytics · Public health · China · Prevention · Big data

1 Introduction

SARS-CoV-2 has caused Coronavirus disease 2019, also known as COVID-19, to multiply more rapidly than ever before. A cause for concern has been established by the World Health Organization (WHO) on January 30, 2020, and it has been elevated to a health emergency. Saudi Arabia implemented harsh measures to stop the disease spread (Jamshidi et al., 2020). The Ministry of Health in Saudi Arabia has been following WHO guidelines for identifying and isolating probable COVID-19 cases.

The pandemic has spread rapidly, killing more than a million people (Xu et al., 2020). The rapid spread and ever-changing symptoms make managing the pandemic increasingly difficult. A lot of countries have been affected by the pandemic, leaving their health systems and medical resources inadequate (Alnazer et al., 2017). Non-pharmaceutical approaches were the only way to prevent transmission at the beginning of the pandemic. In addition to drugs, non-pharmaceutical treatment can include isolated treatment, community incarceration, social isolation and treatments provided in the hospitality sector (Alzoubi et al., 2021).

Since advanced innovation has progressed altogether over the past decade, alongside the developing number of cell phones and get to information, the non-pharmaceutical reaction to COVID-19 contrasts essentially from earlier plagues (Smartphone possession expanded from 172 million in 2009 to 156 billion gauges for 2020). With progressions in information analytics, gigantic sums of information can presently be analyzed in real-time, and the coming about data can be turned into significant data. A huge information framework could be an information preparing framework able of putting away, overseeing, or dealing with expansive sums of information effectively and cost-effectively (Alzoubi et al., 2022a). When compared to conventional information, huge information has five “V” highlights: volume, assortment, speed, veracity, and esteem (Riswantini et al., 2021).

By applying enormous information analytics to persistent records, we can distinguish people who may advantage of preventative care or way of life changes, screen the wellbeing of the populace, and move forward patients' wellbeing through pharmaceutical treatments with the help of accurate information with cost effective way (Ramakrishna & Alzoubi, 2022). Huge information advances can be utilized to foresee plagues, issue widespread notices, track, and follow tainted individuals, distinguish successful pharmaceutical cures, and distribute assets proficiently inside the wellbeing care framework when avoiding and controlling pandemics (Chowdhury et al., 2022). Information analytics is progressively being utilized in infection transmission displaying to assist assess contamination control measures and crisis reactions amid nearby or worldwide illness flare-ups (Alzoubi, 2022). Huge information innovation has mostly been utilized in investigating the avoidance and control of irresistible infections to supply early notices and infection observing (Alsunaidi

et al., 2021). On the taking after four levels, huge information innovation for COVID-19 anticipation and control is conceptualized: application, examination, information, and gathering (Kashif et al., 2021).

Dissecting information and building expectation models are well-known applications of information mining strategies and methods (Mehmood, 2021). Through these methods, valuable data can be inferred from crude information (Alzoubi et al., 2022b). Numerous businesses, counting the healthcare industry, may advantage from the data obtained. The healthcare industry has created an endless sum of information almost its patients, infections, and analyze in later a long time (Saad Masood Butt, 2022). There are two sorts of information mining errands: (1) clear assignments, which are concerned with the fundamental characteristics of the information, and (2) prescient errands, which are concerned with building models that can anticipate the yields from inputs utilizing a portion of the information alluded to as preparing information (Alzoubi & Yanamandra, 2020). It is conceivable to utilize prepared models to foresee the results of obscure inputs shown in Fig. 1. For exploratory inquire, these strategies are more versatile and conservative than conventional factual examination in healthcare sector (Neyara Radwan, 2022).

Enormous information innovation was utilized by the Chinese government and social organizations to anticipate and control the COVID-19 flare-up. Huge information examination has been mobilized to direct investigate and anticipate the epidemic's improvements at the Service of Industry and Data Technology's Planning Assembly on Enormous Information Supporting Avoiding and Controlling Crown

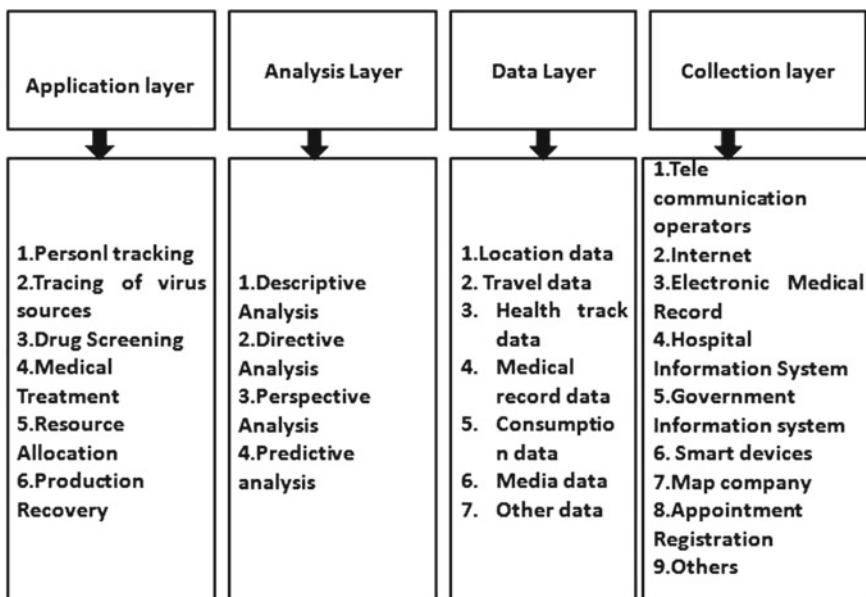


Fig. 1 Coronavirus disease 2019 disease caused by SARS-CoV-2

Infection Malady 2019, held on January 26. It has been proposed to create a joint anticipation (Hanaysha et al., 2021a) and control methodology against plague flare-ups, and huge information is being utilized to direct investigate. By differentiate, this investigation centers on making strides in preventative measures (Mehmood et al., 2019), rather than entering demonstrative or helpful strategies. Utilizing huge information innovation to anticipate and control COVID-19 has come about in nations experiencing potential issues, barricades, and arrangements (Alzoubi & Aziz, 2021).

1.1 Applications of Data Analytics in COVID-19

There's been a lot of data collected on COVID-19, the global pandemic. A lot of things can be done with this info, from diagnosis to risk score estimation to pharmaceutical research with the help of artificial intelligence (Al-Tahat & Moneim, 2020). Below are a few possible applications.

The remainder of this work is organized as follows with Fig. 2. Section 2 shows a variety of big data analytics tools (Ali et al., n.d.). Section 3 defines the methodology. Section 4 investigates the specifics of various data analysis approach about diagnostic techniques. Section 5 discusses the results, problems, and future directions. Section 6 concludes by summarising the impact of big data analytics in COVID-19.

2 Literature Review

2.1 Big Data Analytics Tools

Platforms for big data analytics are enterprise systems that provide big data analytics. Companies can use it to discover previously unknown relationships, market trends (Alzoubi et al., 2022a, 2022b, 2022c), and relevant information hidden within their big data. The following tools are the most popular ones for COVID-19.

2.1.1 Dashboards and Interactive Maps

A dashboard that showed graphs, interactive maps, and data, such as how many cases are active, discharged, and dead, was used in Singapore, Hong Kong, South Korea, and Taiwan to provide information on COVID-19 as early as possible (Garcia-Perez et al., 2022). Various categories are based on nationality, age, gender, and country of origin. Using publicly available interactive maps, patients' tracking information can show the geographic area they came from or visited before diagnosis in real-time. Clusters of cases can be caught by public health professionals on the spot, and

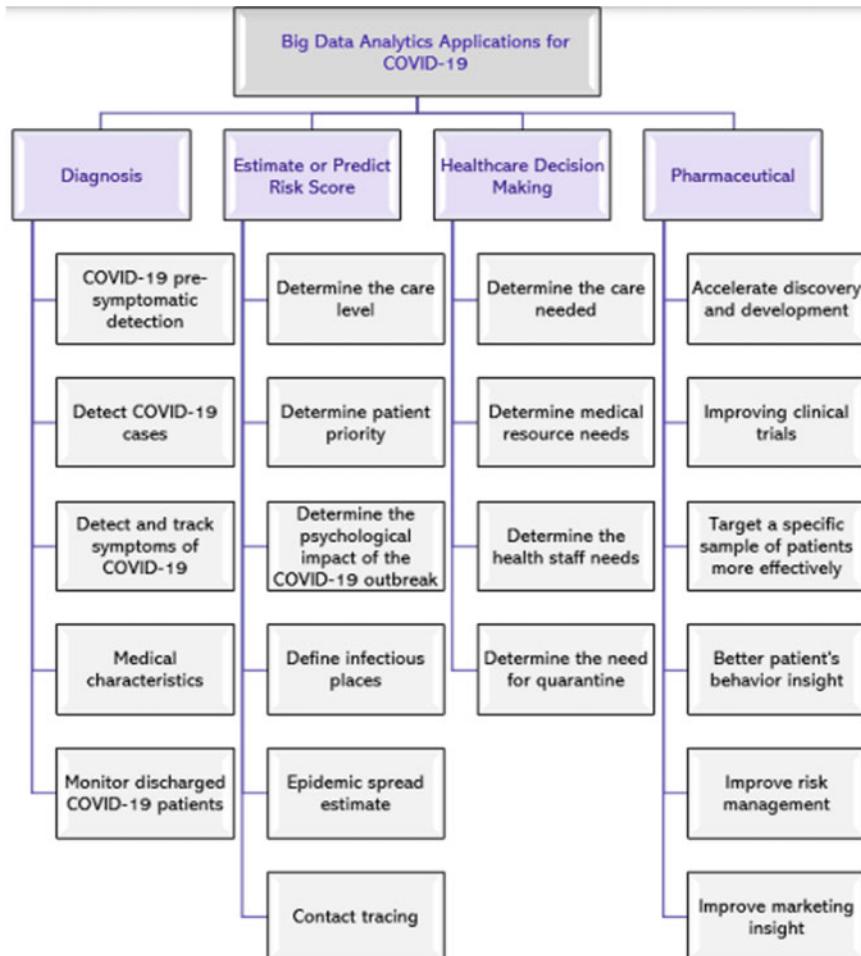


Fig. 2 Potential application areas of big data analytics for COVID-19

individuals can assess their exposure risk. In comparison with previous public health technology, it is digital in real-time and accessible to everyone (Kurdi et al., 2022a).

2.1.2 Tracking Contacts and Monitoring Quarantines and Isolations Through Mobile Phones

As shown below from Hong Kong, Taiwan, and South Korea, mobile phone signals can be tracked without a person's knowledge. There are also public apps that can help you track contacts. It's a Singaporean app called Trace Together. Bluetooth transmits signals over short distances between phones so they can find each other. Rather than

being given to authorities, these records are stored on users' phones as anonymous ID numbers, and they're only given out if the Ministry of Health needs them for a contact-tracing investigation (Alshurideh et al., 2020). COVID-19 does not specify where patients became ill. Instead, it simply lists possible people who met the virus.

2.1.3 Mobile Tracking

Taiwan currently employs a 'digital fence' system to track isolated individuals (55,000 as of 1 April 2020), albeit without wristbands. This strategy is how the five biggest telecommunication companies track restricted individuals (Alhamad et al., 2022). You can find out where their phones are whenever they're on. Only about 1% of the alerts are incorrect, according to the report. This happens even when the phone is off or when the position tells us that the quarantine has been breached (Brown et al., 2020). A lot of information is being collected. 'Digital fencing' has raised privacy concerns (Kurdi et al., 2022b). Those against it are concerned that it is intrusive and that it could lead to error. A government representative recently confirmed that once the virus is eradicated, the surveillance system will be phased out (Garcia-Perez et al., 2022).

2.1.4 Remote Patient Monitoring (RPM)

It is envisaged that the Remote Patient Monitoring (RPM) program will be able to follow up on patients who have been discharged from the hospital after being diagnosed with Coronavirus Infection 2019 (COVID-19). The RPM program will be presented, with its features, and its clinical outcomes discussed. To describe the patient's traits, patients and programs were employed that signifies the each individual preferences and decision making (Hanaysha et al., 2021b). Patients who used RPM after discharge from EDs or hospitals in COVID-19 had a reduced risk of re-admission to EDs or hospitals, and it offered a scalable method of monitoring patients at home (Chong et al., 2021).

2.1.5 Data-Driven Respiratory Sound Technology

COVID-19 diagnosis was enhanced using a large dataset of respiratory sounds collected from the public. Asthmatics and healthy controls are tested using coughing and breathing. Just a simple binary classifier can tell the difference between COVID-19 and healthy sounds. Data mining and machine learning based on audio have great potential (Lee et al., 2022a), but results are still preliminary. Automatic analysis of breathing patterns as a pre-screening signal for the diagnosis of COVID-19 may yet be possible in the future.

2.1.6 Technology Application

Artificial intelligence can help in six main areas: I early warnings and alarms, II monitoring and prediction, III dashboards for analyzing data, IV diagnosis and prognosis, V treatments and cures, VI social control. Currently, the entire world is experiencing a pandemic due to COVID-19 (Shamout et al., 2022).

2.1.7 COVID-19 and Hadoop: The First Half Discusses Big Data Solutions

Consider this to be an endemic context for heterogeneous data and then analyze how technologies such as Hadoop can be adapted for data analytics in this context. It is a need to further justify the selection of globally and flexibility requirements in Sect. 3 using both the partial sub-model setting and the final exact system model. Several Hadoop-based solutions can provide a wide array of functions and capabilities in each of these scenarios, aligning with what has been outlined in part 4 of the COVID-19 site's current heterogeneous data structure. Finally, there is a component devoted to explaining the strategic contexts of data processing. Seeing as they have a great deal of experience in handling big information challenges, they are in the best position to handle COVID-19.

3 Methodology

To incorporate study findings a literature based research was conducted to collect all possible outcomes. This was the best suited way to summarize the findings of the study that can contribute to the literature and future studies. The utilization of conventional and fuzzy decision-making strategies within the healthcare field was already investigated by (Mardani et al., 2019). Over 202 papers were surveyed from 85 high-ranking diaries, of which 130 tended to issues relating to healthcare and therapeutic decision-making. Considerers are classified into points counting natural supportability, squander administration, quality of benefit, chance administration, restorative gear, and fabric determination, wellbeing innovation, operation inquire about in healthcare, healing center healthcare administrations, and other application segments.

4 Data Analysis

Artificial intelligence (AI) relates to the creation of shrewd operators, or robots, able of locks in exercises considered cleverly by people (Farouk, 2021). Brilliant operators are any independent advances that can see their environment and lock-in in activities

that increment their chances of victory. Data mining is the capability of learning and extricating important designs from information (Alzoubi & Ahmed, 2019), and ML-based calculations are intrinsically subordinate to agent highlights. Tragically, these structures are as it were appropriate for circumstances that can be well-constrained or clear. Within the confront of unstructured or troublesome circumstances, in any case, they have certain impediments. On the other hand, diffusion-based learning employs a few layers of representation to uncover an underlying and complex relationship in data (Feizabadi, 2022).

A study conducted by (Albahri et al., 2020) inspected the adequacy and feasibility of the utilize of counterfeit insights (AI) calculations for the discovery and classification of Coronavirus illness 2019 (COVID-19) in terms of evaluation and benchmarking. Based on the crossing point of assessment criteria for each classification errand and AI classification approaches, to begin with, we offer recognizable proof procedures for the development of four choice frameworks, specifically twofold, multi-class, multi-labeled, and progressive (Alnuaimi et al., 2021). Utilizing the explanatory chain of command handle, the Multi-Criteria Decision Analysis (MCDA) technique can be connected to assess AI classification frameworks. At last, the benchmarking arrangements suggested are assessed from both an objective and subjective point of view. Using a variety of computational strategies, (Misra & Bera, 2018) examined big data analytics, artificial intelligence, fuzzy reasoning (Alshurideh et al., 2022), probabilistic models, development computing, computation learning hypotheses, and real-world tools and systems (Joghee et al., 2020).

(Kambatla et al., 2014) proposed a Hadoop Distributed File System (HDFS) framework for ideal information administration. Instead of classifying quality classes as total arrangements, they classified them as fragmented arrangements. In the course, anticipated machine learning models were utilized to rapidly classify quality groupings (Ali et al., 2022), and libraries such as matplotlib were utilized to produce a nitty-gritty chart of the information. Three unique sequences were utilized to classify quality arrangements utilizing the Sklearn library's normal dialect preparing procedure, and comes about were surveyed utilizing consistent regression.

(Xu et al., 2020), In this paper, a deep learning model was presented for the early diagnosis of COVID-19 patients with an accuracy rate of 86.7%. Researchers developed a deep learning convolutional neural network model to predict the presence of COVID-19 based on CT scans, with an F1 of 0.85. Using CNN to predict COVID-19 diagnosis and treatment response, ELGhamrawy demonstrated its efficacy (AI-inspired Model for COVID-19 Diagnosis and Treatment Response Prediction: AIMDP). This is the diagnostic module, which selects and classifies the features necessary to identify COVID-19 patients, while the prediction module predicts how the patient will respond to COVID-19 treatment.

According to (Lee et al., 2020) one of the challenges in predicting infection is the difficulty in responding to infectious diseases. The delay in obtaining infection data has resulted in ambiguous patterns of infectious diseases and the potential for missing illness reports (Akhtar et al., 2021). The best prediction parameter was then determined by applying a deep learning algorithm to a large data set,

specifically social media data (Alzoubi et al., 2022c). To determine whether deep learning models can predict three infectious diseases a week in advance, we compared deep learning models (neural networks and short-long-term memory) with traditional Autoregressive Integrated Moving Averages (ARIMA).

(Jamshidi et al., 2020) proposed an approach to tackle this problem that incorporates generative adversarial networks (GANs), Extreme Learning Machines (ELMs), and Long/Short Term Memory (LSTMs). This paper describes a bioinformatics strategy that integrates structured and unstructured data elements to create easy-to-use platforms for clinicians and researchers alike. A primary advantage of this artificial intelligence (AI)-based system is its ability to quickly diagnose and treat COVID-19. To identify possible network inputs and targets that might assist in the development of a feasible Artificial Neural Network-based solution to the COVID-19 clinical challenges, a review of the most recent medical reports and scholarly publications was undertaken. Various types of data, such as clinical data and medical imaging, can be input into each platform to contribute to the effectiveness of the approaches outlined in the rationale for their use in real-life scenarios.

Using a 2-stage transfer learning algorithm, (Zandehshahvar et al., 2021) developed a CNN that can classify four different sickness severity categories (normal, mild, moderate, and severe) with acceptable accuracy. As a result, radiologists can interpret CXR images more accurately. In conclusion, to describe how the proposed methodology can be applied to analyze the risk factors that led to the development of sickness in an individual patient.

5 Discussion

5.1 Findings

Using data analysis techniques and building solutions to address the COVID-19 pandemic is challenging because of the volume and diversity of data, according to the survey conducted in this study. The improvement of data analysis solutions will be aided by data sharing locally and globally (Alhamad et al., 2021).

5.2 Issues

Developing tactics to control the COVID-19 epidemic may limit the benefits of big data analysis in the health sector (Alzoubi et al., 2020).

5.3 *Sharing Data*

To extract useful information and analyses various occurrences from COVID 19, it is essential to consider the diversity and volume of data. We introduce blockchain-based technology (Ali, 2021), which anonymizes patients as well as verified data. Data can be securely transmitted in large volumes.

5.4 *Information Correctness*

Social media and the Internet serve to disseminate useful information and facilitate communication, but they are also a major source of misinformation about medical policies, diseases (Lee et al., 2022b), virus effects, and vaccines, thwarting government efforts to control virus transmissions and protect the public's health. Furthermore, it may negatively impact the psychological well-being of society.

5.5 *Collaboration with Patients*

The best source of information on the nature and symptoms of new diseases is the patients. So, he must share some of his medical information with research institutes, such as his medical history file. Additionally, the ability to share activity and physiological data generated by wearables may facilitate the development of predictive algorithms.

Most countries are taking steps to curb the spread and impact of COVID-19 despite multiple obstacles, including COVID-19's high cost and limited capacity. Aside from that, there's no way to keep track of people's health, especially if they live alone. To help stakeholders make smarter decisions and forecast trends, big data analytics tools and methods based on artificial intelligence (AI) are recommended.

6 Conclusion

It is crucial to deploy prevention and control measures as soon as possible in emerging epidemics or pandemics to limit their spread and transmission. In conjunction with COVID-19, we are assessing approaches based on Machine Learning (ML) and Deep Learning (DL) using nature-inspired computing, artificial intelligence, and big data analytics. In addition, this paper discusses high-throughput digital data analytical methods and decision support approaches for COVID-19 detection and screening. A classifier that uses ML techniques to diagnose and forecast COVID-19 occurrences is challenging the presently available AI-enabled diagnostics and

forecasting technology. In combination with Deep Learning models, AI and DL models can be applied to predict significant interacting factors globally. A CNN-based AI-based method was the most accurate for predicting COVID-19's diagnosis and the responses of patients to a specific medication. Additional powerful data analytics techniques could be used to detect COVID-19 "hotspots" and alert patients. COVID-19 can be forecasted with the DL technique, but it has limitations and can't explain other factors that can influence the trend such as weather, mobility, etc. DL models will be used to forecast the trend by utilizing all variables in the COVID-19 dataset in the future.

References

- Akhtar, A., Akhtar, S., Bakhtawar, B., Kashif, A.A., Aziz, N., Muhammad, &, Javeid, S. (2021). COVID-19 detection from CBC using machine learning techniques. *International Journal of Technology, Innovation and Management*, 1, 65–78.
- Albahri, O. S., Zaidan, A. A., Albahri, A. S., Zaidan, B. B., Abdulkareem, K. H., Al-qaysi, Z. T., Alamoodi, A. H., Aleesa, A. M., Chyad, M. A., Alesa, R. M., Kem, L. C., Lakulu, M. M., Ibrahim, A. B., & Rashid, N. A. (2020). Systematic review of artificial intelligence techniques in the detection and classification of COVID-19 medical images in terms of evaluation and benchmarking: Taxonomy analysis, challenges, future solutions and methodological aspects. *Journal of Infection and Public Health*, 13, 1381–1396.
- Alhamad, A. Q. M., Akour, I., Alshurideh, M., Al-Hamad, A. Q., Kurdi, B. A., & Alzoubi, H. (2021). Predicting the intention to use google glass: A comparative approach using machine learning models and PLS-SEM. *International Journal of Data and Network Science*, 5, 311–320.
- Alhamad, A., Alshurideh, M., Alomari, K., Al Kurdi, B., Alzoubi, H., Hamouche, S., & Al-Hawary, S. (2022). The effect of electronic human resources management on organizational health of telecommunications companies in Jordan. *International Journal of Data and Network Science*, 6, 429–438.
- Ali, A. A. (2021). The impact of information sharing and quality assurance on customer service at UAE banking sector. *International Journal of Technology, Innovation and Management*, 1, 01–17.
- Ali, N., Ghazal, T. M., Ahmed, A., Abbas, S., Khan, M. A., Alzoubi, H. M., Farooq, U., Ahmad, M., & Khan, M. A. (2022). Fusion-based supply chain collaboration using machine learning techniques. *Intelligent Automation & Soft Computing*, 31, 1671–1687.
- Ali, N., Ahmed, A., Anum, L., Ghazal, T., Abbas S., A. K., M., A., H. M., A., M. (2021). Modelling supply chain information collaboration empowered with machine learning technique. *Intelligent Automation & Soft Computing*, 30, 243–257.
- Alnazer, N. N., Alnuaimi, M. A., & Alzoubi, H. M. (2017). Analysing the appropriate cognitive styles and its effect on strategic innovation in Jordanian universities. *International Journal of Business Excellence*, 13, 127–140.
- Alnuaimi, M., Alzoubi, H. M., Ajelat, D., & Alzoubi, A. A. (2021). Towards intelligent organisations: An empirical investigation of learning orientation's role in technical innovation. *International Journal of Innovation and Learning*, 29, 207–221.
- Alshurideh, M., Gasaymeh, A., Ahmed, G., Alzoubi, H. M., & Kurd, B. A. (2020). Loyalty program effectiveness: Theoretical reviews and practical proofs. *Uncertain Supply Chain Manag.*, 8, 599–612.
- Alzoubi, H. M., Ghazal, T. M., Sahawneh, N., Al-kassem, A. H. (2022). Fuzzy assisted human resource management for supply chain management issues. *Annals of Operations Research*.

- Alsunaidi, S. J., Almuhaideb, A. M., Ibrahim, N. M., Shaikh, F. S., Alqudaihi, K. S., Alhaidari, F. A., Khan, I. U., Aslam, N., & Alshahrani, M. S. (2021). Applications of big data analytics to control covid-19 pandemic. *Sensors* 21.
- Al-Tahat, S., & Moneim, O. A. (2020). The impact of artificial intelligence on the correct application of cyber governance in Jordanian commercial banks. *International Journal of Scientific & Technology Research*, 9, 7138–7144.
- Alzoubi, A. (2022). Machine learning for intelligent energy consumption in smart homes. *International Journal of Computations, Information and Manufacturing*, 2, 2022.
- Alzoubi, H., & Ahmed, G. (2019). Do Total Quality Management (TQM) practices improve organisational success? a case study of electronics industry in the UAE. *International Journal of Economics and Business Research*, 17, 459–472.
- Alzoubi, H. M., & Aziz, R. (2021). Does emotional intelligence contribute to quality of strategic decisions? the mediating role of open innovation. *Journal of Open Innovation: Technology, Market, and Complexity*, 7, 130.
- Alzoubi, H. M., & Yanamandra, R. (2020). Investigating the mediating role of information sharing strategy on agile supply chain in supply chain performance. *Uncertain Supply Chain Manag.*, 8, 273–284.
- Alzoubi, H. M., Ahmed, G., Al-Gasaymeh, A., & Al Kurdi, B. (2020). Empirical study on sustainable supply chain strategies and its impact on competitive priorities: The mediating role of supply chain collaboration. *Management Science Letters*, 10, 703–708.
- Alzoubi, H. M., Vij, M., Vij, A., & Hanaysha, J. R. (2021). What leads guests to satisfaction and loyalty in UAE five-star hotels? AHP analysis to service quality dimensions. *ENLIGHTENING Tour A PATHMAKING J*, 11, 102–135.
- Alzoubi, H., Alshurideh, M., Kurdi, B. A., Akour, I., & Aziz, R. (2022a). Does BLE technology contribute towards improving marketing strategies, customers' satisfaction and loyalty? The role of open innovation. *International Journal of Data and Network Science*, 6, 449–460.
- Alzoubi, H. M., Ahmed, G., & Alshurideh, M. (2022b). An empirical investigation into the impact of product quality dimensions on improving the order-winners and customer satisfaction. *International Journal of Productivity and Quality Management*, 36, 169–186.
- Alzoubi, H. M., Alshurideh, M. T., Kurdi, B. A., Alhyasat, K. M. K., & Ghazal, T. M. (2022c). The effect of e-payment and online shopping on sales growth: Evidence from banking industry. *International Journal of Data and Network Science*, 6, 1369–1380.
- AlzoubiIn'airat, M., & Ahmed, G., H. M. (2022). Investigating the impact of total quality management practices and six sigma processes to enhance the quality and reduce the cost of quality: The case of Dubai. *International Journal of Business Excellence*, 27, 94–109.
- Brown, C., Chauhan, J., Grammenos, A., Han, J., Hasthanasombat, A., Spathis, D., Xia, T., Cicuta, P., & Mascolo, C. (2020). Exploring automatic diagnosis of COVID-19 from crowdsourced respiratory sound data. In *Proc ACM SIGKDD Int Conf Knowl Discov Data Min* (pp. 3474–3484).
- Butt, S. M. (2022). Management and treatment of type 2 diabetes. *International Journal of Computations, Information and Manufacturing*, 2, 1.
- Chong, C., Lee, K., & Ahmed, G. (2021). Improving IoT privacy, data protection and security concerns. *International Journal of Technology, Innovation and Management*, 1, 18–33.
- Chowdhury, S., Rodriguez-Espindola, O., Dey, P., Budhwar, P. (2022). Blockchain technology adoption for managing risks in operations and supply chain management: evidence from the UK. *Annals of Operations Research*
- Farouk, M. (2021). The universal artificial intelligence efforts to face coronavirus COVID-19. *International Journal of Computations, Information and Manufacturing*, 1, 77–93.
- Feizabadi, J. (2022). Machine learning demand forecasting and supply chain performance. *International Journal of Logistics Research and Applications*, 25, 119–142.
- Garcia-Perez, A., Cegarra-Navarro, J.G., Sallos, M.P., Martinez-Caro, E., & Chinnaswamy, A. (2022). Resilience in healthcare systems: Cyber security and digital transformation. *Technovation* 102583.

- Hanaysha, J. R., Al-Shaikh, M. E., Joghee, S., & Alzoubi, H. M. (2021a). Impact of innovation capabilities on business sustainability in small and medium enterprises. *FIIB Business Review*, 12, 55–68.
- Hanaysha, J. R., Shaikh, A., & M. E., A., (2021b). H. M. Importance Mark. Mix Elem. *Determ Consum Purch Decis Retail Mark*, 2, 56–72.
- Jamshidi, M., Lalbakhsh, A., Talla, J., Peroutka, Z., Hadjilooee, F., Lalbakhsh, P., Jamshidi, M., Spada, L. L., Mirmozafari, M., Dehghani, M., Sabet, A., Roshani, S., Roshani, S., Bayat-Makou, N., Mohamadzade, B., Malek, Z., Jamshidi, A., Kiani, S., Hashemi-Dezaki, H.,.... & Mohyuddin, W. (2020). Artificial intelligence and COVID-19: Deep learning approaches for diagnosis and treatment. *IEEE Access*, 8, 109581–109595.
- Joghee, S., Alzoubi, H. M., & Dubey, A. R. (2020). Decisions effectiveness of FDI investment biases at real estate industry: Empirical evidence from Dubai smart city projects. *International Journal of Scientific & Technology Research*, 9, 3499–3503.
- Kambatla, K., Kollias, G., Kumar, V., & Grama, A. (2014). Trends in big data analytics. *Journal of Parallel and Distributed Computing*, 74, 2561–2573.
- Kashif, A. A., Bakhtawar, B., Akhtar, A., Akhtar, S., Aziz, N., & Javeid, M. S. (2021). Treatment response prediction in hepatitis c patients using machine learning techniques. *International Journal of Technology, Innovation and Management*, 1, 79–89.
- Kurdi, B. A., Alshurideh, M., Akour, I., Alzoubi, H. M., Obeidat, B., & Alhamad, A. (2022a). The role of digital marketing channels on consumer buying decisions through eWOM in the Jordanian markets. *International Journal of Data and Network Science*, 6, 1175–1185.
- Kurdi, B. A., Alzoubi, H. M., Akour, I., & Alshurideh, M. T. (2022b). The effect of blockchain and smart inventory system on supply chain performance: Empirical evidence from retail industry. *Uncertain Supply Chain Manag.*, 10, 1111–1116.
- Lee, I. K., Wang, C. C., Lin, M. C., Kung, C. T., Lan, K. C., & Lee, C. T. (2020). Effective strategies to prevent coronavirus disease-2019 (COVID-19) outbreak in hospital. *Journal of Hospital Infection*, 105, 102–103.
- Lee, K. L., Azmi, N. A. N., Hanaysha, J. R., Alzoubi, H. M., & Alshurideh, M. T. (2022a). The effect of digital supply chain on organizational performance: An empirical study in Malaysia manufacturing industry. *Uncertain Supply Chain Manag.*, 10, 495–510.
- Lee, K. L., Romzi, P. N., Hanaysha, J. R., Alzoubi, H. M., & Alshurideh, M. (2022b). Investigating the impact of benefits and challenges of IOT adoption on supply chain performance and organizational performance: An empirical study in Malaysia. *Uncertain Supply Chain Manag.*, 10, 537–550.
- Mardani, A., Hooker, R. E., Ozkul, S., Yifan, S., Nilashi, M., Sabzi, H. Z., & Fei, G. C. (2019). Application of decision making and fuzzy sets theory to evaluate the healthcare and medical problems: A review of three decades of research with recent developments. *Expert Systems with Applications*, 137, 202–231.
- Mehmood, T. (2021). Does information technology competencies and fleet management practices lead to effective service delivery? empirical evidence from e-commerce industry. *International Journal of Technology, Innovation and Management*, 1, 14–41.
- Mehmood, T., Alzoubi, H., Alshurideh, M., Al-Gasaymeh, A., & Ahmed, G. (2019). Schumpeterian entrepreneurship theory: evolution and relevance. *Academy of Entrepreneurship Journal*, 25, 1–10.
- Misra, S., & Bera, S. (2018). Introduction to big data analytics. *Smart Grid Technology*. 38–48.
- Radwan, N. (2022). The internet's role in undermining the credibility of the healthcare industry. *International Journal of Computations, Information and Manufacturing*, 2, 1.
- Ramakrishna, Y., & Alzoubi, H. M. (2022). Empirical investigation of mediating role of six sigma approach in rationalizing the COQ in service organizations. *Operations and Supply Chain Management: An International Journal*, 15, 122–135.
- Riswantini, D., Nugraheni, E., Arisal, A., Khotimah, P.H., Munandar, D., & Suwarningsih, W. (2021). Big data research in fighting COVID-19: Contributions and techniques. *Big Data and Cognitive Computing* ., 5.

- Shamout, M., Ben-Abdallah, R., & Alshurideh, M., Al Kurdi, B., & Hamadneh, S. (2022) A conceptual model for the adoption of autonomous robots in supply chain and logistics industry. *Uncertain Supply Chain Manag.* 10, 577–592.
- Xu, X., Jiang, X., Ma, C., Du, P., Li, X., Lv, S., Yu, L., Ni, Q., Chen, Y., Su, J., Lang, G., Li, Y., Zhao, H., Liu, J., Xu, K., Ruan, L., Sheng, J., Qiu, Y., Wu, W., ... Li, L. (2020). A deep learning system to screen novel coronavirus disease 2019 pneumonia. *Engineering*, 6, 1122–1129.
- Zandehshahvar, M., van Assen, M., Maleki, H., Kiarashi, Y., De Cecco, C. N., & Adibi, A. (2021). Toward understanding COVID-19 pneumonia: A deep-learning-based approach for severity analysis and monitoring the disease. *Science and Reports*, 11, 1–10.

Data Warehousing for Assisting the Decision Makers



Bakheet AlNaoimi, Rashed AlRaesi, Obeid AlKaboory, Abdel Aziz Alrasasi, Waleed T. Al-Sit, Saif E. A. Alnawayseh, and Haitham M. Alzoubi 

Abstract There are lot of changes in the market, the technology has been improved and there is innovation in the technological sector. The use of data mining and data warehousing helps the decision makers in making the right decision that is effective for the company and its management. However, after seeing the market condition and the risk, the management and the decision makers are aligning their objectives to meet the organizational goals. There is need to implement SQL, intelligence business and different other types of software to bring change in the organization settings. After the advent of technology, the market and the business sector has seen a drastic change. There is a lot of improvement in organizations, and they are now making efficient decision that is necessary for the organization. It is evident from the previous studies that organization rely on the managers for making the decisions, this exposes the risk and there are high chances of loss. Managers rely on their intuition and gut; they make decision based on these intuitions which results in the immense loss. However, there is a huge change in the market and the arrival of data warehousing gives the immediate decisions to the organization. Data warehousing is a new technology that stores all the information and gives possible alternatives of every problem. This helps scientists, managers, doctors, and business analyst in making the right decision. However, still

B. AlNaoimi · R. AlRaesi · O. AlKaboory · A. Aziz Alrasasi
School of Information Technology, Skyline University College, Sharjah, UAE

W. T. Al-Sit
Department of Computer Engineering, Mu'tah University, Karak Governorate, Jordan

Higher Colleges of Technology, Dubai, UAE

S. E. A. Alnawayseh
Electrical Engineering Department, Faculty of Engineering, Mutah University, Karak Governorate, Jordan

H. M. Alzoubi (✉)
School of Business, Skyline University College, Sharjah, UAE
e-mail: haitham.alzoubi@skylineuniversity.ac.ae

Applied Science Research Center, Applied Science Private University, Amman, Jordan

S. E. A. Alnawayseh
e-mail: saif982@mutah.edu.jo

there is need to create awareness about the data warehousing in different organization. There is need of a proper marketing style highlight the potential target market.

Keywords Data warehousing · Decision makers

1 Introduction

This is a technological epoch, and technology is continually evolving; new discoveries are created, while old technology is phased out. As a result of modernization, the dynamics have changed, and everyone now employs smart technology. When making judgments, people used to trust their instincts or intuition, but now they rely on the results of numerous programmers and software. A data warehouse is a central repository that allows people to make better decisions (Alzoubi et al., 2021a, 2021b). It is a computer-based system for organizing and storing data. People are reverting to more traditional decision-making approaches (Al-Dmour, 2020). This problem has been identified in several worldwide businesses, when executives make well-informed judgments based on their gut instincts. There is need to understand that data warehouse is the need of market (Hanaysha et al., 2021), and many organizations are implementing different types of software to improve their decision-making skills (Alzoubi & Aziz, 2021; Islam et al., 2020). Managers are now relying on SQL software for making defective decisions (Mehmood, 2021) that can increase the market share of the organization (Kurdi et al., 2022a).

1.1 Problem Definition

Data warehouses are the most current and electronic method of making the best decision since they are properly analyzed and organized, allowing for data mining, and offering the best results to managers (Aziz & Aftab, 2021). Data warehousing makes several technologies (Hussam Al-Hamadi et al., 2015a, 2015b), such as SQL clients, Business Intelligence, and other applications, available (Alnuaimi et al., 2021). Traditional decision-making is risky and results in losses for the company. It is vital to think logically and make research-based conclusions (Kim et al., 2019). Many organizations use the back-of-the-envelope method to make judgments, but occasionally the situation is different, and a prior decision isn't required (Alzoubi et al., 2022e). As a result, the company's regular activities are disrupted (Al-Hamadi et al., 2015a, 2015b), resulting in a loss (Mondol, 2021). The problem lies in the mindset of many people, many business managers believe that use of data warehousing will affect their organization performance (Vorobeva Victoria, 2022), they made their own creative teams and think of different ideas that can be implemented in the organization during problematic situation (Alnazer et al., 2017).

A data warehouse must be utilized to modify the corporate environment and embrace a more progressive decision-making process (Mejia et al., 2019). There is a lot of data in the market, and managers make judgments based on it on occasion (Alshurideh et al., 2020; Mohammad Kamrul Hasan et al., 2021a, 2021b). On the stock market, this type of asymmetric information is created to speculate on false information or profit financially (Mondol, 2021). Managers are oblivious of the market's artificial bubble and make rash judgments based on market data (Alzoubi et al., 2021a, 2021b). The asymmetric information and the artificial market bubble affects the decision-making skills of the manager enforces them in taking the wrong decisions (Ghazal et al., 2021a, 2021b, 2021c, 2021d; Teahan et al., 2012). There is a negative implication of the decision, and it affects the credibility of the organization (Joghee et al., 2020), many investors are not interested to invest their money in the organization that have poor financial performance and have low rate of dealing with the problem (Eli, 2021).

It devalues the company and causes considerable losses; nevertheless, data warehousing gives accurate data and aids decision-makers in obtaining accurate market research (Ramakrishna & Alzoubi, 2022). It is critical to get a full understanding of the market before deciding (Hasan et al., 2021a, 2021b). Data warehousing is a strong network that stores all the necessary information along with the past experiences of the different CEOs, this will help the manager in making the effective decision that is necessary for the organization (Ghazal et al., 2021a). There is a lot of problem that has been caused due to inefficient decision-making skills (Alzoubi et al., 2022b). It increases the high cost, and the chance of failure also increases, manager puts lot of money on the decision management team instead of using the SQL software and IB intelligence application (Al-Dmour & Teahan, 2005; Alzoubi et al., 2022c; Ghazal et al., 2022j). There is a lot of high complexity and redundancy in decision making because manager is not aware of the consequences, the decision is totally based on the experience or the intuition of the manager (Alzoubi et al., 2022a). It increases the chances of risk, moreover it also slows and degrade the performance of the employees (Alshurideh et al., 2022; Guergov & Radwan, 2021; Vo et al., 2010). The use of outdated technology and traditional decision-making skill affects the financial performance of the company in a negative way (Mehmood et al., 2019). It increases the cost of the company which would affect the revenue and sales of the organization, resulting in the immense loss (Ghazal et al., 2022g; Lee et al., 2022a).

The use of outdated technology causes a lot of problems for the company, and it directly affects the revenue, many of the employees have engaged in the voluntary turnover by seeing the poor performance of the company (Al-Naymat et al., 2021). Manager don't allow employees to take part in the decision making, it made the decision and implement on the employees without their consent (Alzoubi & Ahmed, 2019; Ghazal et al., 2022i). However, there is a need to use the different types of data warehousing software that can improve the decision-making skills and assist the manager by giving different alternative solution of the existing problem (Ghazal et al., 2021b, 2022b). All the information has been stored in the data warehousing software (Alzoubi et al., 2022b); this information can easily be accessible after installing the software. These software's are built by using high technologies along with different

types of sensors that can detect the problem in the organization (Ali et al., 2021) and present possible solution to get rid of the existing problem (Alzoubi, 2021). Many software houses and artificial intelligence companies have installed this software to improve the efficiency of their systems (Alzoubi & Yanamandra, 2020; Ghazal et al., 2021c). Data warehousing's software not only give alternative solution, but it also saves time and cost of the company (Al-Hamadi et al., 2021; Ghazal & Taleb, 2022).

1.2 *Proposed Solutions*

There is a lot of information out there, some of which is genuine and some of which is wrong. Using data mining, it is necessary to declutter that information. In an organization, decision-making is valued highly, and managers are given unique autonomy to make decisions that are in the best interests of the company (Hanaysha et al., 2022). Shareholders are worried about the firm's worth, and they look to management to make the best decisions for the organization. Some managers, on the other hand, are unaware of data warehousing and rely on outside organizations to make decisions. The organization is looking for different alternative solutions that helps them in making the informed decision (Alsharari, 2021), there is need to create awareness about the data warehousing and data mining solutions that will solve the existing problem of the managers and gives them alternative solution of the current problem. It's not only improve the situation of the company but also gives them variety of different alternative solutions that helps the employees across the departments and engage them to work in different teams.

There are much software's in the market like SQL clients, business intelligence (BI) that helps the managers in making the informed decisions and implementing the right decision making shall within the organization environment (Alzoubi et al., 2020; Ghazal et al., 2022a). It is not only motivating the employees but also encourages them that end of innovative ideas and implement the decision-making sales using the data warehousing (Ghazal et al., 2022g). This initiation helps the employees in making the informed decision regarding the organization structure and increases the performance of employees (Lee et al., 2022b).

This tool detects problems and offers a variety of methods for fixing them, enabling management in better understanding the situation and choosing the best solution. This increases the efficiency and effectiveness of the firm. Data warehousing systems are used by many scientists, engineers, and business analysts to look for various data trends. This new technology leads to better results, which leads to more earnings and sales. Effective data warehousing tool marketing, as well as personal selling, are essential to reach the target demographic (Asem Alzoubi, 2022; Ghazal et al., 2022k). A significant social media marketing effort for data warehousing technologies also boosts awareness and assists managers in using them to make better decisions (Alzoubi et al., n.d.). There are many proposed solutions implement the data warehouse in technology in making the informed decision, there is need to establish a proper marketing channel that can influence the organization to implement this

high-tech technology (Ghazal et al., 2022d, 2022f). There is need to create awareness on a large platform that can raise the voice and motivate the managers of other companies to install the data warehousing software in their programs and systems. The managers must see the trends of different companies and compare their statistic to evaluate the performance of the company in the market, this will help them in better analyzing the situation of the organization with respect to the market (Alzoubi et al., 2022a). The change in the technological sector motivates the managers to update their systems and install the new version of data warehouse in software that can maximize their performance and give high efficiency. It saves time and cost, the data warehouse in software decrease is that complexity and the chances of risk in the company (Ghazal et al., 2022h). There is need to convince the investor that can put pressure on the managers to use the data warehousing system in the organization settings (Kasem & Al-Gasaymeh, 2022). There is need to conduct a meeting with the investors and board of directors of the company to motivate them in accepting the new technology or data warehousing that will help them in making their informed decision (Alshurideh et al., 2022).

CEOs should also push others to utilize these applications, since doing so will enhance sales and profits with the help of social media marketing and other marketing trends (Abu-Arqoub et al., 2020). A display of CEOs should be exhibited on multiple channels and social media platforms to encourage managers and decision-makers to adopt data warehousing technology to make educated judgments (Kurdi et al., 2022b).

2 Literature Review

It is reported that Dell has used the traditional data collecting method and conduct surveys, it is quite good approach to make the decision however, it is not efficient. There is more effort required than market survey, a risk factor should be considered while deciding in the competitive market (Ghazal et al., 2022c). Dell launches the new generation system in the market and it creates a havoc (Ghazal et al., 2022e), HP has launched the same system a week earlier in the market. People are more willing to buy the HP because of its low price and market initiator (Shehada et al., 2017). Dell without using the right decision-making skill reduces the price, it affects its cost and results in profits (Hamadneh et al., 2021). Most of the people have already bought the system and this causes a huge supply of product in the market and the demand is quite low. People are not willing to buy any more system and HP has managed to gain the competitive advantage in the market. It increases the market share of the company and bring huge profits, it makes the right informed decision and uses the data warehousing skills (Shehada et al., 2018). HP uses SQL clients and has incorporated Business Intelligence (BI) software in different warehouses and offices (Ghazal et al., 2021b). It is also reported that many businesses like Amazon, Walmart, IKEA, Microsoft etc. are using data warehousing in making the informed decision and it also helps in managing their organization problems (Alkeem et al., 2017). This

software stores large information regarding the inventory (Shamout et al., 2022), past experiences, data analysis and it also assists in performing many other functions (Guntur et al., 2018). Businesses are feeling more relaxed using these software as it gives different alternative options in solving the problems and assists the employees in coming up with different innovative ideas (Alzoubi et al., 2022d). There are many businesses in the market that have increased their market by using different types of software, however the use of data warehousing increased the performance of the company and helps in making the right decisions (Ghazal et al., 2022i).

3 Methodology

The hypothesis of research includes,

- The use of data warehousing tools gives high profits and sales projection
- A high-end use of data warehousing tools helps in making informed decision.

Both primary and secondary data collecting methods are used to verify the assertions. The core data is gathered from a survey of managers from various firms who use SQL clients and IB software to make educated decisions. The survey is carried out via the SurveyMonkey website; these surveys save the managers' responses and provide accurate statistics on the use of data warehousing techniques. Secondary research is also done by looking at annual reports from various firms, as well as a quick review of journals and publications to obtain information on the relevance of data warehousing.

The data is collected by using primary research method and survey was conducted based on the information of data warehousing. The questionnaire is properly set and the response of 20 managers were collected to analyze the situation. It shows the most of the businesses are willing to use the data warehousing approach to bring the change in their organization. The quantitative approach is used to understand the current market situation and it depicts that most of the people are now accepting the modern technology and are using them in making the informed decisions.

4 Discussion

The survey is conducted and it shows the response of the businesses, many companies are now using data warehousing is making the right decision as illustrated in Fig. 1. There are many individuals like financial analyst, businessman, scientist, and many other people uses SQL clients and Intelligence business in understanding the problems and think of different alternative solutions.

This result suggests that around 60% business managers have agreed that data warehousing solve their problems and helps in making the informed decision as

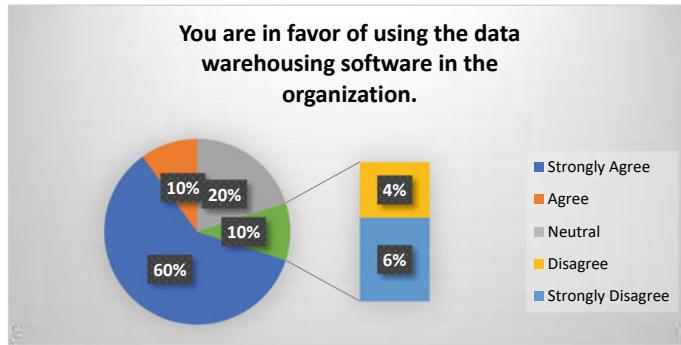


Fig. 1 Response of the businesses (Weshah & Alzoubi, n.d.)



Fig. 2 Response of the managers (Alzoubi et al., 2022c)

shown in Fig. 2. They are in the favor of use of technology in making the right decision.

Around 80% of respondents suggest that data warehousing improves the performance of the company and helps in making informed decision. While 20% people don't agree and there is need to create awareness for those people to motivate them in believing the use of data warehousing in making decision as presented in Fig. 3.

The graph clearly demonstrates that respondents shows their willingness and are showing positive response towards the use of SQL client and Intelligence business in the organization environment. The businesses are making change to adjust in the market and use data warehousing to improved their decision-making skill as in Fig. 4.

This shows that over 70% of companies' manager believe that use of data warehousing increase their revenue and helps the company to sustain in the market and brings lot of revenue by making the informed decision.

Fig. 3 Warehousing in making decision (Joghee et al., 2020)

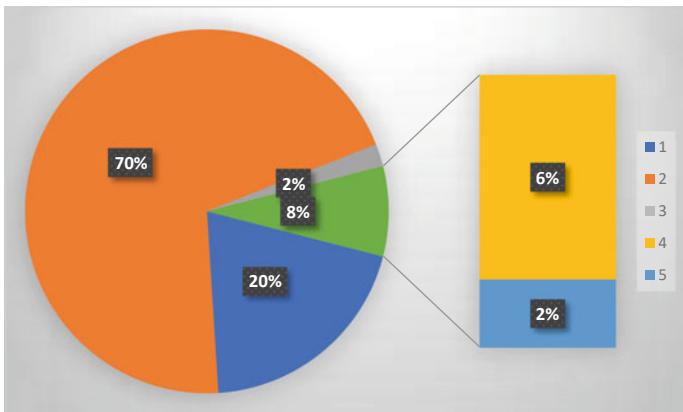


Fig. 4 The increase in the use of data warehousing improves the performance of the company (Alzoubi & Yanamandra, 2020)

5 Conclusion

There have been many changes in the market, technology has improved, and there has been technical innovation. The use of data mining and data warehousing assists decision makers in making the best possible decisions for the organization and its management. However, after assessing the market and risk, managers and decision-makers are aligning their aims in order to achieve the organization's objectives. To bring about change in the organization's settings, SQL, intelligence business, and other sorts of software must be implemented.

References

- Abu-Arqoub, M., Issa, G., Banna, A. E., & Saadeh, H. (2020). Interactive multimedia-based educational system for children using interactive book with augmented reality. *Journal of Computer Science*, 15, 1648–1658.
- Al-Dmour, N. A. (2020). Using unstructured search algorithms for data collection in iot-based WSN. *International Journal of Engineering Research and Technology*, 13, 1992–1998.
- Al-Dmour, N., Teahan, W. (2005). The blackboard resource discovery mechanism for distributed computing over P2P networks. In T. International (Ed.), *PDCN. Conference on Parallel and Distributed Computing and Networks* (pp. 15-17). Innsbruck, Austria, February.
- Al-Hamadi, H., Gawanmeh, A., Baek, J., & Al-Qutayri, M. (2015b). Lightweight security protocol for ECG bio-sensors. *Wireless Personal Communications*, 95, 5097–5120.
- Al-Hamadi, H., Gawanmeh, A., & Al-Qutayri, M. (2015a). Formal validation of QRS wave within ECG. In *2015 international conference on information and communication technology research, ICTRC 2015*. 9, pp. 190–193
- Al-Hamadi, H., Nasir, N., Yeun, C.Y., & Damiani, E. (2021). A verified protocol for secure autonomous and cooperative public transportation in smart cities. In I. June (Ed.), *2021 IEEE International Conference on Communications Workshops (ICC Workshops)*. pp. 1–6.
- Ali, N., Ahmed, A., Anum, L., Ghazal, T. M., Abbas, S., Khan, M. A., Alzoubi, H. M., & Ahmad, M. (2021). Modelling supply chain information collaboration empowered with machine learning technique. *Intell Autom Soft Comput*, 30, 243–257.
- Alkeem, E. A., Shehada, D., Yeun, C. Y., Zemerly, M. J., & Hu, J. (2017). New secure healthcare system using cloud of things. *Cluster Computing*, 20(3), 2211–2229.
- Al-Naymat, G., Hussain, H., Al-Kasassbeh, M., & Al-Dmour, N. (2021). Accurate detection of network anomalies within SNMP-MIB data set using deep learning. *International Journal of Computer Applications in Technology*, 66, 74–85.
- Alnazer, N. N., Alnuaimi, M. A., & Alzoubi, H. M. (2017). Analysing the appropriate cognitive styles and its effect on strategic innovation in Jordanian universities. *International Journal of Business Excellence*, 13, 127–140s.
- Alnuaimi, M., Alzoubi, H. M., Ajelat, D., & Alzoubi, A. A. (2021). Towards intelligent organisations: An empirical investigation of learning orientation's role in technical innovation. *International Journal of Innovation and Learning*, 29, 207–221.
- Alsharari, N. (2021). Integrating blockchain technology with internet of things to efficiency. *International Journal of Technology, Innovation and Management*, 1, 01–13.
- Alshurideh, M., Gasaymeh, A., Ahmed, G., Alzoubi, H., & Kurd, B. A. (2020). Loyalty program effectiveness: Theoretical reviews and practical proofs. *Uncertain Supply Chain Manag*, 8, 599–612.
- Alshurideh, M. T., Al Kurdi, B., Alzoubi, H. M., Obeidat, B., Hamadneh, S., & Ahmad, A. (2022). The influence of supply chain partners' integrations on organizational performance: The moderating role of trust. *Uncertain Supply Chain Manag*, 10, 1191–1202.
- Alzoubi, A. (2021). The impact of process quality and quality control on organizational competitiveness at 5-star hotels in Dubai. *International Journal of Technology, Innovation and Management*, 1, 54–68.
- Alzoubi, A. (2022). Machine learning for intelligent energy consumption in smart homes. *International Journal of Comput Inf Manuf*, 2, 1.
- Alzoubi, H., & Ahmed, G. (2019). Do TQM practices improve organisational success? A case study of electronics industry in the UAE. *International Journal of Economics and Business Research*, 17, 459–472.
- Alzoubi, H. M., & Aziz, R. (2021). Does emotional intelligence contribute to quality of strategic decisions? The mediating role of open innovation. *Journal Open Innov Technol Mark Complex*, 7, 130.
- Alzoubi, H. M., & Yanamandra, R. (2020). Investigating the mediating role of information sharing strategy on agile supply chain. *Uncertain Supply Chain Manag*, 8, 273–284.

- Alzoubi, H. M., Ahmed, G., Al-Gasaymeh, A., & Al Kurdi, B. (2020). Empirical study on sustainable supply chain strategies and its impact on competitive priorities: The mediating role of supply chain collaboration. *Management Science Letters*, 10, 703–708.
- Alzoubi, H., Alhamad, A. Q. M., Akour, I., Alshurideh, M., Al-Hamad, A. Q., Kurdi, B. A., & Alzoubi, H. (2021a). Predicting the intention to use google glass: A comparative approach using machine learning models and PLS-SEM. *International Journal of Data and Network Science*, 5, 311–320.
- Alzoubi, H. M., Vij, M., Vij, A., & Hanaysha, J. R. (2021b). What leads guests to satisfaction and loyalty in UAE five-star hotels? AHP analysis to service quality dimensions. *Enlightening Tour*, 11, 102–135.
- Alzoubi, H., Alhamad, A., Alshurideh, M., Alomari, K., Al Kurdi, B., Hamouche, S., & Al-Hawary, S. (2022a). The effect of electronic human resources management on organizational health of telecommunications companies in Jordan. *International Journal of Data and Network Science*, 6, 429–438.
- Alzoubi, H., Alshurideh, M., Kurdi, B. A., Akour, I., & Aziz, R. (2022b). Does BLE technology contribute towards improving marketing strategies, customers' satisfaction and loyalty? The role of open innovation. *International Journal of Data and Network Science*, 6, 449–460.
- Alzoubi, H. M., Ahmed, G., & Alshurideh, M. (2022c). An empirical investigation into the impact of product quality dimensions on improving the order-winners and customer satisfaction. *International Journal of Productivity and Quality Management*, 36, 169–186.
- Alzoubi, H. M., Ali, N., Ghazal, T. M., Ahmed, A., Abbas, S., Khan, M. A., Farooq, U., Ahmad, M., & Khan, M. A. (2022d). Fusion-based supply chain collaboration using machine learning techniques. *Intelligent Automation and Soft Computing*, 31, 1671–1687.
- Alzoubi, H. M., Elrehaile, H., Hanaysha, J. R., Al-Gasaymeh, A., & Al-Adaileh, R. (2022f). The role of supply chain integration and agile practices in improving lead time during the COVID-19 crisis. *International Journal of Service Science, Management, Engineering, and Technology*, 13, 1–11.
- Alzoubi, H., Alshurideh, M., Kurdi, B. A., Alhyasat, K., & Ghazal, T. (2022). The effect of e-payment and online shopping on sales growth: Evidence from banking industry. *International Journal of Data and Network Science*, 6(4), 1369–1380.
- Alzoubi, H.M., In'airat, M., & Ahmed, G. (2022e). Investigating the impact of total quality management practices and Six Sigma processes to enhance the quality and reduce the cost of quality: the case of Dubai. *International Journal of Business Excellence*, 27, 94–109.
- Alzoubi, H. M., Alshurideh, M. T., Al Kurdi, B., Ghazal, T. M., Said, R. A., AlHamad, A. Q., Hamadneh, S., Sahawneh, N., Al-kassem, A. H. (2022c). Fuzzy assisted human resource management for supply chain management issues. *Ann Oper Res*, 1–19.
- Aziz, N., & Aftab, S. (2021). Data mining framework for nutrition ranking: methodology: SPSS modeller. *International Journal of Technology Innovation Management*, 1, 85–95.
- Eli, T., 2021. Students' Perspectives on the Use of Innovative and Interactive Teaching Methods at the University of Nouakchott Al Aasriya, Mauritania: English department as a case study. *International Journal of Technology, Innovation and Management*, 1, 90–104.
- Ghazal, T. M., Bibi, R., Saeed, Y., Zeb, A., Rahman, T., Said, R. A., Abbas, S., Ahmad, M., & Khan, M. A. (2021b). Edge AI-based automated detection and classification of road anomalies in VANET using deep learning. *Computational Intelligence and Neuroscience*, 2021, 1–19.
- Ghazal, T. M., Hasan, M. K., Alkhalfah, A., Abu Bakar, K. A., Omidvar, A., Nafi, N. S., & Agbinya, J. I. (2021c). *Fischer linear discrimination and quadratic discrimination analysis-based data mining technique for internet of things framework for healthcare* (p. 9). Public Heal.
- Ghazal, T. M., Siddiqui, S. Y., Haider, A., Khan, M. A., Naseer, I., Abbas, S., Rahman, M., Khan, J. A., Ahmad, M., Hasan, M. K., Mohammed, A., & Ateeq, K. (2021d). IoMT cloud-based intelligent prediction of breast cancer stages empowered with deep learning. *IEEE Access*, 9, 146478–146491.

- Ghazal, T. M., Abbas, S., Alhwaiti, Y., Fatima, A., Khan, M. A., Khan, M. A., Kanwal, A., Ahmad, M., & Elmitwally, N. S. (2022b). Convolutional neural network based intelligent handwritten document recognition. *Comput Mater Contin*, 70, 4563–4581.
- Ghazal, T. M., Abbas, S., Munir, S., Khan, M. A., Ahmad, M., Issa, G. F., Zahra, S. B., Khan, M. A., & Hasan, M. K. (2022c). Alzheimer disease detection empowered with transfer learning. *Comput Mater Contin*, 70, 5005–5019.
- Ghazal, T. M., Hasan, M. K., Abdullah, S. N. H., Abubakkar, K. A., & Afifi, M. A. M. (2022f). IoMT-enabled fusion-based model to predict posture for smart healthcare systems. *Comput Mater Contin*, 71, 2579–2597.
- Ghazal, T. M., Hasan, M. K., Saeed, R. A., Pandey, B., Gohel, H., Eshmawi, A. A., Abdel-Khalek, S., & Alkhassawneh, H. M. (2022g). A review on security threats, vulnerabilities, and counter measures of 5G enabled Internet-of-Medical-Things. *IET Communications*, 16, 421–432.
- Ghazal, T. M., Khan, M. A., Lee, S. W., & Rehman, A. (2022h). Data fusion-based machine learning architecture for intrusion detection. *Computers Material Continua*, 70, 3399–3413.
- Ghazal, T. M., Mehmood, S., Khan, M. A., Zubair, M., Naseem, M. T., Faiz, T., & Ahmad, M. (2022i). Malignancy detection in lung and colon histopathology images using transfer learning with class selective image processing. *IEEE Access*, 10, 25657–25668.
- Ghazal, T. M., Zafar, S., Asif, M., Ahmad, M. B., Faiz, T., Ahmad, M., & Khan, M. A. (2022l). Assistive devices analysis for visually impaired persons: a review on taxonomy. *IEEE Access*, 10, 13354–13366.
- Ghazal, T. M., Taleb, N. (2022). *Feature optimization and identification of ovarian cancer using internet of medical things*. *Expert Systems. Expert Systems*.
- Ghazal, T., Hasan, M., Alshurideh, M., Alzoubi, M. H., Ahmad, M., Akbar, S., Al Kurdi, B., & Akour, I. (2021). IoT for smart cities: machine learning approaches in smart healthcare-a review. *Future Internet* 13, 218
- Ghazal, T. M., Abbas, S., Ahmad, M., Aftab, S. (2022a). An IoMT based ensemble classification framework to predict treatment response in hepatitis C patients. In *2022 International Conference on Business Analytics for Technology and Security, ICBATS 2022*. pp. 1–4.
- Ghazal, T. M., Ahmed, Z. E., Hasan, M. K., Hashim, A. A., Saeed, R. A., Mokhtar, R. A., & Singh, S. P. (2022d). Optimization procedure for intelligent internet of things applications. In *2022 International Conference on Business Analytics for Technology and Security, ICBATS 2022*. pp. 1–6.
- Ghazal, T. M., Bukhari, M. M., Abbas, S., Khan, M. A., Farooq, U., Wahbah, H., Ahmad, M., & Adnan, K. M. (2022e). An intelligent proposed model for task offloading in fog-cloud collaboration using logistics regression. *Comput Intell Neurosci*.
- Ghazal, T. M., Noreen, S., Said, R. A., Khan, M. A., Siddiqui, S.Y., Abbas, S., Aftab, S., & Ahmad, M. (2022j). Energy demand forecasting using fused machine learning approaches. *Intelligent Automation and Soft Computing*.
- Ghazal, T. M., Rehman, A. U., Saleem, M., Ahmad, M., Ahmad, S., & Mehmood, F. (2022k). Intelligent model to predict early liver disease using machine learning technique. In *2022 International conference on business analytics for technology and security, ICBATS 2022*. pp. 1–5.
- Guergov, S., & Radwan, N. (2021). Blockchain convergence: Analysis of issues affecting IoT, AI and blockchain. *International Journal of Computations Informations and Manufacturing*, 1, 1–17.
- Guntur, S. R., Gorrepatti, R. R., Dirisala, V. R. (2018). Internet of medical things. In *Medical big data and internet of medical things*, Vol. 4. pp. 271-297.
- Hamadneh, S., Pedersen, O., Alshurideh, M., Kurdi, B. A., & Alzoubi, H. M. (2021). An investigation of the role of supply chain visibility into the scottish blood supply chain. *J Legal Ethical Regul Issues*, 24, 1–12.
- Hanaysha, J. R., Al-Shaikh, M. E., Joghee, S., & Alzoubi, H. M. (2022). Impact of innovation capabilities on business sustainability in small and medium enterprises. *FIIB Bus Rev*, 11, 67–78.

- Hanaysha, J., Al-Shaikh, M., M. Alzoubi, H. (2021). Importance of marketing mix elements in determining consumer purchase decision in the retail market. *International Journal of Service Science, Management, Engineering, and Technology*, 12, 56–72.
- Hasan, M. K., Islam, S., Sulaiman, R., Khan, S., Hashim, A. H. A., Habib, S., Islam, M., Alyahya, S., Ahmed, M. M., Kamil, S., & Hassan, M. A. (2021a). Lightweight encryption technique to enhance medical image security on internet of medical things applications. *IEEE Access*, 9, 47731–47742.
- Hasan, M. K., Musse, M. A., Sherfriz, S. M., Shayla, I., Huda, S. N., A., S., Eklas, H., Nazmus, S. N., Nguyen, V. (2021). An Improv Dyn Therm Curr Rat Model PMU-based wide area Meas. Framew Reliab Anal Util Sens cloud Syst. *IEEE Access* 9, 14446–14458.
- Islam, S., Khalifa, O. O., Hashim, A. H. A., Hasan, M. K., Razzaque, M. A., & Pandey, B. (2020). Design and evaluation of a multihoming-based mobility management scheme to support inter technology handoff in PNEMO. *Wireless Personal Communications*, 114, 1133–1153.
- Joghee, S., Alzoubi, H. M., & Dubey, A. R. (2020). Decisions effectiveness of FDI investment biases at real estate industry: Empirical evidence from Dubai smart city projects. *International Journal of Scientific & Technology Research*, 9, 3499–3503.
- Kasem, J., & Al-Gasaymeh, A. (2022). A cointegration analysis for the validity of purchasing power parity: evidence from Middle East countries. *International Journal of Technology Innovation and Management*, 2, 1.
- Kim, S.-K., Yeun, C. Y., Damiani, E., & Lo, N.-W. (2019). A machine learning framework for biometric authentication using electrocardiogram. *IEEE Access*, 7, 94858–94868.
- Kurdi, B. A., Alshurideh, M., Akour, I., Alzoubi, H. M., Obeidat, B., & Alhamad, A. (2022a). The role of digital marketing channels on consumer buying decisions through eWOM in the Jordanian markets. *Intertional Journal of Data Network Science*, 6, 1175–1185.
- Kurdi, B. A., Alshurideh, M., Akour, I., Tariq, E., Alhamad, A., & Alzoubi, H. M. (2022b). The effect of social media influencers' characteristics on consumer intention and attitude toward Keto products purchase intention. *Intertional Journal of Data Network Science*, 6, 1135–1146.
- Lee, K. L., Azmi, N. A. N., Hanaysha, J. R., Alzoubi, H. M., & Alshurideh, M. T. (2022a). The effect of digital supply chain on organizational performance: An empirical study in Malaysia manufacturing industry. *Uncertain Supply Chain Management*, 10, 495–510.
- Lee, K. L., Romzi, P. N., Hanaysha, J. R., Alzoubi, H. M., & Alshurideh, M. (2022b). Investigating the impact of benefits and challenges of IOT adoption on supply chain performance and organizational performance: An empirical study in Malaysia. *Uncertain Supply Chain Manag.*, 10, 537–550.
- Mehmood, T. (2021). Does information technology competencies and fleet management practices lead to effective service delivery? empirical evidence from e-commerce industry. *International Journal of Technology, Innovation and Management*, 1, 14–41.
- Mehmood, T., Alzoubi, H. M., Alshurideh, M., Al-Gasaymeh, A., & Ahmed, G. (2019). Schumpeterian entrepreneurship theory: Evolution and relevance. *Acad Entrep J*, 25, 1–10.
- Mejia, C., Ciarlante, K., & Chheda, K. (2019). A wearable technology solution and research agenda for housekeeper safety and health. *International Journal of Contemporary Hospitality Management*, 1–3.
- Mondol, E. P. (2021). The impact of block chain and smart inventory system on supply chain performance at retail industry. *Int J Comput Inf Manuf*, 1, 56–76.
- Ramakrishna, Y., & Alzoubi, H. M. (2022). Empirical investigation of mediating role of six sigma approach in rationalizing the COQ in service organizations. *Oper Supply Chain Manag.*, 15, 122–135.
- Shamout, M., Ben-Abdallah, R., Alshurideh, M., Alzoubi, H., Al Kurdi, B., & Hamadneh, S. (2022). A conceptual model for the adoption of autonomous robots in supply chain and logistics industry. *Uncertain Supply Chain Manag.*, 10, 577–592.
- Shehada, D., Yeun, C. Y., Zemerly, M. J., Al-Qutayri, M., Al-Hammadi, Y., & Hu, J. (2018). A new adaptive trust and reputation model for Mobile Agent Systems. *Journal of Network and Computer Application*, 124, 33–43.

- Shehada, D., Yeun, C. Y., Zemerly, M. J., Qutayri, M. Al, Hammadi, Y. Al, Damiani, E., Hu, J. (2017). BROSMAP: A novel broadcast based secure mobile agent protocol for distributed service applications. *Security and Communication Networks*, Wiley, 2017.
- Teahan, W. J., Al-Dmour, N. A., & Tuff, P. G. (2012). Knowledge distribution in multi agent systems. *Asian Journal of Information Technology*, 11, 300–311.
- Victoria, V. (2022). Impact of process visibility and work stress to improve service quality: empirical evidence from Dubai retail industryimpact of process visibility and work stress to improve service quality: empirical evidence from Dubai retail industry. *Int. J. Technol. Innov. Manag.*, 2, 1.
- Vo, D. L., Lee, H., Yeun, C. Y., & Kim, K. (2010). Enhancements of authenticated multiple key exchange protocol based on bilinear pairings. *Computers & Electrical Engineering*, 36, 155–159.
- Weshah, S., Alzoubi, H. M. (n.d). *Business digitalization in accounting and auditing*, pp. 1–11.

Implementing Machine Learning for the Analysis of Data



Ali A. Alzoubi and Haitham M. Alzoubi 

Abstract Machine Learning is a subdivision of Computer Science and Artificial Intelligence which deals use of algorithms and data to mimic the way human brain works and later improving the accuracy. Machine learning is a field of examination to understand and build algorithms that 'learn' that is it can pull up data to increase quality of performance on some set tasks. It's a part of Artificial Intelligence. Machine Learning is a vital part of the upcoming field of data science. Even though using algorithms and quantitative methods are tuned to make predictions or classifications, data mining projects. These methods make drive decision doing within application and businesses. Machine learning, neural networks, deep learning are all sub-fields of Artificial Intelligence. Machine Learning (ML) is type of artificial intelligence that allows applications to become more precise at predicting outputs without being programmed. ML uses previous data as input to predict new outputs. Recommending with previous searches are mainly the common use of machine learning. Other main uses are spam filtering, malware threat alert, fraud detection, malware threat alert, predictive maintenance, BPA. Machine Learning is principal because it gives firms a view of trends in business operational patterns and user behaviour, also encourages in development of new products. Leading companies like Google, Uber, and Facebook makes machine learning an important part of their companies. Machine learning become a supreme selling proposition for many companies.

Keywords Machine learning · Artificial intelligence

A. A. Alzoubi
Public Security Directorate, Amman, Jordan

H. M. Alzoubi 
School of Business, Skyline University College, Sharjah, UAE
e-mail: haitham.alzoubi@skylineuniversity.ac.ae

Applied Science Research Center, Applied Science Private University, Amman, Jordan

1 Introduction

Machine Learning (ML) is a sort of artificial intelligence that allows applications to improve their accuracy at predicting outputs without having to be coded. In order to predict new outputs, machine learning uses existing data as input (Khan et al., 2022). The most typical application of machine learning is recommending based on previous searches (Alhamad et al., 2021). Traditional Machine Learning is frequently judged on how well an algorithm catches (Al-Hamadi et al., 2015a, 2015b) to make more accurate predictions (Ghazal et al., 2022b). There are four basic methods. Reinforcement learning, supervised learning, unsupervised learning, semi-supervised learning the algorithm that a data scientist uses is determined on the type of data they wish to anticipate (Alshurideh et al., 2022; Kashif et al., 2021).

Unsupervised Learning is a sort of machine learning in which a set of instructions is used to tune unlabelled data (Alzoubi et al., 2022a, 2022b, 2022c, 2022d). The instructions search the data sets for any meaningful connections. The data instructions train on as well as recommendations and forecasting the outputs are predicted (Akhtar et al., 2021; Ghazal et al., 2021; Mohammad Kamrul Hasan et al., 2021a, 2021b). Supervised Learning: In this type of Machine learning the scientist uses algorithms with labelled and tuned, check data and define the variables they want the instruction set to find the relations. Both output and inputs are specified (Ghazal et al., 2022e; Siddiqui et al., 2021).

Semi-Supervised learning: This approach is almost a mix of both mentioned above (Saleem et al., 2022). Data Analyst gives algorithm which is mostly with labelled tuning data, but also the system is free to find data on its own and developing new output (Hasan et al., 2022; Kim et al., 2019). Reinforcement Learning: Data Analyst mainly uses this to teach a machine to finish a multi-step process which there are clearly defined sets (Ghazal et al., 2022d). Data analyst programs an algorithm to finish tasks and gives either negative or positive reviews. But mostly the instructions find on its own (Ghazal et al., 2022d; Mehmood et al., 2019).

1.1 Problem Definition

ML uses previous data as input to predict new outputs. Recommending with previous searches are mainly the common use of machine learning. Traditional Machine Learning is often graded by how an algorithm catches to be more precise in predictions (Shamout et al., 2022). There are 4 basic approaches unsupervised learning, Supervised learning, semi supervised learning, Reinforcement Learning (Ghazal et al., 2022f). Algorithm data scientist chooses depends upon what type of data they want to anticipate (Ghazal et al., 2022c; Islam et al., 2020). There are a lot problems that Machine learning data analysts come across to putting skills and build applications with mixture of innovative capabilities (Hanaysha et al., 2022). From past 10 or more years we came across the words big data (Al-Dmour, 2020; Ali

et al., 2022; Lee et al., 2022a), AI, Machine learning. Machine learning helps to take things more informed, correct decisions that are faster than conventional approach (Al-Naymat et al., 2021; Ghazal et al., 2022d). Machine learning has its own set of challenges.

- Under fitting of Training Data: This happens when the information's is unable to find relation between input and output. This scenario similar trying to fit undersized clothes (Kurdi et al., 2022c).
- Poor Quality of data: One thing that plays significant role in machine learning is Data. One of the main problems that data scientist face is the absence of good quality data (Bibi et al., 2021). Noisy data can make the process extremely disturbed (Lee et al., 2022b).
- Overfitting is training machine learning process with large amount of data: It is similar to trying to fit oversized clothes. Regretfully it is one of most awful challenge faces by Machine Learning (Mehmood, 2021). This is similar to training data with most noisy data, which will affect working and output.
- Lack of Training Data: The most vital part of machine learning is tuning data to achieve the end goals (Alnazer et al., 2017). Unlike human Machine learning needs massive amount of data for learning algorithms and perfect output (Shehada et al., 2018).
- Slow Implementation: Common issue that come across professionals in Machine Learning (Abu-Arqoub et al., 2020). The learning models are highly effective in providing accurate outputs, but it takes more time. Since slow programs, excessive requirements, data overload usually takes a lot of time to provide good outputs that can have a big hurdle in accurate information sharing (Alzoubi & Yanamandra, 2020; Kurdi et al., 2022b).
- Complex process of machine learning: This industry is continuously changing and young. Trial and error methods are carried out always (Bukhari et al., 2022; Kurdi et al., 2022a). The method is changing always and so there are high chances for occurrence of error which make the process complicated (Ali et al., 2021). It needs Training data, removing data bias, complex calculations, removing data bias (Aziz & Aftab, 2021).
- Inadequacy in the Algorithm when Data expands: When we settled the machine with all possible data trained them and ready to precise output and it works (Ghazal & Taleb, 2022; Hanaysha et al., 2021a, 2021b). But sometimes it may be useless when the data grows. The best machine today might be bad in the future as data expands (Alzoubi & Aziz, 2021).

As shown in the Table 1, areas demonstrated and summarized of the served challenges proposed solutions.

Table 1 Summary of challenges and proposed solutions

Challenges	Solutions
1. Under fitting of training data	To overcome this issue: <ul style="list-style-type: none"> • Decrease regular parameters • Increase the time of training • Increase the difficulty of the model • Increasing the training time of model • Add more features to the data
2. Poor quality of data	We need to make sure that the method of data pre-processing which includes filtering missing values, removing outliers, and removing unwanted features, is done with the maximum level of perfection
3. Overfitting of training data	We can tackle this issue by: <ul style="list-style-type: none"> • Remove outliers in the training set • Select a model with low features • Finalising the data with the maximum level of perfection • Use data augmentation technique
4. Lack of training data	Machine-learning instructions needs a lot of data to distinguish. For complicated problems, it may even require zillions of information's to be tuned. Therefore, we need to ensure that Machine learning algorithms are trained with massive amounts of data
5. Slow implementation	Maintenance and constant monitoring are the only method to leverage slow implementation
6. Machine learning is a complex process	Bring qualified Data Scientist or Data Analyst to run the complex procedure regarding to Machine Learning
7. Imperfections in the algorithm when data grows	Need regular maintenance and monitoring to keep the algorithm working. This is one of the most difficult issues faced by machine learning Scientists

2 Literature Review

Machine Learning (ML) is a sort of artificial intelligence that allows applications to improve their accuracy at predicting outputs without having to be coded (Guntur et al., 2018). In order to predict new outputs, machine learning uses existing data as input (Alzoubi et al., 2022c). The most typical application of machine learning is recommending based on previous searches (Hasan et al., 2021a, 2021b; Shehada et al., 2017). Traditional Machine Learning is frequently judged on how well an algorithm catches to make more accurate predictions that can be investigated through past data (Alzoubi et al., 2022e). There are four basic methods. Unsupervised learning, supervised learning, semi-supervised learning (Hasan et al., 2021a, 2021b), and reinforcement learning are all terms used to describe different types of learning (Mehmood et al., 2022). The algorithm that a data scientist uses is determined on the type of data they wish to anticipate electronically with the help of workforce (Abbas et al., 2022; Alhamad et al., 2022). From past ten or more years we came across the words big data (Alnuaimi et al., 2021), AI, Machine learning (Ghazal et al., 2022a). Machine

learning helps to take things more informed, correct decisions that are faster than conventional approach. Machine learning has its own set of challenges (Alzoubi et al., 2020).

- Understanding which processes need Automation- The easiest process to automate are the ones that happens automatically without any variable output (Al-Hamadi et al., 2015a, 2015b; Miller, 2021). Complex tasks need further research before automation. Machine learning helps to automate some processes but not all automations cannot be carried out using Machine learning (Ramakrishna & Alzoubi, 2022).
- Lack of quality Data- One among the subsequent problem ML refers are lack of good data. While making Algorithms it eats Data scientist most time in Ai, data quality is essential for algorithms to function as need (Alzoubi et al., 2021; Cruz, 2021). Noise data, incomplete data, dirty data are villains to Perfect machine learning (Zitar et al., 2021). The best thing to do against are data exploration, data integration until you make clean data.
- Inadequate Infrastructure-Machine Learning requires massive amount data gearing capabilities (Alshurideh et al., 2020). Legacy often do not handle the work pressure and handle the pressure. Data scientist should always check whether the machine learning can be handled by Infrastructure that has great impact on business effectiveness (Alzoubi, 2021). If it is not possible you should try to upgrade hardware components and flexible storage (Alzoubi & Ahmed, 2019).
- Implementation- Firms often have problem solving engines going with them by the time they thinking of to upgrade to Machine Learning (Joghee et al., 2020; Vo et al., 2010). Combining methods into existing methods is a complex task (Teahan et al., 2012). Keeping documentation and proper interpretation goes a long way to easy implementation.
- Lack of Skilled Workers- Machine Learning and deep analytics are even now in their current situation also a new technology (Hamadneh et al., 2021). Thus, there is a scarcity of skilled employees present and develop problem solving content to Machine Learning that ultimately benefits the healthcare sector by diagnosing the disease (Saad Masood Butt, 2022). Data scientist needs both domain knowledge as well as in depth knowledge of science, Maths and above all technology (Alzoubi et al., 2022a). Employers will pay huge amount because these combinations are difficult in built (Gul et al., 2012; Hanaysha et al., 2021a, 2021b).

3 Research Methodology

3.1 *Systemic Experimentation*

Systemic Experimentation is key in Machine Learning. In Machine Learning applied we itself must become the scientist and conduct systemic experiments. What algorithm works best on the data or which inputs to use can only be found out using

experimental trials. Most algorithms are too complicated for formal analysis. In design language type of experiment is called as experimental design, and there a lot experimental design (Mehmood et al., 2019). Applied machine learning is special in this, we have whole control over the thing and we can run as much as or as few as trials we wish in our computer. We can have control over the experiments as we can have control all over possible variables. The type of experiments we wish conduct are called controlled experiment. These experiments are all know variables which are independent are held constant and modifies up to a point of time in order to find the vulnerability of dependent variable. The results are compared to base structure.

3.2 Controlling for Variance

Experiments in Machine Learning technologies are more analogous to physics simulations and effectively merges into the technology adopted practices (Neaimi et al., 2020). As a result, a single experiment's results are abductively exposed to variation. For controlled trials, there are two sorts of variance:- Variance in the data, such as data used to train learning algorithms and data used to evaluate skill because electronic data detection is necessary in every field (Alzoubi et al., 2022b). The use of variations in learning algorithms, such as random initial weights in neutral nets, is an example of volatility in the model. With the causes of volatility, a single run or trial outcome could be deceiving.

3.3 Experiments in Machine Learning

Experimentation is a vital part of applied machine learning (Mejia et al., 2019). Some examples for the type of controlled experiments need to practice are given below.

Choose Feature Experiments: When determining the most important input variables for a model, the independent variables may be the input features, and the dependent variables may be the abilities required to run the model on data (Zafar et al., 2022).

Experiments to Tune Machine Learning Models: When tuning a machine learning model, the independent variables might be the algorithm's hypervariable and the dependent variables may be the skill.

Compare experiments: When analysing the performance of machine learning models, compare model experiments. The algorithm is the independent variable, while the model's approximated skill is the dependent variable. These two elements add to the excitement of the experiment.

- **Discovery**—We can discover what works best for right machine problem and data.
- **Contribution**—We can make broad discoveries in the field, without much specialized data other than systemic experiments.

4 Conclusions

Machine Learning is all ready to bring a huge transformation in technology. It is a technology used in fast growing world in speech recognition, medical diagnosis, robotic training, video surveillance, product recommendation. This evolving domain offers great job satisfaction, more opportunities, exorbitant salary, and global exposure. It is high return and high-risk technology. Machine Learning is a subdivision of Computer Science and Artificial Intelligence which deals use of algorithms and data to mimic the way human brain works and later improving the accuracy. Machine learning is a field of examination to understand and build algorithms that 'learn' that is it can pull up data to increase quality of performance on some set tasks. It's a part of Artificial Intelligence. Machine Learning is a vital part of the upcoming field of data science. Even though using algorithms and quantitative methods are tuned to make predictions or classifications, data mining projects. The below displayed graph describes different approach in machine learning and the performance on the data.

References

- Abbas, S., Alhwaiti, Y., Fatima, A., Khan, M. A., Khan, M. A., Ghazal, T. M., Kanwal, A., Ahmad, M., & Elmitwally, N. S. (2022). Convolutional neural network based intelligent handwritten document recognition. *Computers, Materials and Continua*, 70, 4563–4581.
- Abu-Argoub, M., Issa, G., Banna, A. E., & Saadeh, H. (2020). Interactive multimedia-based educational system for children using interactive book with augmented reality. *Journal of Computer Science*, 15, 1648–1658.
- Akhtar, A., Akhtar, S., Bakhtawar, B., Kashif, A. A., Aziz, N., & Muhammad, & Javeid, S. (2021). COVID-19 detection from CBC using machine learning techniques. *International Journal of Innovation, Management and Technology*, 1, 65–78.
- Al-Dmour, N. A. (2020). Using unstructured search algorithms for data collection in IoT-based WSN. *International Journal of Engineering Research and Technology*, 13, 1992–1998.
- Alhamad, A. Q. M., Akour, I., Alshurideh, M., Al-Hamad, A. Q., Kurdi, B. A., & Alzoubi, H. (2021). Predicting the intention to use google glass: A comparative approach using machine learning models and PLS-SEM. *International Journal of Data and Network Science*, 5, 311–320.
- Alhamad, A., Alshurideh, M., Alomari, K., Al Kurdi, B., Alzoubi, H., Hamouche, S., & Al-Hawary, S. (2022). The effect of electronic human resources management on organizational health of telecommunications companies in Jordan. *International Journal of Data and Network Science*, 6, 429–438.
- Al-Hamadi, H., Gawanmeh, A., & Al-Qutayri, M. (2015a). Formal validation of QRS wave within ECG. In *2015 international conference on information and communication technology research, ICTRC* (Vol. 9, pp. 190–193).
- Al-Hamadi, H., Gawanmeh, A., Baek, J., & Al-Qutayri, M. (2015b). Lightweight security protocol for ECG bio-sensors. *Wireless Personal Communications*, 95, 5097–5120.
- Ali, N., Ahmed, A., Anum, L., Ghazal, T. M., Abbas, S., Khan, M. A., Alzoubi, H. M., & Ahmad, M. (2021). Modelling supply chain information collaboration empowered with machine learning technique. *Intelligent Automation & Soft Computing*, 30, 243–257.
- Ali, N., Ghazal, T. M., Ahmed, A., Abbas, S., Khan, M. A., Alzoubi, H. M., Farooq, U., Ahmad, M., & Khan, M. A. (2022). Fusion-based supply chain collaboration using machine learning techniques. *Intelligent Automation & Soft Computing*, 31, 1671–1687.

- Al-Naymat, G., Hussain, H., Al-Kasassbeh, M., & Al-Dmour, N. (2021). Accurate detection of network anomalies within SNMP-MIB data set using deep learning. *International Journal of Computer Applications in Technology*, 66, 74–85.
- Alnazer, N. N., Alnuaimi, M. A., & Alzoubi, H. M. (2017). Analysing the appropriate cognitive styles and its effect on strategic innovation in Jordanian universities. *International Journal of Business Excellence*, 13, 127–140.
- Alnuaimi, M., Alzoubi, H. M., Ajelat, D., & Alzoubi, A. A. (2021). Towards intelligent organisations: An empirical investigation of learning orientation's role in technical innovation. *International Journal of Innovation and Learning*, 29, 207–221.
- Alshurideh, M., Gasaymeh, A., Ahmed, G., Alzoubi, H., & Kurd, B. A. (2020). Loyalty program effectiveness: Theoretical reviews and practical proofs. *Uncertain Supply Chain Management*, 8, 599–612.
- Alshurideh, M., Al Kurdi, B., Alzoubi, H. M., Ghazal, T. M., Said, R. A., AlHamad, A. Q., Hamadneh, S., Sahawneh, N., & Al-kassem, A. H. (2022). Fuzzy assisted human resource management for supply chain management issues. *Annals of Operations Research*, 1–19.
- Alzoubi, H., & Ahmed, G. (2019). Do TQM practices improve organisational success? A case study of electronics industry in the UAE. *International Journal of Economics and Business*, 17, 459–472.
- Alzoubi, H. M., & Aziz, R. (2021). Does emotional intelligence contribute to quality of strategic decisions? The mediating role of open innovation. *Journal of Open Innovation: Technology, Market, and Complexity*, 7, 130.
- Alzoubi, H. M., & Yanamandra, R. (2020). Investigating the mediating role of information sharing strategy on agile supply chain in supply chain performance. *Uncertain Supply Chain Management*, 8, 273–284.
- Alzoubi, H. M., Ahmed, G., Al-Gasaymeh, A., & Al Kurdi, B. (2020). Empirical study on sustainable supply chain strategies and its impact on competitive priorities: The mediating role of supply chain collaboration. *Management Science Letters*, 10, 703–708.
- Alzoubi, H. M., Vij, M., Vij, A., & Hanaysha, J. R. (2021). What leads guests to satisfaction and loyalty in UAE five-star hotels? AHP analysis to service quality dimensions. *Enlightening Tourism. A Pathmaking Journal*, 11, 102–135.
- Alzoubi, H., Alshurideh, M., Kurdi, B. A., Akour, I., & Aziz, R. (2022a). Does BLE technology contribute towards improving marketing strategies, customers' satisfaction and loyalty? The role of open innovation. *International Journal of Data and Network Science*, 6, 449–460.
- Alzoubi, H. M., Ahmed, G., & Alshurideh, M. (2022b). An empirical investigation into the impact of product quality dimensions on improving the order-winners and customer satisfaction. *International Journal of Productivity and Quality Management*, 36, 169–186.
- Alzoubi, H. M., Alshurideh, M. T., Kurdi, B. A., Alhyasat, K. M. K., & Ghazal, T. M. (2022c). The effect of e-payment and online shopping on sales growth: Evidence from banking industry. *International Journal of Data and Network Science*, 6, 1369–1380.
- Alzoubi, H. M., Elrehaile, H., Hanaysha, J. R., Al-Gasaymeh, A., & Al-Adaileh, R. (2022d). The role of supply chain integration and agile practices in improving lead time during the COVID-19 crisis. *The International Journal of Service Science, Management, Engineering, and Technology*, 13, 1–11.
- Alzoubi, H. M., In'airat, M., & Ahmed, G. (2022e). Investigating the impact of total quality management practices and Six Sigma processes to enhance the quality and reduce the cost of quality: The case of Dubai. *Int. J. Bus. Excell.* 27, 94–109.
- Alzoubi, A. (2021). The impact of process quality and quality control on organizational competitiveness at 5-star hotels in Dubai. *International Journal of Innovation, Management and Technology*, 1, 54–68.
- Aziz, N., & Aftab, S. (2021). Data mining framework for nutrition ranking: Methodology: SPSS modeler. *International Journal of Innovation, Management and Technology*, 1, 85–95.

- Bibi, R., Saeed, Y., Zeb, A., Ghazal, T. M., Rahman, T., Said, R. A., Abbas, S., Ahmad, M., & Khan, M. A. (2021). Edge AI-based automated detection and classification of road anomalies in VANET using deep learning. *Computational Intelligence and Neuroscience*, 2021, 1–19.
- Bukhari, M. M., Ghazal, T. M., Abbas, S., Khan, M. A., Farooq, U., Wahbah, H., Ahmad, M., & Adnan, K. M. (2022). An intelligent proposed model for task offloading in fog-cloud collaboration using logistics regression. *Computational Intelligence and Neuroscience*.
- Cruz, A. (2021). Convergence between Blockchain and the Internet of Things. *International Journal of Innovation, Management and Technology*, 1, 34–53.
- Ghazal, T. M., Hasan, M. K., Alkhalfah, A., Abu Bakar, K. A., Omidvar, A., Nafi, N. S., & Agbinya, J. I. (2021). *Fischer linear discrimination and quadratic discrimination analysis-based data mining technique for internet of things framework for healthcare* (p. 9). Public Heal.
- Ghazal, T. M., Abbas, S., Ahmad, M., & Aftab, S. (2022a). An IoMT based ensemble classification framework to predict treatment response in hepatitis C patients. In *2022 international conference on business analytics for technology and security, ICBATS 2022* (pp. 1–4).
- Ghazal, T. M., Abbas, S., Munir, S., Khan, M. A., Ahmad, M., Issa, G. F., Zahra, S. B., Khan, M. A., & Hasan, M. K. (2022b). Alzheimer disease detection empowered with transfer learning. *Computers, Materials and Continua*, 70, 5005–5019.
- Ghazal, T. M., Ahmed, Z. E., Hasan, M. K., Hashim, A. A., Saeed, R. A., Mokhtar, R. A., & Singh, S. P. (2022c). Optimization procedure for intelligent internet of things applications. In *2022 international conference on business analytics for technology and security, ICBATS 2022* (pp. 1–6).
- Ghazal, T. M., Hasan, M. K., Abdullah, S. N. H., Abubakkar, K. A., & Afifi, M. A. M. (2022d). IoMT-enabled fusion-based model to predict posture for smart healthcare systems. *Computers, Materials and Continua*, 71, 2579–2597.
- Ghazal, T. M., Kamrul Hasan, M., Alzoubi, H. M., Al Hmadi, M., Al-Dmour, N. A., Islam, S., Kamran, R., & Mago, B. (2022e). Securing smart cities using blockchain technology. In *2022 1st international conference on AI in cybersecurity (ICAIC)* (pp. 1–4).
- Ghazal, T. M., Noreen, S., Said, R. A., Khan, M. A., Siddiqui, S. Y., Abbas, S., Aftab, S., & Ahmad, M. (2022f). Energy demand forecasting using fused machine learning approaches. *Intelligent Automation & Soft Computing*, 31, 539–553.
- Ghazal, T. M., & Taleb, N. (2022). Feature optimization and identification of ovarian cancer using internet of medical things. *Expert Systems*.
- Gul, O., Al-Qutayri, M., Yeun, C. Y., & Vu, Q. H. (2012). Framework of a national level electronic health record system. In *Proceedings of 2012 international conference on cloud computing technologies, applications and management, ICCCTAM 2012*. Applications and Management (ICCCTAM), Dubai, UAE, December (pp. 60–65).
- Guntur, S. R., Gorrepati, R. R., & Dirisala, V. R. (2018). Internet of medical things. *Medical Big Data and Internet of Medical Things*, 4, 271–297.
- Hamadneh, S., Pedersen, O., Alshurideh, M., Kurdi, B. A., & Alzoubi, H. M. (2021). An investigation of the role of supply chain visibility into the Scottish blood supply chain. *Journal of Legal, Ethical and Regulatory Issues*, 24, 1–12.
- Hanaysha, J., Al-Shaikh, M., & Alzoubi, M. (2021a). Importance of marketing mix elements in determining consumer purchase decision in the retail market. *The International Journal of Service Science, Management, Engineering, and Technology*, 12, 56–72.
- Hanaysha, J. R., Shaikh, A., & M. E., & Alzoubi, H. M. (2021b). Importance of marketing mix elements in determining consumer purchase decision in the retail market. 2, 56–72.
- Hanaysha, J. R., Al-Shaikh, M. E., Joghee, S., & Alzoubi, H. M. (2022). Impact of innovation capabilities on business sustainability in small and medium enterprises. *FIIB Business Review*, 11, 67–78.
- Hasan, M. K., Islam, S., Sulaiman, R., Khan, S., Hashim, A. H. A., Habib, S., Islam, M., Alyahya, S., Ahmed, M. M., Kamil, S., & Hassan, M. A. (2021a). Lightweight encryption technique to enhance medical image security on internet of medical things applications. *IEEE Access*, 9, 47731–47742.

- Hasan, M. K., Ghazal, T. M., Saeed, R. A., Pandey, B., Gohel, H., Eshmawi, A. A., Abdel-Khalek, S., & Alkhassawneh, H. M. (2022). A review on security threats, vulnerabilities, and counter measures of 5G enabled Internet-of-Medical-Things. *IET Communications*, 16, 421–432.
- Hasan, M. K., Musse, M. A., Sherfriz, S. M., Shayla, I., Huda, S. N., A., S., Eklas H., Nazmus S. N., & Nguyen, V. (2021). An Improv. Dyn. Therm. Curr. Rat. Model PMU-based wide area Meas. Framew. Reliab. Anal. Util. Sens. cloud Syst. 9, 14446–14458.
- Islam, S., Khalifa, O. O., Hashim, A. H. A., Hasan, M. K., Razzaque, M. A., & Pandey, B. (2020). Design and evaluation of a multihoming-based mobility management scheme to support inter technology handoff in PNEMO. *Wireless Personal Communications*, 114, 1133–1153.
- Joghee, S., Alzoubi, H. M., & Dubey, A. R. (2020). Decisions effectiveness of FDI investment biases at real estate industry: Empirical evidence from Dubai smart city projects. *International Journal of Scientific & Technology Research*, 9, 3499–3503.
- Kashif, A. A., Bakhtawar, B., Akhtar, A., Akhtar, S., Aziz, N., & Javeid, M. S. (2021). Treatment response prediction in hepatitis C patients using machine learning techniques. *International Journal of Innovation, Management and Technology*, 1, 79–89.
- Khan, M. A., Ghazal, T. M., Lee, S. W., & Rehman, A. (2022). Data fusion-based machine learning architecture for intrusion detection. *Computers, Materials and Continua*, 70, 3399–3413.
- Kim, S.-K., Yeun, C. Y., Damiani, E., & Lo, N.-W. (2019). A machine learning framework for biometric authentication using electrocardiogram. *IEEE Access*, 7, 94858–94868.
- Kurdi, B. A., Alshurideh, M., Akour, I., Alzoubi, H. M., Obeidat, B., & Alhamad, A. (2022a). The role of digital marketing channels on consumer buying decisions through eWOM in the Jordanian markets. *International Journal of Data and Network Science*, 6, 1175–1185.
- Kurdi, B. A., Alshurideh, M., Akour, I., Tariq, E., Alhamad, A., & Alzoubi, H. M. (2022b). The effect of social media influencers' characteristics on consumer intention and attitude toward Keto products purchase intention. *International Journal of Data and Network Science*, 6, 1135–1146.
- Kurdi, B. A., Alzoubi, H. M., Akour, I., & Alshurideh, M. T. (2022c). The effect of blockchain and smart inventory system on supply chain performance: Empirical evidence from retail industry. *Uncertain Supply Chain Management*, 10, 1111–1116.
- Lee, K. L., Azmi, N. A. N., Hanaysha, J. R., Alzoubi, H. M., & Alshurideh, M. T. (2022a). The effect of digital supply chain on organizational performance: An empirical study in Malaysia manufacturing industry. *Uncertain Supply Chain Management*, 10, 495–510.
- Lee, K. L., Romzi, P. N., Hanaysha, J. R., Alzoubi, H. M., & Alshurideh, M. T. (2022b). Investigating the impact of benefits and challenges of IOT adoption on supply chain performance and organizational performance: An empirical study in Malaysia. *Uncertain Supply Chain Management*, 10, 537–550.
- Mehmood, T. (2021). Does information technology competencies and fleet management practices lead to effective service delivery? Empirical evidence from E-commerce industry. *International Journal of Innovation, Management and Technology*, 1, 14–41.
- Mehmood, T., Alzoubi, H. M., Alshurideh, M., Al-Gasaymeh, A., & Ahmed, G. (2019). Schumpeterian entrepreneurship theory: Evolution and relevance. *Academy of Entrepreneurship Journal*, 25, 1–10.
- Mehmood, S., Ghazal, T. M., Khan, M. A., Zubair, M., Naseem, M. T., Faiz, T., & Ahmad, M. M. (2022). Malignancy detection in lung and colon histopathology images using transfer learning with class selective image processing. *IEEE Access*, 10, 25657–25668.
- Mejia, C., Ciarlante, K., & Chheda, K. (2019). A wearable technology solution and research agenda for housekeeper safety and health. *International Journal of Contemporary Hospitality Management*, pp 1–3.
- Miller, D. (2021). The best practice of teach computer science students to use paper prototyping. *International Journal of Innovation, Management and Technology*, 1, 42–63.
- Neaimi, M. Al, Hamadi, H. Al, Yeun, C. Y., & Jamal Zemerly, M. (2020). Digital forensic analysis of files using deep learning. In *2020 3rd international conference on signal processing and information security, ICSPIS 2020* (pp. 1–4). IEEE.

- Ramakrishna, Y., & Alzoubi, H. M. (2022). Empirical investigation of mediating role of six sigma approach in rationalizing the COQ in service organizations. *Operations and Supply Chain Management*, 15, 122–135.
- Saad Masood Butt. (2022). Management and treatment of type 2 diabetes. *International Journal of Computations, Information and Manufacturing*, 2, 1.
- Saleem, M., Abbas, S., Ghazal, T. M., Adnan Khan, M., Sahawneh, N., & Ahmad, M. (2022). Smart cities: Fusion-based intelligent traffic congestion control system for vehicular networks using machine learning techniques. *Egyptian Informatics Journal*.
- Shamout, M., Ben-Abdallah, R., Alshurideh, M., Alzoubi, H., Al Kurdi, B., & Hamadneh, S. (2022). A conceptual model for the adoption of autonomous robots in supply chain and logistics industry. *Uncertain Supply Chain Management*, 10, 577–592.
- Shehada, D., Yeun, C. Y., Zemerly, M. J., Al-Qutayri, M., Al-Hammadi, Y., & Hu, J. (2018). A new adaptive trust and reputation model for mobile agent systems. *Journal of Network and Computer Application*, 124, 33–43.
- Shehada, D., Yeun, C. Y., Zemerly, M. J., Qutayri, M. Al, Hammadi, Y. Al, Damiani, E., & Hu, J. (2017). BROSMPA: A 2017. Novel Broadcast Based Secure Mobile Agent Protocol for Distributed Service Applications. *Security and Communication Networks* (Vol. 2017). Wiley.
- Siddiqui, S. Y., Haider, A., Ghazal, T. M., Khan, M. A., Naseer, I., Abbas, S., Rahman, M., Khan, J. A., Ahmad, M., Hasan, M. K., Mohammed, A., & Ateeq, K. (2021). IoMT cloud-based intelligent prediction of breast cancer stages empowered with deep learning. *IEEE Access*, 9, 146478–146491.
- Teahan, W. J., Al-Dmour, N. A., & Tuff, P. G. (2012). Knowledge distribution in multi agent systems. *Asian Journal of Information Technology*, 11, 300–311.
- Vo, D. L., Lee, H., Yeun, C. Y., & Kim, K. (2010). Enhancements of authenticated multiple key exchange protocol based on bilinear pairings. *Computers & Electrical Engineering*, 36, 155–159.
- Zafar, S., Asif, M., Ahmad, M. B., Ghazal, T. M., Faiz, T., Ahmad, M., & Khan, M. A. (2022). Assistive devices analysis for visually impaired persons: A review on taxonomy. *IEEE Access*, 10, 13354–13366.
- Zitar, R. A., Al-Dmour, N., Nachouki, M., Hussain, H., & Alzboun, F. (2021). Hashing generation using recurrent neural networks for text documents. *ICIC Express Letters, Part B: Applications*, 12, 231–241.

Review of Artificial Intelligence and Machine Learning Recent Advancements



Ali A. Alzoubi, Ibrahim Al Aqeel, and Haitham M. Alzoubi 

Abstract Artificial Intelligence means to duplicate human Intelligence to machines that are supposed to act like human beings and imitate their actions. This can also be applied to any machines that are similar human minds such as problem solving and learning. According to recent studies there are 4 classifications for AI: Self-aware, Theory of mind, reactive, limited memory. Artificial Intelligence is a method for construction of machines that need human intelligence. Decision making, Speech recognition, visual perception are examples of Artificial Intelligence. Artificial intelligence is normally used to give customised opinions to people based on their previous surfing and online purchases or other behaviour on online. Artificial Intelligence is more widely used in commerce, logistics, planning inventory etc. Artificial Intelligence is the capacity to provide human-like intelligence such as learning, reasoning, creativity, planning. Artificial intelligence enables technical systems to understand their environment, trade in what they perceive. Some AI technologies have been in this world more than 60 years, but encourage in computing power, the use of large quantities of new algorithms and data have led to Artificial Intelligence development in these years. Artificial Intelligence has brought tremendous change in these years. Future applications are more expected to bring about trending changes, But AI is there now also. Artificial Intelligence (AI) is Human intelligence for machines, Different from reasonable intelligence shown by animals. The word Artificial intelligence has been used in olden days to say about machines that mimics and copy human perception that are associated with the mind of human such as problem-solving and learning. AI applications include recommendations used by YouTube, Amazon and Netflix, web search engines, automated decision making, understanding

A. A. Alzoubi
Public Security Directorate, Amman, Jordan

I. Al Aqeel
School of Information Technology, Skyline University College, Sharjah, UAE

H. M. Alzoubi (✉)
School of Business, Skyline University College, Sharjah, UAE
e-mail: haitham.alzoubi@skylineuniversity.ac.ae

Applied Science Research Center, Applied Science Private University, Amman, Jordan

human speech, automated car driving, some strategic games. Some AI technologies have been in this world more than 60 years, but encourage in computing power, the use of large quantities of new algorithms and data have led to Artificial Intelligence development in these years. Artificial Intelligence has brought tremendous change in these years. Future applications are more expected to bring about trending changes, But AI is there now also.

Keywords Machine learning · Artificial intelligence

1 Introduction

Artificial Intelligence came into being in 1956, and after that several waves of hope has been showered, following several loses, followed by new methods, successes (Ghazal et al., 2021a). There are various fields of Artificial intelligence are which are used for different purposes also using particular tools. The earlier goals of Artificial intelligence include knowledge representation, reasoning, learning, planning, language processing, insight, and robotics. According to recent studies there are 4 classifications for AI (Alnuaimi et al., 2021): Self-aware, Theory of mind, reactive, limited memory (Ghazal et al., 2022i). Artificial Intelligence is a method for construction of machines that need human intelligence (Obaid, 2021). Decision making, Speech recognition, visual perception are examples of Artificial Intelligence (Alzoubi & Aziz, 2021; Ghazal et al., 2022a). Artificial intelligence is normally used to give customised opinions to people based on their previous surfing (Islam et al., 2020) and online purchases or other behaviour on online (Al-Dmour, 2020). Artificial Intelligence is more widely used in commerce, logistics, planning inventory etc. AI can be used in daily life online shopping and advertising (Al-Hamadi et al., 2015a, 2015b; Kurdi et al., 2022b) they customised recommendations to users based on their previous purchases (Kurdi et al., 2022a), Digital personal assistants use AI to give services that are customised and relevant, Machine learning (Ghazal et al., 2022a; Kim et al., 2019), healthcare, digital business management (Hamadneh et al., 2021) Smart cities, infrastructures, homes, Web search, Automated Cars, Cyber security etc. (Saleem et al., 2022).

Artificial Intelligence is a hope of technology for all businesses health and efficiency (Alzoubi et al., 2022a). Integration of AI gives a business a huge value in the market (Kasem & Anwar Al-Gasaymeh, 2022). Adding AI technology to your business is like death well no matter how friendly is it felt. It is very important to deal the AI problems in the real world (Alzoubi et al., 2021a, 2021b).

- Price Factor-Small business firms struggle a lot when it comes to adopting AI technologies as it is costly. Even huge business entrepreneurs like Apple, Facebook, Amazon, Google etc. have separate budgets for AI (Shehada et al., 2017).
- Lack Of technical knowledge-To combine, utilize, and use AI applications in the firm, the firm must have idea of recent AI advancement and technologies as well

as the deficiencies (Ghazal et al., 2022e; Hanaysha et al., 2022). Only few percent of the firms only have smooth usage of AI technologies. The firms need skilled workers to handle AI technologies (Alshurideh et al., 2022a, 2022b).

- Data acquisition and storage-One of the major problems identified in AI technology is data storage and purchase (Alzoubi et al., 2022c; Shehada et al., 2018). Business AI methods rely on sensor info as its input. For validating data from the sensor is collected. Distracted and noisy data are difficult to store (Alzoubi, 2021). AI works correctly when it has ample amount of data. The AI algorithm works better with quality and quantity of data (Alzoubi et al., 2022a).
- Issue of Responsibility-The deploying of AI application has many responsibilities, anyone who is using it should suffer the burden of hardware malfunctions (Ghazal & Taleb, 2022).
- Rare and Expensive Workforce-As discussed above deploying and installation needs qualified workers like data engineer or data scientist (Alzoubi et al., 2020; Hasan et al., 2021a, 2021b). These kinds of workers are rare and at the same time expensive also. Small firms fail to bring such kind of workers, a research investigated the customer satisfaction depend on best workers of the firm (Alzoubi et al., 2021a, 2021b).
- Ethical Challenges-One of the main concerns to be handled are morality and ethics (Alshurideh et al., 2020). How well an AI system is groomed is the basis of the imitation range of Artificial Intelligence thus it is difficult to find difference between real customer and machine (Mondol, 2021). Ai system responds as how it is trained. If the system is trains about racism, the result of prediction will be a mirror view of what it is groomed (Alzoubi et al., 2022f).

1.1 Problem Definition

The effect of Artificial intelligence on economy and human life has brought a lot of changes. Various companies thinking that with AI they can boost the business productivity up to 40%. The range of AI applications can range from tracking cosmic bodies and tracking asteroids (Alzoubi et al., 2022b) (Fig. 1).

Fig. 1 Artificial intelligence (Shamout et al., 2022)

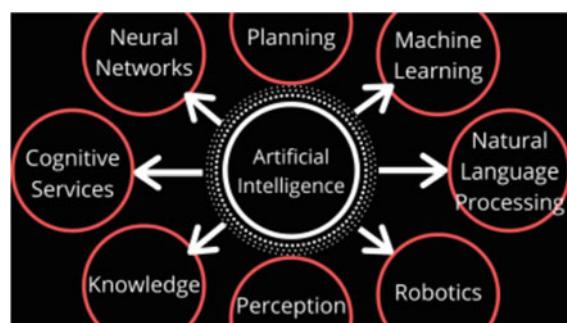




Fig. 2 Challenges faced (Ghazal et al., 2022g)

- **Computing power**—Most developers are turned off by the amount of computing power required by these resource-hungry techniques (Ghazal et al., 2022g). Deep learning and machine learning are Artificial Intelligence approaches that require a large number of cores and GPUs to function properly (Eli, 2021). We have ideas to utilize deep learning substructure in a variety of disciplines (Alzoubi et al., 2022b), including healthcare, asteroids, tracking cosmic bodies, and more (Gul et al., 2012). They'll need expensive supercomputers (Lee et al., 2022b) (Fig. 2).
- **Trust Deficit**—One of the main factors that cause of worry for the Artificial Intelligence is its unpredictable nature that is how these model gives the output (Nada Ratkovic, 2022). Many are even now unaware of the possibilities of Artificial Intelligence in smart phones, TV's, Automates Cars (Al-Naymat et al., 2021).
- **Limited Knowledge**—Although there are many situations, we can make use AI systems but most people are unaware of the technology. The main issue is the knowledge of artificial intelligence (Alnazer et al., 2017; Ghazal et al., 2022c). Apart from who are keen in technology and students, researchers there are only countable people who aware of the AI.
- **Human Level**—One of the main challenges coming across in Artificial Intelligence are human level. In a firm to check an image, distinguished whether it is dog or cat. For a human to find is it a dog or cat needs only macro seconds but for an Artificial Intelligence to do this it needs fine tuning, large dataset (Ghazal et al., 2022f). Optimization, and accuracy (Ali et al., 2021) (Fig. 3).
- **Data privacy and security**—The Artificial Intelligence is based on the amount of data it collected. But the collected is generated from zillions of users across the globe, there are vulnerabilities that data can be used for bad things (Ghazal et al., 2022e).

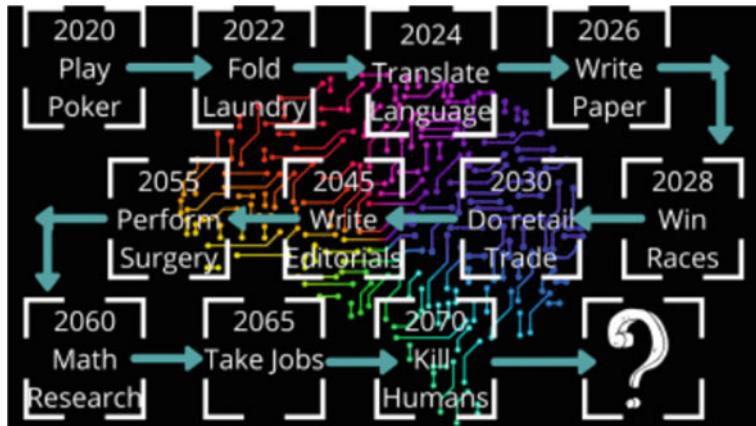


Fig. 3 Future of artificial intelligence (Joghee et al., 2021)

- **The bias problem**—The result of Artificial Intelligence depends upon the quantity and quality of data they fine-tuned. But in times the everyday data the organization collected is feeble and has no trust of its own (Alzoubi & Yanamandra, 2020).
- **Data scarcity**—Major companies like Google, Amazon, and Apple facing issues regarding untrusted data flow from some countries, now they have some it rules regarding the data flow (Victoria, 2022). Thus, these companies now face problems regarding scarcity of local data.

1.2 *Proposed Solution*

Area based proposed solution is mentioned in Table 1.

2 Literature Review

Artificial intelligence is used in different fields like farming Self driving cars, Monitoring cameras are used widely to find the health crops, pest attacks, yielding etc. (Alzoubi & Ahmed, 2019). Self-driving cars is an appreciable invention Artificial Intelligence (Ghazal et al., 2022d). They understand the ecosystem they are moving through and real-life incidents. Biometric system and face recognition helps to track living beings and make it a safe living for the human beings (Ghazal et al., 2021b; Shamout et al., 2022). AI can be used in more real-life scenarios like for managing inventory or stock (Alzoubi et al., 2022e) with apt supply system and management (Lee et al., 2022a). Warehouse management not only improves the experience but

Table 1 Area-based proposed solution

Problem	Solution
Computing power	They can use cloud computers, sharing work space. Not everyone can afford that with an increase in the inflow of amount of data and rapidly increasing complex algorithms
Trust deficit	Fine Tune the Artificial Intelligence System. It requires heavy effort to instil sense of morality, function in full transparency and make aware of the system, it will create opportunity for Business and consumers
Limited knowledge	Study innovative ways to increase their production, sell and manage products online, manage resources, find consumer behaviour and find the market efficiently and effectively. They can use service providers such as Amazon web services, Google cloud
Human level	An easy way to avoid all hard work is by using a service provider, for that they can make deep learning models using pre trained models. They are pre trained for high accuracy
Data privacy and security	Companies can start working innovatively to hold on the barriers, it trains information on smart devices, and so it cannot be sent back to the servers, only trained data set is sent back to the firm
The bias problem	The real difference can be brought only by defining some algorithms that can efficiently track these problems
Data scarcity	Organizations are introducing innovative methods and are concentrated on making AI models that can give accurate results in mind of scarcity of data

also helps customers to have a good shopping experience with help of machine learning (Alzoubi et al., 2022d; Ghazal et al., 2021c). Likewise in health sector Artificial intelligence does a vital role its diagnosis (Ghazal et al., 2022b), analyse, and find various disease's, systemic analysing of the condition (Al-Hamadi et al., 2015a, 2015b; Alsharari, 2022), find new medicines to avoid health problem for all (Ghazal et al., 2022j).

Cambridge network—In recent studies in Artificial Intelligence in Cambridge network there are two methods used in increasing the computer power leveraged AI to progress (Kurdi et al., 2022c). The first one is increasing the power of graphical processing units (GPUs) which are used for machine learning by servers (Alshurideh et al., 2022a, 2022b; Edward Probir Mondol, 2022). The second one is increasing the specifications of PC devices which gives more processing of data and doing of AI models without the reliance on line with cloud servers (Guntur et al., 2018).

E&P Industry—Trust in AI has certain influence on industry's AI initiatives. In E&P professionals there has been a problem in AI initiatives (Al-Hamadi et al., 2015a, 2015b). Out of many reasons they have identified 4 major reasons that initiate deficit of trust in AI. 4 main reasons are- Black box models, Skepticism, Vendor quick fixes, Generic data scientist (Abu-Arqoub et al., 2020).

From all these they concluded there is no short way to address the problems of AI trust deficit. The right skills, good data, supportive (Ha & Choi, 2016; Ramakrishna & Alzoubi, 2022; Vo et al., 2010). Leadership, and healthy communication between end user and data scientist are all important in removing the trust deficit and a major

source of learning for the acquired people in the same industry (Eli & Hamou, 2022) (Fig. 4).

Amazon Web Services, Google Cloud Platform, IBM Cloud, Microsoft Azure, Alibaba Cloud are some among the knowledge providers that Artificial Intelligence system can believe and use.

Specifying the human -level AI more definitely- What characteristics of a human need to be reproduced (Hasan et al., 2021a, 2021b), how much human behaviour needs to make (Ghazal et al., 2022h). In today's world human level AI is they can reproduce a human AI which can replace human itself (Fig. 5).

Data privacy and security can be achieved using Data clouds, Ai aids to maintain Cyber security and guard against the digital frauds. Using machine learning hackers can thwart security algorithms by hacking data they train on (Ghazal et al., 2022d; Zitar et al., 2021). They can safeguard and firewalls utilize AI to get through.

A bias is a problem in the output of machine learning algorithms due to the overriding assumptions made during the algorithm creation process or in training

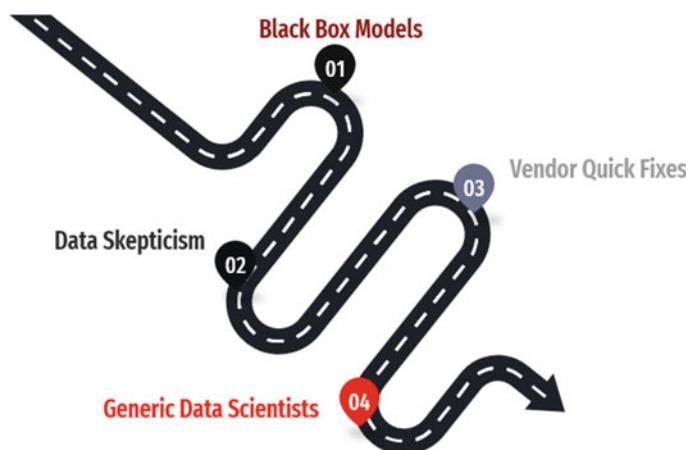
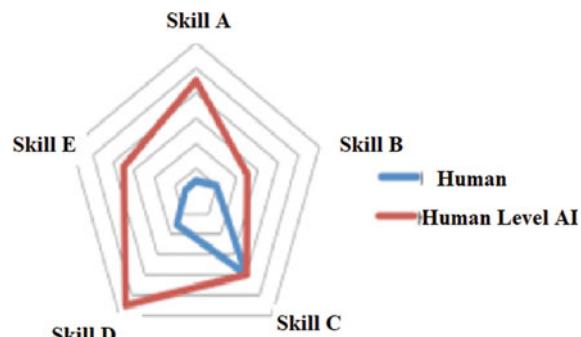


Fig. 4 Issues in AI trust (Shamout et al., 2022)

Fig. 5 AI over human intelligence (Ghazal et al., 2021a)



data. There are several methods in preventing bias- Structure data gathering that allows for varied opinions, Find the training data, thinking about the end users are some methods used by different companies (Hanaysha et al., 2021).

Data Scarcity—Data scarcity is if they face issues like limited amount or a complete lack of data, large firms have access to abundant data they could encounter data freezing. Whereas small firms come across data scarcity. Synthetic learning, External API's, Transfer Learning are some examples against data scarcity (Joghee et al., 2020).

3 Research Methodology (Experimental Evaluation)

Though it is very familiar practice for a field of engineering or science to be guided and identified by the theories, the fields of Artificial Intelligence seem to be different. After more than a century it has been formed AI still has no correctly accepted theory. The best example for intelligence is human brain itself, there is no need for any more theories since AI can be built according to someone's sense (Mehmood et al., 2019). The method of creation of AI is made part by part. There could not be a correct theory. A good theory can be formulated at the end of the result. The formulation of Artificial Intelligence components and systems is critical for the progress of AI. There are 3 types of evaluation: Problem benchmarks, peer confrontation, human discrimination. Let's describe some among the limitation of many schemes and competitions in 3 sets, and follow the development of some the tests. And focus on less challenging ability -oriented evaluation approach, where a system is optimised by its abilities, more than by the tasks designed to formulate. AI is about to make new enterprise to construct computational models of intelligence. The main thought is that human or else can be found in terms of symbolic operations and symbolic structures which can be done in a digital computer. The goal of AI is to make software that can make input and explain output. AI will provide human like behaviour and offer specific task also it cannot be replacement for humans- and cannot be anytime (Ghazal et al., 2022k).

4 Discussion

Artificial Intelligence is the capacity to provide human-like intelligence such as learning, reasoning, creativity, planning. Artificial intelligence enables technical systems to understand their environment, trade in what they perceive. Some AI technologies have been in this world more than 60 years, but encourage in computing power, the use of large quantities of new algorithms and data have led to Artificial Intelligence development in these years.

Artificial Intelligence has brought tremendous change in these years. Future applications are more expected to bring about trending changes, But AI is there now

also. Artificial Intelligence (AI) is Human intelligence for machines, Different from reasonable intelligence shown by animals. The word Artificial intelligence has been used in olden days to say about machines that mimics and copy human perception that are associated with the mind of human such as problem-solving and learning. AI applications include recommendations used by YouTube, Amazon and Netflix, web search engines, automated decision making, understanding human speech, automated car driving, some strategic games. Some AI technologies have been in this world more than 60 years, but encourage in computing power, the use of large quantities of new algorithms and data have led to Artificial Intelligence development in these years. Artificial Intelligence has brought tremendous change in these years. Future applications are more expected to bring about trending changes, But AI is there now also.

5 Conclusions

Artificial Intelligence and the modest technology are one part of life that always surprise us with new ideas, products, innovations, topics etc. For our upcoming days for future generation in which AI will have much persistent influence on our lives. The intelligence of human machines is completely different. AI generally mimics the behaviour of human like memory, decision making, learning, cognitive ability. AI is still not used as films representing i.e., like robots, however there are many sectors trying to reach the level in market to compete. According to recent studies there are 4 classifications for AI: Self-aware, Theory of mind, reactive, limited memory. Artificial Intelligence is a method for construction of machines that need human intelligence. Decision making, Speech recognition, visual perception are examples of Artificial Intelligence. Artificial intelligence is normally used to give customised opinions to people based on their previous surfing and online purchases or other behaviour on online. Artificial Intelligence is more widely used in commerce, logistics, planning inventory etc. AI is affecting the future of every sector and every human being. AI has been a main factor of technologies like robotics, IoT, Big data it also acts as a replacement.

References

- Abu-Arqoub, M., Issa, G., Banna, A. E., & Saadeh, H. (2020). Interactive multimedia-based educational system for children using interactive book with augmented reality. *Journal of Computer Science*, 15, 1648–1658.
- Al-Dmour, N. A. (2020). Using unstructured search algorithms for data collection in IoT-based WSN. *International Journal of Engineering Research and Technology*, 13, 1992–1998.
- Al-Hamadi, H., Gawanmeh, A., Baek, J., & Al-Qutayri, M. (2015b). Lightweight security protocol for ECG bio-sensors. *Wireless Personal Communications*, 95, 5097–5120.

- Al-Hamadi, H., Gawanmeh, A., Al-Qutayri, M. (2015). Formal validation of QRS wave within ECG. In *2015 international conference on information and communication technology research, ICTRC 2015* (Vol. 9, pp. 190–193).
- Ali, N., Ahmed, A., Anum, L., Ghazal, T. M., Abbas, S., Khan, M. A., Alzoubi, H. M., & Ahmad, M. (2021). Modelling supply chain information collaboration empowered with machine learning technique. *Intelligent Automation & Soft Computing*, 30, 243–257.
- Al-Naymat, G., Hussain, H., Al-Kasassbeh, M., & Al-Dmour, N. (2021). Accurate detection of network anomalies within SNMP-MIB data set using deep learning. *International Journal of Computer Applications in Technology*, 66, 74–85.
- Alnazer, N. N., Alnuaimi, M. A., & Alzoubi, H. M. (2017). Analysing the appropriate cognitive styles and its effect on strategic innovation in Jordanian universities. *International Journal of Business Excellence*, 13, 127–140.
- Alnuaimi, M., Alzoubi, H. M., Ajelat, D., & Alzoubi, A. A. (2021). Towards intelligent organisations: An empirical investigation of learning orientation's role in technical innovation. *International Journal of Innovation and Learning*, 29, 207–221.
- Alsharari, N. (2022). The implementation of enterprise resource planning (Erp) in the United Arab Emirates: A case of Musanada corporation. *International Journal of Innovation, Management and Technology*, 2, 1.
- Alshurideh, M., Gasaymeh, A., Ahmed, G., Alzoubi, H., & Kurd, B. A. (2020). Loyalty program effectiveness: Theoretical reviews and practical proofs. *Uncertain Supply Chain Management*, 8, 599–612.
- Alshurideh, M. T., Al Kurdi, B., Alzoubi, H. M., Obeidat, B., Hamadneh, S., & Ahmad, A. (2022a). The influence of supply chain partners' integrations on organizational performance: The moderating role of trust. *Uncertain Supply Chain Management*, 10, 1191–1202.
- Alshurideh, M., Al Kurdi, B., Alzoubi, H. M., Ghazal, T. M., Said, R. A., AlHamad, A. Q., Hamadneh, S., Sahawneh, N., & Al-kassem, A. H. (2022). Fuzzy assisted human resource management for supply chain management issues. *Annals of Operations Research*.
- Alzoubi, A. (2021). Renewable green hydrogen energy impact on sustainability performance. *International Journal of Computations, Information and Manufacturing*, 1, 94–105.
- Alzoubi, H., & Ahmed, G. (2019). Do TQM practices improve organisational success? A case study of electronics industry in the UAE. *International Journal of Economics and Business*, 17, 459–472.
- Alzoubi, H. M., & Aziz, R. (2021). Does emotional intelligence contribute to quality of strategic decisions? The mediating role of open innovation. *Journal of Open Innovation: Technology, Market, and Complexity*, 7, 130.
- Alzoubi, H. M., & In'a'irat, M., Ahmed, G., (2022). Investigating the impact of total quality management practices and Six Sigma processes to enhance the quality and reduce the cost of quality: The case of Dubai. *International Journal of Business Excellence*, 27, 94–109.
- Alzoubi, H. M., & Yanamandra, R. (2020). Investigating the mediating role of information sharing strategy on agile supply chain. *Uncertain Supply Chain Management*, 8, 273–284.
- Alzoubi, H. M., Ahmed, G., Al-Gasaymeh, A., & Al Kurdi, B. (2020). Empirical study on sustainable supply chain strategies and its impact on competitive priorities: The mediating role of supply chain collaboration. *Management Science Letters*, 10, 703–708.
- Alzoubi, H., Alhamad, A. Q. M., Akour, I., Alshurideh, M., Al-Hamad, A. Q., Kurdi, B. A., & Alzoubi, H. (2021a). Predicting the intention to use google glass: A comparative approach using machine learning models and PLS-SEM. *International Journal of Data and Network Science*, 5, 311–320.
- Alzoubi, H. M., Vij, M., Vij, A., & Hanaysha, J. R. (2021b). What leads guests to satisfaction and loyalty in UAE five-star hotels? AHP analysis to service quality dimensions. *Enlightening Tourism. A Pathmaking Journal*, 11, 102–135.
- Alzoubi, H., Alhamad, A., Alshurideh, M., Alomari, K., Al Kurdi, B., Hamouche, S., & Al-Hawary, S. (2022a). The effect of electronic human resources management on organizational health of

- telecommunications companies in Jordan. *International Journal of Data and Network Science*, 6, 429–438.
- Alzoubi, H., Alshurideh, M., Kurdi, B. A., Akour, I., & Aziz, R. (2022b). Does BLE technology contribute towards improving marketing strategies, customers' satisfaction and loyalty? The role of open innovation. *International Journal of Data and Network Science*, 6, 449–460.
- Alzoubi, H. M., Ahmed, G., & Alshurideh, M. (2022c). An empirical investigation into the impact of product quality dimensions on improving the order-winners and customer satisfaction. *International Journal of Productivity and Quality Management*, 36, 169–186.
- Alzoubi, H. M., Ali, N., Ghazal, T. M., Ahmed, A., Abbas, S., Khan, M. A., Farooq, U., Ahmad, M., & Khan, M. A. (2022d). Fusion-based supply chain collaboration using machine learning techniques. *Intelligent Automation & Soft Computing*, 31, 1671–1687.
- Alzoubi, H. M., Alshurideh, M. T., Kurdi, B. A., Alhyasat, K. M. K., & Ghazal, T. M. (2022e). The effect of e-payment and online shopping on sales growth: Evidence from banking industry. *International Journal of Data and Network Scienc*, 6, 1369–1380.
- Alzoubi, H. M., Alshurideh, M. T., Al Kurdi, B., Ghazal, T. M., Said, R. A., AlHamad, A. Q., Hamadneh, S., Sahawneh, N., & Al-kassem, A. H. (2022f). Fuzzy assisted human resource management for supply chain management issues. *Annals of Operations Research* 1–19.
- Alzoubi, H. M., Elrehaile, H., Hanaysha, J. R., Al-Gasaymeh, A., Al-& Adaileh, R. (2022g). The role of supply chain integration and agile practices in improving lead time during the COVID-19 crisis. *The International Journal of Service Science, Management, Engineering, and Technology*, 13, 1–11.
- Eli, T. (2021). Students' perspectives on the use of innovative and interactive teaching methods at the university of Nouakchott Al Aasriya, Mauritania: English department as a case study. *International Journal of Innovation, Management and Technology*, 1, 90–104.
- Eli, T., & Hamou, L. A. S. (2022). Investigating the factors that influence students' choice of English studies as a major: The case of University of Nouakchott Al Aasriya. *Mauritania. International Journal of Innovation, Management and Technology*, 2, 1.
- Ghazal, T. M., Bibi, R., Saeed, Y., Zeb, A., Rahman, T., Said, R. A., Abbas, S., Ahmad, M., & Khan, M. A. (2021a). Edge AI-based automated detection and classification of road anomalies in VANET using deep learning. *Computational Intelligence and Neuroscience*, 2021, 1–19.
- Ghazal, T. M., Hasan, M. K., Alkhalfah, A., Abu Bakar, K. A., Omidvar, A., Nafi, N. S., & Agbinya, J. I. (2021b). *Fischer linear discrimination and quadratic discrimination analysis-based data mining technique for internet of things framework for healthcare* (p. 9). Public Heal.
- Ghazal, T. M., Siddiqui, S. Y., Haider, A., Khan, M. A., Naseer, I., Abbas, S., Rahman, M., Khan, J. A., Ahmad, M., Hasan, M. K., Mohammed, A., & Ateeq, K. (2021c). IoMT cloud-based intelligent prediction of breast cancer stages empowered with deep learning. *IEEE Access*, 9, 146478–146491.
- Ghazal, T. M., Abbas, S., Munir, S., Khan, M. A., Ahmad, M., Issa, G. F., Zahra, S. B., Khan, M. A., & Hasan, M. K. (2022b). Alzheimer disease detection empowered with transfer learning. *Computers, Materials and Continua*, 70, 5005–5019.
- Ghazal, T. M., Hasan, M. K., Abdullah, S. N. H., Abubakkar, K. A., & Afifi, M. A. M. (2022e). IoMT-enabled fusion-based model to predict posture for smart healthcare systems. *Computers, Materials and Continua*, 71, 2579–2597.
- Ghazal, T. M., Hasan, M. K., Saeed, R. A., Pandey, B., Gohel, H., Eshmawi, A. A., Abdel-Khalek, S., & Alkhassawneh, H. M. (2022f). A review on security threats, vulnerabilities, and counter measures of 5G enabled Internet-of-Medical-Things. *IET Communications*, 16, 421–432.
- Ghazal, T. M., Khan, M. A., Lee, S. W., & Rehman, A. (2022g). Data fusion-based machine learning architecture for intrusion detection. *Computers, Materials and Continua*, 70, 3399–3413.
- Ghazal, T. M., Mehmood, S., Khan, M. A., Zubair, M., Naseem, M. T., Faiz, T., & Ahmad, M. (2022h). Malignancy detection in lung and colon histopathology images using transfer learning with class selective image processing. *IEEE Access*, 10, 25657–25668.

- Ghazal, T. M., Zafar, S., Asif, M., Ahmad, M. B., Faiz, T., Ahmad, M., & Khan, M. A. (2022k). Assistive devices analysis for visually impaired persons: A review on taxonomy. *IEEE Access*, 10, 13354–13366.
- Ghazal, T. M., & Taleb, N. (2022). Feature optimization and identification of ovarian cancer using internet of medical things. *Expert Systems*.
- Ghazal, T. M., Abbas, S., Ahmad, M., & Aftab, S. (2022a). An IoMT based ensemble classification framework to predict treatment response in hepatitis C patients. In *2022 international conference on business analytics for technology and security, ICBATS 2022* (pp. 1–4).
- Ghazal, T. M., Ahmed, Z. E., Hasan, M. K., Hashim, A. A., Saeed, R. A., Mokhtar, R. A., & Singh, S. P. (2022c). Optimization procedure for intelligent internet of things applications. In *2022 international conference on business analytics for technology and security, ICBATS 2022* (pp. 1–6).
- Ghazal, T. M., Bukhari, M. M., Abbas, S., Khan, M. A., Farooq, U., Wahbah, H., Ahmad, M., & Adnan, K. M. (2022d). An intelligent proposed model for task offloading in fog-cloud collaboration using logistics regression. *Computational Intelligence and Neuroscience*, 2022.
- Ghazal, T. M., Noreen, S., Said, R. A., Khan, M. A., Siddiqui, S. Y., Abbas, S., Aftab, S., & Ahmad, M. (2022i). Energy demand forecasting using fused machine learning approaches. *Intelligent Automation and Soft Computing*.
- Ghazal, T. M., Rehman, A. U., Saleem, M., Ahmad, M., Ahmad, S., & Mehmood, F. (2022j). Intelligent model to predict early liver disease using machine learning technique. In *2022 international conference on business analytics for technology and security, ICBATS 2022* (pp. 1–5).
- Gul, O., Al-Qutayri, M., Yeun, C. Y., & Vu, Q. H. (2012). Framework of a national level electronic health record system. In *Proceedings of 2012 international conference on cloud computing technologies, applications and management, ICCCTAM 2012. Applications and Management (ICCCTAM), Dubai, UAE* (pp. 60–65).
- Guntur, S. R., Gorrepati, R. R., & Dirisala, V. R. (2018). Internet of medical things. *Medical Big Data and Internet of Medical Things*, 4, 271–297.
- Ha, S., & Choi, S. (2016). Convolutional neural networks for human activity recognition using multiple accelerometer and gyroscope sensors. *Proc. Int. Jt. Conf. Neural Networks*, 381–388.
- Hamadneh, S., Pedersen, O., Alshurideh, M., Kurdi, B. A., & Alzoubi, H. M. (2021). An investigation of the role of supply chain visibility into the Scottish blood supply chain. *Journal of Legal, Ethical and Regulatory Issues*, 24, 1–12.
- Hanaysha, J., Al-Shaikh, M., Alzoubi, M., & H., (2021). Importance of marketing mix elements in determining consumer purchase decision in the retail market. *The International Journal of Service Science, Management, Engineering, and Technology*, 12, 56–72.
- Hanaysha, J. R., Al-Shaikh, M. E., Joghee, S., & Alzoubi, H. M. (2022). Impact of innovation capabilities on business sustainability in small and medium enterprises. *FIIB Business Review*, 11, 67–78.
- Hasan, M. K., Islam, S., Sulaiman, R., Khan, S., Hashim, A. H. A., Habib, S., Islam, M., Alyahya, S., Ahmed, M. M., Kamil, S., & Hassan, M. A. (2021a). Lightweight encryption technique to enhance medical image security on internet of medical things applications. *IEEE Access*, 9, 47731–47742.
- Hasan, M. K., Musse, M. A., Sherfriz, S. M., Shayla, I., Huda, S. N., Eklas, H., Nazmus S. N., & Nguyen, V. (2021). An improved dynamic thermal current rating model for PMU-based wide area measurement framework for reliability analysis utilizing sensor cloud system. 9, 14446–14458
- Islam, S., Khalifa, O. O., Hashim, A. H. A., Hasan, M. K., Razzaque, M. A., & Pandey, B. (2020). Design and evaluation of a multihoming-based mobility management scheme to support inter technology handoff in PNEMO. *Wireless Personal Communications*, 114, 1133–1153.
- Joghee, S., Alzoubi, H. M., & Dubey, A. R. (2020). Decisions effectiveness of FDI investment biases at real estate industry: Empirical evidence from Dubai smart city projects. *International Journal of Scientific & Technology Research*, 9, 3499–3503.

- Joghee, S., Alzoubi, H. M., Alshurideh, M., & Al Kurdi, B. (2021). The role of business intelligence systems on green supply chain management: Empirical analysis of FMCG in the UAE. In *The international conference on artificial intelligence and computer vision* (pp. 539–552). Springer.
- Kasem, J., & Al-Gasaymeh, A. (2022). A cointegration analysis for the validity of purchasing power parity: Evidence from middle East Countries. *International Journal of Innovation, Management and Technology*, 2, 1.
- Kim, S.-K., Yeun, C. Y., Damiani, E., & Lo, N.-W. (2019). A machine learning framework for biometric authentication using electrocardiogram. *IEEE Access*, 7, 94858–94868.
- Kurdi, B. A., Alshurideh, M., Akour, I., Alzoubi, H. M., Obeidat, B., & Alhamad, A. (2022a). The role of digital marketing channels on consumer buying decisions through eWOM in the Jordanian markets. *International Journal of Data and Network Science*, 6, 1175–1185.
- Kurdi, B. A., Alshurideh, M., Akour, I., Tariq, E., Alhamad, A., & Alzoubi, H. M. (2022b). The effect of social media influencers' characteristics on consumer intention and attitude toward Keto products purchase intention. *International Journal of Data and Network Science*, 6, 1135–1146.
- Kurdi, B. A., Alzoubi, H. M., Akour, I., & Alshurideh, M. T. (2022c). The effect of blockchain and smart inventory system on supply chain performance: Empirical evidence from retail industry. *Uncertain Supply Chain Management*, 10, 1111–1116.
- Lee, K. L., Azmi, N. A. N., Hanaysha, J. R., Alzoubi, H. M., & Alshurideh, M. T. (2022a). The effect of digital supply chain on organizational performance: An empirical study in Malaysia manufacturing industry. *Uncertain Supply Chain Management*, 10, 495–510.
- Lee, K. L., Romzi, P. N., Hanaysha, J. R., Alzoubi, H. M., & Alshurideh, M. (2022b). Investigating the impact of benefits and challenges of IOT adoption on supply chain performance and organizational performance: An empirical study in Malaysia. *Uncertain Supply Chain Management*, 10, 537–550.
- Mehmood, T., Alzoubi, H. M., Alshurideh, M., Al-Gasaymeh, A., & Ahmed, G. (2019). Schumpeterian entrepreneurship theory: Evolution and relevance. *Academy of Entrepreneurship Journal*, 25, 1–10.
- Mondol, E. P. (2021). The impact of block chain and smart inventory system on supply chain performance at retail industry. *International Journal of Computations, Information and Manufacturing*, 1, 56–76.
- Mondol, E. P. (2022). The role of Vr games to minimize the obesity of video gamers. *International Journal of Computations, Information and Manufacturing*, 2, 1.
- Obaid, A. J. (2021). Assessment of smart home assistants as an IoT. *International Journal of Computations, Information and Manufacturing*, 1, 18–38.
- Ramakrishna, Y., & Alzoubi, H. M. (2022). Empirical Investigation of mediating role of six sigma approach in rationalizing the COQ in service organizations. *Operations and Supply Chain Management*, 15, 122–135.
- Ratkovic, N. (2022). Improving home security using blockchain. *International Journal of Computations, Information and Manufacturing*, 2, 1.
- Saleem, M., Abbas, S., Ghazal, T. M., Adnan Khan, M., Sahawneh, N., & Ahmad, M. (2022). Smart cities: Fusion-based intelligent traffic congestion control system for vehicular networks using machine learning techniques. *Egyptian Informatics Journal*.
- Shamout, M., Ben-Abdallah, R., Alshurideh, M., Alzoubi, H., Al Kurdi, B., & Hamadneh, S. (2022). A conceptual model for the adoption of autonomous robots in supply chain and logistics industry. *Uncertain Supply Chain Management*, 10, 577–592.
- Shehada, D., Yeun, C. Y., Zemerly, M. J., Al-Qutayri, M., Al-Hammadi, Y., & Hu, J. (2018). A new adaptive trust and reputation model for mobile agent systems. *Journal of Network and Computer Application*, 124, 33–43.
- Shehada, D., Yeun, C. Y., Zemerly, M. J., Qutayri, M. Al, Hammadi, Y. Al, Damiani, E., Hu, J. (2017). BROSMAP: A novel broadcast based secure mobile agent protocol for distributed service applications. *Security and Communication Networks* (Vol. 2017). Wiley.
- Victoria, V. (2022). Impact of process visibility and work stress to improve service quality: Empirical evidence from Dubai retail industry impact of process visibility and work stress to

- improve service quality: Empirical evidence from Dubai retail industry. *International Journal of Innovation, Management and Technology*, 2, 1.
- Vo, D. L., Lee, H., Yeun, C. Y., & Kim, K. (2010). Enhancements of authenticated multiple key exchange protocol based on bilinear pairings. *Computers & Electrical Engineering*, 36, 155–159.
- Zitar, R. A., Al-Dmour, N., Nachouki, M., Hussain, H., & Alzboun, F. (2021). Hashing generation using recurrent neural networks for text documents. *ICIC Express Letters, Part B: Applications*, 12, 231–241.

Digital Wallets, E-commerce, and Consumer Perspectives

Evaluation of Purchasers Mentalities When Buying IoT Home Security Devices



Hussam Al Hamadi, Haitham M. Alzoubi^{ID}, Mohamed Alyafei, Abdulelah Almokahel, Mohamed Alyafei, Waleed T. Al-Sit, and Saif E. A. Alnawayseh

Abstract The Internet of Things (IoT) is a much-advertised idea that spins around interfacing keen contraptions to the Internet instead of people. Purchaser IoT is once in a while alluded to as the “shrewd home” market, and home security gadgets make up a massive piece of that market. Buyers are often constrained to buy brilliant home security contraptions to avoid robberies, which they dread might bring about property harm or threats to their families. They know, notwithstanding, that IoT home security frameworks might represent a gamble to their private data. A study of American clients was performed to look at the general jobs of dread and protection worries in gaining IoT home security frameworks. The review’s hypothetical establishment was the Theory of Reasoned Action. We found that dread impacted purchaser mentalities toward purchasing awesome home security gadgets, while protection concerns affected perspectives antagonistically. We tracked down that mentalities toward buying, the assessments of significant people, and earlier theft

H. Al Hamadi

College of Engineering and IT, University of Dubai, Dubai, UAE

e-mail: Hussam.alhamadi@ieee.org

H. M. Alzoubi (✉)

School of Business, Skyline University College, Sharjah, UAE

e-mail: haitham.alzubi@skylineuniversity.ac.ae

M. Alyafei · A. Almokahel · M. Alyafei

School of Information Technology, Skyline University College, Sharjah, UAE

W. T. Al-Sit

Department of Computer Engineering, Mu’tah University, Mu’tah, Jordan

Higher Colleges of Technology, Dubai, UAE

W. T. Al-Sit

e-mail: w_sitt@mutah.edu.jo

S. E. A. Alnawayseh

Electrical Engineering Department, Mu’tah University, Mu’tah, Jordan

e-mail: saif982@mutah.edu.jo

H. M. Alzoubi

Applied Science Research Center, Applied Science Private University, Amman, Jordan

experience all affected plans to buy. We likewise found that sees ultimately moderate the connection between security concerns and buy aim. At the same time, dread has both immediate and backhanded consequences for a reason.

Keywords IoT · Security · Devices · Purchasers · Market

1 Introduction

The Internet of Things (IoT) is one of the most pitched data frameworks thoughts of the earlier ten years, with its focus on connecting things instead of peopling over the Web. Shrewd TVs, brilliant speakers (for example, Alexa), indoor regulators, lighting controls, video doorbells, and surveillance cameras are, for the most part, instances of IoT for purchasers, some of the time known as the “brilliant home” market (Lee et al., 2022b). By 2023, the worldwide savvy home market is relied upon to be worth more than USD 150 billion, while the U.S. market, which will have 45 million brilliant gadgets in 2019, will be valued at \$42 billion. While most buyers (84%) esteem the accommodation of a brilliant home, 37% gained IoT gadgets for home and family security. In 2018, the worldwide market for brilliant home security gadgets was \$2.14 billion, and it is anticipated to develop to \$5.05 billion by 2025 (Edward Probir Mondol, 2022). Shrewd security contraptions are well known; the most widely recognized home security hardware is a camera, and smart doorbells are additionally famous. Between February 2017 and February 2018, unit deals of cameras and intelligent doorbells flooded by 125%, with Ring, an Amazon-claimed supplier of video doorbells and related security items, selling more than 400,000 units in December 2019 alone (Kurdi et al., 2022a). The showcasing for inventive home security hardware features an assortment of justifications for why a buyer needs to put resources into such gadgets; however, it often requests fear. In a blog entry, Reolink, a home surveillance camera maker, refers to ten reasons why shoppers need a home security framework. “To safeguard your family and assets” is the principal intention. The post then, at that point, gives similar theft insights as those found on the previously mentioned site (Ratkovic, 2022). They proceed to say that “as indicated by FBI theft paces of homes, one in each three homes without a security framework will be a casualty of a robbery, contrasted with one in each 250 homes with a security framework,” prior to showing recordings of criminals endeavouring to break into a home and a vehicle, caught on Reolink cameras (Mejia et al., 2019).

Buyers, then again, know that there might be a tradeoff between security and protection. In a new investigation of more than 1000 US clients, 50.2 percent said they were most worried about getting their homes, while 49.8% said they were most worried about safeguarding their information (Ghazal et al., 2022i, 2022j; Hanaysha et al., 2022). With revealed instances of brilliant doorbells spilling WiFi login passwords, their known weakness to programmers, and the organization’s propensity for offering clients’ accounts to regulation specialists, Ring doorbells have turned into protection stress (Vo et al., 2010). In December 2019, maybe the most notable

rate of protection infringement brought about by using a Ring item happened in Mississippi. An obscure individual hacked into a Ring camera and watched an eight-year-old young lady, in any event, welcoming her to be his dearest companion at a certain point. Guaranteeing he was Santa Claus (Shehada et al., 2017).

We directed a review of potential insightful home security gadget purchasers to concentrate on the jobs of robbery dread and information protection worries in the choice to buy such gadgets (Alzoubi et al., 2022a; Ghazal et al., 2022g). The Theory of Reasoned Action filled in as the hypothetical establishment for our exploration (Ghazal & Taleb, 2022; Shamout et al., 2022). We found that dread convictions impacted mentalities toward buying the most, while security convictions likewise played a part. Buying goal was generally impacted similarly by demeanour toward buys and the assessments of influential people (Islam et al., 2020). The affinity to buy inventive home security gear was likewise impacted by whether or not somebody had firsthand involvement in the theft. The accompanying segment audits the writing and lays the theoretical foundation for our examination (Guergov & Radwan, 2021). From that point forward, we go over our examination procedure, information gathering, and investigation. The conversation of our discoveries and their results comes to a nearby.

2 Literature Review

The Theory of Reasoned Action (TRA) is a notable and commonly used hypothesis for disclosing why individuals need to do specific things. The aim is thought to be impacted by mentalities toward the objective conduct and emotional guidelines regarding Participation in the conduct. As indicated by TRA, a singular's longing to do a particular action decides if that conduct is performed (Alshurideh et al., 2022a, 2022b, 2022c; Ghazal et al., 2022k; Mahmood et al., 2019). Perspectives and abstract standards impact goal. Perspectives are educated by sees about the direct, while principles are educated by standardizing convictions and inspiration to agree, as indicated by Ajzen. Social presumptions, which are promptly accessible in a chief's memory and relate to abstract decisions of such results subsequent to executing the conduct, shape one's mentality toward that conduct (Alsharari, 2021; Ghazal et al., 2022e). Abstract standards are affected by regulating thoughts regarding referent individuals' or gatherings' apparent assumptions, with which the chief is urged to consent. TRA does not determine the particular convictions that are connected with a specific lead, nor does it select referent people or gatherings as an overall hypothesis (Alzoubi et al., 2022a). Both of these errands are passed on to the attentiveness of the specialist and depending on the idea of the conduct viable.

In sociologies, TRA has a long history of utilization. For instance, a meta-examination of 67 investigations on condom aim demonstrated that perspectives toward condom use and emotional guidelines had medium to firm impact sizes in a 1999 meta-examination (Gul et al., 2012). TRA has been demonstrated to be especially helpful as a structure for clarifying buyer merchandise purchasing goals

(Al-Hamadi et al., 2015a, 2015b). Ongoing occurrences are the craving to buy a Volkswagen and the readiness to secure biologically amicable (green) items (Ghazal et al., 2022; Hanaysha et al., 2021; Saleem et al., 2022). Merchandise that is “firsts” (those delivered by the leading mover firm in a market) Yogurt that is “practical” (good food is one to which health benefit has been added) Products that have been “upcycled” (upcycled items make esteem out of old or disposed of materials) Participation in internet-based style leasing and the acquisition of unfamiliar merchandise (Ghazal et al., 2021c, 2022b; Kurdi et al., 2022b). We utilize TRA as the structure for our investigation into the overall impact of dread and protection worries on the goal to obtain IoT home security gear since it is valid, somewhat simple, and trustworthy (Stoyanova et al., 2020).

Abstract standards and demeanour were urgent components in clarifying expectations in a broad scope of ongoing articles about the aim to buy IoT gadgets. The pertinent others distinguished changed with the circumstance where emotional standards were considered, as one would anticipate (Alnazer et al., 2017; Ghazal et al., 2021b). Retailers, as a general rule, contenders, and the media, as well as the nonexclusive “those critical to me” and the conventional “group of friends,” were utterly referenced in these investigations as fundamental others (Hasan et al., 2021a, 2021b). At the point when it came to buying convictions, security and protection concerns were critical contemplations. As a rule, security contemplations impacted aim emphatically, while protection issues affected it adversely (Alzoubi et al., 2022b). Whenever value esteem was given, it either had a positive or no impact on importance.

We joined both in the model as convictions illuminating the disposition toward the buy, in view of these discoveries and the pragmatic variables for zeroing in on security and protection concerns (talked about above) (Cruz, 2021; Ghazal et al., 2022d). We picked dread as an intermediary in light of the different ways security concerns were operationalized (Alzoubi et al., 2022f; Ghazal et al., 2022a). We did exclude value esteem on account of its extraordinariness in different investigations (it was excluded from any of the IoT buying papers we checked out) (Al-Dmour, 2020), the disconnected outcomes when it was framed (no impact on aim in, yet a constructive outcome on the arrangement in), and our failure to find or foster an appropriate measure for the expense of brilliant home security gadgets (Alnuaimi et al., 2021; Alzoubi et al., 2022c).

As fundamental others, we chose to utilize companions, neighbours, family members, and colleagues (Ghazal et al., 2022c; Lee & Ahmed, 2021). We included age, orientation, pay, training, and robbery experience as control factors. The solid connections between emotional standards and plan, as well as among demeanour and expectation, have become regular and expected since their origin during the 1970s in an assortment of exploration traversing an assortment of activities (Alshurideh et al., 2020; Ghazal et al., 2021a). Therefore, we figure:

H1: *Subjective standards with respect to purchasing a home security iot gadget affect the craving to get one.*

H2: *Positive feelings toward the longing to purchase a home security iot gadget emphatically affect the need to get one.*

Dread is a fundamental development in writing on how individuals react to dangers (Alzoubi et al., 2022b) and on security (Mehmood, 2021), returning essentially to its specific incorporation in Protection Motivation Theory. Dread is a “social build, delivered in response to a circumstance considered to be compromising (Alzoubi et al., 2020; Hasan et al., 2021a, 2021b) and toward which preventive activity is made,” as per Rogers (Ghazal et al., 2022h). The circumstance that is considered as dangerous in the case of choosing to buy IoT home security frameworks is having one’s home burglarized (Hamadneh et al., 2021), maybe destroying one’s property and hurting one’s loved ones (Teahan et al., 2012). Purchasing and introducing home security frameworks is a defensive measure (Joghee et al., 2020). Other researcher (Ghazal et al., 2022e) has turned into an unequivocal idea in writing on data frameworks security (Muhammad Turki Alshurideh et al., 2022a, 2022b, 2022c). Dread, as indicated by the dread allure writing, is answerable for mentality adjustment; hence, people with the most dread ought to be the most drawn to IoT home security frameworks (Abu-Arqoub et al., 2020).

H3: Concerns about home security will impact mentalities toward embracing iot home security gear positively.

For a really long time, exploration of purchaser buying goal and conduct have zeroed in our other fundamental idea affecting mentality toward buys: security concerns (Alzoubi et al., 2022d). While prompting customers on their buying choices, the IoT business and government specialists (Alzoubi et al., 2022f), for example, the US FTC, have all stressed the protection issue. Eight principle subjects arose out of an exhaustive assessment of the conducted research on security and web-based business (Farouk, 2022). Three of these subjects have to do with IoT gadgets and security: (1) The benefits of e-Commerce and buyer protection (Alzoubi & Aziz, 2021), (2) perils and concerns associated with security, and (3) data control and protection (Ghazal et al., 2021a). The possibility that shoppers will surrender some security assuming they accept they are getting a fair arrangement is connected with the primary subject (Alzoubi & Yanamandra, 2020). The tradeoff in this situation would be between security and protection. The capability of unwanted results drives apparent gamble in the subsequent concern (Al-Hamadi et al., 2015a, 2015b; Radwan, 2022). Solid points found that protection concerns were connected to higher gamble insights, which impacted sees toward e-Commerce (Alzoubi & Ahmed, 2019; Ghazal et al., 2022f). Command over private data has been a primary subject in the security writing corresponding to the third issue (Neaimi et al., 2020). Control is oftentimes seen as a situational issue rather than an individual attribute. Shoppers with protection worries about data innovation (Kurdi et al., 2022c) are less disposed to buy advancements that can possibly give private data to unwanted individuals, given an emphasis on fair trades, hazard, and control (or deficiency in that department) (Kim et al., 2019). IoT gadgets, dissimilar to conventional “idiotic” devices, are fit for gathering individual information like individual characters, geolocations, propensities, and actual states (Alzoubi et al., 2021a, 2021b). Purchasers might be less intrigued by IoT gadgets assuming that they know about the likely danger to the information gathered by them (Miller, 2021).

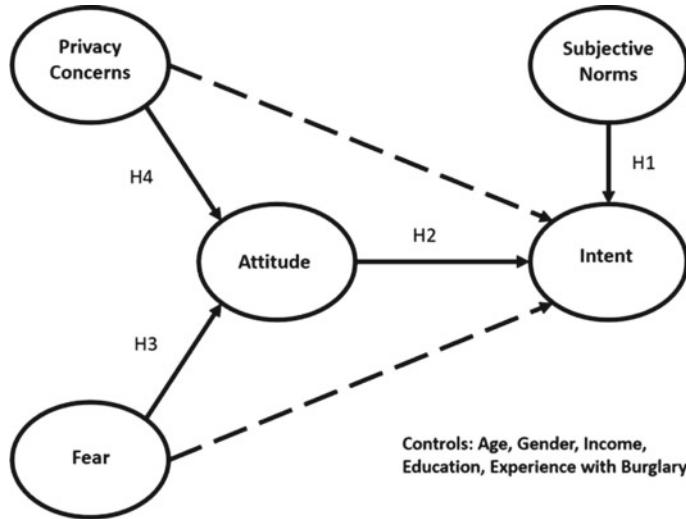


Fig. 1 TRA model of intent purchase IoT security devices (Lee & Ahmed, 2021)

H4: *Beliefs about the apparent protection dangers of IoT home security gadgets will adversely influence mentalities toward buying them.*

The impact of convictions intentionally is interceded by mentalities toward the direct being referred to, as per a basic idea of TRA. Much of the time, direct ways from perspectives to plan are not tried (Alzoubi et al., 2021a, 2021b).

In Fig. 1, we have incorporated those direct pathways (dabbed lines). After we test the TRA primary model, we will rerun it with the common pathways, including perceiving how much convictions about purchasing astute home security gear are interceded by perspectives regarding getting them as far as an expectation to buy. We did not propose a speculation for the primary ways since we were unable to track down any proof in writing to help it.

3 Research Methodology

We researched for a current overview instrument that assessed every one of the vital attributes to test our models. We assembled our own organization since none existed, beginning with a quest for previous estimation scales for whatever number builds as would be prudent (Alzoubi et al., 2022e). Standard TRA measures should be adjusted for the conduct and referent gatherings understudy on the grounds that TRA does not recognize explicit practices or referent gatherings (Lee et al., 2022a). We expected to create and change proper estimations for essential attributes of TRA, like the plan, disposition, and abstract norms, for this situation (Alkeem et al., 2017). Reasoning and emotional standards measures were adjusted from, which was fundamentally

founded on and customized to the particular conduct of utilizing Internet-of-Things home security frameworks (Obaid, 2021). Dread was estimated on a size of one to ten. Protection to catch conclusions about the dangers to security from utilizing IoT home security frameworks, hazard measures were created and changed. We could not find any critical scales that deliberate the longing to send IoT gadgets for home security. In this manner, the creators conceived our own. Except for ‘mentality,’ all things were scored on a 7-point Likert scale, with one addressing ‘unequivocally deviate’ and seven addressing ‘emphatically concur.’ The four ‘disposition’ components were reviewed on a seven-point semantic differential scale going from awful to great, silly to insightful, aversion to like, and awkward to lovely. To see whether your home or the home of somebody you realize has been burglarized, we posed the inquiry “Has your home or the home of somebody you know been burglarized?” insight of customers who will be surveyed. The authors concocted this measurement. It was scored on a five-point scale: 1 for the earlier year, two throughout the previous two years, 3 for the last three to five years, 4 for over five years prior, and 5 for never being burglarized. At last, for the other control factors, we utilized standard measures like age, orientation, instruction, and pay (Ali et al., 2021).

The scholars went through different rounds of updates in fostering the overview poll (Hanaysha et al., 2022). A few developments were estimated ordinarily in the prior variants of the instrument. Three Ph.D. undergraduates and one teacher arranged each of the materials that would be utilized in the gadget freely. Everything was imprinted on its own piece of paper, and the adjudicators were told to sort them into however many heaps as they saw fundamental. From that point forward, they were approached to name each group. In spite of the fact that there was a ton of arrangement among the adjudicators, there was no ideal understanding. A few appointed authorities had a more significant number of heaps of products than others, and the plan of things among the banks changed from one adjudicator to another.

The regions where they differ showed potential issues. In light of the criticism from the arranging system, the creators changed the instrument until it was steady. The creators made the accompanying changes to the gadget: (1) They modified the goal measure, eliminating two things and supplanting them with three new ones; (2) they added pay and instruction to the segment elements, and (3) they included an inquiry whether the respondent’s home had been burglarized.

4 Data Analysis

The updated instrument was therefore confirmed, beginning with a 100-man pilot study. Cint, an organization that gives admittance to the north of 40 million purchasers worldwide for an expense, enlisted the members who purchases security products or prefer to buy security gadgets for transportation (Al-Hamadi et al., 2021). Potential respondents needed to recognize that they were not presently utilizing IoT home security frameworks to be qualified for the survey. As per each development and

its predecessors, the information procured during the pilot was exposed to dependency tests and corroborative component examination. In the essential information assortment exertion, the creators decided to fuse all things from the pilot study. Cint gathered information from 229 U.S. buyers in December 2017, utilizing a similar screening approach as the pilot. The information is commonly dispersed, as indicated by an investigation of standard Q-Q plots for every factor. It is pretty significant that the example is predominantly female. As indicated by both well-known press and examination papers, ladies are more likely than men to secure IoT gadgets for well-being (19% vs. 13%), though men are bound to buy IoT gadgets for energy investment funds. As indicated by Alshurideh et al. (2022a, 2022b, 2022c), albeit 57% of men had ingenious home contraptions, 64% of ladies did. Given our attention on protection issues here, it is actually essential that similar creators found that ladies' confidence in security with regards to smart home devices was lower than men's.

4.1 Demographics Analysis

Sample demographics shown in Table 1 as socioeconomics of the research below.

AMOS 25, which is essential for IBM's SPSS factual program, was utilized to test the estimation and underlying models (Al-Nashashibi et al., n.d.). Our model's five builds were exposed to the corroborative variable investigation (Fig. 2). The information was precise and well-fitting to the model (Table 3). All of the scales' unwavering quality insights were good, and the average change clarified (AVE) values were all more than 0.5 (Table 4). For each build, the square foundations of the AVEs surpassed the development's most fantastic relationship. The estimating model had significant concurrent and discriminant legitimacy. We were taking everything into account. For average method change, we utilized procedural cures (CMV). To be more explicit, we (1) kept the review unknown to decrease respondents' assessment nervousness and the probability of them giving socially alluring, merciful, or submissive reactions; (2) randomized the inquiry request to control for preparing impacts and different inclinations connected with question setting or thing embeddedness; and (3) further developed scale things through the thorough scale improvement process, as recently referenced. We utilized the overview information to direct observational tests to decide the degree of predisposition brought about by CMV. In our model, we fractional out a marker variable (a hypothetically free develop with three things: "I favor blue to different tones," "I appreciate blue tone," and "I like blue pieces of clothing") and examined the relationships between's this marker and every idle variable, taking

Table 1 Sample demographics

Gender	Education	Income
Female: 77.3%	Grad degree: 14.4%	<\$50k: 55.5%
Male: 22.7%	College degree: 29.7%	\$50k–\$100k: 28.8%
	Some college: 27.5%	>\$100k: 16.7%

cues from Lindell and Whitney. Assuming that the relationship between is any of the inert factors and the quality is more than 0.3, normal technique inclination exists; in any case, this was not the situation in this review, as the primary connection we found was 0.109. We inspected the R2 changes of all endogenous factors in our model when somewhat out the above marker variable. Whenever R2 values vacillate essentially, there is a typical procedure predisposition; the main R2 esteem change in our informational collection was 0.004. Subsequently, standard strategy inclination does not represent a gamble to our exploration.

We additionally searched for any indications of multicollinearity. The information was viewed as consistently conveyed utilizing dissipate plots. Protection concerns, dread, and abstract standards all had change expansion factors somewhere in the range of 1.0 and 1.15, showing that multicollinearity was not an issue.

4.2 Descriptive Statistics

Table 2 records enlightening insights for the actions.

The underlying model was tried, and the outcome was $2(185) = 386.8(0.000)$. A decent match of the information to the model was likewise shown by different pointers: RMSEA = 0.069, CFI = 0.951, NFI = 0.911, CFI = 0.951. Worries about protection had a negative and significant association with an ability to purchase IoT home security hardware ($= -0.26, = 0.000$). Dread and demeanor had a positive and critical association ($= 0.46, = 0.000$). Both disposition ($= 0.40, = 0.000$) and emotional standards ($= 0.44, = 0.000$) had a positive and critical association with buy goal. We took a gander at the relationships between's each control variable and the proportion of aim, yet not a single one of them was genuinely huge, except for one. Individual involvement in theft ($= 0.16, = 0.005$), demonstrating that individuals who have individual involvement in thievery were bound to purchase. The model clarified 38% of the difference in purpose to purchase an IoT home security gadget and 28% of the change in mentality toward IoT home security gadgets (changed R2). Each of the four speculations was demonstrated to be valid. Figure 3 portrays the assessed TRA model.

4.3 Measurement Model Fit Statistics

The information was precise and well-fitting to the model summarized in Table 3.

We can assess the degree to which mentalities intervene in the impact of convictions on purpose by including direct ways from protection concerns and dread to buy goals (Fig. 4). The underlying intervention model was tried with a $2(183) = 354.4$ ($p 0.000$) result. The information was well-fitting to the model ($CFI = 0.959$; $NFI = 0.919$; $RMSEA = 0.064$). Once more, both mentality ($= 0.29, p = 0.000$) and abstract standards ($= 0.33, p = 0.000$) had positive and measurably critical connections with

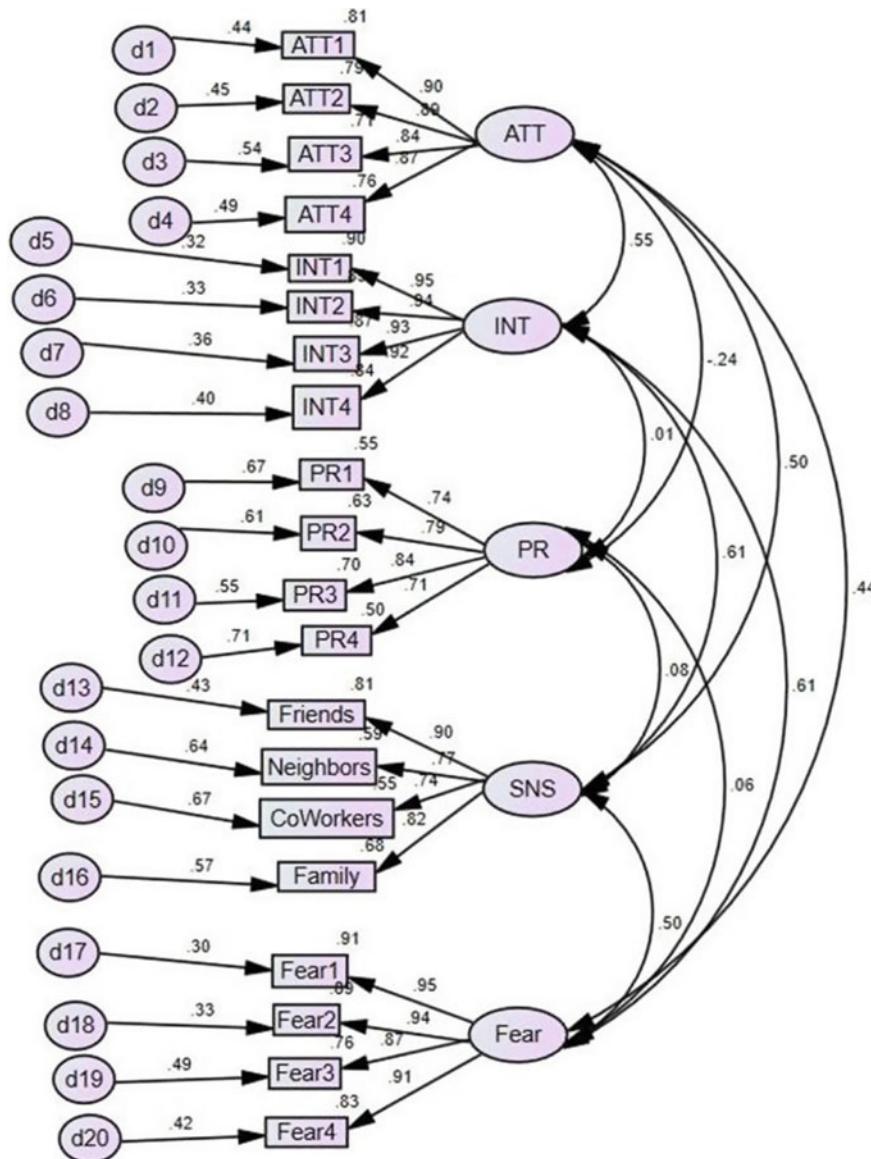


Fig. 2 Confirmatory factor results (Alrasheddeh et al., 2020)

reason. Security concerns affected demeanor ($= -0.26$, $p = 0.000$), while dread had a positive and measurably critical impact ($= 0.45$, $p = 0.000$). These outcomes are almost equivalent to the TRA model's effects.

Table 2 Descriptive statistics (N = 229 for all variables)

	Minimum	Maximum	Mean	Standard deviation
Intent	1.00	7.00	3.28	1.66
Fear	1.00	7.00	3.52	1.73
Attitude	1.00	7.00	5.11	1.37
Privacy concerns	1.00	7.00	4.61	1.15
Subjective norms	1.00	7.00	3.52	1.39

Table 3 Measurement model fit statistics

Criterion	Fit statistic
Chi-square	231.109
DF	160
Chi-square/DF	1.444
P	0.000
CFI	0.983
NFI	0.946
RMSEA	0.044

Table 4 Measurement model convergent validity statistics (standardized regression weights)

INT1	0.948			
INT2	0.942			
INT3	0.932			
INT4	0.919			
Attitude		0.929	0.930	0.770
ATT1	0.900			
ATT2	0.892			
ATT3	0.845			

4.4 Measurement Model Convergent Validity

The convergent validity model is illustrated as shown in Table 4.

Dread impacted reason ($= 0.38$, $p = 0.000$), while protection concerns didn't ($= 0.01$, $p = 0.837$). Mentalities totally directed the effect of protection worries on a plan. Just like the case with the TRA model, robbery experience affected purpose ($= 0.11$, $p = 0.036$). The model clarified 45% of the variety in aim to purchase an IoT security gadget and 27% of the variety in mentality toward getting one (changed R2).

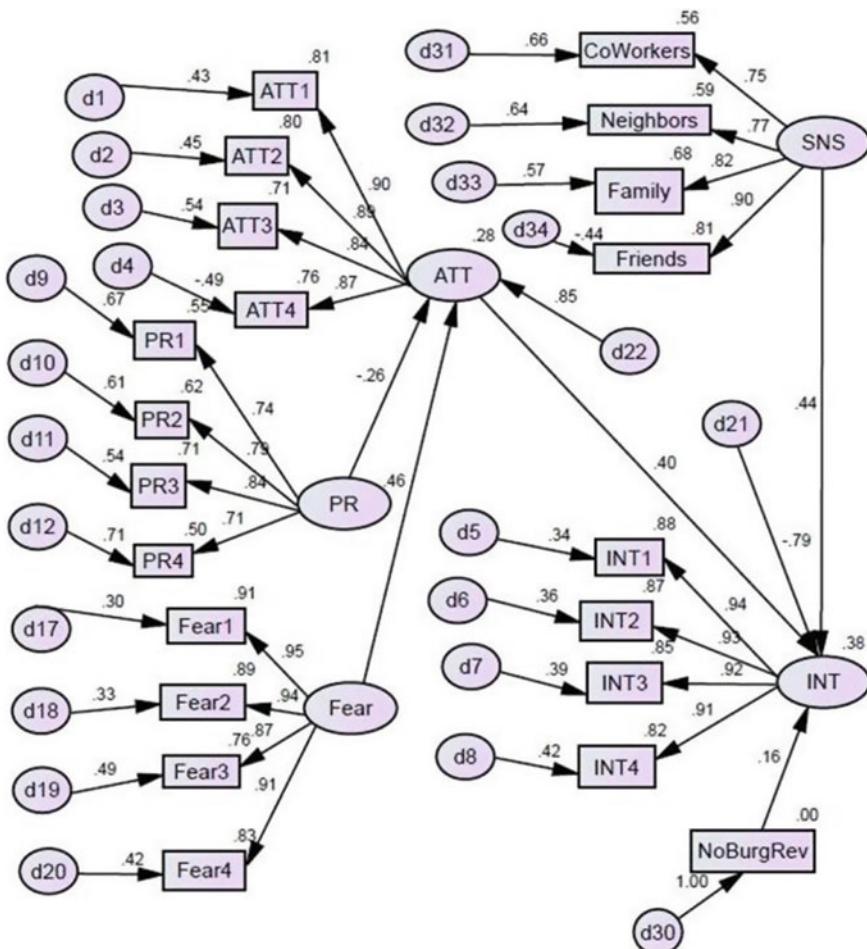


Fig. 3 Evaluated TRA model (Obaid, 2021)

5 Discussion

Utilizing the TRA system, we demonstrated that demeanour toward buying and the assessments of fundamental others affected the expectation to procure IoT home security gear. Companions, family members, neighbours, and associates were among the soul mates. Assuming the respondent's idea that these people thought that buying such hardware was fundamental, the respondent was bound to get them. Dread-based discernments affected buy perspectives. Protection convictions contrarily affected mindset, albeit not close to however much dread did. In spite of worries that IoT home security hardware could prompt a deficiency of protection, respondents were

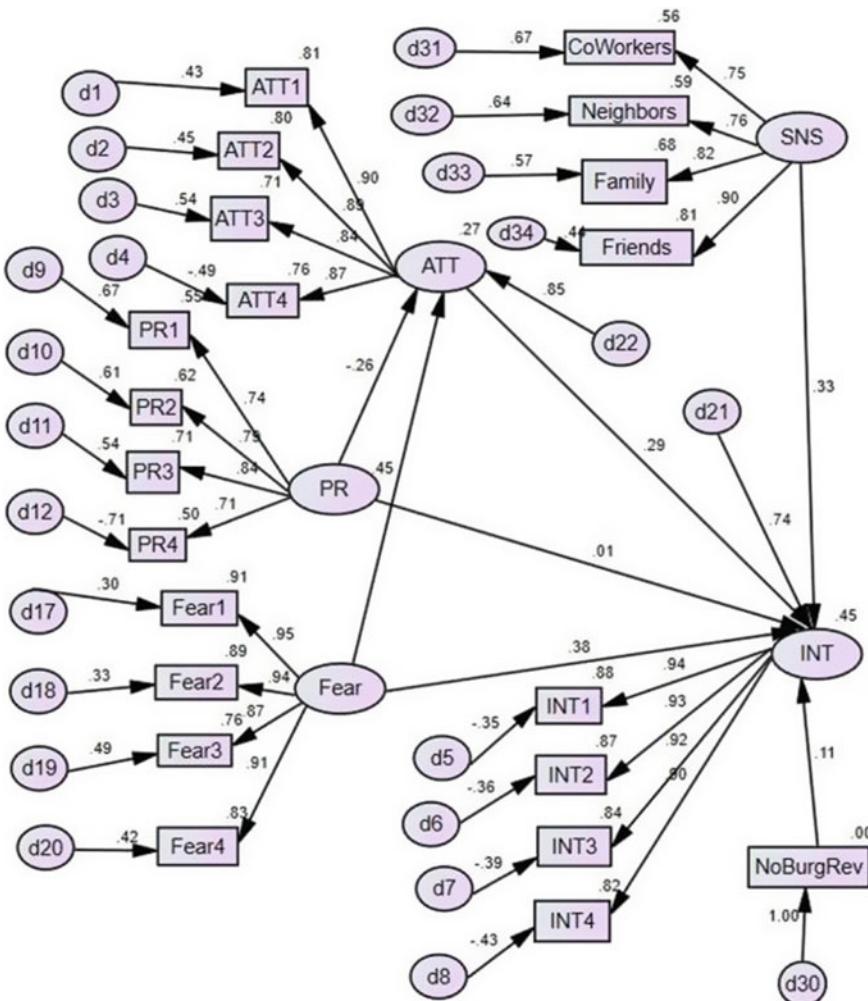


Fig. 4 Evaluated structure model (Ratkovic, 2022)

roused to purchase these contraptions since they feared the home intrusion. Concerns in regards to protection risks are inadequate to refute the apparent danger.

IoT home security gadgets have various benefits. For some shoppers, the gamble of revealing individual data for security is worth the effort. Likewise, respondents' buy goal expanded subsequent to encountering a home theft, regardless of whether it was their own or that of others.

Albeit the discoveries approved our forecasts as a whole and seem, by all accounts, to be plainly obvious, they uncover a more nuanced situation than one could suspect. While dread was an essential inspiration of demeanour, and mentality drove purpose, thoughts regarding vital others' assumptions were similarly significant. This could

be because of the way that the review zeroed in on the arrangement to purchase a specific, explicit kind of home security gadget IoT gadgets as opposed to homing security gear overall. For devices that are not associated with one's home organization yet are instead introduced and checked by outsiders, the assessments of fundamental people may not be as significant. While we found that security concerns impacted perspectives, the public's impression of IoT gadgets as "broken" wellsprings of private information without a doubt helped their worth. The Mississippi Santa Claus case, as well as other sensational instances of voyeur admittance to kids by means of IoT gadgets, may have added to the unmistakable quality of security concerns. We made no presumptions about the importance of control factors, and just thievery experience was measurably huge. This examination uncovered that immediate or aberrant involvement in home robbery supported buy penchant.

Protection issues were completely intervened by sees about obtaining IoT home security gear, as indicated by our intercession study. Our discoveries are instinctive, notwithstanding the way that we had no exact suspicions concerning this connection. As recently expressed, general society sees IoT home security frameworks as well-springs of released individual information or facilitators of protection avoidances. Customer mentalities toward purchasing would be debilitated in the event that they considered an IoT security gadget was not secure, and the purchaser's plan to buy would be cut. Expectation of buying a specific kind of home security gadget IoT gadgets instead of homing security gadgets by and large. The perspectives on soul mates may not be as significant for gadgets that do not sit on one's home organization but instead are introduced and observed by outsiders. While we observed that protection concerns were likewise critical to mentality, their significance was presumably improved by the public view of IoT gadgets as "defective" wellsprings of private information. Emotional instances of voyeur admittance to kids through IoT gadgets, for example, the Mississippi Santa Claus case referenced before, may likewise play had an impact in upgrading the power of security concerns. We did not estimate the possible piece of control factors, and just involvement in thievery was measurably critical. This finding showed that the expectation to buy was upgraded by immediate or backhanded insight with a home robbery.

Our intercession examination showed that protection concerns were altogether interceded by mentalities towards buying IoT home security gadgets. Despite the fact that we did not have explicit assumptions regarding this relationship, our discoveries are instinctive. As we have examined, IoT home security gadgets are seen by the general population as being wellsprings of released individual information or as facilitators of avoidances of protection. In the event that a buyer accepted an IoT security gadget was not secure, their perspectives toward buying would be decreased, and the customer's longing to purchase the things would be reduced. Dread, then again, ended up being a more far and wide conviction, interceded to a limited extent by mentalities yet additionally straightforwardly affecting buy a plan. Regardless of whether a buyer's perspectives about obtaining IoT security hardware were not especially solid, dread could push them to do as such. Subsequently, protection concerns are dependent on security advancements specifically, though nervousness is not.

Hypothetically, TRA has been demonstrated to be a dependable, primary method for pondering and exploring expectations to participate in particular conduct, for this situation, aim to buy IoT home security hardware. Despite the fact that our fundamental spotlight was on differentiating the elements of dread and protection worries in affecting demeanour, we found the significance of others' apparent viewpoints in shaping the plan by relying upon TRA. We had the option to look further into the connections among convictions and reason by penetrating TRA's solutions with respect to the vast pretended by perspectives and doing an intercession study. Future TRA-based examination might research joining intervention investigations of some structure.

From a commonsense stance, apparently, IoT home security gadget advertisers are adroit at zeroing in on the dread to expand deals. They ought to similarly minimize or try also any IoT abilities that could be connected to compromised protection. Our discoveries propose that advertisers could utilize client experience with house robberies to expand nervousness. They could likewise need to consider how vital it would be for others to purchase IoT home security gadgets. "Home thefts are more far-reaching than you might suspect they happen frequently and, surprisingly, in your space," a decent pitch would go. With XYZ IoT home security contraptions, you can keep your home and family protected. Your grandma wants for you to protect her grandkids. "Our exploration, similar to some others, has limits. Shoppers in the United States were the ones in particular who was remembered for the review. Albeit the example size meets the prerequisite of five perceptions for every model boundary, a bigger example size would consider the examination of different convictions and their effect on demeanour. It would have been essential to gather information on saw conduct control assuming the Theory of Planned Behavior had been utilized rather than the Theory of Reasoned Action. Notwithstanding, on the grounds that the objective conduct was buying IoT home security frameworks, which is a sensibly significant activity that should be possible both on the web and face to face, saw social control was probably not going to assume a critical part here could likewise be contrasted in sees toward buying security gadgets that require outsider observing versus the kinds of gadgets we checked out. Future investigations could address every one of these limitations by utilizing a non-American example, a bigger model, an alternate hypothetical structure, or a piece of other gear.

6 Conclusions

By 2023, the overall savvy home market is relied upon to be worth more than \$150 billion USD, with security gadgets like the Ring doorbell representing a critical part of that market. By 2025, the worldwide market for inventive home security hardware is expected to be worth more than \$5 billion USD. Dread is regularly used to advance brilliant home security contraptions, and we found that dread altogether affected buyer sees toward gaining such gadgets. It is not really stunning that we observed that security stresses concerning these devices affected feelings regarding

their buy. Aim to purchase was vigorously impacted by disposition, yet what soul mates thought and past thievery experience additionally assumed a part. The blend of reasoning, abstract standards, and experience clarified 38% of the fluctuation in reason. While examining the primary drivers behind gaining IoT home security hardware, specialists and advertisers ought to think about each of the three factors.

References

- Abu-Arqoub, M., Issa, G., Banna, A. E., & Saadeh, H. (2020). Interactive multimedia-based educational system for children using interactive book with augmented reality. *Journal of Computer Science*, 15, 1648–1658.
- Al-Dmour, N. A. (2020). Using unstructured search algorithms for data collection in IoT-based WSN. *International Journal of Engineering Research & Technology*, 13, 1992–1998.
- Al-Hamadi, H., Gawanmeh, A., Al-Qutayri, M. (2015). Formal validation of QRS wave within ECG. In *2015 international conference on information and communication technology research, ICTRC 2015* (Vol. 9, pp. 190–193).
- Al-Hamadi, H., Gawanmeh, A., Baek, J., & Al-Qutayri, M. (2015b). Lightweight security protocol for ECG bio-sensors. *Wireless Personal Communications*, 95, 5097–5120.
- Al-Hamadi, H., Nasir, N., Yeun, C. Y., & Damiani, E. (2021). A verified protocol for secure autonomous and cooperative public transportation in smart cities. In June, I. (Ed.), *2021 IEEE international conference on communications workshops (ICC Workshops)* (pp. 1–6).
- Al-Nashashibi, M., Hadi, W., El-Khalili, N., Issa, G., AlBanna, A.A. (2021). A new two-step ensemble learning model for improving stress prediction of automobile drivers. *The International Arab Journal of Information Technology*, 6.
- Ali, N., Ahmed, A., Anum, L., Ghazal, T. M., Abbas, S., Khan, M. A., Alzoubi, H. M., & Ahmad, M. (2021). Modelling supply chain information collaboration empowered with machine learning technique. *Intelligent Automation & Soft Computing*, 30, 243–257.
- Alkeem, E. A., Shehada, D., Yeun, C. Y., Zemerly, M. J., & Hu, J. (2017). New secure healthcare system using cloud of things. *Cluster Computing*, 20(3), 2211–2229.
- Alnazer, N. N., Alnuaimi, M. A., & Alzoubi, H. M. (2017). Analysing the appropriate cognitive styles and its effect on strategic innovation in Jordanian universities. *International Journal of Business Excellence*, 13, 127–140.
- Alnuaimi, M., Alzoubi, H. M., Ajelat, D., & Alzoubi, A. A. (2021). Towards intelligent organisations: An empirical investigation of learning orientation's role in technical innovation. *International Journal of Innovation and Learning (IJIL)*, 29, 207–221.
- Alrwashdeh, M., Jahmani, A., Ibrahim, B., & Aljuhmani, H. Y. (2020). Data to model the effects of perceived telecommunication service quality and value on the degree of user satisfaction and e-WOM among telecommunications users in North Cyprus. *Data in Brief*, 28, 104981.
- Alsharari, N. (2021). Integrating blockchain technology with internet of things to efficiency. *International Journal of Innovation, Management and Technology*, 1, 01–13.
- Alshurideh, M., Gasaymeh, A., Ahmed, G., Alzoubi, H., & Kurd, B. A. (2020). Loyalty program effectiveness: Theoretical reviews and practical proofs. *Uncertain Supply Chain Management*, 8, 599–612.
- Alshurideh, M., Kurdi, B., Alzoubi, H., Obeidat, B., Hamadneh, S., & Ahmad, A. (2022a). The influence of supply chain partners' integrations on organizational performance: The moderating role of trust. *Uncertain Supply Chain Management*, 10, 1191–1202.
- Alshurideh, M. T., Al Kurdi, B., Alzoubi, H. M., Obeidat, B., Hamadneh, S., & Ahmad, A. (2022b). The influence of supply chain partners' integrations on organizational performance: The moderating role of trust. *Uncertain Supply Chain Management*, 10, 1191–1202.

- Alshurideh, M., Al Kurdi, B., Alzoubi, H. M., Ghazal, T. M., Said, R. A., AlHamad, A. Q., Hamadneh, S., Sahawneh, N., & Al-kassem, A. H. (2022). Fuzzy assisted human resource management for supply chain management issues. *Annals of Operations Research*.
- Alzoubi, H., & Ahmed, G. (2019). Do TQM practices improve organisational success? A case study of electronics industry in the UAE. *International Journal of Economics and Business Research*, 17, 459–472.
- Alzoubi, H., Alhamad, A., Alshurideh, M., Alomari, K., Al Kurdi, B., Hamouche, S., & Al-Hawary, S. (2022a). The effect of electronic human resources management on organizational health of telecommunications companies in Jordan. *International Journal of Data and Network Science*, 6, 429–438.
- Alzoubi, H., Alhamad, A. Q. M., Akour, I., Alshurideh, M., Al-Hamad, A. Q., Kurdi, B. A., & Alzoubi, H. (2021a). Predicting the intention to use google glass: A comparative approach using machine learning models and PLS-SEM. *International Journal of Data and Network Science*, 5, 311–320.
- Alzoubi, H., Alshurideh, M., Kurdi, B. A., Akour, I., & Aziz, R. (2022b). Does BLE technology contribute towards improving marketing strategies, customers' satisfaction and loyalty? The role of open innovation. *International Journal of Data and Network Science*, 6, 449–460.
- Alzoubi, H. M., Ahmed, G., Al-Gasaymeh, A., & Al Kurdi, B. (2020). Empirical study on sustainable supply chain strategies and its impact on competitive priorities: The mediating role of supply chain collaboration. *Management Science Letters*, 10, 703–708.
- Alzoubi, H. M., Ahmed, G., & Alshurideh, M. (2022c). An empirical investigation into the impact of product quality dimensions on improving the order-winners and customer satisfaction. *International Journal of Productivity and Quality Management*, 36, 169–186.
- Alzoubi, H. M., Ali, N., Ghazal, T. M., Ahmed, A., Abbas, S., Khan, M. A., Farooq, U., Ahmad, M., & Khan, M. A. (2022d). Fusion-based supply chain collaboration using machine learning techniques. *Intelligent Automation & Soft Computing*, 31, 1671–1687.
- Alzoubi, H. M., Alshurideh, M. T., Al Kurdi, B., Ghazal, T. M., Said, R. A., AlHamad, A. Q., Hamadneh, S., Sahawneh, N., & Al-kassem, A. H. (2022c). Fuzzy assisted human resource management for supply chain management issues. *Annals of Operations Research*, 1–19.
- Alzoubi, H. M., Alshurideh, M. T., Kurdi, B. A., Alhyasat, K. M. K., & Ghazal, T. M. (2022f). The effect of e-payment and online shopping on sales growth: Evidence from banking industry. *International Journal of Data and Network Science*, 6, 1369–1380.
- Alzoubi, H. M., & Aziz, R. (2021). Does emotional intelligence contribute to quality of strategic decisions? The mediating role of open innovation. *Journal of Open Innovation: Technology, Market, and Complexity*, 7, 130.
- Alzoubi, H. M., Elrehail, H., Hanaysha, J. R., Al-Gasaymeh, A., & Al-Adaileh, R. (2022g). The role of supply chain integration and agile practices in improving lead time during the COVID-19 crisis. *International Journal of Service Science, Management*, 13, 1–11.
- Alzoubi, H. M., & In'airat, M., Ahmed, G., (2022). Investigating the impact of total quality management practices and Six Sigma processes to enhance the quality and reduce the cost of quality: The case of Dubai. *International Journal of Business Excellence*, 27, 94–109.
- Alzoubi, H. M., Vij, M., Vij, A., & Hanaysha, J. R. (2021b). What leads guests to satisfaction and loyalty in UAE five-star hotels? AHP analysis to service quality dimensions. *Enlightening Tourism. A Pathmaking Journal*, 11, 102–135.
- Alzoubi, H. M., & Yanamandra, R. (2020). Investigating the mediating role of information sharing strategy on agile supply chain. *Uncertain Supply Chain Management*, 8, 273–284.
- Cruz, A. (2021). Convergence between Blockchain and the Internet of Things. *International Journal of Innovation and Technology*, 1, 34–53.
- Edward Probir Mondol. (2022). The role of Vr games to minimize the obesity of video gamers. *International Journal of Computations, Information and Manufacturing*, 2, 1.
- Farouk, M. (2022). Studying human robot interaction and its characteristics. *International Journal of Computations, Information and Manufacturing*, 2, 1.

- Ghazal, T. M., Bibi, R., Saeed, Y., Zeb, A., Rahman, T., Said, R. A., Abbas, S., Ahmad, M., & Khan, M. A. (2021a). Edge AI-based automated detection and classification of road anomalies in VANET using deep learning. *Computational Intelligence and Neuroscience*, 2021, 1–19.
- Ghazal, T. M., Hasan, M. K., Alkhailah, A., Abu Bakar, K. A., Omidvar, A., Nafi, N. S., & Agbinya, J. I. (2021b). *Fischer linear discrimination and quadratic discrimination analysis-based data mining technique for internet of things framework for healthcare* (p. 9). Public Heal.
- Ghazal, T. M., Siddiqui, S. Y., Haider, A., Khan, M. A., Naseer, I., Abbas, S., Rahman, M., Khan, J. A., Ahmad, M., Hasan, M. K., Mohammed, A., & Ateeq, K. (2021c). IoMT cloud-based intelligent prediction of breast cancer stages empowered with deep learning. *IEEE Access*, 9, 146478–146491.
- Ghazal, T. M., Abbas, S., Ahmad, M., & Aftab, S. (2022a). An IoMT based ensemble classification framework to predict treatment response in hepatitis C patients. In *2022 international conference on business analytics for technology and security, ICBATS 2022* (pp. 1–4).
- Ghazal, T. M., Abbas, S., Alhwaiti, Y., Fatima, A., Khan, M. A., Khan, M. A., Kanwal, A., Ahmad, M., & Elmitwally, N. S. (2022b). Convolutional neural network based intelligent handwritten document recognition. *Computers, Materials and Continua*, 70, 4563–4581.
- Ghazal, T. M., Abbas, S., Munir, S., Khan, M. A., Ahmad, M., Issa, G. F., Zahra, S. B., Khan, M. A., & Hasan, M. K. (2022c). Alzheimer disease detection empowered with transfer learning. *Computers, Materials and Continua*, 70, 5005–5019.
- Ghazal, T. M., Ahmed, Z. E., Hasan, M. K., Hashim, A. A., Saeed, R. A., Mokhtar, R. A., & Singh, S. P. (2022d). Optimization procedure for intelligent internet of things applications. In *2022 international conference on business analytics for technology and security, ICBATS 2022* (pp. 1–6).
- Ghazal, T. M., Bukhari, M. M., Abbas, S., Khan, M. A., Farooq, U., Wahbah, H., Ahmad, M., & Adnan, K. M. (2022e). An intelligent proposed model for task offloading in fog-cloud collaboration using logistics regression. *Computational Intelligence and Neuroscience*.
- Ghazal, T. M., Hasan, M. K., Abdullah, S. N. H., Abubakkar, K. A., & Afifi, M. A. M. (2022f). IoMT-enabled fusion-based model to predict posture for smart healthcare systems. *Computers, Materials and Continua*, 71, 2579–2597.
- Ghazal, T. M., Hasan, M. K., Saeed, R. A., Pandey, B., Gohel, H., Eshmawi, A. A., Abdel-Khalek, S., & Alkhassawneh, H. M. (2022g). A review on security threats, vulnerabilities, and counter measures of 5G enabled Internet-of-Medical-Things. *IET Communications*, 16, 421–432.
- Ghazal, T. M., Khan, M. A., Lee, S. W., & Rehman, A. (2022h). Data fusion-based machine learning architecture for intrusion detection. *Comput. Mater. Contin.*, 70, 3399–3413.
- Ghazal, T. M., Mehmood, S., Khan, M. A., Zubair, M., Naseem, M. T., Faiz, T., & Ahmad, M. (2022i). Malignancy detection in lung and colon histopathology images using transfer learning with class selective image processing. *IEEE Access*, 10, 25657–25668.
- Ghazal, T. M., Noreen, S., Said, R. A., Khan, M. A., Siddiqui, S. Y., Abbas, S., Aftab, S., & Ahmad, M. (2022j). Energy demand forecasting using fused machine learning approaches. *Intelligent Automation and Soft Computing*.
- Ghazal, T. M., Rehman, A. U., Saleem, M., Ahmad, M., Ahmad, S., & Mehmood, F. (2022k). Intelligent model to predict early liver disease using machine learning technique. In *2022 International conference on business analytics for technology and security, ICBATS 2022* (pp. 1–5).
- Ghazal, T. M., Zafar, S., Asif, M., Ahmad, M. B., Faiz, T., Ahmad, M., & Khan, M. A. (2022l). Assistive devices analysis for visually impaired persons: A review on taxonomy. *IEEE Access*, 10, 13354–13366.
- Ghazal, T. M., & Taleb, N. (2022). Feature optimization and identification of ovarian cancer using internet of medical things. *Expert Systems*.
- Guergov, S., & Radwan, N. (2021). Blockchain convergence: Analysis of issues affecting IoT, AI and blockchain. *International Journal of Computations, Information and Manufacturing*, 1, 1–17.
- Gul, O., Al-Qutayri, M., Yeun, C. Y., & Vu, Q. H. (2012). Framework of a national level electronic health record system. In *Proceedings of 2012 international conference on cloud computing*

- technologies, applications and management, ICCCTAM 2012. Applications and Management (ICCCTAM), Dubai, UAE* (pp. 60–65).
- Hamadneh, S., Pedersen, O., Alshurideh, M., Kurdi, B. A., & Alzoubi, H. M. (2021). An Investigation of the role of supply chain visibility into the Scottish blood supply chain. *The Journal of Legal, Ethical and Regulatory Issues*, 24, 1–12.
- Hanaysha, J., Al-Shaikh, M., Alzoubi, M., & H., (2021). Importance of marketing mix elements in determining consumer purchase decision in the retail market. *International Journal of Service Science, Management, Engineering, and Technology*, 12, 56–72.
- Hanaysha, J. R., Al-Shaikh, M. E., Joghee, S., & Alzoubi, H. M. (2022). Impact of innovation capabilities on business sustainability in small and medium enterprises. *FIIB Business Review*, 11, 67–78.
- Hasan, M. K., Islam, S., Sulaiman, R., Khan, S., Hashim, A. H. A., Habib, S., Islam, M., Alyahya, S., Ahmed, M. M., Kamil, S., & Hassan, M. A. (2021a). Lightweight encryption technique to enhance medical image security on internet of medical things applications. *IEEE Access*, 9, 47731–47742.
- Hasan, M. K., Musse, M. A., Sherfriz, S. M., Shayla, I., Huda, S. N., Eklas, H., Nazmus S. N., & Nguyen, V. (2021b). An improved dynamic thermal current rating model for PMU-based wide area measurement framework for reliability analysis utilizing sensor cloud system. 9, 14446–14458
- Islam, S., Khalifa, O. O., Hashim, A. H. A., Hasan, M. K., Razzaque, M. A., & Pandey, B. (2020). Design and evaluation of a multihoming-based mobility management scheme to support inter technology handoff in PNEMO. *Wireless Personal Communications*, 114, 1133–1153.
- Joghee, S., Alzoubi, H. M., & Dubey, A. R. (2020). Decisions effectiveness of FDI investment biases at real estate industry: Empirical evidence from Dubai smart city projects. *International Journal of Scientific & Technology Research*, 9, 3499–3503.
- Kim, S.-K., Yeun, C. Y., Damiani, E., & Lo, N.-W. (2019). A machine learning framework for biometric authentication using electrocardiogram. *IEEE Access*, 7, 94858–94868.
- Kurdi, B. A., Alshurideh, M., Akour, I., Alzoubi, H. M., Obeidat, B., & Alhamad, A. (2022a). The role of digital marketing channels on consumer buying decisions through eWOM in the Jordanian markets. *International Journal of Data and Network Science*, 6, 1175–1185.
- Kurdi, B. A., Alshurideh, M., Akour, I., Tariq, E., Alhamad, A., & Alzoubi, H. M. (2022b). The effect of social media influencers' characteristics on consumer intention and attitude toward Keto products purchase intention. *International Journal of Data and Network Science*, 6, 1135–1146.
- Kurdi, B. A., Alzoubi, H. M., Akour, I., & Alshurideh, M. T. (2022c). The effect of blockchain and smart inventory system on supply chain performance: Empirical evidence from retail industry. *Uncertain Supply Chain Management*, 10, 1111–1116.
- Lee, C., & Ahmed, G. (2021). Improving IoT privacy, data protection and security concerns. *International Journal of Innovation, Management and Technology*, 1, 18–33.
- Lee, K. L., Azmi, N. A. N., Hanaysha, J. R., Alzoubi, H. M., & Alshurideh, M. T. (2022a). The effect of digital supply chain on organizational performance: An empirical study in Malaysia manufacturing industry. *Uncertain Supply Chain Management*, 10, 495–510.
- Lee, K. L., Romzi, P. N., Hanaysha, J. R., Alzoubi, H. M., & Alshurideh, M. (2022b). Investigating the impact of benefits and challenges of IoT adoption on supply chain performance and organizational performance: An empirical study in Malaysia. *Uncertain Supply Chain Management*, 10, 537–550.
- Mehmood, T. (2021). Does information technology competencies and fleet management practices lead to effective service delivery? Empirical evidence from e-commerce industry. *International Journal of Innovation, Management and Technology*, 1, 14–41.
- Mehmood, T., Alzoubi, H. M., Alshurideh, M., Al-Gasaymeh, A., & Ahmed, G. (2019). Schumpeterian entrepreneurship theory: Evolution and relevance. *Academy of Entrepreneurship Journal*, 25, 1–10.

- Mejia, C., Ciarlante, K., & Chheda, K. (2019). A wearable technology solution and research agenda for housekeeper safety and health. *International Journal of Contemporary Hospitality Management*, 1–3.
- Miller, D. (2021). The best practice of teach computer science students to use paper prototyping. *International Journal of Innovation, Management and Technology*, 1, 42–63.
- Neaimi, M. Al, Hamadi, H. Al, Yeun, C. Y., & Jamal Zemerly, M. (2020). Digital forensic analysis of files using deep learning. In *2020 3rd international conference on signal processing and information security, ICSPIS 2020* (pp. 1–4). IEEE.
- Obaid, A. J. (2021). Assessment of smart home assistants as an IoT. *International Journal of Computations, Information and Manufacturing*, 1, 18–38.
- Radwan, N. (2022). The internet's role in undermining the credibility of the healthcare industry. *International Journal of Computations, Information and Manufacturing* 2, 1.
- Ratkovic, N. (2022). Improving home security using blockchain. *International Journal of Computations, Information and Manufacturing*, 2, 1.
- Saleem, M., Abbas, S., Ghazal, T. M., Adnan Khan, M., Sahawneh, N., & Ahmad, M. (2022). Smart cities: Fusion-based intelligent traffic congestion control system for vehicular networks using machine learning techniques. *Egyptian Informatics Journal*.
- Shamout, M., Ben-Abdallah, R., Alshurideh, M., Alzoubi, H., Al Kurdi, B., & Hamadneh, S. (2022). A conceptual model for the adoption of autonomous robots in supply chain and logistics industry. *Uncertain Supply Chain Management*, 10, 577–592.
- Shehada, D., Yeun, C. Y., Zemerly, M. J., Qutayri, M. Al, Hammadi, Y. Al, Damiani, E., Hu, J. (2017). BROSMAP: A novel broadcast based secure mobile agent protocol for distributed service applications. In *Security and Communication Networks* (Vol. 2017). Wiley.
- Stoyanova, M., Nikoloudakis, Y., Panagiotakis, S., Pallis, E., & Markakis, E. K. (2020). A survey on the internet of things (IoT) forensics: Challenges, approaches, and open issues. *IEEE Communications Surveys & Tutorials*, 22, 1191–1221.
- Teahan, W. J., Al-Dmour, N. A., & Tuff, P. G. (2012). Knowledge distribution in multi agent systems. *Asian Journal of Information Technology*, 11, 300–311.
- Vo, D. L., Lee, H., Yeun, C. Y., & Kim, K. (2010). Enhancements of authenticated multiple key exchange protocol based on bilinear pairings. *Computers & Electrical Engineering*, 36, 155–159.

Digital Wallet System Development and Evaluation



Shaikha Omar Mubarak, Mahra Khadim Sultan, Saif E. A. Alnawayseh, Waleed T. Al-Sit, and Haitham M. Alzoubi 

Abstract The desire for a better user experience while engaging with mobile payment apps (apps) and electronic wallets (Digital Wallet Systems) is growing as the use of these apps grows. Human- Computer Interaction (HCI) is the study of how to develop, evaluate, and implement interactive computing systems for human use. Usability, or the quality of interactions with a product or system, is one component of HCI. This Research investigates how a Digital Wallet System may be designed to deliver a high level of usability by adhering to excellent HCI practices and utilizing a variety of usability evaluation methods. The research approach began with a literature review and the creation of a prototype, which was iteratively evaluated by a test group using the Thinking-aloud-protocol (TAP) and a combination of performance metrics and questionnaires. The results of the performance metrics, as well as the verbal data, improved with each cycle. According to the data, the most complex or difficult job for the test subjects to complete was Pay by manual entry. Except for the performance target of a proportion of mistakes below 5%, all goals were met for all tasks. To summarize, the test subjects had more difficulty comprehending the notion of the Digital Wallet System than navigating and performing tasks. The challenges stemmed from a lack of understanding of how money was held and transactions were

S. O. Mubarak · M. K. Sultan

School of Information Technology, Skyline University College, Sharjah, UAE

S. E. A. Alnawayseh

Electrical Engineering Department, Mu'tah University, Mu'tah, Jordan

e-mail: saif982@mutah.edu.jo

W. T. Al-Sit

Department of Computer Engineering, Mu'tah University, Mu'tah, Jordan

Higher Colleges of Technology, Dubai, UAE

W. T. Al-Sit

e-mail: w_sitt@mutah.edu.jo

H. M. Alzoubi (✉)

School of Business, Skyline University College, Sharjah, UAE

e-mail: haitham.alzoubi@skylineuniversity.ac.ae

Applied Science Research Center, Applied Science Private University, Amman, Jordan

carried out. We observed that the most essential difficulty when building this Digital Wallet System was to make new functionalities and concepts familiar to the user by tying them to recognizable principles.

Keywords Digital wallet · Human-computer interaction (HCI) · Mobile payment

1 Introduction

So, for this Research Project, we select the Pyypl website. Pyypl is at the heart of UAE digital revolution, pioneering seamless consumer experiences for millions of people throughout the country. Our efforts at the vanguard of the Fintech revolution improve the way our country lives, works, and plays (Alnazer et al., 2017). If we talk about the Brief Introduction, through Pyypl the headway beginning by one device then onto the next is consistent (Shehada et al., 2018). There is a local Website for the significant stages just as the various gadgets with other UAE Websites like Grab Pay, AEON Wallet, we needed to manage awkward substitutes for quite a while before they at long last delivered a work area Website (Vo et al., 2010). Users are protected against making potentially deadly mistakes such as losing all their data or having sensitive information such as credit card details taken, among other scenarios (Alzoubi & Yanamandra, 2020).

Digital wallets are software that saves user credit card information on a device (like with Apple Pay) or through a platform, allowing for one-click or accelerated mobile checkout (as with Amazon Pay and PayPal One Touch) (Mehmood, 2021). The need for a better user experience while dealing with computers has expanded into a multidisciplinary discipline known as Human-Computer Interaction (HCI) (Alhamad et al., 2022). This field includes information from computer science, psychology, ergonomics (Abu-Arqoub et al., 2020), and a variety of other disciplines. Alzoubi et al., (2022a) Demonstrated the service or product quality extensively depends as electronic payment solutions based on electronic wallets (Digital Wallet Systems) are becoming increasingly popular today (Alzoubi et al., 2022b; Ghazal et al., 2022f). In this research, we look at how a Digital Wallet System might be developed to ensure that the user's experience is as positive as possible (Al-Naymat et al., 2021; Ghazal et al., 2022b), using HCI best practices and evaluation methodologies. In the digital transformation of the UAE mobility ecosystem, Pyypl serves as the foundation for millions of UAE (Al-Hamadi et al., 2015a, 2015b; Alshurideh et al., 2022a, 2022b; Alzoubi & Ahmed, 2019). This revolution in financial technology is transforming every aspect of the country's economy, including its work, leisure, and living conditions (Ali et al., 2022a, 2022b; Ghazal et al., 2022d; Kasem & Al-Gasaymeh, 2022).

The following primary customer experience objectives, according to Roger, Pierce, and Sharp, are (Hanaysha et al., 2021):

- Motivation
- Fun
- Enjoying
- Support the Society
- Support Network for Networks.

1.1 Problem Definition

Because Digital Wallet Systems are a relatively new technology (Hanaysha et al., 2022), there is still a lot of research to be done on their usefulness (user experience) (Shehada et al., 2018). This thesis will look into how an Digital Wallet System can be designed to provide a high level of usability by adhering to best HCI practices (from a usability standpoint), as well as try to answer user experience questions that may arise when creating new and innovative apps that employ unconventional technology (Hasan et al., 2021a, 2021b; Shamout et al., 2022). How should a mobile payment app be created to increase its usability in terms of a set of pre-defined usability criteria?

1.2 Research Objective

The goal of this paper is to improve Digital Wallet System usability and, as a result, contribute to a better and more optimal user experience when using Digital Wallet Systems and their intentions of experiencing (Victoria, 2022). The overall goal of this thesis is to show and discuss the results of user testing of a series of mobile payment app prototypes (Ramakrishna & Alzoubi, 2022). The project's final goal is to create a prototype of a mobile payment software that follows HCI principles (Gul et al., 2012). Usability testing will be performed on this prototype. The following six sub-goals have been assigned to this goal (Al-Dmour, 2020).

2 Literature Review

As You produce your user interface, using specific user interface controls and their associated behavior, six design principles are being adhered to

- *Visibility*: In order for them to be effective, they must be visible to as many people as possible (Alzoubi et al., 2020; Lee et al., 2022b). The more people see them, the more they understand them and how to use them. 'Also, keep in mind that it may be difficult to recognize (Ghazal et al., 2022e) and make use of something that is not immediately apparent (Alzoubi et al., 2022d). It is amazing that developers

are still struggling with Touch 'n Go, despite the fact that the concept itself is so simple (Edward Probir Mondol, 2022; Ghazal & Taleb, 2022). As a result of the ongoing debate about the digital wallet or better service provision (Alshurideh et al., 2022a, 2022b; Saleem et al., 2022) over visibility in mobile apps (Siddiqui et al., 2021), the use of either hamburger side-bar menus or tab-bar menus has become popular in the design community recently (Ghazal et al., 2021; Kurdi et al., 2022b). There is one major problem to using the hamburger menu when using a robot-driven system (Teahan et al., 2012): the menu items that are now selected cannot be shown (Alzoubi et al., 2021; Zafar et al., 2022). Rather than relying on the hamburger menu or the tab-bar menu, we focused on highlighting our most important features (Alzoubi, 2021).

- *Mapping*: Mapping control has a direct impact on the globe because of its ability to affect people (Al-Dmour & Teahan, 2005; Khan et al., 2022). As much as possible, make this mapping look as natural as feasible (Alnuaimi et al., 2021). Initially, it's hard to tell what each burner handle controls because the mapping isn't very clear (Abbas et al., 2022; Alshurideh et al., 2022a, 2022b; Farouk, 2022). Make sure to inspect the second picture, which demonstrates how to clean each burner's controls and integrate the various practices (Alzoubi et al., 2022c; Mehmood et al., 2022) and how to optimize the mapping (Lim & Kim, 2020).
- *Affordance*: When it comes to designers, they must be able to see an opportunity and know-how to make use of it immediately (Mehmood et al., 2019). Users must be able to figure out how to access the information they need from the website, or else they will abandon the site altogether (Ghazal et al., 2022a; Hujran et al., 2020).

3 Methodology

3.1 Questionnaire Creation

After a thorough investigation and discussion with academic professionals, a questionnaire for Sfax locals was produced. Six of the questions are open-ended, and the others are closed-ended. There are seventeen questions on the questionnaire. A multiple-choice option is one of the options in a closed question. In a semi-closed question, there is an option "Other" if respondents have other suggestions. It is based on a range of data, such as socioeconomic statistics, travel preferences, and bicycle journeys (Hamadneh et al., 2021).

3.2 Pre-test Using a Questionnaire

Before it was made public, the questionnaire was pre-tested and confirmed with academic specialists to improve comprehension and coherence of the study, as well as to estimate the time required for completion of the questionnaire. The questionnaire

Table 1 Decision criteria for final design

Option	Criterion 1 and its description	Criterion 2 and its description	Criterion 3 and its description
Design option 1	How to login to touch 'n go?	Using the user name	When the user name and password enter they get access directly
Design option 2	Generate alternative	Evaluate alternative	Select the best alternative
Design option 3	Qualitative techniques	Risk analysis techniques	Risk performance

was changed and enhanced because of the comments made by these subject matter experts. The following are the key objectives of the research:

- Identify the type and characteristics of the research into the digital wallet system with collaboration of digital supply chain (Lee et al., 2022a).
- Calculate the total distance traveled and the amount of time required to transfer the amount.

Methodology control has a direct impact on the globe because of its ability to affect people (Ali et al., 2022a, 2022b). As much as possible, make this mapping look as natural as feasible. Initially, it's hard to tell what each burner handle controls because the mapping isn't very clear (Obaid, 2021). Make sure to inspect the second picture, which demonstrates how to clean each burner's controls and how to optimize the mapping (Alshurideh et al., 2020). When it comes to designers, they must be able to see an opportunity and know-how to make use of it immediately. Users must be able to figure out how to access the information they need from the website, or else they will abandon the site altogether.

4 Data Analysis

4.1 State the Design Space

State the design space (decision + criteria) and final design as shown in a Table 1.

4.2 Interface Evaluation

This is where you assess the interface based on your knowledge of design principles and usability objectives.

Table 2 Justification and interpretation of the criterion

Design principles	Rating	Justification and interpretation
1. Visibility	4/5	The deal and award icon is visible: it has a distinct representation of a new user that indicates

Indicate if each criterion is good or bad by giving a number (1: terrible... 5: outstanding) and explain why you chose this value in the reasoning field (Al-Hamadi et al., 2015a, 2015b; Al-Nashashibi et al., n.d.).

As stated in Table 2, the Justification and interpretation of the criterion, as it show the filling in the table below with the ratings for each criterion: 1 equals poor, 2 equals unsatisfactory, 3 equals acceptable, 4 equals very good, and 5 equals excellent. Using an example, provide a clear reason for your rating.

4.3 Solution Suggested

- Design Consistency: A website scrolls vertically (Edward Probir Mondol, 2022), but the home page scrolls horizontally. Although the home page includes a sidebar, most websites feature a top bar (Islam et al., 2020).
- Visibility: The Register now and login on the home page is not easily visible. The menu is difficult to find from the sidebar.
- Affordance: It provides us with a pattern of phone numbers while filling out the Website form, which is a nice thing that enables a smart way of understanding the pattern (Kurdi et al., 2022c).
- Constraints: A person cannot submit a new bank Website until all of the required fields are completed (Zafar et al., 2022); this is a desirable restriction. In the contact or bank, a user cannot input an incorrect mobile number or email address that is comparative approach to protect privacy concerns (Alhamad et al., 2021).

4.4 Understand the Interaction Design Principles in UX

While traversing the Maybank (MAE) website, we have to demonstrate your experience of the given interface in Desirable aspects which are as follows (Cruz, 2021):

- **Desirable Aspects Helpful:** The website was useful since it assisted users in adding cash transactions and saving time (Alhamad et al., 2022).
- **Fun:** It was enjoyable to have all of the information in one spot and to become familiar with all of the different card. There was nothing fascinating about the webpage (Bibi et al., 2021).
- **Entertaining:** The website was enjoyable since it provided all of the information that the user requested (Bibi et al., 2021).

4.5 Undesirable Aspects Boring: The Website Was not Boring Because It Met All of the Standards in Terms of Operations

Frustrating: The lack of a navigation bar in the website for a degree form made the website a bit frustrating for users (Miller, 2021).

Annoying: The website was a bit annoying since there was some inconsistency in the consistency, such as horizontal scalability (Kurdi et al., 2022a).

We investigate the overall design that could impact the user experience (UX). You must use the Digital Wallet System platform to learn about the mechanics, interfaces, and design (Bukhari et al., 2022).

We Analyses and report on the mobile based Digital Wallet System design, gamification features or other factors that influence UX (Hasan et al., 2021a, 2021b; Mejia et al., 2019).

To compare and discuss how the Digital Wallet System design (not limited to visual interface design) of the Website influences the interaction as well as how it can affect the overall user experience and also maintains the information collaborations (Ali et al., 2021). You need to read and support relevant journal articles to discuss these components.

5 Results and Discussion

The research we conducted was divided into two parts, the first of which examined the characteristics of people's movements and the second of which examined their behavior toward a Pyypl website (Ghazal et al., 2022c). There are wallets for both traditional currencies and cryptocurrencies (such as Bitcoin), which require the same functionality, such as the ability to make transactions, check balances, and so on (Alzoubi et al., 2022a, 2022b, 2022c, 2022d). Because there are numerous Digital Wallet Systems on the market, and the purpose of this thesis is to study how one may be developed from a usability aspect, it is necessary to present and compare current Digital Wallet Systems. The next subsections carry out the comparison (Hasan et al., 2022).

6 Conclusion

Given that time, data entry, and screen size are all big stumbling blocks in the mobile conversion process, it makes sense to seek out a resource that can help simplify (and speed up) the mobile checkout process. By focusing on a mobile-first approach to

checkout UX, digital wallets are making shopping considerably easier and faster. Touch ID is integrated with Apple Pay, for example, making purchasing as simple as pressing a button.

7 Future Recommendations

Digital Wallet Systems are a relatively new technology that has grown in popularity in recent years as we approach the digitization era when we are transitioning from physical money and payments to electronic money and cryptocurrency.

Although the markets for these electronic payment methods appear to have a bright future, their success is uncertain due to the possibility of new technology innovations.

A Digital Wallet System, often known as a digital wallet, changes the way consumers buy and pay for products by allowing them to pay with apps on their phones. To ensure that payments and other data are handled securely, every information saved in a wallet is encrypted using public and private key pairs.

References

- Abbas, S., Alhwaiti, Y., Fatima, A., Khan, M. A., Khan, M. A., Ghazal, T. M., Kanwal, A., Ahmad, M., & Elmitwally, N. S. (2022). Convolutional neural network based intelligent handwritten document recognition. *Computers, Materials and Continua*, 70, 4563–4581.
- Abu-Arqoub, M., Issa, G., Banna, A. E., & Saadeh, H. (2020). Interactive multimedia-based educational system for children using interactive book with augmented reality. *Journal of Computer Science*, 15, 1648–1658.
- Al-Dmour, N. A. (2020). Using unstructured search algorithms for data collection in IoT-based WSN. *International Journal of Engineering Research & Technology*, 13, 1992–1998.
- Al-Dmour, N., & Teahan, W. (2005). The blackboard resource discovery mechanism for distributed computing over P2P networks. In International, T. (Ed.), *PDCN. Conference on parallel and distributed computing and networks*, Innsbruck, Austria (pp. 15–17).
- Alhamad, A. Q. M., Akour, I., Alshurideh, M., Al-Hamad, A. Q., Kurdi, B. A., & Alzoubi, H. (2021). Predicting the intention to use google glass: A comparative approach using machine learning models and PLS-SEM. *International Journal of Data and Network Science*, 5, 311–320.
- Alhamad, A., Alshurideh, M., Alomari, K., Al Kurdi, B., Alzoubi, H., Hamouche, S., & Al-Hawary, S. (2022). The effect of electronic human resources management on organizational health of telecommunications companies in Jordan. *International Journal of Data and Network Science*, 6, 429–438.
- Al-Hamadi, H., Gawanmeh, A., & Al-Qutayri, M. (2015a). Formal validation of QRS wave within ECG. In *2015 international conference on information and communication technology research, ICTRC 2015* (Vol. 9, pp. 190–193).
- Al-Hamadi, H., Gawanmeh, A., Baek, J., & Al-Qutayri, M. (2015b). Lightweight security protocol for ECG bio-sensors. *Wireless Personal Communications*, 95, 5097–5120.
- Ali, N., Ahmed, A., Anum, L., Ghazal, T. M., Abbas, S., Khan, M. A., Alzoubi, H. M., & Ahmad, M. (2021). Modelling supply chain information collaboration empowered with machine learning technique. *Intelligent Automation & Soft Computing*, 30, 243–257.

- Ali, A., Septyanto, A. W., Chaudhary, I., Hamadi, H. A., Alzoubi, H. M., Khan, Z. F. (2022a). Applied artificial intelligence as event horizon of cyber security. In *2022 international conference on business analytics for technology and security (ICBATS)* (pp. 1–7).
- Ali, N., Ghazal, T. M., Ahmed, A., Abbas, S., Khan, M. A., Alzoubi, H. M., Farooq, U., Ahmad, M., & Khan, M. A. (2022b). Fusion-based supply chain collaboration using machine learning techniques. *Intelligent Automation & Soft Computing*, 31, 1671–1687.
- Al-Nashashibi, M., Hadi, W., El-Khalili, N., Issa, G., AlBanna, A. A. (2021). A new two-step ensemble learning model for improving stress prediction of automobile drivers. *The International Arab Journal of Information Technology*, 6.
- Al-Naymat, G., Hussain, H., Al-Kasassbeh, M., & Al-Dmour, N. (2021). Accurate detection of network anomalies within SNMP-MIB data set using deep learning. *International Journal of Computer Applications in Technology*, 66, 74–85.
- Alnazer, N. N., Alnuaimi, M. A., & Alzoubi, H. M. (2017). Analysing the appropriate cognitive styles and its effect on strategic innovation in Jordanian universities. *International Journal of Business Excellence*, 13, 127–140.
- Alnuaimi, M., Alzoubi, H. M., Ajelat, D., & Alzoubi, A. A. (2021). Towards intelligent organisations: An empirical investigation of learning orientation's role in technical innovation. *International Journal of Innovation and Learning*, 29, 207–221.
- Alshurideh, M., Gasaymeh, A., Ahmed, G., Alzoubi, H., & Kurd, B. A. (2020). Loyalty program effectiveness: Theoretical reviews and practical proofs. *Uncertain Supply Chain Management*, 8, 599–612.
- Alshurideh, M., Al Kurdi, B., Alzoubi, H. M., Ghazal, T. M., Said, R. A., AlHamad, A. Q., Hamadneh, S., Sahawneh, N., & Al-kassem, A. H. (2022a). Fuzzy assisted human resource management for supply chain management issues. *Annals of Operations Research* 1–19.
- Alshurideh, M. T., Al Kurdi, B., Alzoubi, H. M., Obeidat, B., Hamadneh, S., & Ahmad, A. (2022b). The influence of supply chain partners' integrations on organizational performance: The moderating role of trust. *Uncertain Supply Chain Management*, 10, 1191–1202.
- Alzoubi, H., & Ahmed, G. (2019). Do TQM practices improve organisational success? A case study of electronics industry in the UAE. *International Journal of Economics and Business*, 17, 459–472.
- Alzoubi, H. M., In'airat, M., & Ahmed, G. (2022). Investigating the impact of total quality management practices and Six Sigma processes to enhance the quality and reduce the cost of quality: The case of Dubai. *International Journal of Business Excellence*, 27, 94–109.
- Alzoubi, H. M., & Yanamandra, R. (2020). Investigating the mediating role of Information sharing strategy on agile supply chain in supply chain performance. *Uncertain Supply Chain Management*, 8, 273–284.
- Alzoubi, H. M., Ahmed, G., Al-Gasaymeh, A., & Al Kurdi, B. (2020). Empirical study on sustainable supply chain strategies and its impact on competitive priorities: The mediating role of supply chain collaboration. *Management Science Letters*, 10, 703–708.
- Alzoubi, H. M., Vij, M., Vij, A., & Hanaysha, J. R. (2021). What leads guests to satisfaction and loyalty in UAE five-star hotels? AHP analysis to service quality dimensions. *Enlightening Tourism. A Pathmaking Journal*, 11, 102–135.
- Alzoubi, H., Alshurideh, M., Kurdi, B. A., Akour, I., & Aziz, R. (2022a). Does BLE technology contribute towards improving marketing strategies, customers' satisfaction and loyalty? The role of open innovation. *International Journal of Data and Network Science*, 6, 449–460.
- Alzoubi, H. M., Ahmed, G., & Alshurideh, M. (2022b). An empirical investigation into the impact of product quality dimensions on improving the order-winners and customer satisfaction. *International Journal of Productivity and Quality Management*, 36, 169–186.

- Alzoubi, H. M., Alshurideh, M. T., Kurdi, B. A., Alhyasat, K. M. K., & Ghazal, T. M. (2022c). The effect of e-payment and online shopping on sales growth: Evidence from banking industry. *International Journal of Data and Network Science*, 6, 1369–1380.
- Alzoubi, H. M., Elrehail, H., Hanaysha, J. R., Al-Gasaymeh, A., & Al-Adaileh, R. (2022d). The role of supply chain integration and agile practices in improving lead time during the COVID-19 crisis. *The International Journal of Service Science, Management, Engineering, and Technology*, 13, 1–11.
- Alzoubi, A. (2021). The impact of process quality and quality control on organizational competitiveness at 5-star hotels in Dubai. *International Journal of Innovation and Technology Management*, 1, 54–68.
- Bibi, R., Saeed, Y., Zeb, A., Ghazal, T. M., Rahman, T., Said, R. A., Abbas, S., Ahmad, M., & Khan, M. A. (2021). Edge AI-based automated detection and classification of road anomalies in VANET using deep learning. *Computational Intelligence and Neuroscience*, 2021, 1–19.
- Bukhari, M. M., Ghazal, T. M., Abbas, S., Khan, M. A., Farooq, U., Wahbah, H., Ahmad, M., & Adnan, K. M. (2022). An intelligent proposed model for task offloading in fog-cloud collaboration using logistics regression. *Computational Intelligence and Neuroscience*.
- Cruz, A. (2021). Convergence between Blockchain and the Internet of Things. *International Journal of Innovation and Technology Management*, 1, 34–53.
- Farouk, M. (2022). Studying human robot interaction and its characteristics. *International Journal of Computations, Information and Manufacturing*, 2, 1.
- Ghazal, T. M., Hasan, M. K., Alkhalfah, A., Abu Bakar, K. A., Omidvar, A., Nafi, N. S., & Agbinya, J. I. (2021). *Fischer linear discrimination and quadratic discrimination analysis-based data mining technique for internet of things framework for healthcare* (p. 9). Public Heal.
- Ghazal, T. M., Abbas, S., Ahmad, M., & Aftab, S. (2022a). An IoMT based ensemble classification framework to predict treatment response in hepatitis C patients. In *2022 international conference on business analytics for technology and security, ICBATS 2022* (pp. 1–4).
- Ghazal, T. M., Abbas, S., Munir, S., Khan, M. A., Ahmad, M., Issa, G. F., Zahra, S. B., Khan, M. A., & Hasan, M. K. (2022b). Alzheimer disease detection empowered with transfer learning. *Computers, Materials and Continua*, 70, 5005–5019.
- Ghazal, T. M., Ahmed, Z. E., Hasan, M. K., Hashim, A. A., Saeed, R. A., Mokhtar, R. A., & Singh, S. P. (2022c). Optimization procedure for intelligent internet of things applications. In: *2022 international conference on business analytics for technology and security, ICBATS 2022* (pp. 1–6).
- Ghazal, T. M., Hasan, M. K., Abdullah, S. N. H., Abubakkar, K. A., & Afifi, M. A. M. (2022d). IoMT-enabled fusion-based model to predict posture for smart healthcare systems. *Computers, Materials and Continua*, 71, 2579–2597.
- Ghazal, T. M., Noreen, S., Said, R. A., Khan, M. A., Siddiqui, S. Y., Abbas, S., Aftab, S., & Ahmad, M. (2022e). Energy demand forecasting using fused machine learning approaches. *Intelligent Automation & Soft Computing*, 31, 539–553.
- Ghazal, T. M., Rehman, A. U., Saleem, M., Ahmad, M., Ahmad, S., & Mahmood, F. (2022f). Intelligent model to predict early liver disease using machine learning technique. In *2022 international conference on business analytics for technology and security, ICBATS 2022* (pp. 1–5).
- Ghazal, T. M., & Taleb, N. (2022). Feature optimization and identification of ovarian cancer using internet of medical things. *Expert Systems*.
- Gul, O., Al-Qutayri, M., Yeun, C. Y., & Vu, Q. H. (2012). Framework of a national level electronic health record system. In *Proceedings of 2012 international conference on cloud computing technologies, applications and management, ICCCTAM 2012. Applications and management (ICCCTAM), Dubai, UAE* (pp. 60–65).
- Hamadneh, S., Pedersen, O., Alshurideh, M., Kurdi, B. A., & Alzoubi, H. M. (2021). An investigation of the role of supply chain visibility into the Scottish blood supply chain. *Journal of Legal, Ethical and Regulatory Issues*, 24, 1–12.

- Hanaysha, J., Al-Shaikh, M., Alzoubi, M. (2021). Importance of marketing mix elements in determining consumer purchase decision in the retail market. *The International Journal of Service Science, Management, Engineering, and Technology*, 12, 56–72.
- Hanaysha, J. R., Al-Shaikh, M. E., Joghee, S., & Alzoubi, H. M. (2022). Impact of innovation capabilities on business sustainability in small and medium enterprises. *FIIB Business Review*, 11, 67–78.
- Hasan, M. K., Islam, S., Sulaiman, R., Khan, S., Hashim, A. H. A., Habib, S., Islam, M., Alyahya, S., Ahmed, M. M., Kamil, S., & Hassan, M. A. (2021a). Lightweight encryption technique to enhance medical image security on internet of medical things applications. *IEEE Access*, 9, 47731–47742.
- Hasan, M. K., Musse, M. A., Sherfriz, S. M., Shayla, I., Huda, S. N., Eklas, H., Nazmus S. N., & Nguyen, V. (2021b). An improved dynamic thermal current rating model for PMU-based wide area measurement framework for reliability analysis utilizing sensor cloud system. 9, 14446–14458
- Hasan, M. K., Ghazal, T. M., Saeed, R. A., Pandey, B., Gohel, H., Eshmawi, A. A., Abdel-Khalek, S., & Alkhassawneh, H. M. (2022). A review on security threats, vulnerabilities, and counter measures of 5G enabled Internet-of-Medical-Things. *IET Communications*, 16, 421–432.
- Hujran, O., Alikaj, A., Durrani, U. K., & Al-Dmour, N. (2020). Big data and its effect on the music industry. In *ACM international conference proceeding series* (pp. 5–9).
- Islam, S., Khalifa, O. O., Hashim, A. H. A., Hasan, M. K., Razzaque, M. A., & Pandey, B. (2020). Design and evaluation of a multihoming-based mobility management scheme to support inter technology handoff in PNEMO. *Wireless Personal Communications*, 114, 1133–1153.
- Kasem, J., & Al-Gasaymeh, A. (2022). A cointegration analysis for the validity of purchasing power parity: Evidence from middle east countries. *International Journal of Innovation, Management and Technology*, 2, 1.
- Khan, M. A., Ghazal, T. M., Lee, S. W., & Rehman, A. (2022). Data fusion-based machine learning architecture for intrusion detection. *Computers, Materials and Continua*, 70, 3399–3413.
- Kurdi, B. A., Alshurideh, M., Akour, I., Alzoubi, H. M., Obeidat, B., & Alhamad, A. (2022a). The role of digital marketing channels on consumer buying decisions through eWOM in the Jordanian markets. *International Journal of Data and Network Science*, 6, 1175–1185.
- Kurdi, B. A., Alshurideh, M., Akour, I., Tariq, E., Alhamad, A., & Alzoubi, H. M. (2022b). The effect of social media influencers' characteristics on consumer intention and attitude toward Keto products purchase intention. *International Journal of Data and Network Science*, 6, 1135–1146.
- Kurdi, B. A., Alzoubi, H. M., Akour, I., & Alshurideh, M. T. (2022c). The effect of blockchain and smart inventory system on supply chain performance: Empirical evidence from retail industry. *Uncertain Supply Chain Management*, 10, 1111–1116.
- Lee, K. L., Azmi, N. A. N., Hanaysha, J. R., Alzoubi, H. M., & Alshurideh, M. T. (2022a). The effect of digital supply chain on organizational performance: An empirical study in Malaysia manufacturing industry. *Uncertain Supply Chain Management*, 10, 495–510.
- Lee, K. L., Romzi, P. N., Hanaysha, J. R., Alzoubi, H. M., & Alshurideh, M. (2022b). Investigating the impact of benefits and challenges of IOT adoption on supply chain performance and organizational performance: An empirical study in Malaysia. *Uncertain Supply Chain Management*, 10, 537–550.
- Lim, S. H., & Kim, D. J. (2020). Does emotional intelligence of online shoppers affect their shopping behavior? From a cognitive-affective-conative framework perspective. *International Journal of Human Computer Interaction*, 36, 1304–1313.
- Mehmood, T. (2021). Does information technology competencies and fleet management practices lead to effective service delivery? Empirical evidence from e-commerce industry. *International Journal of Innovation, Management and Technology*, 1, 14–41.
- Mehmood, T., Alzoubi, H. M., Alshurideh, M., Al-Gasaymeh, A., & Ahmed, G. (2019). Schumpeterian entrepreneurship theory: Evolution and relevance. *Academy of Entrepreneurship Journal*, 25, 1–10.

- Mehmood, S., Ghazal, T. M., Khan, M. A., Zubair, M., Naseem, M. T., Faiz, T., & Ahmad, M. (2022). Malignancy detection in lung and colon histopathology images using transfer learning with class selective image processing. *IEEE Access*, 10, 25657–25668.
- Mejia, C., Ciarlante, K., & Chheda, K. (2019). A wearable technology solution and research agenda for housekeeper safety and health. *International Journal of Contemporary Hospitality Management*, 1–3.
- Miller, D. (2021). The best practice of teach computer science students to use paper prototyping. *International Journal of Innovation, Management and Technology*, 1, 42–63.
- Mondol, E. P. (2022). The role of Vr games to minimize the obesity of video gamers. *International Journal of Computations, Information and Manufacturing*, 2, 1.
- Obaid, A. J. (2021). Assessment of smart home assistants as an IoT. *International Journal of Computations, Information and Manufacturing*, 1, 18–38.
- Ramakrishna, Y., & Alzoubi, H. M. (2022). Empirical investigation of mediating role of six sigma approach in rationalizing the COQ in service organizations. *Operations and Supply Chain Management*, 15, 122–135.
- Saleem, M., Abbas, S., Ghazal, T. M., Adnan Khan, M., Sahawneh, N., & Ahmad, M. (2022). Smart cities: Fusion-based intelligent traffic congestion control system for vehicular networks using machine learning techniques. *Egyptian Informatics Journal*.
- Shamout, M., Ben-Abdallah, R., Alshurideh, M., Alzoubi, H., Al Kurdi, B., & Hamadneh, S. (2022). A conceptual model for the adoption of autonomous robots in supply chain and logistics industry. *Uncertain Supply Chain Management*, 10, 577–592.
- Shehada, D., Yeun, C. Y., Zemerly, M. J., Al-Qutayri, M., Al-Hammadi, Y., & Hu, J. (2018). A new adaptive trust and reputation model for mobile agent systems. *Journal of Network and Computer Application*, 124, 33–43.
- Siddiqui, S. Y., Haider, A., Ghazal, T. M., Khan, M. A., Naseer, I., Abbas, S., Rahman, M., Khan, J. A., Ahmad, M., Hasan, M. K., Mohammed, A., & Ateeq, K. (2021). IoMT cloud-based intelligent prediction of breast cancer stages empowered with deep learning. *IEEE Access*, 9, 146478–146491.
- Teahan, W. J., Al-Dmour, N. A., & Tuff, P. G. (2012). Knowledge distribution in multi agent systems. *Asian Journal of Information Technology*, 11, 300–311.
- Victoria, V. (2022). Impact of process visibility and work stress to improve service quality: Empirical evidence from dubai retail industry impact of process visibility and work stress to improve service quality: Empirical evidence from dubai retail industry. *International Journal of Innovation, Management and Technology*, 2.
- Vo, D. L., Lee, H., Yeun, C. Y., & Kim, K. (2010). Enhancements of authenticated multiple key exchange protocol based on bilinear pairings. *Computers & Electrical Engineering*, 36, 155–159.
- Zafar, S., Asif, M., Ahmad, M. B., Ghazal, T. M., Faiz, T., Ahmad, M., & Khan, M. A. (2022). Assistive devices analysis for visually impaired persons: A review on taxonomy. *IEEE Access*, 10, 13354–13366.

Entrepreneurship and Technology Diversification: A Strategy or Desperation? FAM Case Study



Anil Roy Dubey, Shanmugan Joghee, and Haitham M. Alzoubi 

Abstract Entrepreneurship demands drive, self-motivation, perseverance and above all finding out business opportunities, when others don't. Personal and business failures often build resilience, a requisite quality in a successful entrepreneur's acumen. Business opportunities have a life cycle, some long, some short and some with stagnancy. Some of them rewards the entrepreneur immediately, some in the long term and some phase out gradually with time. Very often, disruption changes the pattern of business life cycle too. A truly proactive strategy of Diversification is by adding new business (es) to an existing array of portfolio to improve overall return for a business enterprise. This strategy could be, to develop new product / service or expand to a new or existing market which is rewarding. A planned initiative to diversify, therefore, is also a technique to thin out the effects of negative impact of businesses, especially, at the declining stage of its Life cycle. History, however, is replete with instances where businesses have been driven to choosing Diversification as resort to bail out the existing pitfall, mostly as a result of the decline of, what was once perceived to be a perennial profitable opportunity. Should the strategy of Diversification, therefore, be seen as a challenge to an entrepreneur's proactive risk taking ability or should it be seen as a defensive/ reactive strategy which business compulsions drive him to? The following case study poses a challenge to budding as well as seasoned entrepreneurs and hopefully stimulates the thought process as to what, when, why and how to go about diversifying the business portfolio to establish a sustainable business with reasonable longevity.

A. R. Dubey
Lingayas Vidyapeeth University, Nacholi, India
e-mail: cv@lingayasvidyapeeth.edu.in

S. Joghee · H. M. Alzoubi (✉)
School of Business, Skyline University College, Sharjah, UAE
e-mail: haitham.alzoubi@skylineuniversity.ac.ae

S. Joghee
e-mail: jshanmugan@skylineuniversity.ac.ae

H. M. Alzoubi
Applied Science Research Center, Applied Science Private University, Amman, Jordan

1 Introduction

The notion said by Forbes (2014) “If you don’t drive your business, you will be driven out of business”. This question, interestingly, is certain to pop up in any entrepreneur’s business life, either out of choice or as they say, desperation. Moreover, the Objectives of this case to Stimulation in strategic approaches of budding I future crop of entrepreneurs. And to evaluate the legacy of a successful entrepreneur. As well as to educate the reader about the benefits and challenges of diversification. Then to explain how FAM holding company intend to reach their long term financial goals. Finally, to understand the dynamics behind the diversification strategy by FAM Holdings.

The case aimed to investigate the reality of entrepreneurship at the studied case, and to explore the learning outcomes from the case which is intended for the readers to understand the nuances of Entrepreneurship, which are: Building internal capabilities (Alnuaimi et al., 2021); Facing external challenges (economic or political); Facing, challenging and overcoming failures; Re-strategizing business based on business requirements; Holistic market strategy in order to capture higher market share; Planning for the unplanned (facing the disruption); Business lessons from personal experiences; Influence of family in entrepreneurship (Joghee et al., 2020).

On the other hand, to understand the nuances of Diversification, which are: The rationale behind diversification; Proactive initiatives or reactive strategies; Benefits of diversification; an investor’s perspective of diversification Vs business perspective of diversification; Developing Core Competencies.

2 Theoretical Framework and Corporate History

The journey of Ali Mousa and Sons Holding Group (AMSHG) started in 1978 in the coastal town of KhorFakkan, when the founder and current Chairman Mr. Ali Mousa Al Naqbi set up AMS Contracting as a small private family office with a vision of contributing to the construction boom sweeping the United Arab Emirates, which was on the cusp of becoming a leading economic Centre in UAE. AMS started in 1978 and all through their history, has prided itself an impressive record of successfully completed projects. They earned recognition for undertaking large complex projects and making a difference for our clients, employees and the community. All their successes were based on the mutual trust they built with their clients, ease of communication and smooth collaborations across locations and departments.

The group exemplified professionalism, efficiency, professionalism and ethical values. This ensured high customer satisfaction providing their clients with services that exceeded their expectations. They executed many important strategic projects and extended to even include University of Sharjah, American University, Technical colleges, Governmental buildings, Traffic centers, Hospitals, Forensic Labs, Police Stations, Etisalat Buildings, Sports Halls & Clubs and a large number of

model schools (Alnazer et al., 2017). It also included thousands of Residential units and Towers, Luxury Villas, Compounds, several business & Marketing centers, Commercial complexes and various industrial buildings.

The company also prides itself in providing integrated services through its subsidiaries, as follows: Construction Contracting Company

- Electrical and Mechanical Contracting Company
- Industrial Metal works Company
- Joinery and Decoration Company
- Aluminum and Glass Company
- Real Estate Development and Property Management Company
- Prefabricated Houses and Fiberglass Company
- Crushers Equipment Company

The Company and its subsidiaries, having developed good reputation and activities extended its through direct Branch offices/representatives across GCC (Alzoubi et al., 2022d).

A number of promising opportunities in and near the above states are being explored and evaluated (Victoria, 2022). The efficient and effective management has enhanced the ability of the privileged group (Alhamad et al., 2022) which has developed competencies in implementation of projects of any size or type.

2.1 *The Promoter's Profile*

2.1.1 Dr. Faisal Ali Mousa (FAM) from Bare Hands to a Billion

While his father was undergoing commotion in business, his son Mr. Faisal Ali Mousa, a young Emirati redefined the landscape of family business. With his true insight and dynamic thought process he stood tall and made his visible space in the business community. This young Emirati has emerged and is now well known in the economic circles. His father was a wealthy contractor in the 70s and 80s. The second Gulf war hurricane shattered his wealth but not his dream. The Son, a Communication Engineer, did not want to be a Government employee after his graduation nor he did he interest to manage his father's family business because of differences in vision.

He ventured out with his clear vision with a determined decision to make his own empire. Mr. Faisal was born in 1974, one among 7 brothers and 4 sisters to a father who worked as a Driver in his own business. He used to transport goods between UAE and Oman and comes from a family that loves sea-faring. Khor Fakkan, where he was born, is a beautiful city in the eastern shores of the UAE.

His childhood see-sawed and looked like a Stock Market chart with several falls and rises through the primary, junior high and senior schools. The progress of his school education was not that satisfactory, primarily because of the family circumstances, but, he remained good in the faculty of communication.

2.1.2 Brief Biography of Mr. Faisal's Father

Just two years after his birth, his father Mr. Issamia decided to work as a contractor in 1976. The beginning was modest indeed and limited to his father's physical and human potential. He began to undertake contract work for group of villas in the desert area, which, over the coming years, highly rewarded him. He kept successfully completing small projects, until he landed on a large project of His Highness Sheikh Zayed worth UAE Dh. 40 million. This was a dream-come-true contract since the amount was astounding. But unfortunately, the winds of the Second Gulf war, the desert storm, was not in their favour. The cost of Building materials rose by 900% due to the war, resulting in huge losses. The children too, were taken by surprise, when their father collected them and moved them to Sharjah to a modest house.

Musa saw his last days of school in the fall of 1992 and the conditions of this tender boy and his siblings became difficult. Like a silver lining in the dark clouds, His Highness Sheikh Sultan al Qasmi, the then Governor of the Emirate of Sharjah, heard about the financial instability. He asked for a meeting to find out the reasons and provide help. However, his father politely declined the financial assistance and instead started focusing on turning around the entire project with all his might. He collected all his energies and his son's hard work could now completed the project ahead of scheduled time of one year; in just six months. This, apparently, impressed the Governor who now firmly believed in his father's capabilities. The Governor commissioned to implement 30 real estate units and in due course 150 more. The family now made a decent profit which motivated them to undertake projects in the private as well as public sectors. One of the most prominent projects that Ali Musa participated was the successful completion of the Universities of Sharjah and American University, along with Darwish. The government, announced the commencement of the academic session in a year's time. However, the project was moving at a slow pace. With more encouragement and motivation of Sheikh Sultan during his several personal visits to the site, work now was 'going on 24 h at full throttle. And the project got completed, as already mentioned in 50% of the time expected.

3 Literature Review and FAM Case

The challenging learning experiences with his father, made him a disciplined person with good management skills, strict in his dealings with associates and the society. His father also, instilled in him, religious values, ethical and human norms which helped him in the years ahead in his life.

After Graduation, Faisal was forced to work as a Communication engineer. He had the good fortune to work the UAE vision project. He quickly grasped the technicalities of Project Management from his manager whom he loved but was hated by everyone else. He was sent to training courses to the US, Belgium, Norway and France. A phone call from his father requesting him to leave and join him in business was

all that was needed for Faisal to make up his mind. He decided to give his father a supportive hand in expansion of the business. As a good obedient son, Faisal realized that this decision was in all righteousness.

In 1998, foregoing his personal desires, aspirations and ambitions, Faisal now decided to deal with all types of construction materials including wood, paint, aluminums and glass. This would support the expansion plans of his father's business. He set up four Installation and Supply plants to supply materials to his father's business. But the businesses were so successful that he now started export to several countries.

Faisal never considered himself as the manager or the son of the owner. He became one of the workers who was willing to dirty his hands, go through the grinds and eventually excelled in the Manufacturing and supply first class materials. He could now manage 2000 workers of his company, very effectively. The group became a school for the family where most of his.

Brother's joined to help Faisal.

In the year 2015, Mr. Faisal's growth plan had a setback and running out of new ideas, and he also skeptical that his ideas may fail given the irony of the situation and the unequal equation.

But at the end, he had to take a step. His idea of personal accomplishment had be translated to reality. He sought the help of a Lebanese man who was an interior designer. Faisal had an idea of a tower that revolves around itself. But this was unconvincing until he drew the sketch of the tower. His Lebanese friend now got fully assured of its viability and success.

But then, a piece of paper cannot be worth billions isn't' it? Ideas are only ideas till they become reality. Where would the funds come from for such a huge project and how? His mind was struggling to find a solution.

He somehow managed to show the project to the country's most powerful real estate company. Jad al Ameer, partner, Abdul Hakeem al Tayer, Consulting engineers and others eventually agreed to provide help. Some of them agreed to give -him an office, others provided funding, guidance and now the famous Dubailand is about to be implemented. From this point, there was no looking back. He once again displayed the business acumen that made the business grow exponentially.

In a year's time from then, Faisal has now managed to announce the launch of projects worth AED 27 billion across UAE. He also explored beyond boundaries ambitiously in Egypt, Syria and Madagascar.

Faisal fondly recalls how his life with only a few thousand Dirhams in beginning, restored his self-confidence, opened the doors of wealth and prosperity to his family, contributed some of the memorable projects for the benefits of his mother land. If only, the father and son had been together, they would have been declared as, perhaps the richest family in the Gulf.

4 Discussion

FAM's business journey is truly inspiring indeed, especially to budding entrepreneurs and even seasoned professionals. Scaling up, expansion, diversification, strategic alliances turning around are some of FAM's milestones which should guide the future generations. His ability to counter unexpected disruptions, including a personal one, is remarkable indeed.

4.1 *The Case in Hand*

One fine morning, Mr. Faisal Ali Musa, now the Iconic entrepreneur having a formidable DNA of business acumen, was going through the usual task of signing cheques for payables. His expression changed to fury, when he observed a cheque for a huge amount to a Chemical supplies company that needs his approval signature. He was not aware of the details and sought clarification, (though very much upset and disturbed), as to why such a large amount is due for payment, to whom and where does this company exist, etc.

His accountant, keeping his cool, humbly confirms that the payment is indeed due and that the company has committed for this since it has procured Chemicals from them. He immediately calls for a meeting to determine from the concerned project heads (Alzoubi et al., 2021). At the same time, he also seeks information from the Finance department to submit the details on how much the company has spent in Chemical so far and what is the current liability to the suppliers. He also wants to understand the contractual obligations in addition to the current liabilities to the suppliers.

The sudden upsurge of the boss certainly created a little panic among the team members. In the meantime, Faisal obtains advice from industry professional regarding the business strategy to be deployed by his company and clarify the following.

- Type of Chemicals used in Construction industry (Gallo et al., 2021)
- Cost of chemicals as a percentage of total cost of project in real estate (Alzoubi et al., 2022d)
- Leading players in the market for supply of Chemicals related to construction (Hanaysha et al., 2021)
- The impact of value addition of supply of Construction chemicals to his integrated services (which includes complementary services like contracting, electrical, metal, joinery aluminums, prefab, crushers etc. as mentioned earlier) (Hamadneh et al., 2021)

All the above information was required for him to establish the way forward to consider yet another strategic business move. i.e. diversification.

There were several unanswered questions:

- Whether a Construction I Real estate company could actually develop competencies in manufacturing Construction chemicals
- Or he should look at the option of any other form of Strategic alliance.
- He also wanted to understand the additional contribution in any of such strategic moves.
- What business edge or advantage would the company derive from such a move?

4.2 *Diversification—What Drives It?*

His mind was toying with many models including a N with the world's best Construction Chemical company. Though in the past, he was fairly successful in backward integration by diversifying his investments into related business, he was intrigued by “what actually drives diversification?”.

He also came across a simple but very meaningful depiction of “Dubey Shan Model of Diversification” given below. He was impressed with the basic premise of this model, where Risk and Growth shapes strategy, which then coupled with Experience and losses drives towards diversification to new businesses eventually leading to successes (Fig. 1).

But before embarking on a due diligence exercise Faisal wanted to have a peek on the current scenario of both the Construction Industry scenario in the Middle East and the potential feasibility and viability of Construction Related Chemical industries (Alnuaimi et al., 2021). His decision would now depend on the outcome of the analysis of the future of the Construction industry in general and more particularly (Alzoubi et al., 2020), investing in the Construction related Chemical Industry as an entrepreneur as well as strengthening his current portfolio of his enterprise (Khan, 2021).

The findings from various sources are summarized below.

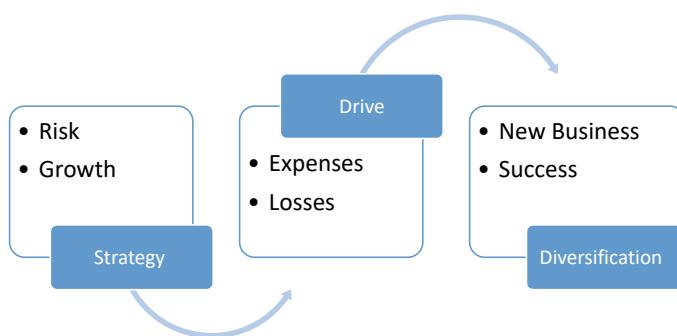


Fig. 1 DUBEY SHAN model of diversification

4.3 Current Scenario—The GCC

The GCC has one of the fastest growing populations in the world, with a continued influx of people that is set to increase in the next couple of years, driven by global events like Expo 2020 Dubai and the 2022 FIFA World Cup in Qatar. In response to this, countries are positioning themselves as global business hubs, with leading airlines, and national visions that aim to push forward the development of non-oil sectors and boost diversification within their economies (Alzoubi et al., 2022a, 2022b, 2022c, 2022d). As a result of such plans, property developers in the region are confident that demand for residential property will not subside any time soon (Hanaysha et al., 2022).

Many industry leaders are at odds about its true current state, and what the future may hold (Ahmed & Amiri, 2022). Experts, including David Godchaux, CEO of Core Savills, believe that the property market in the GCC—and, more specifically, in the UAE—has matured over the last decade. The overall effect, they say, has been a positive one, despite the hardships caused by stagnant oil prices, and the austerity measures taken by states in order to counter their impact. There can be little doubt that the property market in the region is seeing new trends (Alzoubi & Ahmed, 2019), be it as a result of market maturation, or a necessary adaptation in the face of current market challenges (Lee et al., 2022b).

This optimism is also supported by the growth within the tourism sector, not only in the UAE and Qatar, but also in countries such as Saudi Arabia, which, in 2017, is focusing on the hospitality market like never before (Alzoubi et al., 2021). In fact, Saudi-based Cayan Group chairman, Ahmad Alhatti, tells Construction Week that his company is determined to embrace the new opportunities presented by the hospitality field (Alshurideh et al., 2022). He explained: “From the aspiration for serviced apartments, to resort-style living, hospitality is changing the game,” adding that hospitality is intrinsically linked to tourism and real estate across the GCC (Corluka & Lindh, 2017).

Though most industry insiders claim to be optimistic about the future such as, hospitality, pharmaceuticals, banking (Alzoubi et al., 2022b) and transportation (Alzoubi et al., 2022c); reports continue to indicate declines in certain sub-sectors of the property market throughout Qatar, Bahrain, Saudi Arabia, and the UAE.

4.4 The Shift Towards Mid-Market Segment

Whatever the future may hold, it goes without saying that the shifting trends of today’s real estate market will shape the face of the GCC’s construction industry for years to come. The noticeable shift towards mid-market and more affordable residential units in many countries are clearly visible and is increasingly becoming a key driver behind new residential projects in major regional markets such as Saudi Arabia and specifically, the UAE (Ali, 2021).

Very recently, at Cityscape, Abu Dhabi, leading property developers launched a number of massive residential projects across the UAE, despite continued fears of a slowdown in the market among many of the exhibition's visitors.

Aldar Properties, one of the largest property developers in the Emirates, recently announced plans to invest \$518 m (AED1.9bn) in the development of mid-market residential, hospitality, and retail projects (Kurdi et al., 2022b). Aldar subsequently sold out two of the development's six towers during the three-day event. A few weeks later, the development's third tower sold out in just four hours, generating a total of \$163 m (AED600m) across all three towers, conclusively proving the resilience of the mid-market segment, and highlighting the changing appetites of consumers in the market (Alzoubi et al., 2022a).

Emaar Properties, the developer behind Burj Khalifa has until now focused on the luxury segment through its partnership with Giorgio Armani, with which it plans to develop about 10 hotels over the next decade (Alzoubi & Aziz, 2021). But, now the surging visitor numbers to the emirate are also encouraging the company to target mid-range and budget travelers with its recently launched Dubai Inn brand. The property heavyweight's expansion into the budget hotel segment is a clear sign there is room for growth in the area, say analysts.

Developments as cited above and many more, are only convincing entrepreneurs, especially in the Construction industry to continue to explore market opportunities. But perhaps, in a different orientation.

4.5 Asian and Global Developments

Needless to say, the GCC market will ricochet the developments of both Asian and the Global developments, especially, in the real estate segments. Asian investors with a stronger appetite for risks are expected to seek opportunities outside gateway cities in locations offering attractive pricing (Kasem & Al-Gasaymeh, 2022). The low yield environment will continue to encourage investors to look outside conventional asset classes as they try to take advantage of new demand resulting from changes in consumer behaviour. Global economic uncertainty will drive a stronger occupier focus on portfolio optimization (Kurdi et al., 2022a). Companies will be more cautious towards investment and expansion, and execute strategies that improve operational efficiency (Monostori, 2018). Softening demand and new supply will drive an emphasis on place making and prompt landlords to be more creative and proactive in managing their tenant community (Lee et al., 2022a).

Globally, for the past five years, rapid change has taken place against a backdrop of weaker than-normal economic growth (Alshurideh et al., 2022). However, the mild recession in the oil and commodities sector is over, unemployment continues to fall, and governments are starting to invest more in much-needed infrastructure upgrades that may increase the marketing demand (Hanaysha et al., 2021).

All of the real estate sectors we review in this outlook for 2020 are in the process of reinventing themselves to accommodate technology-driven changes in business

operations (Ali et al., n.d.). Although the rate of change is rapid, it is the most exciting and interesting time to be involved in commercial real estate.

In addition to macroeconomics and real estate coverage, our 2020 Global Real Estate Market Outlook has five key research themes:

- Capital markets: the search for alternatives
- Office: new work styles, new locations
- Retail: changing technology
- Industrial: transformation of the supply chain
- Hotel: new experiences, new platforms

4.6 *Dubai Realty Trends*

In the global macroeconomic picture, last year was largely seen as volatile. The world can't wait to move on to the next. Nonetheless, having avoided a bubble in the previous year and getting past a slowdown last year, the UAE property sector has done comparatively well (Shamout et al., 2022). Many new landmark projects have been announced and the newly launched Dubai Water Canal is emerging as a major talking point, ending the year on a happy note (Mondol, 2021). Analysts are now cautiously dipping their toes into optimism, suggesting the property market is poised to recover next year. However, global headwinds may affect Dubai as many markets battle uncertainty.

Dima Isshak, head of research and advisory at Chestertons, calls this a period of "correction and normalization" following a series of global and regional events in the last couple of years. "Has the market bottomed out? The answer is not yet clear," she says. "The reason is that real estate is not immune to external factors, whether geopolitical or economic."

A report by Cluttons states that, the real-estate market will continue to receive a boost from infrastructure projects linked to the World Expo in 2020 and other mega developments. "These will help sustain or lift public sentiment, which has proved instrumental in keeping the emirate's economic growth profile the most positive in the region," the report states (Obaid, 2021).

According to Chesterton's, prices came down in many residential locations across Dubai last year. Dubai land saw a 13% downward movement, whereas Downtown Burj Khalifa saw a 9% decline. Prices were down 5–8% in areas such as the Meadows and Springs, Al Furjan, Dubai Motor City, Arabian Heights and Victory Heights. The top transaction areas were Dubai Marina with 1,442 transactions, followed by International City (1,348), Emirates Living (831) and Jumeirah Lakes Towers (733). Dubai land saw 699 transactions. Cluttons says the average residential values have been down by 7.4% during the past 12 months. Despite some submarkets heading towards bottoming out, transaction volumes are still weak and reflect a general nervousness among buyers (Kurdi et al., 2022a, 2022b, 2022c). Quarterly transaction volumes slipped by 21% in the third quarter, led by a 22% fall in apartment deal volumes,

which are down 26% when compared with the third quarter in 2015. The average price of a transacted villa has also fallen by 28.1% since the start of the year to stand at Dh3 0.9 million (Dahan, 2018).

4.7 *Value Driven Market*

Highlighting value as a key theme, Cluttons' report shows that values over the past 12 months in high-end locations such as Hattan Villas at The Lakes and the Palm Jumeirah, receded by 11.9% and 11.1% respectively. Mid-range homes in locations such as Emirates Living, Arabian Ranches and Victory Heights recorded a negligible 0.1% increase in prices (Alzoubi, 2022). Commenting on the contracting villa prices, Faisal Durrani, head of research at Cluttons, says, Average prices contracted mainly due to the weak performance of the luxury segment of the market (Mehmood et al., 2019). This is down to affordability issues that persist, along with a slowing in the rate of creation of senior-level executive positions (Alshurideh et al., 2022).

These two factors, combined with a weak but notable nervousness to commit to more expensive purchases, are continuing to drive down villa values across the board. Over the past three years for instance, villa prices have fallen by close to 10%.

Isshak says that the buyer profile today is very different from the historic type, which she says consisted of "foreign buyers, flippers and bulk investors". While this type of buyer injects cash into the market, improving market sentiment and has a positive impact on the economy, the downside is a "volatile market, controlled by a few and sensitive to external factors" such as innovation, technological implications and machine learning techniques (Ali et al., 2022). On the other hand, the current buyer profile consists of "end users, expats, long-term investors and first-time buyers". These are investors who evaluate their returns unmercifully demanding "true value" of every Dirham spent by them, which is understandable and justified enough, though.

This type of buyer creates stability in the market, builds a large pool of buyers that is less sensitive to external factors and encourages expat spending (Ramakrishna & Alzoubi, 2022). The downside is lower liquidity, lukewarm market sentiment and lower transactions.

4.8 *Supply-Led Pricing*

Urray Strang, head of Cluttons Dubai, notes that with 34,000 units unveiled last year, "it's clear that project announcements are continuing at an unrestrained pace, despite what could be perceived to be challenging trading conditions".

"If supply continues to increase in the next 12–18 months, as the global economy remains unstable, it is likely to cause the current stability and projected bottoming out of the real estate market to unravel, with further price falls likely to follow

suit. “Developers have traditionally overestimated levels of completions of homes in Dubai, with only around 30% of all announced projects actually being delivered on schedule over the past few years,” says Craig Plumb, head of research at JLL Middle East and North Africa.

4.9 *Rentals*

In the rental market, the Cluttons report shows that after a sharp 4.4% fall in average rents across the city’s freehold areas in the second quarter, which was the strongest decrease recorded in five years, the rate of decline moderated to 1.5% in the third quarter. The latest change leaves average rents 8% down in the fourth quarter (Alhamad et al., 2021). Durrani says: Positively, however, apartment rents were unchanged in the third quarter across all the submarkets we monitor, hinting perhaps that this segment of the market may be starting to flatten out. On an annualized basis, villa rents are down by 9.4%, while apartment rents are 5.8% lower than this time last year.

“Similar to the sales market, the top end of the villa market in locations such as the Palm Jumeirah, Jumeirah Islands and The Lakes have experienced the strongest rental drops over the past 12 months.” He says sales and rental values are around 10% down compared to the same period last year, “with any bottoming out unlikely to materialize until next autumn at the earliest”.

4.9.1 **Office Market**

The demand for quality office space persists, resulting in more stability. Cluttons says the lack of supply in sought-after submarkets such as Dubai International Financial Centre (DIFC), Dubai Internet City and Dubai Media City, coupled with a relatively buoyant domestic economy, and has resulted in rents being sustained. Grade A offices near established commute areas will continue to see good occupancy and healthy demand. However, there will be pressure on prices as companies look to consolidate. Office rents may witness a correction due to weak occupier demand and profitability (Alzoubi, 2021).

Despite Dubai’s continued resilience to global economic factors, compared with other prominent cities in the region, the year is ending with fewer requirements compared to the same time last year. The Cluttons report says that consolidation activities in the finance and banking sector, in addition to the oil and gas sector, which commenced about 18 months ago, is now winding down.

The pharmaceutical, legal and technology sectors, on the other hand, are among the most active occupier groups in the market and expansion activity continues from these tenants (Radwan & Farouk, 2021). “Despite the somewhat flat conditions, Dubai’s office market has been the most resilient in the region, which stems from its appeal among international occupiers and the strong belief in the domestic economy’s

ability to shake off any fringe impacts of an uncertain global outlook,” says Durrani. “This is reflected in the fact that occupiers such as Huawei and MasterCard are pressing ahead with purpose-built schemes in sought-after office hotspots such as Dubai Internet City.”

4.9.2 Dubai Diversification

Dubai’s efforts at diversification continue to make it a global example of how an economy can overcome any challenge it faces. A recent report shows that Dubai’s “stable macroeconomic environment, its diversification and sustainability policies, growth strategies and infrastructure initiatives continue to fuel outstanding economic performance” even when the global economy faces headwinds (Schilirò, 2013).

Dubai last year grew by 2.85% while global GDP growth stood at 2.4%. Dubai has achieved this by positioning itself as a global hub and one of the top five international centers for trade, transport, finance and tourism. “Diversification, resilience and sustainability are enshrined in every project, policy and strategy that Dubai adopts, including, for example, the Dubai Plan 2021, Dubai Industrial Strategy 2030, and Expo 2021,” said Shaikh Ahmad Bin Saeed Al Maktoum, Second Deputy Chairman of the Executive Council and Chairman of the Economic Development Committee.

Dubai has achieved this by applying an innovative vision and strategy to facilitating business, improving service efficiencies, creating new investment opportunities, and encouraging entrepreneurship. This has helped Dubai become one of the most competitive economies in the world, with its stated determination to become the most competitive economy in the world by 2021. The vision of Dubai’s leadership continues to inspire the country to find new ways of driving the economy.

This economic success of course benefits us all, by allowing us all to become a city of happy, creative and empowered people. This kind of society also helps promote further economic growth that will help us sustain future generations. While we look to the future, we know that growth is expected to continue for at least the next two years, with 3.1% growth in 2017 and 3.6% growth in 2018. The domestic trade sector was the chief driver of the emirate’s impressive GDP growth in 2016; however, tourism, real estate and manufacturing are expected to dominate economic activity in the years ahead.

But if one statistic truly demonstrates how successful Dubai economy diversification has become, it is that oil now contributes only 1% to Dubai’s GDP. While many oil producing economies have suffered from the fall of global crude prices over the past two years, Dubai’s economy continues to grow, providing its citizens and residents with jobs in multiple sectors.

Appendix

Entrepreneurship Survey

- List out three important factors that has made FAM, a successful entrepreneur.
- In his entrepreneurship journey FAM encountered many disruptions. List out three significant of them and how would you have handled if you were in such a situation
- What do you think was the role of his family in shaping FAM as a successful entrepreneur with a sharp business acumen? Do you think an entrepreneur could do it all alone? If not, why?
- What are the key lessons learnt by FAM from both business and family disruptions?
- What is your opinion about adding Construction Chemicals in FAM's investment portfolio as an entrepreneur?
- Name three most influential drivers that shapes Diversification.

Diversification

- In what way the diversification of various Construction services has helped them in providing a comprehensive services and has been inclusive in the growth of the company. List out at least three benefits.
- Do you think the initiatives taken in diversifying a business should be pro-active or reactive? Give your views in the light of the above case.
- When entering into a new field (in the above case Construction Chemicals) what determines success in establishing competencies? Can we not just have a strategic partnership with a Construction Chemical company rather than developing internal competencies?
- With this kind of net worth, do you think the company could adopt heterogeneous diversification? Give at least three justifications.
- In the current scenario of shifting market paradigm in the Construction Industry in the UAE and GCC, what is the value proposition can his firm now provide to all the stakeholders?

References

- Ahmed, G., & Amiri, N. A. (2022). The transformational leadership of the founding leaders of the United Arab Emirates: Sheikh Zayed Bin Sultan Al Nahyan and Sheikh Rashid Bin Saeed Al Maktoum. *The International Journal on Technology, Innovation, and Management*, 2, 1.
- Alhamad, A., Alshurideh, M., Alomari, K., Al Kurdi, B., Alzoubi, H., Hamouche, S., & Al-Hawary, S. (2022). The effect of electronic human resources management on organizational health of

- telecommunications companies in Jordan. *International Journal of Data and Network Science*, 6, 429–438.
- Alhamad, A. Q. M., Akour, I., Alshurideh, M., Al-Hamad, A. Q., Kurdi, B. A., & Alzoubi, H. (2021). Predicting the intention to use google glass: A comparative approach using machine learning models and PLS-SEM. *International Journal of Data and Network Science*, 5, 311–320.
- Ali, A. A. (2021). The impact of information sharing and quality assurance on customer service at UAE banking sector. *The International Journal on Technology, Innovation, and Management*, 1, 01–17.
- Ali, N., Ahmed, A., Anum, L., Ghazal, T., Abbas, S., & A.K., M., A., H. M., A., n.d. M. (2021). Modelling supply chain information collaboration empowered with machine learning technique. *Intelligent Automation & Soft Computing*, 30, 243–257.
- Ali, N., Ghazal, T. M., Ahmed, A., Abbas, S., Khan, M. A., Alzoubi, H. M., Farooq, U., Ahmad, M., & Khan, M. A. (2022). Fusion-based supply chain collaboration using machine learning techniques. *Intelligent Automation & Soft Computing*, 31, 1671–1687.
- Alnazer, N. N., Alnuaimi, M. A., & Alzoubi, H. M. (2017). Analysing the appropriate cognitive styles and its effect on strategic innovation in Jordanian universities. *International Journal of Business Excellence*, 13, 127–140.
- Alnuaimi, M., Alzoubi, H. M., Ajelat, D., & Alzoubi, A. A. (2021). Towards intelligent organisations: An empirical investigation of learning orientation's role in technical innovation. *International Journal of Innovation and Learning*, 29, 207–221.
- Alshurideh, M., Al Kurdi, B., Alzoubi, H. M., Ghazal, T. M., Said, R. A., AlHamad, A. Q., Hamadneh, S., Sahawneh, N., & Al-kassem, A. H. (2022). Fuzzy assisted human resource management for supply chain management issues. *Annals of Operations Research*.
- Alzoubi, H., & Ahmed, G. (2019). Do total quality management (TQM) practices improve organisational success? A case study of electronics industry in the UAE. *International Journal of Economics and Business Research*, 17, 459–472.
- Alzoubi, ali., (2021). The impact of process quality and quality control on organizational competitiveness at 5-star hotels in Dubai. *The International Journal on Technology, Innovation, and Management*, 1, 54–68.
- Alzoubi, A. (2022). Machine learning for intelligent energy consumption in smart homes. *International Journal of Economics and Business Research*, 2, 2022.
- Alzoubi, H., Alshurideh, M., Kurdi, B. A., Akour, I., & Aziz, R. (2022a). Does BLE technology contribute towards improving marketing strategies, customers' satisfaction and loyalty? The role of open innovation. *International Journal of Data and Network Science*, 6, 449–460.
- Alzoubi, H. M., Ahmed, G., Al-Gasaymeh, A., & Al Kurdi, B. (2020). Empirical study on sustainable supply chain strategies and its impact on competitive priorities: The mediating role of supply chain collaboration. *Management Science Letters*, 10, 703–708.
- Alzoubi, H. M., Ahmed, G., & Alshurideh, M. (2022b). An empirical investigation into the impact of product quality dimensions on improving the order-winners and customer satisfaction. *International Journal of Productivity and Quality Management*, 36, 169–186.
- Alzoubi, H. M., Alshurideh, M. T., Kurdi, B. A., Alhyasat, K. M. K., & Ghazal, T. M. (2022c). The effect of e-payment and online shopping on sales growth: Evidence from banking industry. *International Journal of Data and Network Science*, 6, 1369–1380.
- Alzoubi, H. M., & Aziz, R. (2021). Does emotional intelligence contribute to quality of strategic decisions? The mediating role of open innovation. *Journal of Open Innovation: Technology, Market, and Complexity*, 7, 130.
- Alzoubi, H. M., Elrehail, H., Hanaysha, J. R., Al-Gasaymeh, A., & Al-Adaileh, R. (2022d). The role of supply chain integration and agile practices in improving lead time during the COVID-19 crisis. *The International Journal of Service Science, Management, Engineering, and Technology*, 13, 1–11.
- Alzoubi, H. M., & In'airat, M., Ahmed, G., (2022). Investigating the impact of total quality management practices and Six Sigma processes to enhance the quality and reduce the cost of quality: The case of Dubai. *International Journal of Business Excellence*, 27, 94–109.

- Alzoubi, H. M., Vij, M., Vij, A., & Hanaysha, J. R. (2021). What leads guests to satisfaction and loyalty in UAE five-star hotels? AHP analysis to service quality dimensions. *Enlightening Tourism. A pathmaking Journal*, 11, 102–135.
- Corluka, D., & Lindh, U. (2017). Blockchain—A New Technology That Will Transform the Real Estate Market. Thesis 74.
- Dahan, A. A. (2018). The future of the real estate industry of Dubai: The demand for real estates (2000–2020). *Eurasian Journal of Analytical Chemistry*, 13, 301–309.
- Gallo, P., Romano, R., & Belardi, E. (2021). CARES research: Product and process digitalization for design and manufacturing of prefabricated cardboard panels. *Journal of Physics: Conference Series*, 2042.
- Hamadneh, S., Pedersen, O., Alshurideh, M., Kurdi, B. A., & Alzoubi, H. M. (2021). An investigation of the role of supply chain visibility into the Scottish blood supply chain. *The Journal of Legal, Ethical and Regulatory Issues*, 24, 1–12.
- Hanaysha, J. R., Al-Shaikh, M. E., Joghee, S., & Alzoubi, H. M. (2022). Impact of innovation capabilities on business sustainability in small and medium enterprises. *FIIB Business Review*, 11, 67–78.
- Hanaysha, J., Al-Shaikh, M., Alzoubi, M., & H., (2021). Importance of marketing mix elements in determining consumer purchase decision in the retail market. *International Journal of Service Science, Management, Engineering, and Technology*, 2, 56–72.
- Joghee, S., Alzoubi, H. M., & Dubey, A. R. (2020). Decisions effectiveness of FDI investment biases at real estate industry: Empirical evidence from Dubai smart city projects. *International Journal of Scientific & Technology Research*, 9, 3499–3503.
- Kasem, J., & Al-Gasaymeh, A. (2022). A cointegration analysis for the validity of purchasing power parity: Evidence from Middle East Countries. *The International Journal on Technology, Innovation, and Management*, 2, 1.
- Khan, M. A. (2021). Challenges facing the application of IoT in medicine and healthcare. *International Journal of Computations, Information and Manufacturing*, 1, 39–55.
- Kurdi, B. A., Alshurideh, M., Akour, I., Alzoubi, H. M., Obeidat, B., & Alhamad, A. (2022a). The role of digital marketing channels on consumer buying decisions through eWOM in the Jordanian markets. *International Journal of Data and Network Science*, 6, 1175–1185.
- Kurdi, B. A., Alzoubi, H. M., Akour, I., & Alshurideh, M. T. (2022b). The effect of blockchain and smart inventory system on supply chain performance: Empirical evidence from retail industry. *Uncertain Supply Chain Management*, 10, 1111–1116.
- Kurdi, B. A., Alshurideh, M., & Akour, I. (2022c). The effect of social media influencers' characteristics on consumer intention and attitude toward Keto products purchase intention. *International Journal of Data and Network Science*, 6, 1135–1146.
- Lee, K. L., Azmi, N. A. N., Hanaysha, J. R., Alzoubi, H. M., & Alshurideh, M. T. (2022a). The effect of digital supply chain on organizational performance: An empirical study in Malaysia manufacturing industry. *Uncertain Supply Chain Management*, 10, 495–510.
- Lee, K. L., Romzi, P. N., Hanaysha, J. R., Alzoubi, H. M., & Alshurideh, M. (2022b). Investigating the impact of benefits and challenges of IOT adoption on supply chain performance and organizational performance: An empirical study in Malaysia. *Uncertain Supply Chain Management*, 10, 537–550.
- Mehmood, T., Alzoubi, H., Alshurideh, M., Al-Gasaymeh, A., & Ahmed, G. (2019). Schumpeterian entrepreneurship theory: Evolution and relevance. *Academic Entrepreneur*, 25, 1–10.
- Mondol, E. P. (2021). The impact of block chain and smart inventory system on supply chain performance at retail industry. *International Journal of Computations, Information and Manufacturing*, 1, 56–76.
- Monostori, J. (2018). Supply chains robustness: Challenges and opportunities. *Procedia CIRP*, 67, 110–115.
- Obaid, A. J. (2021). Assessment of smart home assistants as an IoT. *International Journal of Computations, Information and Manufacturing*, 1, 18–38.

- Radwan, N., & Farouk, M. (2021). The growth of internet of things (IoT) in the management of healthcare issues and healthcare policy development. *The International Journal on Technology, Innovation, and Management*, 1, 69–84.
- Ramakrishna, Y., & Alzoubi, H. M. (2022). Empirical investigation of mediating role of six sigma approach in rationalizing the COQ in service organizations. *Operations and Supply Chain Management*, 15, 122–135.
- Schilirò, D. (2013). Diversification and development of the United Arab Emirates' economy. *Journal of Applied Economic Sciences*, 8, 228–239.
- Shamout, M., Ben-Abdallah, R., Alshurideh, M., Alzoubi, H., Kurdi, B. A., & Hamadneh, S. (2022). A conceptual model for the adoption of autonomous robots in supply chain and logistics industry. *Uncertain Supply Chain Management*, 10, 577–592.
- Victoria, V. (2022). Impact of process visibility and work stress to improve service quality: Empirical evidence from dubai retail industryimpact of process visibility and work stress to improve service quality: Empirical evidence from dubai retail industry. *The International Journal on Technology, Innovation, and Management* 2.

Internet of Things (IoT) and the Medical Field

Security Flaws in Medical Wearables Devices Used in Health Care Systems



Ali A. Alzoubi, Ali Al Neyadli, and Haitham M. Alzoubi 

Abstract Internet of medical things (IoMT) is the modern development in a health-care system that helps healthcare workers to diagnose and treat various diseases. However, there are some security issues with these medical wearables like poor connectivity. In this paper, the security flaws in medical wearables devices, such as weak encryption and a lack of authentication, were discussed. Additionally, some potential solutions to these problems have been presented by this research, including techniques and algorithms.

Keywords IoMT · Authentication · Wearable · Encryption · Medical devices

1 Introduction

Internet of medical things is inter-connection of medical devices like wearable bands, electronic chips, and heart-rate monitors using internet (Guntur et al., 2018). These devices have introduced technology into the healthcare system and improved the diagnosis and treatment procedures because these devices detect changes in human body through sensors (Akhtar et al., 2021). But there are some security and privacy issues that are the main concern of this research. However, IoMT is a very broad topic on which numerous researches can be done from different angles but this study focuses on addressing security issues of medical wearables with quality maintenance (Alzoubi et al., 2022a) and to find their possible successful solutions (Lee

A. A. Alzoubi
Public Security Directorate, Amman, Jordan

A. Al Neyadli
School of Information Technology, Skyline University College, Sharjah, UAE

H. M. Alzoubi (✉)
School of Business, Skyline University College, Sharjah, UAE
e-mail: haitham.alzoubi@skylineuniversity.ac.ae

Applied Science Research Center, Applied Science Private University, Amman, Jordan

et al., 2022b). In this research, the major security issues of medical wearables and their possible solutions will be discovered and suggested (Ghazal et al., 2022a). These security and privacy issues are the main concern of the healthcare system (Alzoubi & Yanamandra, 2020) because due to low-security standards, gathered data may get corrupted. Considering these things, this research is very helpful for those companies that design or produce these medical wearables. Also, this research will give a pathway to those researchers that want to do further research on this topic.

1.1 Problem Definition

Internet of medical things now plays a crucial part in the healthcare system by providing advancements in checking and monitoring basic and serious diseases (Al Hamadi et al., 2017). But there are many security issues in these medical wearables that may cause an error in results, cannot detect actual disease, and may corrupt all gathered data of a patient (Al-Hamadi et al., 2015a, 2015b; Alzoubi et al., 2022b). The first security issue of medical wearables is the lack of authentication (Ghazal et al., 2022k). It is noted that many times the manufacturers do not add built-in security in medical wearables like PIN system protection system or user authentication cause security issue in medical wearables. Also, lack of encryption is another major security issue of IoMT (Alzoubi & Aziz, 2021).

Due to lack of encryption, collected data may get corrupted, and gathered data may be lost due to poor security standards (Kashif et al., 2021). The medical wearables are wireless and get connected with smartphones and other devices via Bluetooth but insufficient connectivity also raises a security issue in these devices that causes different connectivity issues (Hamadneh et al., 2021) while detecting diseases. Cloud data is one of the major aspects (Ali et al., 2021; Gul et al., 2012) that can make these medical wearables more effective but the lack of cloud data raises questions about the security of these devices (H. M. Alzoubi et al., 2022f; Hasan et al., 2021a, 2021b). Synchronization of data is very important to prevent attacks like distributed denial service attacks but if they are left unchecked, these attacks can exploit the record of hospitals (Eli, 2021).

1.2 Proposed Solution

After the detection of these security issues of medical wearables, every specialist and production company started to find the best solutions to resolve these solutions (Lee et al., 2022a). Software-defined solutions (Ghazal et al., 2022e) platform is the best solution for these issues (Shamout et al., 2022) because it can detect and monitor medical wearables by inspecting their network data as it flows from these wearables. Also, this can automatically detect any threat and can resolve it on time without making any issue in the detection of disease (Ghazal et al., 2022d; Vo et al.,

2010). This approach can stop security attacks (Kurdi et al., 2022c) and can stop any suspicious happening in these medical wearables (Alzoubi et al., 2021a, 2021b). Vulnerable authentication methods like machine-to-machine (M2M) are another solution that can easily resolve and minimize the security threats of these wearables (Ghazal et al., 2021c, 2022h).

Cryptographic (Alzoubi et al., 2022d) algorithms are also a way the solution these issues. Not only this, an adaptation of encryption is another way because if data is not encrypted (Ramakrishna & Alzoubi, 2022), it may get corrupted and all gathered data will vanish (Alsharari, 2022). So, using an advanced encryption standard (AES) (Aziz & Aftab, 2021) is the best solution because it can encrypt fixed blocks of data which means the gathered data will become secure (Alnuaimi et al., 2021). In addition, cloud data technology is also a solution to security threats of medical wearables (Saleem et al., 2022) because it can process the gathered data in an efficient way using the marketing and strategic decisions (Ghazal et al., 2022l; Kurdi et al., 2022a) that can help medical staff to find results and cure diseases (Ghazal et al., 2022g).

2 Literature Review

The healthcare (Alzoubi et al., 2022b) system was not advanced. For the solution to these issues, the internet of medical things (IoMT) was designed (Ghazal et al., 2022j). After the invention of these medical wearables, they were proved to be the best solution for several medical issues (Hanaysha et al., 2022). However, IoMT suffers from certain issues like security and privacy, awareness, and training (Al-Tahat & Moneim, 2020). Due to a lack of awareness, medical staff and patients do not use them in the right way (Kurdi et al., 2022b) due to which accurate results are not retrieved (Eli & Hamou, 2022). To avoid this issue, training medical staff and of those patients that are wearing those medical wearables is the first step (Mehmood et al., 2019). Also, the major issue and challenges of IoMT are security and privacy (Hanaysha et al., 2021). The authors proposed some solutions to overcome these privacy issues (Ghazal et al., 2021c, 2022b; Islam et al., 2020). These solutions are classified as cryptographic and non-cryptographic (Ghazal et al., 2022g). In addition to these classifications and suggested that cryptographic algorithms are the solution that can resolve security issues (Alnazer et al., 2017; Alshurideh et al., 2022) of the internet of medical things (Ghazal et al., 2021a, 2021b). Authors suggested that there is a need to design an efficient prevention system that can help to manage or control privacy issues of the internet of medical things (Alzoubi et al., 2022c). But zero-day attacks and exploits are still the main challenges (Ghazal et al., 2022g) that cannot be resolved with cryptographic and non-cryptographic solutions (Joghee et al., 2020).

Day by day, the use of technology is increasing and spreading in every field of life (Ghazal et al., 2022c). In the healthcare system, the internet of medical things is the latest technology that introduces CE (circular economy models) in the healthcare industry (Al-Hamadi et al., 2015a, 2015b; Ghazal et al., 2022f). These medical wearables allow e-visits, the assistance of elder people (Alshurideh et al., 2020),

and remote sensing of various diseases like diabetes (Saad Masood Butt, 2022) but many privacy issues are the main concern of these medical wearables which is not possible by physical means (Alzoubi et al., 2022a; Ghazal et al., 2022i). Both patients and healthcare staff has utilizes their smartphones or tablets to gather, monitor, and process medical data but these wearables are materialistic and can be easily hacked due to low-security standards (Alzoubi & Ahmed, 2019). For these issues, this is a need for time to provide core security standards for these medical wearables. For this purpose, Common Criteria Evaluation Methodology (CEM) can be an approach that can resolve these security issues in a better manner (Al-Nashashibi et al., n.d.).

The increasing demand for medical wearables also demands their security and privacy (Alzoubi et al., 2021a, 2021b) for better treatment and diagnosis of various diseases (Farouk, 2021). For this purpose, different new and improved algorithms (Al-Dmour, 2020; M K Hasan et al., 2021a, 2021b) were proposed that can improve the privacy of medical wearables and also can resolve security issues of them (Alzoubi et al., 2020). Open Source Security Testing Methodology is a new and improved approach to the privacy and security of medical wearables (Stoyanova et al., 2020). It can detect and resolve security attacks on these devices which will improve its working and diagnosing of several diseases (Alzoubi et al., 2022e). Because confidentiality is the property that can disclose the gathered data from the user (Ghazal & Taleb, 2022).

3 Research Methodology

In this research, theoretical methodology has been selected in which the data from previous research which is the secondary data will be used as introductory data and to derive solutions to these security issues that have been addressed. In theoretical analysis, the theoretical data is gathered, and then using that data, further research is done. This approach is best suited to the research because algorithms and experimental approaches cannot be used because of their complexity, limited resources and vastness of the research topic, as all suggested approaches and algorithms are tested and successfully implemented. It means there is very less chance that these algorithms can give false results if implemented in the right way. In this research, medical wearables are dependent variables, and technology like the internet and related technologies are independent variables because medical wearables like bands depend on technologies and internet connection that can connect them to other devices like smartphones or tablets to show results or readings of patient's body to the caregivers or doctors and also to the patient itself. But if there is a connectivity issue in these wearables due to which these wearables cannot connect to the internet or Bluetooth, they will not give any reading or data which means these devices totally depend on a connection to operate but connections like internet do not depend on it. Due to the theoretical approach, the targeted results will be derived and various approaches or algorithms will be discovered that can easily give solutions to the issues of security of medical wearables. This approach may give successful and right

results because these algorithms are tested and have no flaws in them. In contrast to this, if an experimental approach is used, it may discover different types of gaps in algorithms and may not give favorable results which means these security issues that have been discussed in this research may not be resolved by removing gaps in algorithms requires much time and practice and still has a chance to fail.

4 Conclusions

The term “Internet of medical things” refers to a group of medical gadgets, including electronic chips, wearable bands, and heart-rate monitors. These technologies, which use sensors to monitor changes in the human body, have brought technology into the healthcare system and enhanced the diagnosing system. In this research, the security issues of medical wearables have been discovered like lack of authentication and poor encryption. Also, this research has suggested some possible solutions to these issues has been suggested like algorithms and approaches. In this research, theoretical analysis has been done in which the data from previous research have been used as introductory data and secondary data is used to derive solutions to these security issues that have been addressed because this approach does not have any chance of failure. This research will give a light or a pathway to future researchers to do further research on it.

This research has covered all aspects that are crucial as an introduction to this topic that will give help other researchers to find other security issues of these medical wearables because this is a very vast topic and cannot be covered through only one research as there are many other security issues of medical wearables that are not discussed in detail in this research.

Internet of medical things (IoMT) is a very vast and broad topic that cannot be covered in only one research. In this research, only security issues of medical wearables have been discussed but still, there are many other aspects of this area that are not discussed in this research like how to use these things.

References

- Akhtar, A., Akhtar, S., Bakhtawar, B., Kashif, A. A., Aziz, N., & Javeid, M. S. (2021). COVID-19 detection from CBC using machine learning techniques. *International Journal of Innovation, Management and Technology*, 1, 65–78.
- Al-Dmour, N. A. (2020). Using unstructured search algorithms for data collection in IoT-based WSN. *International Journal of Engineering Research & Technology*, 13, 1992–1998.
- Al-Hamadi, H., Gawanmeh, A., & Al-Qutayri, M. (2015). Formal validation of QRS wave within ECG. In *2015 international conference on information and communication technology research, ICTRC 2015* (Vol. 9, pp. 190–193).
- Al-Hamadi, H., Gawanmeh, A., Baek, J., & Al-Qutayri, M. (2015b). Lightweight security protocol for ECG bio-sensors. *Wireless Personal Communications*, 95, 5097–5120.

- Al-Nashashibi, M., Hadi, W., El-Khalili, N., Issa, G., AlBanna, A.A. (2021). A new two-step ensemble learning model for improving stress prediction of automobile drivers. *The International Arab Journal of Information Technology*, 6.
- Al-Tahat, S., & Moneim, O. A. (2020). The impact of artificial intelligence on the correct application of cyber governance in Jordanian commercial banks. *International Journal of Scientific & Technology Research*, 9, 7138–7144.
- Al Hamadi, H., Gawanmeh, A., & Al-Qutayri, M. (2017). Guided test case generation for enhanced ECG bio-sensors functional verification. *The Journal of E-Health and Medical Communications*, 8, 1–20.
- Ali, N., Ahmed, A., Anum, L., Ghazal, T. M., Abbas, S., Khan, M. A., Alzoubi, H. M., & Ahmad, M. (2021). Modelling supply chain information collaboration empowered with machine learning technique. *Intelligent Automation & Soft Computing*, 30, 243–257.
- Alnazer, N. N., Alnuaimi, M. A., & Alzoubi, H. M. (2017). Analysing the appropriate cognitive styles and its effect on strategic innovation in Jordanian universities. *International Journal of Business Excellence*, 13, 127–140.
- Alnuaimi, M., Alzoubi, H. M., Ajelat, D., & Alzoubi, A. A. (2021). Towards intelligent organisations: An empirical investigation of learning orientation's role in technical innovation. *International Journal of Innovation and Learning*, 29, 207–221.
- Alsharari, N. (2022). The implementation of enterprise resource planning (Erp) in the United Arab emirates: A case of Musanada corporation. *International Journal of Innovation, Management and Technology*, 2, 1.
- Alshurideh, M., Gasaymeh, A., Ahmed, G., Alzoubi, H., & Kurd, B. A. (2020). Loyalty program effectiveness: Theoretical reviews and practical proofs. *Uncertain Supply Chain Management*, 8, 599–612.
- Alshurideh, M. T., Al Kurdi, B., Alzoubi, H. M., Obeidat, B., Hamadneh, S., & Ahmad, A. (2022). The influence of supply chain partners' integrations on organizational performance: The moderating role of trust. *Uncertain Supply Chain Management*, 10, 1191–1202.
- Alzoubi, H., & Ahmed, G. (2019). Do TQM practices improve organisational success? A case study of electronics industry in the UAE. *International Journal of Economics and Business Research*, 17, 459–472.
- Alzoubi, H., Alhamad, A., Alshurideh, M., Alomari, K., Al Kurdi, B., Hamouche, S., & Al-Hawary, S. (2022a). The effect of electronic human resources management on organizational health of telecommunications companies in Jordan. *International Journal of Data and Network Science*, 6, 429–438.
- Alzoubi, H., Alhamad, A. Q. M., Akour, I., Alshurideh, M., Al-Hamad, A. Q., Kurdi, B. A., & Alzoubi, H. (2021a). Predicting the intention to use google glass: A comparative approach using machine learning models and PLS-SEM. *International Journal of Data and Network Science*, 5, 311–320.
- Alzoubi, H., Alshurideh, M., Kurdi, B. A., Akour, I., & Aziz, R. (2022b). Does BLE technology contribute towards improving marketing strategies, customers' satisfaction and loyalty? The role of open innovation. *International Journal of Data and Network Science*, 6, 449–460.
- Alzoubi, H. M., Ahmed, G., Al-Gasaymeh, A., & Al Kurdi, B. (2020). Empirical study on sustainable supply chain strategies and its impact on competitive priorities: The mediating role of supply chain collaboration. *Management Science Letters*, 10, 703–708.
- Alzoubi, H. M., Ahmed, G., & Alshurideh, M. (2022c). An empirical investigation into the impact of product quality dimensions on improving the order-winners and customer satisfaction. *International Journal of Productivity and Quality Management*, 36, 169–186.
- Alzoubi, H. M., Ali, N., Ghazal, T. M., Ahmed, A., Abbas, S., Khan, M. A., Farooq, U., Ahmad, M., & Khan, M. A. (2022d). Fusion-based supply chain collaboration using machine learning techniques. *Intelligent Automation & Soft Computing*, 31, 1671–1687.
- Alzoubi, H. M., Alshurideh, M. T., Al Kurdi, B., Ghazal, T. M., Said, R. A., AlHamad, A. Q., Hamadneh, S., Sahawneh, N., & Al-kassem, A. H. (2022c). Fuzzy assisted human resource management for supply chain management issues. *Annals of Operations Research* 1–19.

- Alzoubi, H. M., Alshurideh, M. T., Kurdi, B. A., Alhyasat, K. M. K., & Ghazal, T. M. (2022f). The effect of e-payment and online shopping on sales growth: Evidence from banking industry. *International Journal of Data and Network Science*, 6, 1369–1380.
- Alzoubi, H. M., & Aziz, R. (2021). Does emotional intelligence contribute to quality of strategic decisions? The mediating role of open innovation. *Journal of Open Innovation: Technology, Market, and Complexity*, 7, 130.
- Alzoubi, H. M., Elrehaile, H., Hanaysha, J. R., Al-Gasaymeh, A., & Al-Adaileh, R. (2022g). The role of supply chain integration and agile practices in improving lead time during the COVID-19 crisis. *The International Journal of Service Science, Management, Engineering, and Technology*, 13, 1–11.
- Alzoubi, H. M., & In'airat, M., Ahmed, G., (2022). Investigating the impact of total quality management practices and Six Sigma processes to enhance the quality and reduce the cost of quality: The case of Dubai. *International Journal of Business Excellence*, 27, 94–109.
- Alzoubi, H. M., Vij, M., Vij, A., & Hanaysha, J. R. (2021b). What leads guests to satisfaction and loyalty in UAE five-star hotels? AHP analysis to service quality dimensions. *Enlightening Tourism*, 11, 102–135.
- Alzoubi, H. M., & Yanamandra, R. (2020). Investigating the mediating role of information sharing strategy on agile supply chain. *Uncertain Supply Chain Management*, 8, 273–284.
- Aziz, N., & Aftab, S. (2021). Data mining framework for nutrition ranking: Methodology: SPSS modeller. *The International Journal on Technology, Innovation, and Management*, 1, 85–95.
- Eli, T. (2021). Students' perspectives on the use of innovative and interactive teaching methods at the university of Nouakchott Al Aasriya, Mauritania: English department as a case study. *The International Journal on Technology, Innovation, and Management*, 1, 90–104.
- Eli, T., & Hamou, L. A. S. (2022). Investigating the factors that influence students' choice of English studies as a major: The case of University of Nouakchott Al Aasriya. *The International Journal on Technology, Innovation, and Management*, 2, 1.
- Farouk, M. (2021). The universal artificial intelligence efforts to face coronavirus COVID-19. *International Journal of Computations, Information and Manufacturing*, 1, 77–93.
- Ghazal, T. M., Abbas, S., Ahmad, M., & Aftab, S. (2022a). An IoMT based ensemble classification framework to predict treatment response in hepatitis C patients. In: *2022 international conference on business analytics for technology and security, ICBATS 2022* (pp. 1–4).
- Ghazal, T. M., Abbas, S., Alhwaiti, Y., Fatima, A., Khan, M. A., Khan, M. A., Kanwal, A., Ahmad, M., & Elmitwally, N. S. (2022b). Convolutional neural network based intelligent handwritten document recognition. *Computers, Materials and Continua*, 70, 4563–4581.
- Ghazal, T. M., Abbas, S., Munir, S., Khan, M. A., Ahmad, M., Issa, G. F., Zahra, S. B., Khan, M. A., & Hasan, M. K. (2022c). Alzheimer disease detection empowered with transfer learning. *Computers, Materials and Continua*, 70, 5005–5019.
- Ghazal, T. M., Ahmed, Z. E., Hasan, M. K., Hashim, A. A., Saeed, R. A., Mokhtar, R. A., & Singh, S. P. (2022d). Optimization procedure for intelligent internet of things applications. In *2022 international conference on business analytics for technology and security, ICBATS 2022* (pp. 1–6).
- Ghazal, T. M., Bibi, R., Saeed, Y., Zeb, A., Rahman, T., Said, R. A., Abbas, S., Ahmad, M., & Khan, M. A. (2021a). Edge AI-based automated detection and classification of road anomalies in VANET using deep learning. *Computational Intelligence and Neuroscience*, 2021, 1–19.
- Ghazal, T. M., Bukhari, M. M., Abbas, S., Khan, M. A., Farooq, U., Wahbah, H., Ahmad, M., & Adnan, K. M. (2022e). An intelligent proposed model for task offloading in fog-cloud collaboration using logistics regression. *Computational Intelligence and Neuroscience*, 2022.
- Ghazal, T. M., Hasan, M. K., Abdullah, S. N. H., Abubakkar, K. A., & Afifi, M. A. M. (2022f). IoMT-enabled fusion-based model to predict posture for smart healthcare systems. *Computers, Materials and Continua*, 71, 2579–2597.
- Ghazal, T. M., Hasan, M. K., Alkhalfah, A., Abu Bakar, K. A., Omidvar, A., Nafi, N. S., & Agbinya, J. I. (2021b). *Fischer linear discrimination and quadratic discrimination analysis-based data mining technique for internet of things framework for healthcare* (p. 9). Public Heal.

- Ghazal, T. M., Hasan, M. K., Saeed, R. A., Pandey, B., Gohel, H., Eshmawi, A. A., Abdel-Khalek, S., & Alkhassawneh, H. M. (2022g). A review on security threats, vulnerabilities, and counter measures of 5G enabled Internet-of-Medical-Things. *IET Communications*, 16, 421–432.
- Ghazal, T. M., Khan, M. A., Lee, S. W., & Rehman, A. (2022h). Data fusion-based machine learning architecture for intrusion detection. *Computers, Materials and Continua*, 70, 3399–3413.
- Ghazal, T. M., Mehmood, S., Khan, M. A., Zubair, M., Naseem, M. T., Faiz, T., & Ahmad, M. (2022i). Malignancy detection in lung and colon histopathology images using transfer learning with class selective image processing. *IEEE Access*, 10, 25657–25668.
- Ghazal, T. M., Noreen, S., Said, R. A., Khan, M. A., Siddiqui, S. Y., Abbas, S., Aftab, S., & Ahmad, M. (2022j). Energy demand forecasting using fused machine learning approaches. *Intelligent Automation and Soft Computing*.
- Ghazal, T. M., Rehman, A. U., Saleem, M., Ahmad, M., Ahmad, S., & Mehmood, F. (2022k). Intelligent model to predict early liver disease using machine learning technique. In *2022 international conference on business analytics for technology and security, ICBATS 2022* (pp. 1–5).
- Ghazal, T. M., Siddiqui, S. Y., Haider, A., Khan, M. A., Naseer, I., Abbas, S., Rahman, M., Khan, J. A., Ahmad, M., Hasan, M. K., Mohammed, A., & Ateeq, K. (2021c). IoMT cloud-based intelligent prediction of breast cancer stages empowered with deep learning. *IEEE Access*, 9, 146478–146491.
- Ghazal, T. M., & Taleb, N. (2022). Feature optimization and identification of ovarian cancer using internet of medical things. *Expert Systems*.
- Ghazal, T. M., Zafar, S., Asif, M., Ahmad, M. B., Faiz, T., Ahmad, M., & Khan, M. A. (2022l). Assistive devices analysis for visually impaired persons: A review on taxonomy. *IEEE Access*, 10, 13354–13366.
- Gul, O., Al-Qutayri, M., Yeun, C. Y., & Vu, Q. H. (2012). Framework of a national level electronic health record system. In *Proceedings of 2012 international conference on cloud computing technologies, applications and management, ICCCTAM 2012. Applications and management (ICCCTAM), Dubai, UAE* (pp. 60–65).
- Guntur, S. R., Gorrepati, R. R., & Dirisala, V. R. (2018). Internet of medical things. *Medical Big Data and Internet of Medical Things*, 4, 271–297.
- Hamadneh, S., Pedersen, O., Alshurideh, M., Kurdi, B. A., & Alzoubi, H. M. (2021). An investigation of the role of supply chain visibility into the Scottish blood supply chain. *The Journal of Legal, Ethical and Regulatory Issues*, 24, 1–12.
- Hanaysha, J., Al-Shaikh, M., Alzoubi, M., & H., (2021). Importance of marketing mix elements in determining consumer purchase decision in the retail market. *The International Journal of Service Science, Management, Engineering, and Technology*, 12, 56–72.
- Hanaysha, J. R., Al-Shaikh, M. E., Joghee, S., & Alzoubi, H. M. (2022). Impact of innovation capabilities on business sustainability in small and medium enterprises. *FIIB Business Review*, 11, 67–78.
- Hasan, M. K., Islam, S., Sulaiman, R., Khan, S., Hashim, A. H. A., Habib, S., Islam, M., Alyahya, S., Ahmed, M. M., Kamil, S., & Hassan, M. A. (2021a). Lightweight encryption technique to enhance medical image security on internet of medical things applications. *IEEE Access*, 9, 47731–47742.
- Hasan, M. K., Musse, M. A., Sherfriz, S. M., Shayla, I., Huda, S. N., & A., S., (2021b). Eklas H.; Nazmus S. N.; Nguyen V. An Improv. Dyn. Therm. Curr. Rat. Model PMU-based wide area Meas. Framew. *Reliability Analytics and Utility Sensing Cloud Systems*, 9, 14446–14458.
- Islam, S., Khalifa, O. O., Hashim, A. H. A., Hasan, M. K., Razzaque, M. A., & Pandey, B. (2020). Design and evaluation of a multihoming-based mobility management scheme to support inter technology handoff in PNEMO. *Wireless Personal Communications*, 114, 1133–1153.
- Joghee, S., Alzoubi, H. M., & Dubey, A. R. (2020). Decisions effectiveness of FDI investment biases at real estate industry: Empirical evidence from Dubai smart city projects. *International Journal of Scientific & Technology Research*, 9, 3499–3503.

- Kashif, A. A., Bakhtawar, B., Akhtar, A., Akhtar, S., Aziz, N., & Javeid, M. S. (2021). Treatment response prediction in hepatitis C patients using machine learning techniques. *International Journal of Innovation, Management and Technolog*, 1, 79–89.
- Kurdi, B. A., Alshurideh, M., Akour, I., Alzoubi, H. M., Obeidat, B., & Alhamad, A. (2022a). The role of digital marketing channels on consumer buying decisions through eWOM in the Jordanian markets. *International Journal of Data and Network Science*, 6, 1175–1185.
- Kurdi, B. A., Alshurideh, M., Akour, I., Tariq, E., Alhamad, A., & Alzoubi, H. M. (2022b). The effect of social media influencers' characteristics on consumer intention and attitude toward Keto products purchase intention. *International Journal of Data and Network Science*, 6, 1135–1146.
- Kurdi, B. A., Alzoubi, H. M., Akour, I., & Alshurideh, M. T. (2022c). The effect of blockchain and smart inventory system on supply chain performance: Empirical evidence from retail industry. *Uncertain Supply Chain Management*, 10, 1111–1116.
- Lee, K. L., Azmi, N. A. N., Hanaysha, J. R., Alzoubi, H. M., & Alshurideh, M. T. (2022a). The effect of digital supply chain on organizational performance: An empirical study in Malaysia manufacturing industry. *Uncertain Supply Chain Management*, 10, 495–510.
- Lee, K. L., Romzi, P. N., Hanaysha, J. R., Alzoubi, H. M., & Alshurideh, M. (2022b). Investigating the impact of benefits and challenges of IOT adoption on supply chain performance and organizational performance: An empirical study in Malaysia. *Uncertain Supply Chain Management*, 10, 537–550.
- Mehmood, T., Alzoubi, H. M., Alshurideh, M., Al-Gasaymeh, A., & Ahmed, G. (2019). Schumpeterian entrepreneurship theory: Evolution and relevance. *Academy of Entrepreneurship Journal*, 25, 1–10.
- Ramakrishna, Y., & Alzoubi, H. M. (2022). Empirical investigation of mediating role of six sigma approach in rationalizing the COQ in service organizations. *Operations and Supply Chain Management*, 15, 122–135.
- Saad Masood Butt. (2022). Management and treatment of type 2 diabetes. *International Journal of Computations, Information and Manufacturing*, 2, 1.
- Saleem, M., Abbas, S., Ghazal, T.M., Adnan Khan, M., Sahawneh, N., & Ahmad, M. (2022). Smart cities: Fusion-based intelligent traffic congestion control system for vehicular networks using machine learning techniques. *Egyptian Informatics Journal*.
- Shamout, M., Ben-Abdallah, R., Alshurideh, M., Alzoubi, H., Al Kurdi, B., & Hamadneh, S. (2022). A conceptual model for the adoption of autonomous robots in supply chain and logistics industry. *Uncertain Supply Chain Management*, 10, 577–592.
- Stoyanova, M., Nikoloudakis, Y., Panagiotakis, S., Pallis, E., & Markakis, E. K. (2020). A survey on the internet of things (IoT) forensics: Challenges, approaches, and open issues. *IEEE Communications Surveys and Tutorials*, 22, 1191–1221.
- Vo, D. L., Lee, H., Yeun, C. Y., & Kim, K. (2010). Enhancements of authenticated multiple key exchange protocol based on bilinear pairings. *Computers & Electrical Engineering*, 36, 155–159.

Evaluation of Ethics and Security Challenges in Internet of Medical Things (IoMT)



Hamdan Alshehhi, Abdulla Almazrouei, Omar ALshehhi,
and Haitham M. Alzoubi 

Abstract This paper provides an overview of current developments in Internet of Things (IoT) embedded systems, wireless networks, and biosensors that have aided in the quick growth of wearable sensor implants. This paper also reviews the benefits of the internet of medical things (IoMT), which has drawn significant interest as an ecosystem of interconnected clinical systems, computing systems, and medical sensors aimed at enhancing the caliber of healthcare services. The concept of healthcare and lifestyle can be completely changed by AI technology based on 5G. The goal of this paper is to identify dangers that might jeopardize the integrity, privacy, and security of IoMT systems in light of the significance of IoT platforms and 5G networks. Additionally, there are cutting-edge blockchain- based methods that can aid in enhancing IoMT network secrecy. IoMT has been shown to be vulnerable to a number of attacks, including malware, DoS attacks, and eavesdropping attacks. IoMT is also exposed to a number of vulnerabilities, including those related to security, privacy, and confidentiality. There are innovative cryptographic solutions, like as access control, identity authentication, and data encryption, that may aid in enhancing the security and dependability of IoMT devices despite a variety of security risks.

Keywords IoMT · Clinical systems · Encryption · And Blockchain

H. Alshehhi · A. Almazrouei · O. ALshehhi

School of Information Technology, Skyline University College, Sharjah, UAE

H. M. Alzoubi 

School of Business, Skyline University College, Sharjah, UAE

e-mail: haitham.alzoubi@skylineuniversity.ac.ae

Applied Science Research Center, Applied Science Private University, Amman, Jordan

1 Introduction

Microelectron mechanical sensors and systems are among the latest advancements in semiconductor and associated technologies, and the internet of things (IoT) has drawn a lot of interest (Lee et al., 2022b). Artificial intelligence (AI) is a tool used by smart gadgets to provide insightful predictions. However, in order for these devices to properly apply federated learning—a perfect type of collaborative learning for IoMT devices (Alzoubi et al., 2022c) they must be linked to a wireless communication network in order to carry out several laborious computing tasks (Ghazal et al., 2022d). For this reason, only 5G or higher-level communication technologies can provide the support needed for intelligent medical equipment (Hasan et al., 2022). These technologies, as stated by Alshurideh et al. (2022a, 2022b), have a wide range of applications (Zafar et al., 2022), from smart watches to healthcare monitoring (Guergov & Radwan, 2021), and their usage is not only restricted to smartphones (Shamout et al., 2022). While the cost, flexibility, and functionality of the IoMT network can be considerably improved by the implementation of 5G network design (Maged Farouk, 2022). Despite the demanding specifications, 5G networks will employ terahertz signals for transmission, have a data rate of more than 1TBPS, and use a 3-dimensional communication structure (frequency, space, and time) (Ghazal et al., 2022c; Islam et al., 2020) rather than a 2-dimensional one that has less features and accessibilities (Kurdi et al., 2022a) like those seen in 5G networks (Hasan et al., 2022). This will give medical IoT devices a solid architecture with wider and deeper coverage.

Blockchain support the Internet of Things (IoT) (Alzoubi et al., 2020) is a growing technology paradigm (Hasan et al., 2022) that has connected billions of intelligent items (Alsharari, 2021), leading to the development of intelligent ecosystems including smart industries, homes, cities, and grids (Kurdi et al., 2022c). One of the most important sectors in the use of technology to offer all-encompassing and immediate services (Bibi et al., 2021) in the healthcare industry and found an evidence of (Alzoubi et al., 2021). A wide range of entities, including machines, people, and things, are connected into data space anywhere and at any time under the IoT umbrella (Radwan & Farouk, 2021). With the introduction of IoMT, where medical devices are connected through a global network (Hussam Al-Hamadi et al., 2015a, 2015b) that is accessible by anyone who have intention to utilize of purchase (Kurdi et al., 2022b), everywhere, and at any time, the development and evolution of IoT are dramatically transforming the healthcare sector (Al-Dmour, 2020; Ghazal et al., 2022b).

IoT has a growth rate of over 270%, making it the net milestone in the global development of technology (Saleem et al., 2022). The collecting, transmission, and processing of data in the course of people's private lives is becoming more widespread (Hamadneh et al., 2021; Vo et al., 2010), dense, and invisible, yet although playing a significant part in shaping the future of smart cities, this is raising considerable privacy issues (Abbas et al., 2022; Alzoubi et al., 2022a, 2022b, 2022c, 2022d). IoMT devices, such as implanted sensors and medical wearables (Hujran et al., 2020), which make

up the majority of the edge network's basic components are particularly vulnerable to cybersecurity attacks (Ali, 2021), and as a result, they represent a significant danger to the patient's safety and privacy (Alzoubi & Aziz, 2021; Khan et al., 2022). The dynamic and heterogeneous nature of IoT devices significantly increases the risk of cyberattacks (Hasan et al., 2022) that could result in data-injection attacks, Denial of Service (DoS), Distributed Denial of Service (DDoS) (H Al-Hamadi et al., 2015a, 2015b), sophisticated botnet attacks, and advanced persistent attacks that could endanger the confidentiality and availability of available processes, data, or even destabilize an entire ecosystem (Ramakrishna & Alzoubi, 2022). Unauthorized access to a patient's medical records may result in improper prescriptions being written, which might endanger the patient's health or possibly result in death (Al-Hamadi et al., 2015a, 2015b; Ghazal et al., 2022f). As a result, although if IoMT offers tremendous advantages (Hanaysha et al., 2022; Mohammad Kamrul Hasan et al., 2021a, 2021b; Siddiqui et al., 2021), it is also susceptible to cyber threats like keylogging, phishing, and the growth of dangerous bots (Al-Dmour & Teahan, 2005). This makes the biomedical sector a crucial field for research (Hasan et al., 2022). In addition to possible cybersecurity risks and its prevention to secure the database in the system (Alnazer et al., 2017) and information security risks (Chong et al., 2021), the IoMT's digital environment is vulnerable to hacking techniques (Alzoubi & Ahmed, 2019) that can compromise physical security (Ghazal & Taleb, 2022; Khan, 2021). As a result, a security mechanism that can protect the security of the IoMT network is required for the effective integration of IoMT technology into healthcare systems (Ghazal et al., 2022d, 2022e; Hasan et al., 2021a, 2021b).

Security is a vital component (Alhamad et al., 2021) that depends on the dependability of the medical equipment (Al-Naymat et al., 2021). The first step in doing this is to pinpoint current and potential risks to the IoMT network (Ali et al., 2021). Attacks that target IoT networks (Ghazal et al., 2021; Zitar et al., 2021) can also be viewed as threats (Alshurideh et al., 2020) that could harm IoMT devices (Alkeem et al., 2017) since IoMT devices and IoT devices have comparable technological capabilities and features (Ali et al., 2022). This paper will conclude by highlighting the relevance of contemporary approaches to reducing cybersecurity risks.

1.1 Problem Statement

Information security threats can have a detrimental influence on business continuity (Alzoubi & Yanamandra, 2020), public perception (Hanaysha et al., 2021), and, in the event of non-compliance, legal issues (Mehmood et al., 2019), as more firms are beginning to discover. These dangers can also lead to monetary loss and have a bad effect on partnerships, client connections, and the happiness of those relationships. "Information security is the preservation of data and the vital elements included within," Confidentiality, integrity, and availability are the three primary traits that define information security. Confidentiality is crucial since it restricts who can access information (Alshurideh et al., 2022a, 2022b; Ghazal et al., 2022a). Information's

integrity is measured by how full and unmodified it is. The availability feature enables users and other systems to access data.

The internal threat has been a prominent issue in information security for a while now. Depressingly, there is little information accessible on this topic. Only eternal assaults, not insider exploitation, were expected to cause financial losses in 2008, according to 50% of those surveyed (Alnuaimi et al., 2021). However, insider misuse was acknowledged by 44% of those surveyed to have occurred in 2008, making it the second most frequent type of information security fraud (after viruses) (Shehada et al., 2018). According to the most current Ernst and Young poll, 25% of respondents said there had been an increase in internal assaults, and 13% said there had been an increase in internally committed fraud.

An authorized employee, e-employee, partner, or customer may utilize that access to an organization's assets in a way (Alzoubi et al., 2022a) that jeopardizes the information security of the company (Ahmed & Amiri, 2022; Bukhari et al., 2022). This is known as "internal threat." For many organizations, internal danger is a problem since employee conduct or ignorance can result in events of different severity, from a few missed workdays to bad press or financial harm, and as a result, the organization may not survive. According to some experts, internal danger may be more significant than external threat, however not many businesses view their workers as a significant threat component (Alhamad et al., 2022; Kim et al., 2019).

2 Literature Review

2.1 *Confidentiality*

Sensitive information about a patient's behaviors may be revealed by the data gathered via IoMT devices. For instance, signals sent by sensors meant to report a patient's status might expose the device's medical capabilities. The same is true for passive assaults like traffic analysis, which enable attackers to collect sensitive and secret data as well as the identities of patients. More crucially, attacks like man-in-the-middle (MiTM) can compromise the security and privacy of IoMT networks by interfering with communication to affect the exchange of data between two parties covertly. This was highlighted by, who also noted that attacks like MiTM can be prevented. In order to violate their privacy, for instance, the acquired medical data may be transferred to a remote server where attackers may alter and intercept it. Researchers like have declared privacy and security concerns a severe danger to user privacy and data confidentiality because unauthorized information storage is susceptible to integrity, privacy, and data security threats. Because IoMT devices lack a trustworthy authentication method, this is fairly obvious. As a result, without network access restriction and data encryption, users' privacy can be violated through eavesdropping by malicious parties.

2.2 2 Attacks Types in IoMT

The attacks such as DoS and Malware attack has been identified, the detail discussions are as below:

- **DoS attack:** The recent rise in identity theft and hacking has made the internet a dangerous place. Due to the economic, social, and medical infrastructure's reliance on computer networks and information technology (IT), such assaults may have an impact on the biomedical field (Al-Tahat & Moneim, 2020). Cybersecurity experts have identified a variety of cyber threats throughout the years that might endanger information security (Lee et al., 2022a). Malware, eavesdropping, and Denial of Service (DoS) assaults are among the most hazardous cybersecurity risks that might jeopardize IoMT security, according to a new analysis. A malicious attacker uses a DoS attack to flood a computer or wearable device with requests in an effort to slow down its processing power.

According to the report, these attacks are carried out in several ways. One attacker system, for instance, can overload a victim's workstation by sending a large number of network packets, many of which look valid. Usually, this action is done to get around network security. On the other side, a hostile party may also employ several devices to carry out spread assaults in unison. Additionally, as mentioned by, DoS attacks obstruct a specific medical IoMT device or system's use in order to prevent approved patients from receiving medicine and to bar medical professionals from accessing patient information.

- **Malware attack:** IoMT devices are vulnerable to a variety of malware, including viruses, worms, Trojan horses, adware, botnets, and more. According to analyses of the phenomena, malware infections propagate automatically throughout the network by taking advantage of known or undiscovered weaknesses. These assaults can take down any network server through DDoS attacks in addition to posing a danger to the integrity and confidentiality of IoMT devices. This may compel a backdoor to a certain medical system or device to open. In addition, taking advantage of the security flaw may result in patient data being deleted, disclosed, or given unauthorized access to medical records. Attackers may take advantage of a malware's successful attempt to establish backdoors to prevent access to IoMT devices. The dependability, accuracy, and privacy of IoMT devices or systems can also be compromised by an attacker using firmware or software, which they can also exploit to delete medical information, execute intrusive or harmful applications, or both. A denial of service can be brought on in this scenario by sophisticated malware varieties that employ polymorphic or encryption tactics. Preventing malware attacks is thus of the utmost importance in the biomedical field since they may seriously harm IoMT systems.
- **Access control:** Access control is a tactic used to prevent unauthorized users from accessing resources while establishing appropriate permission levels for authorized users. By specifying access levels for each user, access management in IoMT systems allows users to limit access to IoMT devices. It's critical to

emphasize that access control can help IoMT devices maintain data confidentiality. This is demonstrated in the paper where the authors developed a simple glass-breaking access control algorithm that combines attribute-based access and glass-breaking access (Mehmood et al., 2022). Glass-breaking access is only used in dire situations, whereas attribute-based access is used for finer-grained access control. The authors claim that their technique is safe and produces incredibly precise results. A feasible two-fold access control scheme for an IoMT information storage system was presented in similar study. The authors claim that their access control system can avoid duplication of medical data using a smart, safe duplication mechanism and is self-adaptive for both emergency and typical settings. A cipher text policy based on the attribute-based encryption method was introduced in a different research. The medical attribute values used in this study are concealed by encrypted s-health data (SHRs). The authors effectively handled the patient's privacy and medical record problems with this access control solution. The project involved creating a secure data-sharing architecture for IoMT devices that leverages the Salopian Wolf coding method to ensure patient privacy while preventing insider assaults. The study claims that the infrastructure they proposed is capable of coordinating various cloud servers to provide patient data to healthcare without disclosing its information.

3 Methodology

The research paper may employ a mixed, qualitative, or quantitative methodology. When using a qualitative technique, the research focuses on an in-depth analysis of the theoretical information that is often gathered to assert or characterize a phenomena using open-ended instruments. However, when a quantitative technique is used, the study is concentrated on numerical or statistical information that is gathered to either verify any hypothesis or assess connections between the chosen variables. The pre-established objectives must guide the choice of the study methodology. Therefore, this research used a quantitative strategy to achieve the goals of the current study.

The choice of an appropriate research strategy serves as the foundation for the study; nevertheless, the data collection stage is crucial for gathering the essential information from the sources that can be analyzed for interpretation and statistical findings. Primary and secondary data sources are typically the two types of information used in research. The participants who are chosen for gathering first-hand, authentic data that is explicitly geared towards the study purpose serve as primary data sources in most cases. Due to time and financial restrictions, businesses typically hire research organizations to conduct these studies. However, secondary data sources can also be found in books, articles from websites, conference proceedings, journal articles, or yearly reports. It has been determined that there is a chance that this material will become out of current or irrelevant. Secondary research, however, is typically seen as being time and money efficient and minimizing ethical issues.

Data is gathered in this respect from sources including IEEE, Springer, and Elsevier publications.

4 Discussion

IoMT devices are susceptible to network/wireless assaults because of their reliance on open wireless connection. The lack of security protections that IoMT devices experience as a result of poor design or security authentication mechanisms makes it possible for an adversary to intercept and eavesdrop on both incoming and outgoing data (Joghee et al., 2020). Furthermore, because most IoMT devices are unable to recognize and stop assaults, competent attackers can get through security to obtain patient data without authorization. As a result, attackers are able to use higher access to infect devices with malware or harmful software. It was shown in the study that medical equipment are susceptible to zombie or botnet attacks, which makes this clear. For instance, an assault may potentially alter or manipulate a patient's medication, which could have fatal consequences for their health. As a result, an enemy can locate the patient's record on the blockchain network because the majority of IoMT devices use blockchain technology. Medical data are also susceptible to falsification in healthcare systems, which can result in incorrect medicine delivery and patient prognosis, both of which increase the risk of an allergic reaction (Alzoubi et al., 2022d). Attackers may transmit phony medical warnings and create large financial losses as a result of security flaws (Hasan et al., 2022).

On the other hand, healthcare institutions now need to see cyber-security as a strategic concern. Due to the antiquated infrastructure, subpar information systems (Alzoubi et al., 2022b), and overall lack of IT management in hospitals, healthcare institutions are a top target for hackers. They threaten to make private information public, disable the systems with ransomware, sell patient data to the highest bidder, and turn off the electricity to the hospitals.

5 Conclusions

The emergence of networked medical devices has altered the dynamics of healthcare operations thanks to cutting-edge technological advancements. As a result, network security for medical equipment has attracted a lot of interest. The healthcare sector will undergo a total change as a result of the adoption of new communication technology, such as 5G networks. We shall see a paradigm shift in the healthcare industry as a result of the quick advancement of communication technologies. Due to communication problems, modern, cutting-edge healthcare frameworks are unable to execute tele surgery. Ambulance services will be supplanted by 5G frameworks, and wearable technology will be reimagined. But because of technical improvements,

this platform is exposed to several security risks, which might significantly jeopardize patient privacy and safety. As a result, current security issues have compelled researchers to examine various medical device vulnerabilities. Additionally, new protection strategies that can maintain the integrity and security of IoMT systems are required since security is a crucial component of ensuring the dependability of IoMT devices and for the effective integration of this technology into healthcare systems. In this regard, the study presented here emphasized the numerous possible risks and assaults that might jeopardize the IoMT devices' capacity to be available, authorized, authenticated, non-reputable, maintain integrity, and maintain secrecy. The research also highlighted cutting-edge countersecurity techniques against anomalies that endanger IoMT systems, which were gleaned from the literature. Finally, many strategies and frameworks for establishing a more reliable and improved IoMT that can further aid in enhancing patient experience and health were discussed.

References

- Abbas, S., Alhwaiti, Y., Fatima, A., Khan, M. A., Khan, M. A., Ghazal, T. M., Kanwal, A., Ahmad, M., & Elmitwally, N. S. (2022). Convolutional neural network based intelligent handwritten document recognition. *Computers Material Continue*, 70, 4563–4581.
- Ahmed, G., & Amiri, N. A. (2022). The transformational leadership of the founding leaders of the United Arab Emirates: Sheikh Zayed Bin Sultan Al Nahyan and Sheikh Rashid Bin Saeed Al Maktoum. *International Journal Technology Innovation Management*, 2, 1.
- Al-Dmour, N., & Teahan, W. (2005). The blackboard resource discovery mechanism for distributed computing over P2P networks. In T. International (Ed.), *PDCN. Conference on Parallel and Distributed Computing and Networks, Innsbruck, Austria, February* (pp. 15–17).
- Al-Dmour, N. A. (2020). Using unstructured search algorithms for data collection in IoT-based WSN. *International Journal Engineering Research Technology*, 13, 1992–1998.
- Al-Hamadi, H., Gawanmeh, A., & Al-Qutayri, M. (2015). Formal validation of QRS wave within ECG. In *2015 International Conference on Information and Communication Technology Research, ICTRC 2015*. 9 (pp. 190–193).
- Al-Hamadi, H., Gawanmeh, A., Baek, J., & Al-Qutayri, M. (2015b). Lightweight security protocol for ECG bio-sensors'. *Wireless Personal Communications*, 95, 5097–5120.
- Al-Naymat, G., Hussain, H., Al-Kasassbeh, M., & Al-Dmour, N. (2021). Accurate detection of network anomalies within SNMP-MIB data set using deep learning. *International Journal of Computer Applications in Technology*, 66, 74–85.
- Al-Tahat, S., & Moneim, O. A. (2020). The impact of artificial intelligence on the correct application of cyber governance in Jordanian commercial banks. *International Journal of Scientific & Technology Research*, 9, 7138–7144.
- Alhamad, A., Alshurideh, M., Alomari, K., Al Kurdi, B., Alzoubi, H., Hamouche, S., & Al-Hawary, S. (2022). The effect of electronic human resources management on organizational health of telecommunications companies in Jordan. *International Journal Data Network Science*, 6, 429–438.
- Alhamad, A. Q. M., Akour, I., Alshurideh, M., Al-Hamad, A. Q., Kurdi, B. A., & Alzoubi, H. (2021). Predicting the intention to use google glass: A comparative approach using machine learning models and PLS-SEM. *International Journal Data Network Science*, 5, 311–320.
- Ali, A. A. (2021). The impact of information sharing and quality assurance on customer service at UAE banking sector. *International Journal Technology Innovation Management*, 1, 01–17.

- Ali, N., Ahmed, A., Anum, L., Ghazal, T. M., Abbas, S., Khan, M. A., Alzoubi, H. M., & Ahmad, M. (2021). Modelling supply chain information collaboration empowered with machine learning technique. *Intelligent Automation & Soft Computing*, 30, 243–257.
- Ali, N., Ghazal, T. M., Ahmed, A., Abbas, S., Khan, M. A., Alzoubi, H. M., Farooq, U., Ahmad, M., & Khan, M. A. (2022). Fusion-based supply chain collaboration using machine learning techniques. *Intelligent Automation & Soft Computing*, 31, 1671–1687.
- Alkeem, E. A., Shehada, D., Yeun, C. Y., Zemerly, M. J., & Hu, J. (2017). New secure healthcare system using cloud of things. *Cluster Computing*, 20(3), 2211–2229.
- Alnazer, N. N., Alnuaimi, M. A., & Alzoubi, H. M. (2017). Analysing the appropriate cognitive styles and its effect on strategic innovation in Jordanian universities. *International Journal of Business Excellence*, 13, 127–140.
- Alnuaimi, M., Alzoubi, H. M., Ajelat, D., & Alzoubi, A. A. (2021). Towards intelligent organisations: An empirical investigation of learning orientation's role in technical innovation. *International Journal of Innovation and Learning*, 29, 207–221.
- Alsharari, N. (2021). Integrating blockchain technology with internet of things to efficiency. *The International Journal on Technology, Innovation, and Management*, 1, 01–13.
- Alshurideh, M., Al Kurdi, B., Alzoubi, H. M., Ghazal, T. M., Said, R. A., AlHamad, A. Q., Hamadneh, S., Sahawneh, N., & Al-kassem, A. H. (2022). Fuzzy assisted human resource management for supply chain management issues. *The Annals of Operations Research* 1–19.
- Alshurideh, M., Gasaymeh, A., Ahmed, G., Alzoubi, H., & Kurd, B. A. (2020). Loyalty program effectiveness: Theoretical reviews and practical proofs. *Uncertain Supply Chain Management*, 8, 599–612.
- Alshurideh, M. T., Al Kurdi, B., Alzoubi, H. M., Obeidat, B., Hamadneh, S., & Ahmad, A. A. (2022b). The influence of supply chain partners' integrations on organizational performance: The moderating role of trust. *Uncertain Supply Chain Management*, 10, 1191–1202.
- Alzoubi, H., & Ahmed, G. (2019). Do TQM practices improve organisational success? A case study of electronics industry in the UAE. *International Journal of Economics and Business Research*, 17, 459–472.
- Alzoubi, H. M., Ahmed, G., Al-Gasaymeh, A., & Al Kurdi, B. (2020). Empirical study on sustainable supply chain strategies and its impact on competitive priorities: The mediating role of supply chain collaboration. *Management Science Letters*, 10, 703–708.
- Alzoubi, H., Alshurideh, M., Kurdi, B. A., Akour, I., & Aziz, R. (2022a). Does BLE technology contribute towards improving marketing strategies, customers' satisfaction and loyalty? The role of open innovation. *International Journal of Data and Network Science*, 6, 449–460.
- Alzoubi, H. M., Ahmed, G., & Alshurideh, M. (2022b). An empirical investigation into the impact of product quality dimensions on improving the order-winners and customer satisfaction. *International Journal of Productivity and Quality Management*, 36, 169–186.
- Alzoubi, H. M., Alshurideh, M. T., Kurdi, B. A., Alhyasat, K. M. K., & Ghazal, T. M. (2022c). The effect of e-payment and online shopping on sales growth: Evidence from banking industry. *International Journal of Data and Network Science*, 6, 1369–1380.
- Alzoubi, H. M., Elrehaile, H., Hanaysha, J. R., Al-Gasaymeh, A., & Al-Adaileh, R. (2022d). The role of supply chain integration and agile practices in improving lead time during the COVID-19 crisis. *International Journal of Service Science, Management, Engineering, and Technology*, 13, 1–11.
- Alzoubi, H. M., & Aziz, R. (2021). Does emotional intelligence contribute to quality of strategic decisions? The mediating role of open innovation. *Journal of Open Innovation: Technology, Market, and Complexity*, 7, 130.
- Alzoubi, H. M., Vij, M., Vij, A., & Hanaysha, J. R. (2021). What leads guests to satisfaction and loyalty in UAE five-star hotels? AHP analysis to service quality dimensions. *Enlightening Tourism: A Pathmaking Journal*, 11, 102–135.
- Alzoubi, H. M., & Yanamandra, R. (2020). Investigating the mediating role of information sharing strategy on agile supply chain in supply chain performance. *Uncertain Supply Chain Management*, 8, 273–284.

- Bibi, R., Saeed, Y., Zeb, A., Ghazal, T. M., Rahman, T., Said, R. A., Abbas, S., Ahmad, M., & Khan, M. A. (2021). Edge AI-based automated detection and classification of road anomalies in VANET using deep learning. *Computational Intelligence and Neuroscience*, 2021, 1–19.
- Bukhari, M. M., Ghazal, T. M., Abbas, S., Khan, M. A., Farooq, U., Wahbah, H., Ahmad, M., & Adnan, K. M. (2022). An intelligent proposed model for task offloading in fog-cloud collaboration using logistics regression. *Computational Intelligence and Neuroscience*
- Chong, C., Lee, K., & Ahmed, G. (2021). Improving IoT privacy, data protection and security concerns. *The International Journal on Technology, Innovation, and Management*, 1, 18–33.
- Farouk, M. (2022). Studying human robot interaction and its characteristics. *International Journal of Computations, Information and Manufacturing*, 2, 1.
- Ghazal, T. M., Abbas, S., Ahmad, M., & Aftab, S. (2022a). An IoMT based ensemble classification framework to predict treatment response in hepatitis C patients. In *2022 International Conference on Business Analytics for Technology and Security, ICBATS 2022* (pp. 1–4).
- Ghazal, T. M., Abbas, S., Munir, S., Khan, M. A., Ahmad, M., Issa, G. F., Zahra, S. B., Khan, M. A., & Hasan, M. K. (2022b). Alzheimer disease detection empowered with transfer learning. *Computers, Materials & Continua*, 70, 5005–5019.
- Ghazal, T. M., Ahmed, Z. E., Hasan, M. K., Hashim, A. A., Saeed, R. A., Mokhtar, R. A., & Singh, S. P. (2022c). Optimization procedure for intelligent internet of things applications. In *2022 International Conference on Business Analytics for Technology and Security, ICBATS 2022* (pp. 1–6).
- Ghazal, T. M., Hasan, M. K., Abdullah, S. N. H., Abubakkar, K. A., & Afifi, M. A. M. (2022d). IoMT-enabled fusion-based model to predict posture for smart healthcare systems. *Computers, Materials & Continua*, 71, 2579–2597.
- Ghazal, T. M., Hasan, M. K., Alkhalfah, A., Abu Bakar, K. A., Omidvar, A., Nafi, N. S., & Agbinya, J. I. (2021). *Fischer linear discrimination and quadratic discrimination analysis-based data mining technique for internet of things framework for healthcare* (p. 9). Public Heal.
- Ghazal, T. M., Noreen, S., Said, R. A., Khan, M. A., Siddiqui, S. Y., Abbas, S., Aftab, S., & Ahmad, M. (2022e). Energy demand forecasting using fused machine learning approaches. *Intelligent Automation & Soft Computing*, 31, 539–553.
- Ghazal, T. M., Rehman, A. U., Saleem, M., Ahmad, M., Ahmad, S., & Mehmood, F. (2022f). Intelligent model to predict early liver disease using machine learning technique. In *2022 International Conference on Business Analytics for Technology and Security, ICBATS 2022* (pp. 1–5).
- Ghazal, T. M., & Taleb, N. (2022). Feature optimization and identification of ovarian cancer using internet of medical things. *Expert Systems*.
- Guergov, S., & Radwan, N. (2021). Blockchain convergence: analysis of issues affecting IoT, AI and blockchain. *International Journal of Computations, Information and Manufacturing*, 1, 1–17.
- Hamadneh, S., Pedersen, O., Alshurideh, M., Kurdi, B. A., & Alzoubi, H. M. (2021). An investigation of the role of supply chain visibility into the scottish blood supply chain. *Journal of Legal, Ethical and Regulatory Issues*, 24, 1–12.
- Hanaysha, J., Al-Shaikh, M., & Alzoubi, H. M. (2021). Importance of marketing mix elements in determining consumer purchase decision in the retail market. *International Journal of Service Science, Management, Engineering, and Technology*, 12, 56–72.
- Hanaysha, J. R., Al-Shaikh, M. E., Joghee, S., & Alzoubi, H. M. (2022). Impact of innovation capabilities on business sustainability in small and medium enterprises. *FIIB Business Review*, 11, 67–78.
- Hasan, M. K., Ghazal, T. M., Saeed, R. A., Pandey, B., Gohel, H., Eshmawi, A. A., Abdel-Khalek, S., & Alkhassawneh, H. M. (2022). A review on security threats, vulnerabilities, and counter measures of 5G enabled Internet-of-Medical-Things. *IET Communications*, 16, 421–432.
- Hasan, M. K., Islam, S., Sulaiman, R., Khan, S., Hashim, A. H. A., Habib, S., Islam, M., Alyahya, S., Ahmed, M. M., Kamil, S., & Hassan, M. A. (2021a). Lightweight encryption technique to enhance medical image security on internet of medical things applications. *IEEE Access*, 9, 47731–47742.

- Hasan, M. K., Musse, M. A., Sherfriz, S. M., Shayla, I., Huda, S. N., & A. S., Eklas, H., Nazmus, S. N., Nguyen, V. (2021b). An improved dynamic thermal current rating model for PMU-based wide area measurement framework for reliability analysis utilizing sensor cloud system *IEEE Access*, 9, 14446–14458.
- Hujran, O., Alikaj, A., Durrani, U. K., & Al-Dmour, N. (2020). Big data and its effect on the music industry. In *ACM International Conference Proceeding Series* (pp. 5–9).
- Islam, S., Khalifa, O. O., Hashim, A. H. A., Hasan, M. K., Razzaque, M. A., & Pandey, B. (2020). Design and evaluation of a multihoming-based mobility management scheme to support inter technology handoff in PNEMO. *Wireless Personal Communications*, 114, 1133–1153.
- Joghee, S., Alzoubi, H. M., & Dubey, A. R. (2020). Decisions effectiveness of FDI investment biases at real estate industry: Empirical evidence from Dubai smart city projects. *International Journal of Scientific & Technology Research*, 9, 3499–3503.
- Khan, M. A. (2021). Challenges facing the application of IoT in medicine and healthcare. *International Journal of Computations, Information and Manufacturing*, 1, 39–55.
- Khan, M. A., Ghazal, T. M., Lee, S. W., & Rehman, A. (2022). Data fusion-based machine learning architecture for intrusion detection. *Computers, Materials & Continua*, 70, 3399–3413.
- Kim, S.-K., Yeun, C. Y., Damiani, E., & Lo, N.-W. (2019). A machine learning framework for biometric authentication using electrocardiogram. *IEEE Access*, 7, 94858–94868.
- Kurdi, B. A., Alshurideh, M., Akour, I., Alzoubi, H. M., Obeidat, B., & Alhamad, A. (2022a). The role of digital marketing channels on consumer buying decisions through eWOM in the Jordanian markets. *International Journal of Data and Network Science*, 6, 1175–1185.
- Kurdi, B. A., Alshurideh, M., Akour, I., Tariq, E., Alhamad, A., & Alzoubi, H. M. (2022b). The effect of social media influencers' characteristics on consumer intention and attitude toward Keto products purchase intention. *International Journal of Data and Network Science*, 6, 1135–1146.
- Kurdi, B. A., Alzoubi, H. M., Akour, I., & Alshurideh, M. T. (2022c). The effect of blockchain and smart inventory system on supply chain performance: Empirical evidence from retail industry. *Uncertain Supply Chain Management*, 10, 1111–1116.
- Lee, K. L., Azmi, N. A. N., Hanaysha, J. R., Alzoubi, H. M., & Alshurideh, M. T. (2022a). The effect of digital supply chain on organizational performance: An empirical study in Malaysia manufacturing industry. *Uncertain Supply Chain Management*, 10, 495–510.
- Lee, K. L., Romzi, P. N., Hanaysha, J. R., Alzoubi, H. M., & Alshurideh, M. (2022b). Investigating the impact of benefits and challenges of IOT adoption on supply chain performance and organizational performance: An empirical study in Malaysia. *Uncertain Supply Chain Management*, 10, 537–550.
- Mehmood, S., Ghazal, T. M., Khan, M. A., Zubair, M., Naseem, M. T., Faiz, T., & Ahmad, M. (2022). Malignancy detection in lung and colon histopathology images using transfer learning with class selective image processing. *IEEE Access*, 10, 25657–25668.
- Mehmood, T., Alzoubi, H. M., Alshurideh, M., Al-Gasaymeh, A., & Ahmed, G. (2019). Schumpeterian entrepreneurship theory: Evolution and relevance. *Academy of Entrepreneurship Journal*, 25, 1–10.
- Radwan, N., & Farouk, M. (2021). The growth of internet of things (IoT) in the management of healthcare issues and healthcare policy development. *The International Journal on Technology, Innovation, and Management*, 1, 69–84.
- Ramakrishna, Y., & Alzoubi, H. M. (2022). Empirical investigation of mediating role of six sigma approach in rationalizing the COQ in service organizations. *Operations and Supply Chain Management*, 15, 122–135.
- Saleem, M., Abbas, S., Ghazal, T. M., Adnan Khan, M., Sahawneh, N., & Ahmad, M. (2022). Smart cities: Fusion-based intelligent traffic congestion control system for vehicular networks using machine learning techniques. *Egyptian Informatics Journal*.
- Shamout, M., Ben-Abdallah, R., Alshurideh, M., Alzoubi, H., Al Kurdi, B., & Hamadneh, S. (2022). A conceptual model for the adoption of autonomous robots in supply chain and logistics industry. *Uncertain Supply Chain Management*, 10, 577–592.

- Shehada, D., Yeun, C. Y., Zemerly, M. J., Al-Qutayri, M., Al-Hammadi, Y., & Hu, J. (2018). A new adaptive trust and reputation model for mobile agent systems. *Journal of Network and Computer Application*, 124, 33–43.
- Siddiqui, S. Y., Haider, A., Ghazal, T. M., Khan, M. A., Naseer, I., Abbas, S., Rahman, M., Khan, J. A., Ahmad, M., Hasan, M. K., Mohammed, A., & Ateeq, K. (2021). IoMT cloud-based intelligent prediction of breast cancer stages empowered with deep learning. *IEEE Access*, 9, 146478–146491.
- Vo, D. L., Lee, H., Yeun, C. Y., & Kim, K. (2010). Enhancements of authenticated multiple key exchange protocol based on bilinear pairings. *Computers & Electrical Engineering*, 36, 155–159.
- Zafar, S., Asif, M., Ahmad, M. B., Ghazal, T. M., Faiz, T., Ahmad, M., & Khan, M. A. (2022). Assistive devices analysis for visually impaired persons: A review on taxonomy. *IEEE Access*, 10, 13354–13366.
- Zitar, R. A., Al-Dmour, N., Nachouki, M., Hussain, H., & Alzboun, F. (2021). Hashing generation using recurrent neural networks for text documents. *ICIC Express Letters Part B: Applications*, 12, 231–241.

Data Protection and Privacy Management for Healthcare Wearable Devices



Abdulla AlMazrouei, Ali A. Alzoubi, and Haitham M. Alzoubi 

Abstract The advent of mobile health has opened up fascinating new avenues for patient engagement in their healthcare. Health data collected by wearable devices may be examined to reveal insights into the user's health. Despite the importance of data privacy and data safety concerns raised by such technology, very little study has been done on the topic. Reduction of the discipline toward data or information flow linkages in medical wearables is one example of a defect in technology that may lead to security issues like data and privacy breaches. The challenge of protecting sensitive information and individual privacy while collecting data using wearable healthcare devices wants more investigation. This paper examines the technological, managerial, and legal elements of data protection and privacy management for healthcare wearable devices.

Keywords Privacy · Data protection · Wearable devices · Healthcare · And legal elements

1 Introduction

Health care is undergoing a profound transformation as a result of the integration of science and technology (Ghazal et al., 2022d). Widespread potential uses for improved connection are a driving force behind these shifts. Information on the host's health may be collected in real-time via wearable medical equipment (Alnazer et al.,

A. AlMazrouei

School of Information Technology, Skyline University College, Sharjah, UAE

A. A. Alzoubi

Public Security Directorate, Amman, Jordan

H. M. Alzoubi 

School of Business, Skyline University College, Sharjah, UAE

e-mail: haitham.alzoubi@skylineuniversity.ac.ae

Applied Science Research Center, Applied Science Private University, Amman, Jordan

2017). Information on the patient's sleeping habits, daily routine, and emotional state are all included, and they have both commercial and social significance (Khan, 2021). Medical The Internet of Things (IoT) and sensing technologies are brought together with the help of wearable devices to form a huge medical network that connects patients and healthcare facilities (Bibi et al., 2021). These gadgets are key hubs for linking healthcare networks together (Kurdi et al., 2022c). When data is sent to the cloud, wearable devices may become more vulnerable to attacks and data breaches (Al-Hamadi et al., 2015a, 2015b). The reason for this is that wearables may collect data on their users at any time and in any place (Siddiqui et al., 2021). Occasionally, issues may arise as a result of flaws in the technology (Alzoubi et al., 2022a, 2022b, 2022c, 2022d). These issues may include, for example, a lack of autonomy over information flow links in wearable devices, or an increased possibility of data and privacy breaches (Chong et al., 2021). The subject of how to protect sensitive information and the privacy of patients while using wearable technology in healthcare is an important one (Al Neaimi et al., 2020). This research aimed to examine the technological, administrative, and legal implications of using wearable devices to collect health insurance data (Islam et al., 2020). User privacy or data protection for generic health care wearables are also studied to ensure the safety of sensitive information and individual privacy (Alzoubi et al., 2022a), while also bolstering the long-term viability of the universal health care wearable technology market and advancing scientific knowledge through data analysis (Hasan et al., 2021a, 2021b).

Provider devices from companies like Fitbit, Huawei, and Xiaomi may be acquired (Hanaysha et al., 2021) while still connected to the network, with the IP address intact; this is just one of the numerous data leakage incidents (Joghee et al., 2020) to emerge in recent years (Hasan et al., 2022). Concerns about users' privacy have led to the recall of several of these wearable devices (Alnuaimi et al., 2021; Alshurideh et al., 2022a, 2022b). When it comes to medical wearables, data security and online privacy are impacted (Radwan & Farouk, 2021) not only by technical elements like equipment and network but also by privacy awareness (Alzoubi & Aziz, 2021). Since wearable devices may collect user data at any time and from any place (Abbas et al., 2022) by uploading it to the cloud (Bukhari et al., 2022), they open themselves exposed to attacks and data breaches.

Therefore, the study will also examine the reasons behind this, as well as the remedies that have been proposed and offered by many specialists in the sector (Alzoubi et al., 2022d; Hasan et al., 2022). Some of the important issues are included after the study, and the report concludes with a discussion of some of the relevant systems, which also points out the problem extensively and discussed any particular remedy.

1.1 Problem Statement

Every device in the current age is evolving toward the digital computing, which involves the sharing of the information using the digital medium, in the current case the medical wearable is used with the body of the patient or the normal user, it shares their data with the mobile device or the cloud, it contains every information about the host if such information is leaked out to some vulnerable person, then it can cause the chaos for such type of the person. So these devices are useful, as well as vulnerable to their hosts as well.

2 Literature Review

This section will explain the related work of the report, for example, the methods introduced by the others, that are similar to the current method (Hasan et al., 2021a, 2021b; Khan, 2021). Recent years have seen a surge in interest in the study of cyber-physical (CP) assaults (Al Hamadi et al., 2017), which have their roots in the digital realm (Al-Nashashibi et al., 2021) but cause harm to the real world (Ali et al., 2022). Many CP systems, including smart grids, ITS, and medical equipment (Ghazal & Taleb, 2022), have been compromised by these kinds of assaults. In this chapter, we will discuss methods for spotting and protecting against CP assaults on medical equipment. Threats of this magnitude pose serious security concerns (Alshurideh et al., 2022a, 2022b; Radwan, 2022). Our research is grounded on methodology, a group of mathematically-grounded methodologies for the design and validation (Alshurideh et al., 2022a, 2022b; Alzoubi et al., 2022b; Islam et al., 2020) of safety-critical systems. Our primary focus is on the interplay between the heart and a cardiac pacemaker (Ghazal et al., 2021). Then, we present a summary of formal methods (Alzoubi et al., 2022c), focusing especially on run-time-based approaches (Kurdi et al., 2022b) that are well suited to the development of safety checkers (Alhamad et al., 2022). Then, we go deep into two recent techniques for detecting and preventing attacks (Guergov & Radwan, 2021) that were created by our team. This chapter has provided an in-depth review of the state-of-the-art formal methods for medical device attack detection and prevention at runtime (Mehmood et al., 2019, 2022).

In the early 2000s, wireless clinician controls (Alzoubi & Yanamandra, 2020) and monitoring capabilities started (Ghazal et al., 2022a) to be included in a wide variety of implantable medical devices (Ramakrishna & Alzoubi, 2022), including pacemakers, defibrillators, and heart and infusion pumps for the neurological system (Khan et al., 2022). Rapid advances in technology have allowed doctors and patients to utilize cellphones (Hanaysha et al., 2022) to remotely administer and check implants by pairing two devices (Vo et al., 2010) (through Bluetooth, for example) (Al-Hamadi et al., 2021) or linking them to a centralized computer or server online (Ali et al., 2021). While wirelessly connected IMDs have numerous advantages (Abu-Arqoub et al., 2020), there is rising worry that equipment may be exploited by

attackers (i.e. hostile hackers) (Alsharari, 2021) due to poor cybersecurity safeguards (Alhamad et al., 2021). Due to their remote monitoring capabilities, networked IMDs are vulnerable to attacks from anywhere in the world (Ghazal et al., 2022e).

Healthier Connection's broad applicability results in substantial improvements (Alzoubi et al., 2020) to current health care systems by fusing cutting-edge (Lee et al., 2022b) medical research with cutting-edge technology (Saleem et al., 2022). Wearable medical and health devices may one-day capture information (Lee et al., 2022a) in real-time about a person's health (Ghazal et al., 2022f), including the person's mood, activity level, and sleep habits (Ghazal et al., 2022b). The economic and societal importance of this sort of information is high. When it comes to the interconnection of health systems, wearable medical devices play a crucial role as nodes (Shamout et al., 2022; Zafar et al., 2022). Such devices facilitate the development of comprehensive healthcare infrastructure by linking individuals and healthcare facilities to IoT sensors (Ghazal et al., 2022c) and other related equipment (Al-Tahat & Moneim, 2020). Publication of data to the cloud increases the wearable sensors system's susceptibility to assaults and data loss (Alzoubi et al., 2021). This is because data from wearable devices may be collected at any time and in any location (Alshurideh et al., 2020). Technology flaws, such as an inability to manage data flow linkages in wearables (Al-Hamadi et al., 2015a, 2015b; Maged Farouk, 2022), may sometimes lead to issues. Additionally, due to these flaws, there is a higher probability of a compromise in data security (Ali, 2021). Keeping this in mind, investigating the issue of data security and data privacy is crucial when gathering information via wearables.

3 Methodology

The main issue is caused because of the data that is generated by the sensors of the wearable devices. The main point of the addressing is the classification of the wearable devices that are two in number, the bio wearable, that are inside the body or attached to the body and produce the results according to the requirement, using the sensors. After that, the other type of device is the interaction type the device, which responds to any action that is predefined by the developers. In the past, it is tried hard to refine such types of devices to generate the possible results as correct as can be, for example, in the old days the pulse sensor is not responding to the smart devices, or the rate of the pulse was different. All this can be because of the issue in the device, otherwise the manipulation in the device because of any security breach, it can be addressed using the following solutions:

- **Auditing:** By auditing IMDs, it will be possible to keep a detailed record of all device operations and access actions. This might be used in conjunction with anomaly detection and reporting systems to alert the user (patient) or doctor to potential issues (Hamadneh et al., 2021).

- Reporting bugs: Post-release monitoring should include more efficient methods for discovering security holes and implementing fixes as soon as possible. Manufacturers should remove the barriers that prevent independent security researchers from appropriately disclosing flaws.
- Authentication using many factors: Multiple authentication factors make it harder for attackers to get access to an IMD. The inclusion of patient-specific biometric information or proximity-based access restrictions as entry criteria is simple to implement and might significantly improve security.
- Education related to the Device: Neither doctors nor IMD producers seem to be very aware of the risks associated with cybersecurity at present (Alzoubi & Ahmed, 2019). Security measures and public trust in IMDs may benefit from efforts to raise knowledge of this threat and the steps that may be taken to mitigate it and can assist in developing a better market of the medical treatment (Kurdi et al., 2022a).

4 Conclusions

The report discussed the security issues that are faced by the people using the medical devices or the wearables. For example, hackers or intruders get access to such devices and steal the data that can be dangerous for the host of the wearable. The report mentioned some of the Chinese brands that faced the issues of data-stealing. The report defines what the problem is, in the section of the problem statement, also the solution is provided for the defined problem. The security of the data or the information that is generated by the Wearable devices is secured by using the four points. The auditing, in which the activities of the systems are monitored and detected if there are any anomaly occurs, if there is any bug in the report, on the next section this will be identified, and the proper method of the secure authentication should be provided to the devices so only authorized user can get the data that is generated by the wearable device, also the user of the device need to be educated so one can easily get how to make their data more secure, and why the security of the data is important.

References

- Abbas, S., Alhwaiti, Y., Fatima, A., Khan, M. A., Khan, M. A., Ghazal, T. M., Kanwal, A., Ahmad, M., & Elmitwally, N. S. (2022). Convolutional neural network based intelligent handwritten document recognition. *Computers, Materials & Continua*, 70, 4563–4581.
- Abu-Arqoub, M., Issa, G., Banna, A. E., & Saadeh, H. (2020). Interactive multimedia-based educational system for children using interactive book with augmented reality. *Journal of Computer Science*, 15, 1648–1658.
- Al-Hamadi, H., Gawanmeh, A., Al-Qutayri, M. (2015). Formal validation of QRS wave within ECG. In *2015 International Conference on Information and Communication Technology Research, ICTRC 2015*, (Vol. 9, pp. 190–193).

- Al-Hamadi, H., Gawanmeh, A., Baek, J., & Al-Qutayri, M. (2015b). Lightweight security protocol for ECG bio-sensors". *Wireless Personal Communications*, 95, 5097–5120.
- Al-Hamadi, H., Nasir, N., Yeun, C. Y., & Damiani, E. (2021). A verified protocol for secure autonomous and cooperative public transportation in smart cities. In I. June (Ed.), *2021 IEEE International Conference on Communications Workshops (ICC Workshops)* (pp. 1–6).
- Al-Nashashibi, M., Hadi, W., El-Khalili, N., Issa, G., & Al Banna, A. A. (2021). A new two-step ensemble learning model for improving stress prediction of automobile. *The International Arab Journal of Information Technology*, 6
- Al-Tahat, S., & Moneim, O. A. (2020). The impact of artificial intelligence on the correct application of cyber governance in Jordanian commercial banks. *International Journal of Scientific & Technology Research*, 9, 7138–7144.
- Al Hamadi, H., Gawanmeh, A., & Al-Qutayri, M. (2017). Guided test case generation for enhanced ECG bio-sensors functional verification. *International Journal of E-Health and Medical Communications*, 8, 1–20.
- Alhamad, A., Alshurideh, M., Alomari, K., Al Kurdi, B., Alzoubi, H., Hamouche, S., & Al-Hawary, S. (2022). The effect of electronic human resources management on organizational health of telecommunications companies in Jordan. *International Journal of Data and Network Science*, 6, 429–438.
- Alhamad, A. Q. M., Akour, I., Alshurideh, M., Al-Hamad, A. Q., Kurdi, B. A., & Alzoubi, H. (2021). Predicting the intention to use google glass: A comparative approach using machine learning models and PLS-SEM. *International Journal of Data and Network Science*, 5, 311–320.
- Ali, A. A. (2021). The impact of information sharing and quality assurance on customer service at UAE banking sector. *International Journal of Technology, Innovation and Management*, 1, 01–17.
- Ali, N., Ahmed, A., Anum, L., Ghazal, T. M., Abbas, S., Khan, M. A., Alzoubi, H. M., & Ahmad, M. M. (2021). Modelling supply chain information collaboration empowered with machine learning technique. *Intelligent Automation & Soft Computing*, 30, 243–257.
- Ali, N., Ghazal, T. M., Ahmed, A., Abbas, S., Khan, M. A., Alzoubi, H. M., Farooq, U., Ahmad, M., & Khan, M. A. (2022). Fusion-based supply chain collaboration using machine learning techniques. *Intelligent Automation & Soft Computing*, 31, 1671–1687.
- Alnazer, N. N., Alnuaimi, M. A., & Alzoubi, H. M. (2017). Analysing the appropriate cognitive styles and its effect on strategic innovation in Jordanian universities. *International Journal of Business Excellence*, 13, 127–140.
- Alnuaimi, M., Alzoubi, H. M., Ajelat, D., & Alzoubi, A. A. (2021). Towards intelligent organisations: An empirical investigation of learning orientation's role in technical innovation. *International Journal of Innovation and Learning*, 29, 207–221.
- Alsharari, N. (2021). Integrating blockchain technology with internet of things to efficiency. *International Journal of Technology, Innovation and Management*, 1, 01–13.
- Alshurideh, M., Al Kurdi, B., Alzoubi, H. M., Ghazal, T. M., Said, R. A., AlHamad, A. Q., Hamadneh, S., Sahawneh, N., & Al-kassem, A. H. (2022). Fuzzy assisted human resource management for supply chain management issues. *Annals of Operations Research* 1–19.
- Alshurideh, M., Gasaymeh, A., Ahmed, G., Alzoubi, H., & Kurd, B. A. (2020). Loyalty program effectiveness: Theoretical reviews and practical proofs. *Uncertain Supply Chain Management*, 8, 599–612.
- Alshurideh, M. T., Al Kurdi, B., Alzoubi, H. M., Obeidat, B., Hamadneh, S., & Ahmad, A. (2022b). The influence of supply chain partners' integrations on organizational performance: The moderating role of trust. *Uncertain Supply Chain Management*, 10, 1191–1202.
- Alzoubi, H., & Ahmed, G. (2019). Do TQM practices improve organisational success? A case study of electronics industry in the UAE. *International Journal of Economics and Business Research*, 17, 459–472.
- Alzoubi, H., Alshurideh, M., Kurdi, B. A., Akour, I., & Aziz, R. (2022a). Does BLE technology contribute towards improving marketing strategies, customers' satisfaction and loyalty? The role of open innovation. *International Journal of Data and Network Science*, 6, 449–460.

- Alzoubi, H. M., Ahmed, G., Al-Gasaymeh, A., & Al Kurdi, B. (2020). Empirical study on sustainable supply chain strategies and its impact on competitive priorities: The mediating role of supply chain collaboration. *Management Science Letters*, 10, 703–708.
- Alzoubi, H. M., Ahmed, G., & Alshurideh, M. (2022b). An empirical investigation into the impact of product quality dimensions on improving the order-winners and customer satisfaction. *International Journal of Productivity and Quality Management*, 36, 169–186.
- Alzoubi, H. M., Alshurideh, M. T., Kurdi, B. A., Alhyasat, K. M. K., & Ghazal, T. M. (2022c). The effect of e-payment and online shopping on sales growth: Evidence from banking industry. *International Journal of Data and Network Science*, 6, 1369–1380.
- Alzoubi, H. M., & Aziz, R. (2021). Does emotional intelligence contribute to quality of strategic decisions? The mediating role of open innovation. *Journal of Open Innovation: Technology, Market, and Complexity*, 7, 130.
- Alzoubi, H. M., Elrechail, H., Hanaysha, J. R., Al-Gasaymeh, A., & Al-Adaileh, R. (2022d). The role of supply chain integration and agile practices in improving lead time during the COVID-19 crisis. *International Journal of Service Science, Management, Engineering, and Technology*, 13, 1–11.
- Alzoubi, H. M., Vij, M., Vij, A., & Hanaysha, J. R. (2021). What leads guests to satisfaction and loyalty in UAE five-star hotels? AHP analysis to service quality dimensions. *Enlightening Tourism. A Pathmaking Journal*, 11, 102–135.
- Alzoubi, H. M., & Yanamandra, R. (2020). Investigating the mediating role of information sharing strategy on agile supply chain in supply chain performance. *Uncertain Supply Chain Management*, 8, 273–284.
- Bibi, R., Saeed, Y., Zeb, A., Ghazal, T. M., Rahman, T., Said, R. A., Abbas, S., Ahmad, M., & Khan, M. A. (2021). Edge AI-based automated detection and classification of road anomalies in VANET using deep learning. *Computational Intelligence and Neuroscience*, 2021, 1–19.
- Bukhari, M. M., Ghazal, T. M., Abbas, S., Khan, M. A., Farooq, U., Wahbah, H., Ahmad, M., & Adnan, K. M. (2022). An intelligent proposed model for task offloading in fog-cloud collaboration using logistics regression. *Computational Intelligence and Neuroscience*
- Chong, C., Lee, K., & Ahmed, G. (2021). Improving IoT privacy, data protection and security concerns. *International Journal of Technology, Innovation and Management*, 1, 18–33.
- Farouk, M. (2022). Studying Human Robot Interaction and Its Characteristics. *International Journal of Computations, Information and Manufacturing*, 2, 1.
- Ghazal, T. M., Abbas, S., Ahmad, M., & Aftab, S. (2022a). An IoMT based ensemble classification framework to predict treatment response in hepatitis C patients. In *2022 International Conference on Business Analytics for Technology and Security, ICBATS 2022* (pp. 1–4).
- Ghazal, T. M., Abbas, S., Munir, S., Khan, M. A., Ahmad, M., Issa, G. F., Zahra, S. B., Khan, M. A., & Hasan, M. K. (2022b). Alzheimer disease detection empowered with transfer learning. *Computers, Materials & Continua*, 70, 5005–5019.
- Ghazal, T. M., Ahmed, Z. E., Hasan, M. K., Hashim, A. A., Saeed, R. A., Mokhtar, R. A., & Singh, S. P. (2022c). Optimization procedure for intelligent internet of things applications. In *2022 International Conference on Business Analytics for Technology and Security, ICBATS 2022* (pp. 1–6).
- Ghazal, T. M., Hasan, M. K., Abdullah, S. N. H., Abubakkar, K. A., & Afifi, M. A. M. (2022d). IoMT-enabled fusion-based model to predict posture for smart healthcare systems. *Computers, Materials & Continua*, 71, 2579–2597.
- Ghazal, T. M., Hasan, M. K., Alkhailah, A., Abu Bakar, K. A., Omidvar, A., Nafi, N. S., & Agbinya, J. I. (2021). *Fischer linear discrimination and quadratic discrimination analysis-based data mining technique for internet of things framework for healthcare* (p. 9). Public Heal.
- Ghazal, T. M., Noreen, S., Said, R. A., Khan, M. A., Siddiqui, S. Y., Abbas, S., Aftab, S., & Ahmad, M. (2022e). Energy demand forecasting using fused machine learning approaches. *Intelligent Automation & Soft Computing*, 31, 539–553.

- Ghazal, T. M., Rehman, A. U., Saleem, M., Ahmad, M., Ahmad, S., & Mehmood, F. (2022f). Intelligent model to predict early liver disease using machine learning technique. In *2022 International Conference on Business Analytics for Technology and Security, ICBATS 2022* (pp. 1–5).
- Ghazal, T. M., & Taleb, N. (2022). Feature optimization and identification of ovarian cancer using internet of medical things. *Expert Systems*.
- Guergov, S., & Radwan, N. (2021). Blockchain convergence: Analysis of issues affecting IoT, AI and blockchain. *International Journal of Computations, Information and Manufacturing*, 1, 1–17.
- Hamadneh, S., Pedersen, O., Alshurideh, M., Kurdi, B. A., & Alzoubi, H. M. (2021). An investigation of the role of supply chain visibility into the scottish blood supply chain. *Journal of Legal, Ethical and Regulatory Issues*, 24, 1–12.
- Hayansha, J., Al-Shaikh, M., & Alzoubi, M. H. (2021). Importance of marketing mix elements in determining consumer purchase decision in the retail market. *International Journal of Service Science, Management, Engineering, and Technology*, 12, 56–72.
- Hayansha, J. R., Al-Shaikh, M. E., Joghee, S., & Alzoubi, H. M. (2022). Impact of innovation capabilities on business sustainability in small and medium enterprises. *FIIB Business Review*, 11, 67–78.
- Hasan, M. K., Ghazal, T. M., Saeed, R. A., Pandey, B., Gohel, H., Eshmawi, A. A., Abdel-Khalek, S., & Alkhassawneh, H. M. (2022). A review on security threats, vulnerabilities, and counter measures of 5G enabled internet-of-medical-things. *IET Communications*, 16, 421–432.
- Hasan, M. K., Islam, S., Sulaiman, R., Khan, S., Hashim, A. H. A., Habib, S., Islam, M., Alyahya, S., Ahmed, M. M., Kamil, S., & Hassan, M. A. (2021a). Lightweight encryption technique to enhance medical image security on internet of medical things applications. *IEEE Access*, 9, 47731–47742.
- Hasan, M. K., Ahmed, M. M., Musa, S. S., Islam, S., Abdullah, S. N. H. S., Hossain, E., Nafi, N. S., & Vo, N. (2021b). An improved dynamic thermal current rating model for PMU-based wide area measurement framework for reliability analysis utilizing sensor cloud system *IEEE Access*, 9, 14446–14458.
- Islam, S., Khalifa, O. O., Hashim, A. H. A., Hasan, M. K., Razzaque, M. A., & Pandey, B. (2020). Design and evaluation of a multihoming-based mobility management scheme to support inter technology handoff in PNEMO. *Wireless Personal Communications*, 114, 1133–1153.
- Joghee, S., Alzoubi, H. M., & Dubey, A. R. (2020). Decisions effectiveness of FDI investment biases at real estate industry: Empirical evidence from Dubai smart city projects. *International Journal of Scientific & Technology Research*, 9, 3499–3503.
- Khan, M. A. (2021). Challenges Facing the Application of IoT in Medicine and Healthcare. *International Journal of Computations, Information and Manufacturing*, 1, 39–55.
- Khan, M. A., Ghazal, T. M., Lee, S. W., & Rehman, A. (2022). Data fusion-based machine learning architecture for intrusion detection. *Computers, Materials & Continua*, 70, 3399–3413.
- Kurdi, B. A., Alshurideh, M., Akour, I., Alzoubi, H. M., Obeidat, B., & Alhamad, A. (2022a). The role of digital marketing channels on consumer buying decisions through eWOM in the Jordanian markets. *International Journal of Data and Network Science*, 6, 1175–1185.
- Kurdi, B. A., Alshurideh, M., Akour, I., Tariq, E., Alhamad, A., & Alzoubi, H. M. (2022b). The effect of social media influencers' characteristics on consumer intention and attitude toward Keto products purchase intention. *International Journal of Data and Network Science*, 6, 1135–1146.
- Kurdi, B. A., Alzoubi, H. M., Akour, I., & Alshurideh, M. T. (2022c). The effect of blockchain and smart inventory system on supply chain performance: Empirical evidence from retail industry. *Uncertain Supply Chain Management*, 10, 1111–1116.
- Lee, K. L., Azmi, N. A. N., Hanaysha, J. R., Alzoubi, H. M., & Alshurideh, M. T. (2022a). The effect of digital supply chain on organizational performance: An empirical study in Malaysia manufacturing industry. *Uncertain Supply Chain Management*, 10, 495–510.

- Lee, K. L., Romzi, P. N., Hanaysha, J. R., Alzoubi, H. M., & Alshurideh, M. (2022b). Investigating the impact of benefits and challenges of IOT adoption on supply chain performance and organizational performance: An empirical study in Malaysia. *Uncertain Supply Chain Management*, 10, 537–550.
- Mehmood, S., Ghazal, T. M., Khan, M. A., Zubair, M., Naseem, M. T., Faiz, T., & Ahmad, M. (2022). Malignancy detection in lung and colon histopathology images using transfer learning with class selective image processing. *IEEE Access*, 10, 25657–25668.
- Mehmood, T., Alzoubi, H. M., Alshurideh, M., Al-Gasaymeh, A., & Ahmed, G. (2019). Schumpeterian entrepreneurship theory: Evolution and relevance. *Academy of Entrepreneurship Journal*, 25, 1–10.
- Al Neaimi, M., Al Hamadi, H., Yeun, C. Y., Zemerly, M. J. (2020). Digital forensic analysis of files using deep learning. In *2020 3rd International Conference on Signal Processing and Information Security, ICSPIS 2020. IEEE*, 2020 (pp. 1–4).
- Radwan, N. (2022). The internet'S role in undermining the credibility of the healthcare industry. *International Journal of Computations, Information and Manufacturing*, 2, 1.
- Radwan, N., & Farouk, M. (2021). The growth of internet of things (IoT) in the management of healthcare issues and healthcare policy development. *International Journal of Technology, Innovation and Management*, 1, 69–84.
- Ramakrishna, Y., & Alzoubi, H. M. (2022). Empirical investigation of mediating role of six sigma approach in rationalizing the COQ in service organizations. *Operations and Supply Chain Management: An International Journal*, 15, 122–135.
- Saleem, M., Abbas, S., Ghazal, T. M., Adnan Khan, M., Sahawneh, N., & Ahmad, M. (2022). Smart cities: Fusion-based intelligent traffic congestion control system for vehicular networks using machine learning techniques. *Egyptian Informatics Journal*
- Shamout, M., Ben-Abdallah, R., Alshurideh, M., Alzoubi, H., Al Kurdi, B., & Hamadneh, S. (2022). A conceptual model for the adoption of autonomous robots in supply chain and logistics industry. *Uncertain Supply Chain Management*, 10, 577–592.
- Siddiqui, S. Y., Haider, A., Ghazal, T. M., Khan, M. A., Naseer, I., Abbas, S., Rahman, M., Khan, J. A., Ahmad, M., Hasan, M. K., Mohammed, A., & Ateeq, K. (2021). IoMT cloud-based intelligent prediction of breast cancer stages empowered with deep learning. *IEEE Access*, 9, 146478–146491.
- Vo, D. L., Lee, H., Yeun, C. Y., & Kim, K. (2010). Enhancements of authenticated multiple key exchange protocol based on bilinear pairings. *Computers & Electrical Engineering*, 36, 155–159.
- Zafar, S., Asif, M., Ahmad, M. B., Ghazal, T. M., Faiz, T., Ahmad, M., & Khan, M. A. (2022). Assistive devices analysis for visually impaired persons: A review on taxonomy. *IEEE Access*, 10, 13354–13366.

Privacy Violation and Information Misuse in the Internet of Medical Things (IoMT)



Ali A. Alzoubi, Mohammed Yousif Alzarooni, and Haitham M. Alzoubi 

Abstract In this paper, a greater emphasis has been given to analyzing the security issues and ethical challenges faced while using the Internet of medical things during healthcare services. The primary objectives of this paper are to examine the factors associated with Google violence and security challenges resulting in the data breach of patients. Developing a robust solution to minimize this issue is another area of priority which has been focused upon while executing this paper. The process includes a detailed analysis of secondary sources of library data to analyze the problematic areas that need to be addressed to reduce security issues and challenges on ethical balance while utilizing the Internet of medical things in healthcare. By evaluating existing theories and published secondary sources presented by verified authors, a robust solution has been developed. Furthermore, the focus has been given to making this solution effective so that it can be used on avoider platforms and eliminate growing concerns associated with properly utilizing the Internet of medical things.

Keywords Internet of medical things · Medical devices · Security · And privacy

1 Introduction

The Internet of medical things (Siddiqui et al., 2021) plays a vital role in accurately delivering appropriate medical services to patients. This is because devices falling within the Internet of medical things allow the sharing of patient data to the doctors

A. A. Alzoubi
Public Security Directorate, Amman, Jordan

M. Y. Alzarooni
School of Information Technology, Skyline University College, Sharjah, UAE

H. M. Alzoubi (✉)
School of Business, Skyline University College, Sharjah, UAE
e-mail: haitham.alzoubi@skylineuniversity.ac.ae

Applied Science Research Center, Applied Science Private University, Amman, Jordan

on a real-time basis (Lee et al., 2022b), making it possible for the doctors to be aware of the patient's health at times (Alzoubi et al., 2022b; Kim et al., 2019). The availability of patient data in the hands of the doctors also results in the proper analysis being done, which ensures that the doctors can then make decisions (Ramakrishna & Alzoubi, 2022) based on evidential facts (Gul et al., 2012).

In this situation, there is also a severe matter that needs to be considered: the breach of security provided by this Internet of medical things (Hussam Al-Hamadi et al., 2015a, 2015b; Ghazal et al., 2022d). Therefore, even though the benefits provided by the medical staff are substantial (Alnazer et al., 2017), as they function using technology and data, which can be altered or attacked by outside sources, there is a genuine threat (Bukhari et al., 2022). Therefore, it is essential to tackle this issue correctly.

As the Internet of medical things is a system of open connections, it is always prone to attacks from third-party users (Ali et al., 2021), which apart from stealing patient information, also have the capability of causing physical damage to the devices worn by the patient (Ghazal et al., 2022e). Such a situation can possibly lead to further injuries to the patient (Al-Hamadi et al., 2015a, 2015b). Thus, it is necessary to provide the appropriate level of security to these devices for the entire duration they operate to ensure that such scenarios do not happen (Alshurideh et al., 2020; Islam et al., 2020). Some measures can be adopted, but the degree of protection that can be provided to be devices still has to be confirmed in trials (Joghee et al., 2020).

Further, other areas in the devices, like scalability, clout, bandwidth, etc., need to be addressed along with the security aspect; otherwise, the threat of attacks will continue to persist (Hasan et al., 2022).

1.1 Problem Statement

The violation of privacy and misuse of information is such a significant problem because it has the potential to completely disrupt the trust of the people on the Internet of medical things, which is then likely to lead to a drastic fall in the usage of these things and the loss of potential benefits derivable from them (Ghazal et al., 2022a).

The devices that belong to the Internet of medical things are designed to provide proper medical treatment to the patients (Alzoubi et al., 2021; Mohammad Kamrul Hasan et al., 2021a, 2021b) and are also used to continuously assess their health along with transferring data back to the IT healthcare systems for the appropriate analysis by the doctors and proper use of IT practices (Alzoubi et al., n.d.). Due to this, the devices are required to handle a substantial amount of data while connected to an open network (Chong et al., 2021), which can be attacked in several ways even after having the required security mechanisms in place.

Further, even the privacy of the patients at times is under threat due to medical devices work by them for their health safety (Hamadneh et al., 2021). This is because these devices, apart from recording the health data, also have the facility to transfer data over a network (Hanaysha et al., 2021). This network which can be hacked into

for personal data can also be used to manipulate the device itself to make it function as a router pointing to the location of the person wearing the device. Thus, allowing the person to be tracked at all times results in the person's privacy being compromised (Al Neaimi et al., 2020).

1.2 Proposed Solutions to Overcome the Issues

The possible solutions that can be used to tackle the issue of privacy violation and information misuse range (Mehmood et al., 2019) from better cryptographic algorithms (Nada Ratkovic, 2022) to faster processing hardware that can handle considerable information (Abbas et al., 2022; Alshurideh et al., 2022a, 2022b; Kurdi et al., 2022c). As the main threat to the devices is through the theft of data (Alzoubi & Yana-mandra, 2020), the focus is primarily placed on using practical cryptographic algorithms (Edward Probir Mondol, 2022) that can tackle the cyber-attacks proficiently (Cruz, 2021). Similarly, to tackle the threat, a proper threat analysis or prevention system has to be developed (Ali et al., 2022) with surety of its effectiveness established through trials that showcase the system's ability to handle different types of attack (Alzoubi & Aziz, 2021).

Similarly, (Guntur et al., 2018) investigated while running the Internet of medical things, it is also essential to ensure that the communication protocols are protected and efficiently learned (Miller, 2021), the failure of which would undoubtedly result in the complete loss of security in the network (Alnuaimi et al., 2021) and eventually compromise the entire device (Saleem et al., 2022).

Finally, to ensure that such devices can handle large data clusters correctly (Lee et al., 2022a) and maintaining data sustainability (Alzoubi et al., 2020), the database management system implemented (Kurdi et al., 2022b) on the Internet of medical things (Eli et al., 2022) should also be given due attention before including them in the device's software (Bibi et al., 2021; Ramakrishna & Alzoubi, 2022). One solution to the storage and security issue of the data can be done (Alzoubi, 2021; Bukhari et al., 2022) by establishing a blockchain network (Alhamad et al., 2022) which would provide the desired level of security in the healthcare system (Ghazal et al., 2022f) and enable the people to trust the devices. The story of the security supplied by the Blockchain would eventually lead to the patient's information (Alzoubi & Ahmed, 2019; Vo et al., 2010; Zafar et al., 2022) being safeguarded from third-party attacks proficiently (Guergov & Radwan, 2021).

2 Literature Review

The article "Healthcare Data Breaches: Insights and Implications" by Adil Hussain and others have used and Evaluated data in the form of a numerical pattern (Al Hamadi et al., 2017) where primary analysis has been done (Saad Masood Butt, 2022). The

method consists of first compilation of all the sources (Kurdi et al., 2022a) that have been mentioned and extracting what's awesome (Ghazal et al., 2022b; Shamout et al., 2022), percentages and averages all the different patterns. These patterns in the article have helped to understand the sources and evaluate the consequences (Alhamad et al., 2021) that might arise in case of any data breach (Alshurideh et al., 2022a, 2022b; Obaid, 2021). In addition, the article has also analyzed a time series method for forecasting of data breaches (Mehmood et al., 2022) in the healthcare sector (Ghazal et al., 2022a).

Our research, on the other hand has applied the secondary method of data collection where different journals and sources have been evaluated, which has been further represented in the form of a thematic analysis that has led to understanding the diverse themes (Hasan et al., 2021a, 2021b) or factors that the research identifies in terms of privacy and misusing of information in the health care sector (Ghazal et al., 2022c). The method adopted in our study is more effective because it has led to the evaluation of the data sources in a less complicated manner (Alzoubi et al., 2022c; Khan et al., 2022). In contrast, the method adopted by the above mentioned article has represented data in a tabular format that is complicated. The research involves an interpretation of a wide range of literature that has been divided into factors and themes to evaluate the views of different authors into kinds of data breaches that happen in the healthcare sector.

3 Research Methodology

3.1 *Experimental and Theoretical Evaluation*

Selections of relevant tools and methods that will present optimized findings and will be beneficial to determining the factors and effective solution in reduction of the privacy and misuse of data in the IoMT have been prioritized in this chapter of methodology.

The interpretivist research philosophy has been followed to gain insights from published sources belonging to authentic secondary sources. This philosophy provides proper direction of the data collection will be gained which will lead towards in making effective observation on the violation of privacy and misuse of information within the healthcare systems while managing Security Issues in the Internet of Medical Things. Obligation to secondary data sets has been made and authentic information has been extracted.

3.2 Data Collection

Various published contemporary literature sources have been reviewed in the process to gather significant knowledge on violation of privacy and misuse of information in the course of utilization Internet of Medical Things and the ethical violation and security challenges associated with it.

3.3 Design

Consideration of a qualitative research design technique has been followed by means of which focus has been given on selection of both high quality published set of evidences has been done from contemporary sources of literature. With the use of this research design technique, detailed illustration of the data has been done with proper descriptive to have better clarity on the effective solution to reduce the ethical violation and security challenges while using Internet of Medical Things within the healthcare practices.

4 Analysis

High end focus has been provided for proper evaluation of the accumulated information to have proper idea on the consequences resulted due to the ethical violation and security challenges while using Internet of Medical Things. By the analysis of the data proper understanding has been promoted to develop measures in enhancing the security system and develop robust policies to strengthen the ethical guideline associated with the proper utilization of Internet of Medical Things.

5 Discussion

With the evolvement of technology new IoT are developed in the healthcare sector and some steps like digital twins can help improve or keep a check on the IoT measurement of patients (Alzoubi et al., 2022a), thus improving treatment methods and also to help remove challenges related to privacy and data misuse. At present, there is an issue regarding the computational complexity posed by the Internet of medical things as there is significant difficulty regarding the hardware that can be placed in the medical things (Ghazal et al., 2021). The security loophole often created by these medical devices also exposes other information technology infrastructure in the healthcare system as well, which has the potential to completely shut down the medical operations of the healthcare sector. In order to make sure that the privacy

errors are minimized, new generation IoMT devices can also be worn by the patients itself to make sure that they are monitored in a continuous period of time (Alzoubi et al., 2022a, 2022b, 2022c). Since most of the IoMT devices have to handle all kind of physiological and personal data of the users larger impact upon the security attacks becomes more frequent and severe in comparison to the other IoT systems. Some of the malicious attacks on these devices can have life threatening impacts on the patients (Ghazal & Taleb, 2022; Zitar et al., 2021). So with very minimal security protection the medical devices can get hacked easily. Biometric authentication can be another major discovery in the field of IOM privacy and security; however certain limitations of these devices include costs of sensors and low performance authentication. Even the devices themselves can be manipulated through the network and can be programmed to cause physical damage to the patient once the device is hacked into. Thus, it can also lead to patients facing dire consequences as a direct result of the device itself being compromised. Similarly, there can also be situations where the manufacturer of the devices itself can neglect the informed consent of the patient, which could effectively shatter the trust of the people on the Internet of medical things.

6 Conclusion

To conclude, the research has provided useful evidence about some possible solutions that can be adopted by healthcare institutions in order to protect the privacy and misuse of the Internet of Medical things. With the Internet and wireless connectivity all around the Internet of Medical things are facing some real security and privacy challenges as mentioned before. The most severe form of privacy breach, in this case, is the theft of the health data generated through the devices and stored with them for future transfer. This is a serious issue as this has the capability of shifting the mind-set of the patients from accepting the Internet of medical things to altogether rejecting the devices based on the threats of data theft. It can reduce the acceptability of such devices in the healthcare system due to the inability to keep the patients' data safe. As a part of future research work it is recommended to focus on extracting primary data that will be further enhancing the validation of the results. The greater amount of focus should be given in accumulating permission from relevant medical authorities and healthcare institutes by means of which an interview program of medical experts and healthcare professionals can be conducted on this given research area. By obtaining first-hand information from qualified experts and experienced medical professionals, potential solutions on privacy violation and information misuse will be gathered. This will be beneficial in the development of a solid and effective technique to address the ethical violence and security threat faced.

References

- Abbas, S., Alhwaiti, Y., Fatima, A., Khan, M. A., Khan, M. A., Ghazal, T. M., Kanwal, A., Ahmad, M., & Elmitwally, N. S. (2022). Convolutional neural network based intelligent handwritten document recognition. *Computers, Materials & Continua*, 70, 4563–4581.
- Al-Hamadi, H., Gawanmeh, A., & Al-Qutayri, M. (2015). Formal validation of QRS wave within ECG. In *2015 International Conference on Information and Communication Technology Research, ICTRC 2015* (Vol. 9, pp. 190–193).
- Al-Hamadi, H., Gawanmeh, A., Baek, J., & Al-Qutayri, M. (2015b). Lightweight security protocol for ECG bio-sensors. *Wireless Personal Communications*, 95, 5097–5120.
- Al Hamadi, H., Gawanmeh, A., & Al-Qutayri, M. (2017). Guided test case generation for enhanced ECG bio-sensors functional verification. *International Journal of E-Health and Medical Communications*, 8, 1–20.
- Alhamad, A., Alshurideh, M., Alomari, K., Al Kurdi, B., Alzoubi, H., Hamouche, S., & Al-Hawary, S. (2022). The effect of electronic human resources management on organizational health of telecommunications companies in Jordan. *International Journal of Data and Network Science*, 6, 429–438.
- Alhamad, A. Q. M., Akour, I., Alshurideh, M., Al-Hamad, A. Q., Kurdi, B. A., & Alzoubi, H. (2021). Predicting the intention to use google glass: A comparative approach using machine learning models and PLS-SEM. *International Journal of Data and Network Science*, 5, 311–320.
- Ali, N., Ahmed, A., Anum, L., Ghazal, T. M., Abbas, S., Khan, M. A., Alzoubi, H. M., & Ahmad, M. (2021). Modelling supply chain information collaboration empowered with machine learning technique. *Intelligent Automation & Soft Computing*, 30, 243–257.
- Ali, N., Ghazal, T. M., Ahmed, A., Abbas, S., Khan, M. A., Alzoubi, H. M., Farooq, U., Ahmad, M., & Khan, M. A. (2022). Fusion-based supply chain collaboration using machine learning techniques. *Intelligent Automation & Soft Computing*, 31, 1671–1687.
- Alnazer, N. N., Alnuaimi, M. A., & Alzoubi, H. M. (2017). Analysing the appropriate cognitive styles and its effect on strategic innovation in Jordanian universities. *International Journal of Business Excellence*, 13, 127–140.
- Alnuaimi, M., Alzoubi, H. M., Ajelat, D., & Alzoubi, A. A. (2021). Towards intelligent organisations: An empirical investigation of learning orientation's role in technical innovation. *International Journal of Innovation and Learning*, 29, 207–221.
- Alshurideh, M., Al Kurdi, B., Alzoubi, H. M., Ghazal, T. M., Said, R. A., AlHamad, A. Q., Hamadneh, S., Sahawneh, N., & Al-kassem, A. H. (2022). Fuzzy assisted human resource management for supply chain management issues. *Annals of Operations Research*, 1–19.
- Alshurideh, M., Gasaymeh, A., Ahmed, G., Alzoubi, H., & Kurd, B. A. (2020). Loyalty program effectiveness: Theoretical reviews and practical proofs. *Uncertain Supply Chain Management*, 8, 599–612.
- Alshurideh, M. T., Al Kurdi, B., Alzoubi, H. M., Obeidat, B., Hamadneh, S., & Ahmad, A. (2022b). The influence of supply chain partners' integrations on organizational performance: The moderating role of trust. *Uncertain Supply Chain Management*, 10, 1191–1202.
- Alzoubi, A. (2021). Renewable Green hydrogen energy impact on sustainability performance. *International Journal of Computations, Information and Manufacturing*, 1, 2021.
- Alzoubi, H., & Ahmed, G. (2019). Do TQM practices improve organisational success? A case study of electronics industry in the UAE. *International Journal of Economics and Business Research*, 17, 459–472.
- Alzoubi, H. M., & Yanamandra, R. (2020). Investigating the mediating role of information sharing strategy on agile supply chain in supply chain performance. *Uncertain Supply Chain Management*, 8, 273–284.
- Alzoubi, H. M., Ahmed, G., Al-Gasaymeh, A., & Al Kurdi, B. (2020). Empirical study on sustainable supply chain strategies and its impact on competitive priorities: The mediating role of supply chain collaboration. *Management Science Letters*, 10, 703–708.

- Alzoubi, H. M., & Aziz, R. (2021). Does emotional intelligence contribute to quality of strategic decisions? The mediating role of open innovation. *Journal of Open Innovation: Technology, Market, and Complexity*, 7, 130.
- Alzoubi, H. M., Vij, M., Vij, A., & Hanaysha, J. R. (2021). What leads guests to satisfaction and loyalty in UAE five-star hotels? AHP analysis to service quality dimensions. *Enlightening Tourism. A Pathmaking Journal*, 11, 102–135.
- Alzoubi, H., Alshurideh, M., Kurdi, B. A., Akour, I., & Aziz, R. (2022a). Does BLE technology contribute towards improving marketing strategies, customers' satisfaction and loyalty? The role of open innovation. *International Journal of Data and Network Science*, 6, 449–460.
- Alzoubi, H. M., Ahmed, G., & Alshurideh, M. (2022b). An empirical investigation into the impact of product quality dimensions on improving the order-winners and customer satisfaction. *International Journal of Productivity and Quality Management*, 36, 169–186.
- Alzoubi, H. M., Elrechail, H., Hanaysha, J. R., Al-Gasaymeh, A., & Al-Adaileh, R. (2022c). The role of supply chain integration and agile practices in improving lead time during the COVID-19 crisis. *International Journal of Service Science, Management, Engineering, and Technology*, 13, 1–11.
- Alzoubi, H., Alshurideh, M., Kurdi, B.A., Alhyasat, K., & Ghazal, T. (2022d). The effect of e-payment and online shopping on sales growth: Evidence from banking industry. *International Journal of Data and Network Science*, 6, 94–109.
- Alzoubi, H. M., In'a'rat, M., & Ahmed, G. (2022e). Investigating the impact of total quality management practices and Six Sigma processes to enhance the quality and reduce the cost of quality: The case of Dubai. *International Journal of Business Excellence*, 27, 94–109.
- Bibi, R., Saeed, Y., Zeb, A., Ghazal, T. M., Rahman, T., Said, R. A., Abbas, S., Ahmad, M., & Khan, M. A. (2021). Edge AI-based automated detection and classification of road anomalies in VANET using deep learning. *Computational Intelligence and Neuroscience*, 2021, 1–19.
- Bukhari, M. M., Ghazal, T. M., Abbas, S., Khan, M. A., Farooq, U., Wahbah, H., Ahmad, M., & Adnan, K. M. (2022). An intelligent proposed model for task offloading in fog-cloud collaboration using logistics regression. *Computational Intelligence and Neuroscience*.
- Butt, S. M. (2022). Management and treatment of type 2 diabetes. *International Journal of Computations, Information and Manufacturing*, 2, 1.
- Chong, C., Lee, K., & Ahmed, G. (2021). Improving IoT privacy, data protection and security concerns. *International Journal of Technology, Innovation and Management*, 1, 18–33.
- Cruz, A. (2021). Convergence between blockchain and the internet of things. *International Journal of Technology, Innovation and Management*, 1, 34–53.
- Eli, T., & Hamou, L. A. S. (2022). Investigating the factors that influence students' choice of English studies as a major: The case of University of Nouakchott Al Aasriya. *Mauritania. International Journal of Technology, Innovation and Management*, 2, 1.
- Ghazal, T. M., Abbas, S., Ahmad, M., & Aftab, S. (2022a). An IoMT based Ensemble classification framework to predict treatment response in hepatitis C patients. In *2022 International Conference on Business Analytics for Technology and Security, ICBATS 2022* (pp. 1–4).
- Ghazal, T. M., Abbas, S., Munir, S., Khan, M. A., Ahmad, M., Issa, G. F., Zahra, S. B., Khan, M. A., & Hasan, M. K. (2022b). Alzheimer disease detection empowered with transfer learning. *Computers, Materials & Continua*, 70, 5005–5019.
- Ghazal, T. M., Ahmed, Z. E., Hasan, M. K., Hashim, A. A., Saeed, R. A., Mokhtar, R. A., & Singh, S. P. (2022c). Optimization procedure for intelligent internet of things applications. In *2022 International Conference on Business Analytics for Technology and Security, ICBATS 2022* (pp. 1–6).
- Ghazal, T. M., Hasan, M. K., Abdullah, S. N. H., Abubakkar, K. A., & Afifi, M. A. M. (2022d). IoMT-enabled fusion-based model to predict posture for smart healthcare systems. *Computers, Materials & Continua*, 71, 2579–2597.
- Ghazal, T. M., Hasan, M. K., Alkhalfah, A., Abu Bakar, K. A., Omidvar, A., Nafi, N. S., & Agbinya, J. I. (2021). *Fischer linear discrimination and quadratic discrimination analysis-based data mining technique for internet of things framework for healthcare* (p. 9). Public Heal.

- Ghazal, T. M., Noreen, S., Said, R. A., Khan, M. A., Siddiqui, S. Y., Abbas, S., Aftab, S., & Ahmad, M. (2022e). Energy demand forecasting using fused machine learning approaches. *Intelligent Automation & Soft Computing*, 31, 539–553.
- Ghazal, T. M., Rehman, A. U., Saleem, M., Ahmad, M., Ahmad, S., & Mehmood, F. (2022f). Intelligent model to predict early liver disease using machine learning technique. In *2022 International Conference on Business Analytics for Technology and Security, ICBATS 2022* (pp. 1–5).
- Ghazal, T. M., & Taleb, N. (2022). Feature optimization and identification of ovarian cancer using internet of medical things. *Expert Systems*.
- Guergov, S., & Radwan, N. (2021). Blockchain convergence: Analysis of issues affecting IoT, AI and blockchain. *International Journal of Computations, Information and Manufacturing*, 1, 1–17.
- Gul, O., Al-Qutayri, M., Yeun, C. Y., & Vu, Q. H. (2012). Framework of a national level electronic health record system. In *Proceedings of 2012 International Conference on Cloud Computing Technologies, Applications and Management, ICCCTAM 2012. Applications and Management (ICCTAM), Dubai, UAE, December* (pp. 60–65).
- Guntur, S. R., Gorrepati, R. R., & Dirisala, V. R. (2018). Internet of medical things. *Medical Big Data and Internet of medical things*, 4, 271–297.
- Hamadneh, S., Pedersen, O., Alshurideh, M., Kurdi, B. A., & Alzoubi, H. M. (2021). An investigation of the role of supply chain visibility into the scottish blood supply chain. *Journal of Legal, Ethical and Regulatory Issues* 24, 1–12.
- Hanaysha, J., Al-Shaikh, M., & Alzoubi, M. H. (2021). Importance of marketing mix elements in determining consumer purchase decision in the retail market. *International Journal of Service Science, Management, Engineering, and Technology*, 12, 56–72.
- Hasan, M. K., Ghazal, T. M., Saeed, R. A., Pandey, B., Gohel, H., Eshmawi, A. A., Abdel-Khalek, S., & Alkhassawneh, H. M. (2022). A review on security threats, vulnerabilities, and counter measures of 5G enabled Internet-of-Medical-Things. *IET Communications*, 16, 421–432.
- Hasan, M. K., Islam, S., Sulaiman, R., Khan, S., Hashim, A. H. A., Habib, S., Islam, M., Alyahya, S., Ahmed, M. M., Kamil, S., & Hassan, M. A. (2021a). Lightweight encryption technique to enhance medical image security on internet of medical things applications. *IEEE Access*, 9, 47731–47742.
- Hasan, M. K., Musse, M. A., Sherfriz, S. M., Shayla, I., Huda, S. N., A. S., Eklas H., Nazmus, S. N., & Nguyen, V. (2021b). An improved dynamic thermal current rating model for PMU-based wide area measurement framework for reliability analysis utilizing sensor cloud system *IEEE Access*, 9, 14446–14458.
- Islam, S., Khalifa, O. O., Hashim, A. H. A., Hasan, M. K., Razzaque, M. A., & Pandey, B. (2020). Design and evaluation of a multihoming-based mobility management scheme to support inter technology handoff in PNEMO. *Wireless Personal Communications*, 114, 1133–1153.
- Joghee, S., Alzoubi, H. M., & Dubey, A. R. (2020). Decisions effectiveness of FDI investment biases at real estate industry: Empirical evidence from Dubai smart city projects. *International Journal of Scientific & Technology Research*, 9, 3499–3503.
- Khan, M. A., Ghazal, T. M., Lee, S. W., & Rehman, A. (2022). Data fusion-based machine learning architecture for intrusion detection. *Computers, Materials & Continua*, 70, 3399–3413.
- Kim, S.-K., Yeun, C. Y., Damiani, E., & Lo, N.-W. (2019). A machine learning framework for biometric authentication using electrocardiogram. *IEEE Access*, 7, 94858–94868.
- Kurdi, B. A., Alshurideh, M., Akour, I., Alzoubi, H. M., Obeidat, B., & Alhamad, A. (2022a). The role of digital marketing channels on consumer buying decisions through eWOM in the Jordanian markets. *International Journal of Data and Network Science*, 6, 1175–1185.
- Kurdi, B. A., Alshurideh, M., Akour, I., Tariq, E., Alhamad, A., & Alzoubi, H. M. (2022b). The effect of social media influencers' characteristics on consumer intention and attitude toward Keto products purchase intention. *International Journal of Data and Network Science*, 6, 1135–1146.
- Kurdi, B. A., Alzoubi, H. M., Akour, I., & Alshurideh, M. T. (2022c). The effect of blockchain and smart inventory system on supply chain performance: Empirical evidence from retail industry. *Uncertain Supply Chain Management*, 10, 1111–1116.

- Lee, K. L., Azmi, N. A. N., Hanaysha, J. R., Alzoubi, H. M., & Alshurideh, M. T. (2022a). The effect of digital supply chain on organizational performance: An empirical study in Malaysia manufacturing industry. *Uncertain Supply Chain Management*, 10, 495–510.
- Lee, K. L., Romzi, P. N., Hanaysha, J. R., Alzoubi, H. M., & Alshurideh, M. (2022b). Investigating the impact of benefits and challenges of IOT adoption on supply chain performance and organizational performance: An empirical study in Malaysia. *Uncertain Supply Chain Management*, 10, 537–550.
- Mehmood, S., Ghazal, T. M., Khan, M. A., Zubair, M., Naseem, M. T., Faiz, T., & Ahmad, M. (2022). Malignancy detection in lung and colon histopathology images using transfer learning with class selective image processing. *IEEE Access*, 10, 25657–25668.
- Mehmood, T., Alzoubi, H. M., Alshurideh, M., Al-Gasaymeh, A., & Ahmed, G. (2019). Schumpeterian entrepreneurship theory: Evolution and relevance. *Academy of Entrepreneurship Journal*, 25, 1–10.
- Miller, D. (2021). The best practice of teach computer science students to use paper prototyping. *International Journal of Technology, Innovation and Management*, 1, 42–63.
- Mondol, E. P. (2022). The role of Vr games to minimize the obesity of video gamers. *International Journal of Computations, Information and Manufacturing*, 2, 1.
- Al Neaimi, M., Al Hamadi, H., Yeun, C. Y., & Jamal Zemerly, M. (2020). Digital forensic analysis of files using deep learning. In 2020 3rd International Conference on Signal Processing and Information Security, ICSPIS 2020. IEEE, 2020 (pp. 1–4).
- Obaid, A. J. (2021). Assessment of smart home assistants as an IoT. *International Journal of Computations, Information and Manufacturing*, 1, 18–38.
- Ramakrishna, Y., & Alzoubi, H. M. (2022). Empirical investigation of mediating role of six sigma approach in rationalizing the COQ in service organizations. *Operations and Supply Chain Management: An International Journal*, 15, 122–135.
- Ratkovic, N. (2022). Improving home security using blockchain. *International Journal of Computations, Information and Manufacturing*, 2, 1.
- Saleem, M., Abbas, S., Ghazal, T. M., Adnan Khan, M., Sahawneh, N., & Ahmad, M., (2022). Smart cities: Fusion-based intelligent traffic congestion control system for vehicular networks using machine learning techniques. *Egyptian Informatics Journal*
- Shamout, M., Ben-Abdallah, R., Alshurideh, M., Alzoubi, H., Al Kurdi, B., & Hamadneh, S. (2022). A conceptual model for the adoption of autonomous robots in supply chain and logistics industry. *Uncertain Supply Chain Management*, 10, 577–592.
- Siddiqui, S. Y., Haider, A., Ghazal, T. M., Khan, M. A., Naseer, I., Abbas, S., Rahman, M., Khan, J. A., Ahmad, M., Hasan, M. K., Mohammed, A., & Ateeq, K. (2021). IoMT cloud-based intelligent prediction of breast cancer stages empowered with deep learning. *IEEE Access*, 9, 146478–146491.
- Vo, D. L., Lee, H., Yeun, C. Y., & Kim, K. (2010). Enhancements of authenticated multiple key exchange protocol based on bilinear pairings. *Computers & Electrical Engineering*, 36, 155–159.
- Zafar, S., Asif, M., Ahmad, M. B., Ghazal, T. M., Faiz, T., Ahmad, M., & Khan, M. A. (2022). Assistive devices analysis for visually impaired persons: A review on taxonomy. *IEEE Access*, 10, 13354–13366.
- Zitar, R. A., Al-Dmour, N., Nachouki, M., Hussain, H., & Alzboun, F. (2021). Hashing generation using recurrent neural networks for text documents. *ICIC Express Letters Part B: Applications*, 12, 231–241.

IoMT Monitoring Devices: Challenges and Opportunities



Ali A. Alzoubi, Abdalla Alketbi, Ameen Alzarooni,
and Haitham M. Alzoubi 

Abstract The Internet of Medical Things has demonstrated considerable promise in improving health-related assurance and enables a variety of applications. The implementation of the Internet of things in the medical field comes with the additional danger of collecting a lot of customer data over an extended period. It is the duty of organizations (Health care centers) to safely maintain information about their patients. Many health care centers are offering remote and real-time treatment. A medical tool called tele monitoring enables medical professionals to examine sufferers away from typical medical setting. And in remote and real-time treatments, they have to face many problems and ethical issues to using medical and internet equipment. In an urgent situation, the patient, who may be kilometers away, also could receive virtual health care aid. Obtaining prompt immediate treatment can reduce the need for critical situations rooms and avoid further issues. These medical institutions are particularly helpful for those who live alone, in rural locations, and old-age persons or spouses who require more extensive medical services. This remote and real-time monitoring may have many challenges. These challenges can be Non—secure Connectivity, Inexpensive Gadget, and Information Sharing Mechanisms.

Keywords IoMT · Monitoring devices · Health care · Security · And privacy

A. A. Alzoubi
Public Security Directorate, Amman, Jordan

A. Alketbi · A. Alzarooni
School of Information Technology, Skyline University College, Sharjah, UAE

H. M. Alzoubi (✉)
School of Business, Skyline University College, Sharjah, UAE
e-mail: haitham.alzoubi@skylineuniversity.ac.ae

Applied Science Research Center, Applied Science Private University, Amman, Jordan

1 Introduction

Since its introduction, IoMT has become increasingly significant in enhancing the healthcare, protection, and welfare of millions and millions of humans. Individuals' wellness factors may be continually and meaningful observed virtually, analyzed, and uploaded to healthcare data centers, like cloud services, without having to visit the hospital (Ghazal et al., 2022a). This dramatically improves the effectiveness, simplicity, and cost-effectiveness (Ramakrishna & Alzoubi, 2022) of health and healthcare sector with proper implementation on internet of things and IoMT (Akhtar et al., 2021). Since the Internet of Medical Things, devices manage significantly more data, and confidentiality is exposed to more people (Al-Hamadi et al., 2015a, 2015b; Hamadneh et al., 2021). There are still many open questions regarding the protection of data acquired by Internet of Medical Things devices, during both propagations to the clouds (Alnazer et al., 2017) however being kept there the cloud system emerges the technological integrations (Alkeem et al., 2017). The data protection considerations for the flow of data inside the Internet of Medical Things are the main emphasis of this article (Farouk, 2021). We also do a thorough analysis of the current confidentiality solutions (Alzoubi et al., 2022a, 2022b, 2022c, 2022d; El Khatib et al., 2022), as well as the unresolved problems and investigation recommendations for future development (Abu-Arqoub et al., 2020). The Internet of Medical Things (IoMT) has demonstrated considerable promise (Islam et al., 2020) in improving health-related assurance (Ghazal et al., 2022d) and enables a variety of applications (Joghee et al., 2020), including wireless body area networks and implanted medical devices (WBAN) (Cruz, 2021).

1.1 Problem Definition

Internet of Medical Things devices needs flexible and comprehensive greater efficiency computing and huge data centers for actual analysis and information storage seeing as devices lack the necessary storage (Vo et al., 2010), computing, and ability of firms (Alhamad et al., 2022). The implementation of the Internet of things in the medical field comes with the additional danger of collecting a lot of customer data over an extended period (Al Neaimi et al., 2020). The majority of Internet of Medical Things organizations currently install their data centers (Ali et al., 2021; Hasan et al., 2021a, 2021b), and servers for applications and retain the gathered healthcare data in the cloud (Ghazal et al., 2022e; Mehmood, 2021). The gadgets can appropriately outsource medical activities to the cloud (Bukhari et al., 2022). Cloud computing solutions and services provide a potential option for the effective administration of persistent patient records due to their flexibility and right to view files and underlying factors in a distributed network way (Alkeem et al., 2017; Alzoubi et al., 2022c).

1.2 *Proposed Solution*

A medical tool called tele monitoring enables medical professionals to examine sufferers away from typical medical settings such as data management and supply of healthcare products (Shamout et al., 2022). It is known as tele-homecare (Mejia et al., 2019), and its primary usage is to prevent and treat underlying illnesses (Al-Naymat et al., 2021). Internet of Medical Things devices provide a variety of advantages (Siddiqui et al., 2021) when used in the healthcare and medical industry (Lee et al., 2022b), and their use is expected to grow significantly (Ghazal et al., 2022g). They will need to be implemented carefully, though (Kurdi et al., 2022b). The growth of the Internet of things in the medical will increase ethical issues (Abbas et al., 2022; Ali et al., 2022a, 2022b; Kashif et al., 2021) that maybe increase the customer intention to get treatment for the specific disease from a specific institution (Alzoubi et al., 2021). Internet of things, devices may be used in a medical setting (Alshurideh et al., 2022a, 2022b; Ghazal et al., 2022c). For illustration, a smartphone application that measures and analyzes blood pressure is connected to insulin pumps and blood pressure devices (Ghazal et al., 2022b). Technology helps people to control and maintain their health conditions (Lee et al., 2022a). People may take a greater interest in their well-being thanks to the Internet of Medical Things (Al-Dmour, 2020; Zafar et al., 2022). Patients who use insulin pumps have better control over their blood pressure (Alhamad et al., 2021), which helps them manage their blood sugar levels (Kurdi et al., 2022a). The Internet of Things in health coverage can track and gather data on heart-related rates and vital signs (Ali et al., 2022a, 2022b; Alzoubi, 2021; Bibi et al., 2021). Because of the several advantages that the Internet of Things and devices offer (Alnuaimi et al., 2021), the medical sector is expected to grow (Aziz & Aftab, 2021). A system of linked sensing, smart watches, hospital instruments, and healthcare settings makes up the Internet of Medical Things (Alzoubi et al., 2022b) that may require an effective supply chain to make a successful healthcare system (Alzoubi et al., 2020). It is a way to pass, retain, and evaluate the customer data that has been collected through internet or manually (Zitar et al., 2021). Researching possibilities are made possible by this that may evaluate and gather the required information (Alzoubi & Yanamandra, 2020). The medical industry is growing the usage of the Internet of things in wellness (Muhammad Alshurideh et al., 2022a, 2022b; Miller, 2021) and have a great impact of innovative changes on healthcare sector (Bukhari et al., 2022; Hanaysha et al., 2022). This research will elaborate the remote patient monitoring in healthcare systems (Hasan et al., 2022).

2 Literature Review

The health sector uses machine learning techniques for tasks including observation, forecasting, and diagnosis (Ghazal et al., 2022f). The electronic health records professionals think that by utilizing ML approaches, lives can be spared (Alzoubi,

2022). Persons with obese and diabetic retinopathy may be identified utilizing SVM (Al-Hamadi et al., 2015a, 2015b). Additionally, when combined with genetic and physiological data from several diabetics, a choice plant technique can be used to discover anomalies sooner (Alzoubi & Aziz, 2021). SVM, Naive Bayes (NB), decision tree (DT), and random forest (RF) techniques may all be used to successfully classify data based on gender (Hanaysha et al., 2021; Butt, 2022). For learning from the bigger group of information (Mehmood et al., 2019), ML techniques are integrated into predictive analytics profile (Mehmood et al., 2022). In addition to producing superior outcomes, employing linear regression analysis (LR) and sequential minimal optimization (SMO) classifications was also successful (Ghazal et al., 2021). TQWT was used to diagnose a patient, and an unprocessed Electrocardiogram was used to examine and track the heart rate signals. LR, NB, and ANN are the supervised classification techniques utilized for the forecasting model (Al-Hamadi et al., 2015a, 2015b; Ramakrishna & Alzoubi, 2022).

3 Research Methodology

The empirical facets of the review methodology are defined in this paper. It consists of 5 steps:

- Planning the review
- Defining research questions
- Database search
- Applying inclusion and exclusion criteria
- Synthesizing and reporting the results of the survey.

3.1 *Planning the Review*

It is defined as a thorough overview of earlier studies on a subject. In a research study, academic books, journal articles, and other materials that are pertinent to a certain field of study are surveyed. Every prior research should be listed, described, summed up, impartially evaluated, and clarified in the review (Khan et al., 2022; Shehada et al., 2018). It needs to provide a theoretical framework for the study and assist you in defining the scope. By acknowledging the contributions of prior studies, the review article reassures the readers knowing the paper has been thoughtfully designed. When prior studies on the subject are mentioned, it is expected that perhaps the publisher had studied, assessed, and incorporated this research into the current project. The audience may tell from this environment that now the creator has incorporated all of earlier, important works on the topic into their creation.

3.2 Defining Research Questions

To conduct the field study, we used pre-established hypotheses and questions related to the Internet of Medical Things and certain communication protocols (Guntur et al., 2018). We have undertaken considerable study resolving the different technological, operational, and safety issues (Hasan et al., 2021a, 2021b) of the Internet of Medical Things-related communication protocols focusing on such survey questions (Siddiqui et al., 2021).

Which Internet of Things communication protocols are employed in the context of the Internet of Medical Things?

So what were the protection characteristics, potential weaknesses, and interactions between these procedures and the medical setting?

What are the potential assaults and probably accessible defenses in the scope of the routing protocols for the Internet of Medical Things?

3.3 Database Search

The Relativity academic database served as the foundation of our comprehensive search technique for discovering pertinent documents. We also have considered the first 100 Google results to widen our research, especially to incorporate materials from pertinent publications. Efficient information management often involves the use of a database. The development and administration of information are both critically dependent on DBMSs. Efficient information administration and operation are impossible without the need for a database management system. It converts all inquiries it gets into intricate actions that satisfy that demand and gives the end-user a uniform, combined picture of the data.

4 Data Analysis

4.1 Applying Inclusion and Exclusion Criteria

The qualities that potential participants should possess to be in the research are known as inclusion criteria. Exclusion criteria would be traits that preclude potential research participants from participation (Al-Hamadi et al., 2015a, 2015b). Sex, race, the kind and nature of the problem and disease, the patient's prior medical record, and the existence or exclusion of additional medical, psychological, or mental issues may all be included in the inclusion and exclusion criteria that may improve patients condition as well as quality management of the hospitals (Alzoubi & Ahmed, 2019). Healthy patients are those who do not exhibit any of the specific non-healthy characteristics. The researcher should be ready to defend their decisions if any of the inclusion or

exclusion criteria are called into question. Consisting of a collection of inclusion and exclusion criteria, we assessed the suitability of the returned material. Because the interaction channels used by the Internet of Things and the Internet of Medical Things sufficiently intersect. Furthermore, the majority of the Internet of Things protocols are applied in areas related to areas of medicine (Hasan et al., 2022). We were able to find scientific journals discussing problems with protocols in the area of healthcare sectors. By defining these mechanisms, we conducted a thorough research study on the Internet of Things to derive the different tactical, operational, and protection features of the ultimately chosen Internet of Medical Things specific protocols.

4.2 *Synthesizing and Reporting the Results of the Survey*

In this case, we merged the material from the searches into a logical totality along with an assessment that demonstrates a greater comprehension of the pile of empirical. A subjective summary should be included in every assessment, and a statistical software package might not even be included. Researchers combined the published research in a variety of methods to present the findings of our investigation in a solid and precise way.

In November 2016, a thorough analysis of the research paper was carried out to determine whether ethical problems have previously been recognized and studied in the context of the healthcare internet of things. The research is systematic in that it employed a regular keywords strategy across several databases to locate a preliminary sample of articles.

To find articles addressing the ethical implications of H-IoT and IoMT, 6 databases were analyzed. To filter the research to papers discussing ethics, healthcare or medicines, the IoT, and associated technologies, search phrases (with wildcards) were used (Table 1).

Table 1 Database search queries and results

Data base	Results returned
Web of science	192
Scopus	332
GlobaHealth	88
Philpapers	42
PubMed	154
GoogleSchoalr	1400

5 Discussion

It is a list of sources broken down by year of publishing. The 6 database searches produced a total of 1108 non-unique sources. Every paper's title and, in certain circumstances, summaries got evaluated for preliminary sorting. 128 publications in all were thoroughly examined. Key portions from each completely evaluated paper were studied, and they were then grouped into themes that appeared in several sources and further interpreted. Important sections from each paper that had been thoroughly evaluated were analyzed, and they were then grouped into themes that appeared in several sources. Statements and sections that looked to link to ethical principles or concerns were marked after an initial review of title/abstract pairings to exclude off-topic sources. The above strategy insisted that the narration summary included information from all sources that addressed a certain theme, not only those where the theme in question was first manually picked out.

Hospitals may have been the most common location for Internet of Medical Things technology. Additionally, this discovered also that the healthcare thread gaining the greatest focus for the Internet of Medical Things included neuroscience, cardiologists, and psychologist. Patients can live comfortably inside their residences while yet having actual access to healthcare specialists due to the internet of things in medicine (Al Hamadi et al., 2017). In an urgent situation, the victim, who may be kilometers away, also could receive virtual health care aid. Obtaining prompt immediate treatment can reduce the need for critical situations rooms and avoid further issues (Alzoubi et al., 2022a). These medical institutions are particularly helpful for those who live independently, in rural locations, and old-age persons or spouses who require more extensive medical services (Saleem et al., 2022).

6 Conclusion

The learning and growing on the Internet of Medical Things will consider the effects of numerous aspects to achieve a higher balanced while creating remotely, real-time monitoring, and medical aid systems. Several issues need specific consideration in terms of improving real-time monitoring, medical aid systems, and protection situations. To offer coverage, minimal sensors-based hardware and software need to adhere to a set of policies and proxies regulations. These challenges can be Non—ecure Connectivity, Inexpensive Gadget, and Information Sharing Mechanisms. Additionally, the majority of uncertified signal repeaters connections in public spaces are untrustworthy connections.

References

- Abbas, S., Alhwaiti, Y., Fatima, A., Khan, M. A., Khan, M. A., Ghazal, T. M., Kanwal, A., Ahmad, M., & Elmitwally, N. S. (2022). Convolutional neural network based intelligent handwritten document recognition. *Computers, Materials & Continua*, 70, 4563–4581.
- Abu-Arqoub, M., Issa, G., Banna, A. E., & Saadeh, H. (2020). Interactive multimedia-based educational system for children using interactive book with augmented reality. *Journal of Computer Science*, 15, 1648–1658.
- Akhtar, A., Akhtar, S., Bakhtawar, B., Kashif, A. A., Aziz, N., Muhammad, &, Javeid, S. (2021). COVID-19 Detection from CBC using machine learning techniques. *International Journal of Technology, Innovation and Management / International Journal of Technology, Innovation and Management*, 1, 65–78
- Al-Dmour, N. A. (2020). Using unstructured search algorithms for data collection in iot-based WSN. *International Journal of Engineering Research and Technology*, 13, 1992–1998.
- Al-Hamadi, H., Gawanmeh, A., & Al-Qutayri, M. (2015). Formal validation of QRS wave within ECG. In *2015 International Conference on Information and Communication Technology Research, ICTRC 2015* (Vol. 9, pp. 190–193).
- Al-Hamadi, H., Gawanmeh, A., Baek, J., & Al-Qutayri, M. (2015b). Lightweight security protocol for ECG bio-sensors. *Wireless Personal Communications*, 95, 5097–5120.
- Al-Naymat, G., Hussain, H., Al-Kasassbeh, M., & Al-Dmour, N. (2021). Accurate detection of network anomalies within SNMP-MIB data set using deep learning. *International Journal of Computer Applications in Technology*, 66, 74–85.
- Al Hamadi, H., Gawanmeh, A., & Al-Qutayri, M. (2017). Guided test case generation for enhanced ECG bio-sensors functional verification. *International Journal of E-Health and Medical Communications*, 8, 1–20.
- Alhamad, A., Alshurideh, M., Alomari, K., Al Kurdi, B., Alzoubi, H., Hamouche, S., & Al-Hawary, S. (2022). The effect of electronic human resources management on organizational health of telecommunications companies in Jordan. *International Journal of Data and Network Science*, 6, 429–438.
- Alhamad, A. Q. M., Akour, I., Alshurideh, M., Al-Hamad, A. Q., Kurdi, B. A., & Alzoubi, H. (2021). Predicting the intention to use google glass: A comparative approach using machine learning models and PLS-SEM. *International Journal of Data and Network Science*, 5, 311–320.
- Ali, A., Septyanto, A. W., Chaudhary, I., Hamadi, H. A., Alzoubi, H. M., & Khan, Z. F. (2022). Applied artificial intelligence as event horizon of cyber security. In *2022 International Conference on Business Analytics for Technology and Security (ICBATS)* (pp. 1–7).
- Ali, N., Ahmed, A., Anum, L., Ghazal, T. M., Abbas, S., Khan, M. A., Alzoubi, H. M., & Ahmad, M. (2021). Modelling supply chain information collaboration empowered with machine learning technique. *Intelligent Automation & Soft Computing*, 30, 243–257.
- Ali, N., Ghazal, T. M., Ahmed, A., Abbas, S., Khan, M. A., Alzoubi, H. M., Farooq, U., Ahmad, M., & Khan, M. A. (2022b). Fusion-based supply chain collaboration using machine learning techniques. *Intelligent Automation & Soft Computing*, 31, 1671–1687.
- Alkeem, E. A., Shehada, D., Yeun, C. Y., Zemerly, M. J., & Hu, J. (2017). New secure healthcare system using cloud of things. *Cluster Computing*, 20(3), 2211–2229.
- Alnazer, N. N., Alnuaimi, M. A., & Alzoubi, H. M. (2017). Analysing the appropriate cognitive styles and its effect on strategic innovation in Jordanian universities. *International Journal of Business Excellence*, 13, 127–140.
- Alnuaimi, M., Alzoubi, H. M., Ajelat, D., & Alzoubi, A. A. (2021). Towards intelligent organisations: An empirical investigation of learning orientation's role in technical innovation. *International Journal of Innovation and Learning*, 29, 207–221.
- Alshurideh, Muhammad, Al Kurdi, B., Alzoubi, H. M., Ghazal, T. M., Said, R. A., AlHamad, A. Q., Hamadneh, S., Sahawneh, N., & Al-kassem, A. H. (2022). Fuzzy assisted human resource management for supply chain management issues. *Annals of Operations Research*, 1–19.

- Alshurideh, M., Kurdi, B., Alzoubi, H., Obeidat, B., Hamadneh, S., & Ahmad, A. (2022b). The influence of supply chain partners' integrations on organizational performance: The moderating role of trust. *Uncertain Supply Chain Management*, 10, 1191–1202.
- Alzoubi, A. (2021). The impact of process quality and quality control on organizational competitiveness at 5-star hotels in Dubai. *International Journal of Technology, Innovation and Management*, 1, 54–68.
- Alzoubi, A. (2022). Machine learning for intelligent energy consumption in smart homes. *International Journal of Computations, Information and Manufacturing*, 2 (2022).
- Alzoubi, H., & Ahmed, G. (2019). Do TQM practices improve organisational success? A case study of electronics industry in the UAE. *International Journal of Economics and Business Research*, 17, 459–472.
- Alzoubi, H., Alshurideh, M., Kurdi, B. A., Akour, I., & Aziz, R. (2022a). Does BLE technology contribute towards improving marketing strategies, customers' satisfaction and loyalty? The role of open innovation. *International Journal of Data and Network Science*, 6, 449–460.
- Alzoubi, H. M., Ahmed, G., Al-Gasaymeh, A., & Al Kurdi, B. (2020). Empirical study on sustainable supply chain strategies and its impact on competitive priorities: The mediating role of supply chain collaboration. *Management Science Letters*, 10, 703–708.
- Alzoubi, H. M., Ahmed, G., & Alshurideh, M. (2022b). An empirical investigation into the impact of product quality dimensions on improving the order-winners and customer satisfaction. *International Journal of Productivity and Quality Management*, 36, 169–186.
- Alzoubi, H. M., Alshurideh, M. T., Kurdi, B. A., Alhyasat, K. M. K., & Ghazal, T. M. (2022c). The effect of e-payment and online shopping on sales growth: Evidence from banking industry. *International Journal of Data and Network Science*, 6, 1369–1380.
- Alzoubi, H. M., & Aziz, R. (2021). Does emotional intelligence contribute to quality of strategic decisions? The mediating role of open innovation. *Journal of Open Innovation: Technology, Market, and Complexity*, 7, 130.
- Alzoubi, H. M., Elrehaile, H., Hanaysha, J. R., Al-Gasaymeh, A., & Al-Adaileh, R. (2022d). The role of supply chain integration and agile practices in improving lead time during the COVID-19 crisis. *International Journal of Service Science, Management, Engineering, and Technology*, 13, 1–11.
- Alzoubi, H. M., Vij, M., Vij, A., & Hanaysha, J. R. (2021). What leads guests to satisfaction and loyalty in UAE five-star hotels? AHP analysis to service quality dimensions. *Enlightening Tourism: A Pathmaking Journal*, 11, 102–135.
- Alzoubi, H. M., & Yanamandra, R. (2020). Investigating the mediating role of information sharing strategy on agile supply chain in supply chain performance. *Uncertain Supply Chain Management*, 8, 273–284.
- Aziz, N., & Aftab, S. (2021). Data mining framework for nutrition ranking: Methodology: SPSS modeller. *International Journal of Technology, Innovation and Management*, 1, 85–95.
- Bibi, R., Saeed, Y., Zeb, A., Ghazal, T. M., Rahman, T., Said, R. A., Abbas, S., Ahmad, M., & Khan, M. A. (2021). Edge AI-based automated detection and classification of road anomalies in VANET using deep learning. *Computational Intelligence and Neuroscience*, 2021, 1–19.
- Bukhari, M. M., Ghazal, T. M., Abbas, S., Khan, M. A., Farooq, U., Wahbah, H., Ahmad, M., & Adnan, K. M. (2022). An intelligent proposed model for task offloading in fog-cloud collaboration using logistics regression. *Computational Intelligence and Neuroscience*.
- Butt, S. M. (2022). Management and treatment of type 2 diabetes. *International Journal of Computations, Information and Manufacturing*, 2, 1.
- Cruz, A. (2021). Convergence between blockchain and the internet of things. *International Journal of Technology, Innovation and Management*, 1, 34–53.
- El Khatib, M. M., Alzoubi, H. M., Ahmed, G., Kazim, H. H., Al Falasi, S. A. A., Mohammed, F., & Al Mulla, M. (2022). Digital transformation and SMART-the analytics factor. In 2022 *International Conference on Business Analytics for Technology and Security, ICBATS 2022* (pp. 1–11).

- Farouk, M. (2021). The Universal Artificial Intelligence Efforts to Face Coronavirus COVID-19. *International Journal of Computations, Information and Manufacturing*, 1, 77–93.
- Ghazal, T. M., Abbas, S., Ahmad, M., & Aftab, S. (2022a). An IoMT based ensemble classification framework to predict treatment response in hepatitis C patients. In 2022 International Conference on Business Analytics for Technology and Security, ICBATS 2022 (pp. 1–4).
- Ghazal, T. M., Abbas, S., Munir, S., Khan, M. A., Ahmad, M., Issa, G. F., Zahra, S. B., Khan, M. A., & Hasan, M. K. (2022b). Alzheimer disease detection empowered with transfer learning. *Computers, Materials & Continua*, 70, 5005–5019.
- Ghazal, T. M., Ahmed, Z. E., Hasan, M. K., Hashim, A. A., Saeed, R. A., Mokhtar, R. A., & Singh, S. P. (2022c). Optimization procedure for intelligent internet of things applications. In 2022 International Conference on Business Analytics for Technology and Security, ICBATS 2022 (pp. 1–6).
- Ghazal, T. M., Hasan, M. K., Abdullah, S. N. H., Abubakkar, K. A., & Afifi, M. A. M. (2022d). IoMT-enabled fusion-based model to predict posture for smart healthcare systems. *Computers, Materials & Continua*, 71, 2579–2597.
- Ghazal, T. M., Hasan, M. K., Alkhalfah, A., Abu Bakar, K. A., Omidvar, A., Nafi, N. S., & Agbinya, J. I. (2021). *Fischer linear discrimination and quadratic discrimination analysis-based data mining technique for internet of things framework for healthcare* (p. 9). Public Heal.
- Ghazal, T. M., Kamrul Hasan, M., Alzoubi, H. M., Al Hammadi, M., Al-Dmour, N. A., Islam, S., Kamran, R., & Mago, B. (2022e). Securing smart cities using blockchain technology. In 2022 1st International Conference on AI in Cybersecurity (ICAIC) (pp. 1–4).
- Ghazal, T. M., Noreen, S., Said, R. A., Khan, M. A., Siddiqui, S. Y., Abbas, S., Aftab, S., & Ahmad, M. (2022f). Energy demand forecasting using fused machine learning approaches. *Intelligent Automation & Soft Computing*, 31, 539–553.
- Ghazal, T. M., Rehman, A. U., Saleem, M., Ahmad, M., Ahmad, S., & Mehmood, F. (2022g). Intelligent model to predict early liver disease using machine learning technique. In 2022 International Conference on Business Analytics for Technology and Security, ICBATS 2022 (pp. 1–5).
- Guntur, S. R., Gorrepati, R. R., & Dirisala, V. R. (2018). Internet of Medical Things. *Medical Big Data and Internet of Medical Things*, 4, 271–297.
- Hamadneh, S., Pedersen, O., Alshurideh, M., Kurdi, B. A., & Alzoubi, H. M. (2021). An investigation of the role of supply chain visibility into the scottish blood supply chain. *Journal of Legal, Ethical and Regulatory Issues* 24, 1–12.
- Hanaysha, J., Al-Shaikh, M., & Alzoubi, M. H. (2021). Importance of marketing mix elements in determining consumer purchase decision in the retail market. *International Journal of Service Science, Management, Engineering, and Technology*, 12, 56–72.
- Hanaysha, J. R., Al-Shaikh, M. E., Joghee, S., & Alzoubi, H. M. (2022). Impact of Innovation Capabilities on Business Sustainability in Small and Medium Enterprises. *FIIB Business Review*, 11, 67–78.
- Hasan, M. K., Ghazal, T. M., Saeed, R. A., Pandey, B., Gohel, H., Eshmawi, A. A., Abdel-Khalek, S., & Alkhassawneh, H. M. (2022). A review on security threats, vulnerabilities, and counter measures of 5G enabled Internet-of-Medical-Things. *IET Communications*, 16, 421–432.
- Hasan, M. K., Islam, S., Sulaiman, R., Khan, S., Hashim, A. H. A., Habib, S., Islam, M., Alyahya, S., Ahmed, M. M., Kamil, S., & Hassan, M. A. (2021a). Lightweight encryption technique to enhance medical image security on internet of medical things applications. *IEEE Access*, 9, 47731–47742.
- Hasan, M. K., Ahmed, M. M., Musa, S. S., Islam, S., Abdullah, S. N. H. S., Hossain, E., Nafi, N. S. & Vo, N. (2021b). An improved dynamic thermal current rating model for PMU-based wide area measurement framework for reliability analysis utilizing sensor cloud system *IEEE Access*, 9, 14446–14458.
- Islam, S., Khalifa, O. O., Hashim, A. H. A., Hasan, M. K., Razzaque, M. A., & Pandey, B. (2020). Design and evaluation of a multihoming-based mobility management scheme to support inter technology handoff in PNEMO. *Wireless Personal Communications*, 114, 1133–1153.

- Joghee, S., Alzoubi, H. M., & Dubey, A. R. (2020). Decisions effectiveness of FDI investment biases at real estate industry: Empirical evidence from Dubai smart city projects. *International Journal of Scientific & Technology Research*, 9, 3499–3503.
- Kashif, A. A., Bakhtawar, B., Akhtar, A., Akhtar, S., Aziz, N., & Javeid, M. S. (2021). Treatment response prediction in hepatitis C patients using machine learning techniques. *International Journal of Technology, Innovation and Management*, 1, 79–89.
- Khan, M. A., Ghazal, T. M., Lee, S. W., & Rehman, A. (2022). Data fusion-based machine learning architecture for intrusion detection. *Computers, Materials & Continua*, 70, 3399–3413.
- Kurdi, B. A., Alshurideh, M., Akour, I., Tariq, E., Alhamad, A., & Alzoubi, H. M. (2022a). The effect of social media influencers' characteristics on consumer intention and attitude toward Keto products purchase intention. *International Journal of Data and Network Science*, 6, 1135–1146.
- Kurdi, B. A., Alzoubi, H. M., Akour, I., & Alshurideh, M. T. (2022b). The effect of blockchain and smart inventory system on supply chain performance: Empirical evidence from retail industry. *Uncertain Supply Chain Management*, 10, 1111–1116.
- Lee, K. L., Azmi, N. A. N., Hanaysha, J. R., Alzoubi, H. M., & Alshurideh, M. T. (2022a). The effect of digital supply chain on organizational performance: An empirical study in Malaysia manufacturing industry. *Uncertain Supply Chain Management*, 10, 495–510.
- Lee, K. L., Romzi, P. N., Hanaysha, J. R., Alzoubi, H. M., & Alshurideh, M. (2022b). Investigating the impact of benefits and challenges of IOT adoption on supply chain performance and organizational performance: An empirical study in Malaysia. *Uncertain Supply Chain Management*, 10, 537–550.
- Mehmood, S., Ghazal, T. M., Khan, M. A., Zubair, M., Naseem, M. T., Faiz, T., & Ahmad, M. (2022). Malignancy detection in lung and colon histopathology images using transfer learning with class selective image processing. *IEEE Access*, 10, 25657–25668.
- Mehmood, T. (2021). Does information technology competencies and fleet management practices lead to effective service delivery? Empirical evidence from e-commerce industry. *International Journal of Technology, Innovation and Management*, 1, 14–41.
- Mehmood, T., Alzoubi, H. M., Alshurideh, M., Al-Gasaymeh, A., & Ahmed, G. (2019). Schumpeterian entrepreneurship theory: Evolution and relevance. *Academy of Entrepreneurship Journal*, 25, 1–10.
- Mejia, C., Ciarlante, K., & Chheda, K. (2019). A wearable technology solution and research agenda for housekeeper safety and health. *International Journal of Contemporary Hospitality Management* 1–3.
- Miller, D. (2021). The best practice of teach computer science students to use paper prototyping. *International Journal of Technology, Innovation and Management*, 1, 42–63.
- Al Neaimi, M., Al Hamadi, H., Yeun, C. Y., & Jamal Zemerly, M. (2020). Digital forensic analysis of files using deep learning. In *2020 3rd International Conference on Signal Processing and Information Security, ICSPIS 2020. IEEE*, 2020 (pp. 1–4).
- Ramakrishna, Y., & Alzoubi, H. M. (2022). Empirical investigation of mediating role of six sigma approach in rationalizing the COQ in service organizations. *Operations and Supply Chain Management*, 15, 122–135.
- Saleem, M., Abbas, S., Ghazal, T. M., Adnan Khan, M., Sahawneh, N., & Ahmad, M. (2022). Smart cities: Fusion-based intelligent traffic congestion control system for vehicular networks using machine learning techniques. *Egyptian Informatics Journal*
- Shamout, M., Ben-Abdallah, R., Alshurideh, M., Alzoubi, H., Al Kurdi, B., & Hamadneh, S. (2022). A conceptual model for the adoption of autonomous robots in supply chain and logistics industry. *Uncertain Supply Chain Management*, 10, 577–592.
- Shehada, D., Yeun, C. Y., Zemerly, M. J., Al-Qutayri, M., Al-Hammadi, Y., & Hu, J. (2018). A new adaptive trust and reputation model for mobile agent systems. *Journal of Network and Computer Application*, 124, 33–43.
- Siddiqui, S. Y., Haider, A., Ghazal, T. M., Khan, M. A., Naseer, I., Abbas, S., Rahman, M., Khan, J. A., Ahmad, M., Hasan, M. K., Mohammed, A., & Ateeq, K. (2021). IoMT cloud-based

- intelligent prediction of breast cancer stages empowered with deep learning. *IEEE Access*, 9, 146478–146491.
- Vo, D. L., Lee, H., Yeun, C. Y., & Kim, K. (2010). Enhancements of authenticated multiple key exchange protocol based on bilinear pairings. *Computers & Electrical Engineering*, 36, 155–159.
- Zafar, S., Asif, M., Ahmad, M. B., Ghazal, T. M., Faiz, T., Ahmad, M., & Khan, M. A. (2022). Assistive devices analysis for visually impaired persons: A review on taxonomy. *IEEE Access*, 10, 13354–13366.
- Zitar, R. A., Al-Dmour, N., Nachouki, M., Hussain, H., & Alzboun, F. (2021). Hashing generation using recurrent neural networks for text documents. *ICIC Express Letters Part B: Applications*, 12, 231–241.

Analyzing the Approaches for Discovering Privacy and Security Breaches in IoMT



Ali A. Alzoubi, Alya AlSuwaidi, and Haitham M. Alzoubi 

Abstract This paper includes a brief description of the ethics in IoMT and the motivation behind selecting the research topic is due to the ethical and privacy concerns. Lacks of security measures within the IoMT such as in wearable devices, telemedicine and so on was proved to be a devastating concern for the patients and healthcare professionals. Hence, the IoMT is more vulnerable to the hacking of personal data. Moreover, the lack of proper infrastructure and unskilled professional regarding the use of technology within the medical field increases the chances of unauthorized access. Therefore, the paper discussed the related literature work from the other journal articles. On the bases of the related work, it has been found that the different factors are responsible for the privacy concern while using the IoMT. These include the lack of proper infrastructure, technological backwardness and the inadequate features of the wearable devices for the data collection. Thus to overcome this factor, strategies such as on-job specialized training opportunities or collaborated training opportunities for the medical professionals need to be incorporated along with the incorporation of enhanced infrastructure. Moreover, encryptions and data authentications using cryptography could prove to be effective measured against privacy breaches concerning the use of wearables within the sector of healthcare.

Keywords IoMT · Encryptions · Privacy · Security · Breaches

A. A. Alzoubi
Public Security Directorate, Amman, Jordan

A. AlSuwaidi
School of Information Technology, Skyline University College, Sharjah, UAE

H. M. Alzoubi (✉)
School of Business, Skyline University College, Sharjah, UAE
e-mail: haitham.alzoubi@skylineuniversity.ac.ae

Applied Science Research Center, Applied Science Private University, Amman, Jordan

1 Introduction

The problem of this research study is the ethical and privacy issue while using Internet of Medical Things (IoMT). According to Ghazal et al. (2022e), IoMT system comprises of four key technical components that includes smart medical devices (enabled with trackers and sensors), gateway, middleware and application (See Fig. 1). These components need to be worked synchronously to provide meaningful solution, however, the prevalence of certain glitches cause different problem that include both data loss and data theft (Lee & Ahmed, 2021). Besides IoMT are more vulnerable to the privacy attacks due to the lack of standard security protocol and lack of measures in the fabrication of the devices (Ali et al., 2021). Therefore, this report aims to identify the factors that create the privacy issue while using the IoMT (Ghazal et al., 2021c). For this, the basic approach will be to collect the data from the authentic journals and the research articles to find out the factors that causes privacy issue (Alzoubi et al., 2021a, 2021b), in the IoMT devices. Moreover, the study would tend to identify the strategy through which the factors that cause privacy and ethical issue could be overcome (Al-Hamadi et al., 2015a, 2015b; Ghazal et al., 2022f). Besides, the strategy may tend to be related to infrastructure and training because most of the ethical issue occurs due to low technical skills of the professional in utilizing gadgets or absence of inadequate infrastructure to handle complex operations (Alzoubi et al., 2020; Ghazal et al., 2022h).

1.1 Problem Definition

It was found that at the global level, only 60% of the healthcare institution are incorporated IoMT, 27% are thinking of implementing it while 13% of the healthcare institution did not think about implementing it as shown in Fig. 2 (Alkeem et al.,

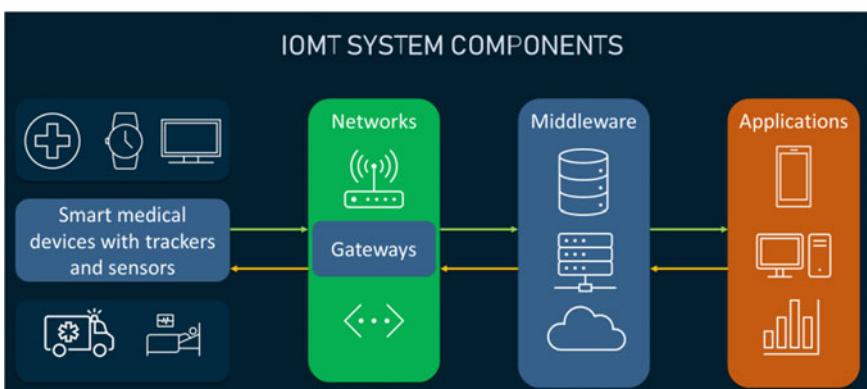


Fig. 1 Showing IoMT system components (Ghazal et al., 2022a)

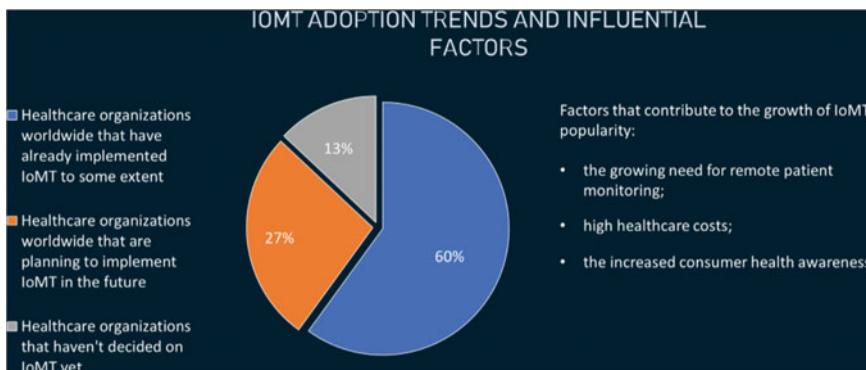


Fig. 2 Showing the reason behind the adoption of IoMT (Ghazal et al., 2022a)

2017). The lack of implementation is majorly due to the presence of risk related to data discrepancy (Alzoubi et al., 2022a), data loss and data theft. The IoMT such as the use of telemedicine allows the transfer of medical data over the internet (Islam et al., 2020; Mejia et al., 2019). Most of the digital medical data include the patient personal information, medical history, or demographics (Alnuaimi et al., 2021). Hence, as cyber-attacks are becoming more of the concern, it become a risk to send the confidential information of the patient over the internet (Al-Tahat & Moneim, 2020). Thus, the use of IoMT could be regarded as safe and ethical as there is a chance that other people (unauthorized person) could access the data easily (Al-Hamadi et al., 2015a, 2015b) that is possible with innovative ideas and technological development (Ghazal et al., 2022d; Hanaysha et al., 2022). Therefore, it is important to look for the factors in the privacy issues while using the IoMT (Ghazal et al., 2022f). Another interesting reason for choosing this research problem is the ethical issues (Mehmood et al., 2019) connected with the IoMT such as the fair use of the personal data and the transparency of the individual data usage with the proper authentication (Al Neaimi et al., 2020). Within the healthcare industry, professionals are restricted to share their patient's details (Ghazal et al., 2022g), however, as IoMT with low security measures as found in wearable could be hacked due to which (Neyara Radwan, 2022), professional could not be able to maintain their ethical indignity.

1.2 *Proposed Solution*

The increase in the demand for the cloud computing servers with thousand or millions of system connected (Alsharari, 2021) through the internet need the requirement of the infrastructure to reduce the burden on any single infrastructure. Therefore, the purposed solution for the securing the privacy of the personal data on the IoMT is the built the IoT infrastructure. The purpose of this structure is for medical data storage

along with data processing and analysis (Khan, 2021). The infrastructure of the IoMT must include the hardware, and IoT-based software for the data collection and to transmit the data across the network (Alzoubi et al., 2022b; Ghazal et al., 2022c) that is connected through the internet. The different system works on different protocols and the IT giants bring the new technologies frequently (Al Hamadi et al., 2017). The major technological challenge for the IoMT is the lack of encryption along with the lack of testing and updating (Alzoubi & Aziz, 2021; Hasan et al., 2021a, 2021b). Therefore, the proposed solution for the technological backwardness is to make all the medical devices work under the standard protocol and should be updated with the latest technologies with end-to-end encryption (Ghazal et al., 2022a). The inadequate features in wearable devices for data collection are also a major concern in the IoMT (Al-Dmour & Teahan, 2005). Data security concerns have always been associated with the medical device as some of the medical devices do not offer their privacy policy (Alzoubi et al., 2022b) and the terms and conditions before performing the function. Along with this wearable technology are very expensive when compared with traditional methods (Alnazer et al., 2017; Kurdi et al., 2022b). The proposed solution for this is the proper authentication and following of the privacy policies for data protection (Farouk, 2022) It is also recommended to update the wearable medical devices so the security features are up to date.

2 Literature Review

In the opinion of (Ghazal et al., 2021b), there are different types of applications of IOMT within the sector of healthcare ranging from tracing contact, detection of the pathogen, sterilization of medical instruments (Al-Nashashibi et al., 2021; Hanaysha et al., 2021a, 2021b), tracking of patient health, and conduction of medical tests, use of biometric scanners, dispensing of medications and communication systems for remote patients (Joghee et al., 2020). Infrastructure is an important requirement for the implementation of IOMT within a healthcare-based organization (Alzoubi et al., 2022c) that help to maintain the quality management in healthcare sector (Alzoubi & Ahmed, 2019; Ghazal et al., 2021a). In the opinion of BCH, the children's hospital in Boston has for example invested largely in the implementation of IOMT through the installation of GPS systems and VPNs to provide their data from being misused (Alshurideh et al., 2022; Ghazal & Taleb, 2022). The hospital has adopted a system of wayfinding for the patients through IOMT devices (Alzoubi et al., 2021a, 2021b) and the hospital-based locations are sensitive to misuse (Alshurideh et al., 2020). As a result, the hospital has taken the strategy of strengthening its infrastructure for protecting against data breaches (Lee et al., 2022b). Authentication of patient access and use of biometry has also been introduced not for medical purpose but also for all electronic transactions, such as e-banking, e-shopping etc. (Alzoubi et al., 2022d; Vo et al., 2010), moreover, the emphasis on infrastructure to improve the total quality management in hospital services (Alzoubi et al., 2022f) to protect data and privacy breaches (Hanaysha et al., 2021a, 2021b; Radwan & Farouk, 2021). Zigbee mesh

protocol has also been adopted within the infrastructure which protects sensitive data (Alzoubi et al., 2022e) regarding the hospital and the patients from being misused (Hamadneh et al., 2021).

2.1 Initiatives for Improving Technologically Backwardness

The technological knowledge of medical practitioners is an essential means of managing the problem of faulty use of IOMT-based devices within hospitals and healthcare centers (Ghazal et al., 2022i). This leads to a lack of prevention measures in the process of data privacy protection (Al-Hamadi et al., 2021). This factor or challenge could be combatted through the provision of on-job specialized training opportunities or collaborated training opportunities for the medical professionals. In the UAE, Rashid hospital and DHA have entered into a collaboration for the provision of training opportunities for doctors and medical professionals on telemedicine which has emerged as a useful means for providing remote treatment (Ghazal et al., 2022b). This has elevated the technological skills of the professionals through which the creation of awareness reading the pros and cons of the technology has been simplified (Kurdi et al., 2022c). As a result, data protection and privacy protection have been simplified (Al Ali, 2021). Similarly, in the Philippines, the implementation of telemedicine has been done through understanding the behavioral perception so that the ethics of the approach could be protected (Shamout et al., 2022).

2.2 Features in Wearables for Protection of Data Privacy

New features have been added to the IOMT-enabled devices that are widely used within hospitals. New technologies for data protection such as cryptography or SRAM Puff have been introduced which has enabled the protection of private information through secured fingerprints and data protection with blockchain strategy (Guergov & Radwan, 2021). This has enabled the protection of valuable patient-based information within healthcare centers and hospitals to maintain the service quality in healthcare (Ramakrishna & Alzoubi, 2022). Encryptions and data authentications are certain functions that are achieved through the use of cryptography to protect against privacy breaches concerning the use of wearables (Hasan et al., 2021a, 2021b) within the sector of healthcare (Alzoubi et al., 2022a; Ghazal et al., 2022k). This has helped to gain protection against forgery and misuse of data that are private to the patients and medical practitioners (Alzoubi & Yanamandra, 2020). The ethical protection of privacy has thus been enabled through these added features within the wearable devices that are powered by IOMT (Ghazal et al., 2022j). SRAM Puff is a physically un-clonable function. This helps in protecting private data through fingerprints which makes the data inaccessible to unauthorized users (Kurdi et al., 2022a). This helps in protecting the privacy of the users stealing personal information or

confidential data has become difficult as a result of the use of these features within the wearables (Ahmed and Amiri, 2022). As a result, the protection of privacy for medical practitioners has become easier with use of digitization (Alshurideh et al., 2022; Lee et al., 2022a) and also through the use of these features within medical wearables (Saleem et al., 2022).

3 Research Methodology

Secondary data will be used within the study for the collection of relevant information regarding the previous research concerning the topic. The journal articles composed of eminent research that has been released from 2018 onwards will only be shortlisted to ensure market relevance. The deductive method will be used in the study through which a solution has been proposed for the problem of the study which will be evaluated through the collected secondary data. The factors that have been identified through the study that affects privacy in the implementation of IoMT within health-care sectors are lack of a proper infrastructure which could be improved through improved infrastructure, absence of knowledge and technological backwardness of medical professionals which could be improved through the provision of training and technological counseling and absence of adequate features within IoMT enables wearables that are used within the sector of health care which could be improved through added features like cryptography, SRAM cuff, and blockchain. Secondary data has been used for the study and primary data in the form of surveys and interviews have been avoided. This has been advantageous for the study as the credibility of collected data is ensured through the method. The easy accessibility of secondary data is a reason for its use in the study. Surveys have not been conducted to avoid bias in responses and the collection of inaccurate data. The risk associated with personal bias has been the reason for the exclusion of interview conduction.

4 Discussion

The theory has been adequately supported through the collected secondary data. The proposed solution of the study had identified three factors that impact the privacy of IoMT within the healthcare sector. The factors include the absence of infrastructure which needs to be which could be improved through improved investments and decision-making. This has been supported through the example of the case of the children's hospital in Boston that has hugely invested in the implementation of IoMT-based solutions within their hospital for the protection of data privacy and misuse. The second factor identified had been technological backwardness and lack of knowledge which could be improved training. This has been supported through the case of Rashid hospital which tied up with DHA to provide specialized training for medical practitioners to educate them about telemedicine. The third had been the

lack of adequate features of data protection in wearables which has been improved in different parts of the world through the implementation of technologies like cryptography and SRAM Puff. The diverse and specific data has been able to be collected due to the use of secondary data which is a strength of the method used. Similarly, the exclusion of primary data has disabled the collection of professional, first-hand opinions regarding the problem.

5 Conclusion

From the above, it can be concluded that the factor which is responsible for the ethical and privacy issue for the IoMT is the technological backwardness, lack of proper infrastructure, and inadequate features in the wearable devices for the data collection method. Therefore, the proposed solution for the given problem includes the setting up of a large number of infrastructure to support the thousands of devices that are connected over the internet and provides the facilities for data storage and security. This report also highlighted the related literature work for the same research topic from the other research articles. The research methodology of the study involves the use of secondary data from the related work journals that are from 2018 onwards due to the time constraint. The secondary data from the related work literature also identifies the same factors that are responsible for the ethics and privacy issue of the measurable devices. Nevertheless, conducting secondary data proved to be the limitation of the research because it did not provide recent information. Besides, if I had more time, I would rather collect primary data and perform statistical analysis. The future work of this report is to collect the primary data and conduct hypothesis testing by selecting the particular factor that play the most crucial role in prevailing ethical issues within the healthcare industry. Collecting the primary data would enhance the reliability of the study and hypothesis testing could clarify whether the factors such as infrastructure, skill of the professionals are the major factor for the prevalence of ethical issues within the IoMT system or not. Moreover, the future work will also involve analyzing the significant strategy through which not only the ethical issue of IoMT is overcome but it become a cost-effective measure for the healthcare organization.

References

- Ahmed, G., & Amiri, N. A. (2022). The transformational leadership of the founding leaders of the United Arab Emirates: Sheikh Zayed Bin Sultan Al Nahyan and Sheikh Rashid Bin Saeed Al Maktoum. *International Journal of Technology, Innovation and Management*, 2, 1.
- Al-Dmour, N., & Teahan, W. (2005). The blackboard resource discovery mechanism for distributed computing over P2P networks. In: International, T. (Ed.), *PDCN. Conference on Parallel and Distributed Computing and Networks, Innsbruck, Austria, February* (pp. 15–17).

- Al-Hamadi, H., Gawanmeh, A., & Al-Qutayri, M. (2015a). Formal validation of QRS wave within ECG. In *2015 International Conference on Information and Communication Technology Research, ICTRC 2015* (Vol. 9, pp. 190–193).
- Al-Hamadi, H., Gawanmeh, A., Baek, J., & Al-Qutayri, M. (2015b). Lightweight security protocol for ECG bio-sensors". *Wireless Personal Communications*, 95, 5097–5120.
- Al-Hamadi, H., Nasir, N., Yeun, C. Y., & Damiani, E. (2021). A verified protocol for secure autonomous and cooperative public transportation in smart cities. In June, I. (Ed.), *2021 IEEE International Conference on Communications Workshops (ICC Workshops)* (pp. 1–6).
- Al-Nashashibi, M., Hadi, W., El-Khalili, N., Issa, G., & Al Banna, A. A. (2021). A new two-step ensemble learning model for improving stress prediction of automobile. *The International Arab Journal of Information Technology*, 6.
- Al-Tahat, S., & Moneim, O. A. (2020). The impact of artificial intelligence on the correct application of cyber governance in Jordanian commercial banks. *International Journal of Scientific & Technology Research*, 9, 7138–7144.
- Al Ali, A. (2021). The impact of information sharing and quality assurance on customer service at UAE banking sector. *International Journal of Technology, Innovation and Management*, 1, 01–17.
- Al Hamadi, H., Gawanmeh, A., & Al-Qutayri, M. (2017). Guided test case generation for enhanced ECG bio-sensors functional verification. *International Journal of E-Health and Medical Communications*, 8, 1–20.
- Ali, N., Ahmed, A., Anum, L., Ghazal, T. M., Abbas, S., Khan, M. A., Alzoubi, H. M., & Ahmad, M. (2021). Modelling supply chain information collaboration empowered with machine learning technique. *Intelligent Automation & Soft Computing*, 30, 243–257.
- Alkeem, E. A., Shehada, D., Yeun, C. Y., Zemerly, M. J., & Hu, J. (2017). New secure healthcare system using cloud of things. *Cluster Computing*, 20(3), 2211–2229.
- Alnazer, N. N., Alnuaimi, M. A., & Alzoubi, H. M. (2017). Analysing the appropriate cognitive styles and its effect on strategic innovation in Jordanian universities. *International Journal of Business Excellence*, 13, 127–140.
- Alnuaimi, M., Alzoubi, H. M., Ajelat, D., & Alzoubi, A. A. (2021). Towards intelligent organisations: An empirical investigation of learning orientation's role in technical innovation. *International Journal of Innovation and Learning*, 29, 207–221.
- Alsharari, N. (2021). Integrating blockchain technology with internet of things to efficiency. *International Journal of Technology, Innovation and Management*, 1, 01–13.
- Alshurideh, M., Gasaymeh, A., Ahmed, G., Alzoubi, H., & Kurd, B. A. (2020). Loyalty program effectiveness: Theoretical reviews and practical proofs. *Uncertain Supply Chain Management*, 8, 599–612.
- Alshurideh, M. T., Al Kurdi, B., Alzoubi, H. M., Obeidat, B., Hamadneh, S., & Ahmad, A. (2022). The influence of supply chain partners' integrations on organizational performance: The moderating role of trust. *Uncertain Supply Chain Management*, 10, 1191–1202.
- Alzoubi, H., & Ahmed, G. (2019). Do TQM practices improve organisational success? A case study of electronics industry in the UAE. *International Journal of Economics and Business Research*, 17, 459–472.
- Alzoubi, H. M., & Yanamandra, R. (2020). Investigating the mediating role of information sharing strategy on agile supply chain. *Uncertain Supply Chain Management*, 8, 273–284.
- Alzoubi, H. M., Ahmed, G., Al-Gasaymeh, A., & Al Kurdi, B. (2020). Empirical study on sustainable supply chain strategies and its impact on competitive priorities: The mediating role of supply chain collaboration. *Management Science Letters*, 10, 703–708.
- Alzoubi, H. M., & Aziz, R. (2021). Does emotional intelligence contribute to quality of strategic decisions? The mediating role of open innovation. *Journal of Open Innovation: Technology, Market, and Complexity*, 7, 130.
- Alzoubi, H., Alhamad, A. Q. M., Akour, I., Alshurideh, M., Al-Hamad, A. Q., Kurdi, B. A., & Alzoubi, H. (2021a). Predicting the intention to use google glass: A comparative approach

- using machine learning models and PLS-SEM. *International Journal of Data and Network Science*, 5, 311–320.
- Alzoubi, H. M., Vij, M., Vij, A., & Hanaysha, J. R. (2021b). What leads guests to satisfaction and loyalty in UAE five-star hotels? AHP analysis to service quality dimensions. *Enlightening Tourism*, 11, 102–135.
- Alzoubi, H., Alhamad, A., Alshurideh, M., Alomari, K., Al Kurdi, B., Hamouche, S., & Al-Hawary, S. (2022a). The effect of electronic human resources management on organizational health of telecommunications companies in Jordan. *International Journal of Data and Network Science*, 6, 429–438.
- Alzoubi, H., Alshurideh, M., Kurdi, B. A., Akour, I., & Aziz, R. (2022b). Does BLE technology contribute towards improving marketing strategies, customers' satisfaction and loyalty? The role of open innovation. *International Journal of Data and Network Science*, 6, 449–460.
- Alzoubi, H. M., Ahmed, G., & Alshurideh, M. (2022c). An empirical investigation into the impact of product quality dimensions on improving the order-winners and customer satisfaction. *International Journal of Productivity and Quality Management*, 36, 169–186.
- Alzoubi, H. M., Ali, N., Ghazal, T. M., Ahmed, A., Abbas, S., Khan, M. A., Farooq, U., Ahmad, M., & Khan, M. A. (2022d). Fusion-based supply chain collaboration using machine learning techniques. *Intelligent Automation & Soft Computing*, 31, 1671–1687.
- Alzoubi, H. M., Alshurideh, M. T., Al Kurdi, B., Ghazal, T. M., Said, R. A., AlHamad, A. Q., Hamadneh, S., Sahawneh, N., & Al-kassem, A. H. (2022e). Fuzzy assisted human resource management for supply chain management issues. *Annals of Operations Research*, 1–19.
- Alzoubi, H. M., Alshurideh, M. T., Kurdi, B. A., Alhyasat, K. M. K., & Ghazal, T. M. (2022f). The effect of e-payment and online shopping on sales growth: Evidence from banking industry. *International Journal of Data and Network Science*, 6, 1369–1380.
- Farouk, M. (2022). Studying human robot interaction and its characteristics. *International Journal of Computations, Information and Manufacturing*, 2, 1.
- Ghazal, T. M., Bibi, R., Saeed, Y., Zeb, A., Rahman, T., Said, R. A., Abbas, S., Ahmad, M., & Khan, M. A. (2021a). Edge AI-based automated detection and classification of road anomalies in VANET using deep learning. *Computational Intelligence and Neuroscience*, 2021, 1–19.
- Ghazal, T. M., Hasan, M. K., Alkhailah, A., Abu Bakar, K. A., Omidvar, A., Nafi, N. S., & Agbinya, J. I. (2021b). *Fischer linear discrimination and quadratic discrimination analysis-based data mining technique for internet of things framework for healthcare* (p. 9). Public Heal.
- Ghazal, T. M., Siddiqui, S. Y., Haider, A., Khan, M. A., Naseer, I., Abbas, S., Rahman, M., Khan, J. A., Ahmad, M., Hasan, M. K., Mohammed, A., & Ateeq, K. (2021c). IoMT cloud-based intelligent prediction of breast cancer stages empowered with deep learning. *IEEE Access*, 9, 146478–146491.
- Ghazal, T. M., Abbas, S., Ahmad, M., & Aftab, S. (2022a). An IoMT based ensemble classification framework to predict treatment response in hepatitis C patients. In *2022 International Conference on Business Analytics for Technology and Security, ICBATS 2022* (pp. 1–4).
- Ghazal, T. M., Abbas, S., Alhwaiti, Y., Fatima, A., Khan, M. A., Khan, M. A., Kanwal, A., Ahmad, M., & Elmitwally, N. S. (2022b). Convolutional neural network based intelligent handwritten document recognition. *Computers, Materials & Continua*, 70, 4563–4581.
- Ghazal, T. M., Ahmed, Z. E., Hasan, M. K., Hashim, A. A., Saeed, R. A., Mokhtar, R. A., & Singh, S. P. (2022c). Optimization procedure for intelligent internet of things applications. In *2022 International Conference on Business Analytics for Technology and Security, ICBATS 2022* (pp. 1–6).
- Ghazal, T. M., Bukhari, M. M., Abbas, S., Khan, M. A., Farooq, U., Wahbah, H., Ahmad, M., & Adnan, K. M. (2022d). An intelligent proposed model for task offloading in fog-cloud collaboration using logistics regression. *Computational Intelligence and Neuroscience*.
- Ghazal, T. M., Hasan, M. K., Abdullah, S. N. H., Abubakkar, K. A., & Afifi, M. A. M. (2022e). IoMT-enabled fusion-based model to predict posture for smart healthcare systems. *Computers, Materials & Continua*, 71, 2579–2597.

- Ghazal, T. M., Hasan, M. K., Saeed, R. A., Pandey, B., Gohel, H., Eshmawi, A. A., Abdel-Khalek, S., & Alkhassawneh, H. M. (2022f). A review on security threats, vulnerabilities, and counter measures of 5G enabled internet-of-medical-things. *IET Communications*, 16, 421–432.
- Ghazal, T. M., Khan, M. A., Lee, S. W., & Rehman, A. (2022g). Data fusion-based machine learning architecture for intrusion detection. *Computers, Materials & Continua*, 70, 3399–3413.
- Ghazal, T. M., Mehmood, S., Khan, M. A., Zubair, M., Naseem, M. T., Faiz, T., & Ahmad, M. (2022h). Malignancy detection in lung and colon histopathology images using transfer learning with class selective image processing. *IEEE Access*, 10, 25657–25668.
- Ghazal, T. M., Noreen, S., Said, R. A., Khan, M. A., Siddiqui, S. Y., Abbas, S., Aftab, S., & Ahmad, M. (2022i). Energy demand forecasting using fused machine learning approaches. *Intelligent Automation and Soft Computing*.
- Ghazal, T. M., Rehman, A. U., Saleem, M., Ahmad, M., Ahmad, S., & Mehmood, F. (2022j). Intelligent model to predict early liver disease using machine learning technique. In 2022 International Conference on Business Analytics for Technology and Security, ICBATS 2022 (pp. 1–5).
- Ghazal, T. M., Zafar, S., Asif, M., Ahmad, M. B., Faiz, T., Ahmad, M., & Khan, M. A. (2022k). Assistive devices analysis for visually impaired persons: A review on taxonomy. *IEEE Access*, 10, 13354–13366.
- Ghazal, T. M., & Taleb, N. (2022). Feature optimization and identification of ovarian cancer using internet of medical things. *Expert Systems*.
- Guergov, S., & Radwan, N. (2021). Blockchain convergence: Analysis of issues affecting IoT, AI and blockchain. *International Journal of Computations, Information and Manufacturing*, 1, 1–17.
- Hamadneh, S., Pedersen, O., Alshurideh, M., Kurdi, B. A., & Alzoubi, H. M. (2021). An investigation of the role of supply chain visibility into the scottish blood supply chain. *Journal of Legal, Ethical and Regulatory Issues* 24, 1–12.
- Hanaysha, J. R., Al Shaikh, M. E., & Alzoubi, H. M. (2021a). Importance of marketing mix elements in determining consumer purchase decision in the retail market. *International Journal of Service Science, Management, Engineering, and Technology*, 12, 56–72.
- Hanaysha, J. R., Al Shaikh, M. E., & Alzoubi, H. M. (2021b). Importance of marketing mix elements in determining consumer purchase decision in the retail market. *International Journal of Service Science, Management, Engineering, and Technology*, 2, 56–72.
- Hanaysha, J. R., Al-Shaikh, M. E., Joghee, S., & Alzoubi, H. M. (2022). Impact of innovation capabilities on business sustainability in small and medium enterprises. *FIIB Business Review*, 11, 67–78.
- Hasan, M. K., Islam, S., Sulaiman, R., Khan, S., Hashim, A. H. A., Habib, S., Islam, M., Alyahya, S., Ahmed, M. M., Kamil, S., & Hassan, M. A. (2021a). Lightweight encryption technique to enhance medical image security on internet of medical things applications. *IEEE Access*, 9, 47731–47742.
- Hasan, M. K., Ahmed, M. M., Musa, S. S., Islam, S., Abdullah, S. N. H. S., Hossain, E., Nafi, N. S., & Vo, N. (2021b). An improved dynamic thermal current rating model for PMU-based wide area measurement framework for reliability analysis utilizing sensor cloud system. *IEEE Access*, 9, 14446–14458.
- Islam, S., Khalifa, O. O., Hashim, A. H. A., Hasan, M. K., Razzaque, M. A., & Pandey, B. (2020). Design and evaluation of a multihoming-based mobility management scheme to support inter technology handoff in PNEMO. *Wireless Personal Communications*, 114, 1133–1153.
- Joghee, S., Alzoubi, H. M., & Dubey, A. R. (2020). Decisions effectiveness of FDI investment biases at real estate industry: Empirical evidence from Dubai smart city projects. *International Journal of Scientific & Technology Research*, 9, 3499–3503.
- Khan, M. A. (2021). Challenges facing the application of IoT in medicine and healthcare. *International Journal of Computations, Information and Manufacturing*, 1, 39–55.
- Kurdi, B. A., Alshurideh, M., Akour, I., Alzoubi, H. M., Obeidat, B., & Alhamad, A. (2022a). The role of digital marketing channels on consumer buying decisions through eWOM in the Jordanian markets. *International Journal of Data and Network Science*, 6, 1175–1185.

- Kurdi, B. A., Alshurideh, M., Akour, I., Tariq, E., Alhamad, A., & Alzoubi, H. M. (2022b). The effect of social media influencers' characteristics on consumer intention and attitude toward Keto products purchase intention. *International Journal of Data and Network Science*, 6, 1135–1146.
- Kurdi, B. A., Alzoubi, H. M., Akour, I., & Alshurideh, M. T. (2022c). The effect of blockchain and smart inventory system on supply chain performance: Empirical evidence from retail industry. *Uncertain Supply Chain Management*, 10, 1111–1116.
- Lee, C., & Ahmed, G. (2021). Improving IoT privacy, data protection and security concerns. *International Journal of Technology, Innovation and Management*, 1, 18–33.
- Lee, K. L., Azmi, N. A. N., Hanaysha, J. R., Alzoubi, H. M., & Alshurideh, M. T. (2022a). The effect of digital supply chain on organizational performance: An empirical study in Malaysia manufacturing industry. *Uncertain Supply Chain Management*, 10, 495–510.
- Lee, K. L., Romzi, P. N., Hanaysha, J. R., Alzoubi, H. M., & Alshurideh, M. (2022b). Investigating the impact of benefits and challenges of IOT adoption on supply chain performance and organizational performance: An empirical study in Malaysia. *Uncertain Supply Chain Management*, 10, 537–550.
- Mehmood, T., Alzoubi, H. M., Alshurideh, M., Al-Gasaymeh, A., & Ahmed, G. (2019). Schumpeterian entrepreneurship theory: Evolution and relevance. *Academy of Entrepreneurship Journal*, 25, 1–10.
- Mejia, C., Ciarlante, K., & Chheda, K. (2019). A wearable technology solution and research agenda for housekeeper safety and health. *International Journal of Contemporary Hospitality Management* 1–3.
- Al Neaimi, M., Al Hamadi, H., Yeun, C. Y., & Jamal Zemerly, M. (2020). Digital forensic analysis of files using deep learning. In *2020 3rd International Conference on Signal Processing and Information Security, ICSPIS 2020*. IEEE, 2020 (pp. 1–4).
- Radwan, N. (2022). The internet's role in undermining the credibility of the healthcare industry. *International Journal of Computations, Information and Manufacturing*, 2, 1.
- Radwan, N., & Farouk, M. (2021). The growth of internet of things (IoT) in the management of healthcare issues and healthcare policy development. *International Journal of Technology, Innovation and Management*, 1, 69–84.
- Ramakrishna, Y., & Alzoubi, H. M. (2022). Empirical investigation of mediating role of six sigma approach in rationalizing the COQ in service organizations. *Operations and Supply Chain Management: An International Journal*, 15, 122–135.
- Saleem, M., Abbas, S., Ghazal, T. M., Adnan Khan, M., Sahawneh, N., & Ahmad, M. (2022). Smart cities: Fusion-based intelligent traffic congestion control system for vehicular networks using machine learning techniques. *Egyptian Informatics Journal*
- Shamout, M., Ben-Abdallah, R., Alshurideh, M., Alzoubi, H., Al Kurdi, B., & Hamadneh, S. (2022). A conceptual model for the adoption of autonomous robots in supply chain and logistics industry. *Uncertain Supply Chain Management*, 10, 577–592.
- Vo, D. L., Lee, H., Yeun, C. Y., & Kim, K. (2010). Enhancements of authenticated multiple key exchange protocol based on bilinear pairings. *Computers & Electrical Engineering*, 36, 155–159.

Investigating E-Supply Chain Challenges in The Internet of Medical Things (IoMT)



Ali A. Alzoubi, Shamaa Shammas, and Haitham M. Alzoubi 

Abstract The Internet of Medical Things (IOMT) is assisting to enhance the precision, durability, and efficiency of electrical gadgets in the health industry. By connecting the available medical resources and health services, researchers are working to build a modernized health system. As the Internet of Things (IoT) conforms different sectors, our focus will be on the study project of IoT in the healthcare domain. This report examines people's contributions to the Internet of Things in the healthcare domain, including its applicability and future challenges in relation to medical services in healthcare. We hope that this study will indeed be useful to academics and professionals in the field, assisting them in comprehending the tremendous potential of Technology in the medical field and identifying major IOMT issues. This research would also aid researchers in increasing comprehension of IoT technology in the healthcare domain. This contribution will assist researchers in getting a greater understanding of IOT's earlier achievements to the health industry.

Keywords E-supply chain · IoMT · OpenEHR · Healthcare

1 Introduction

All submissions must always be prepared in the English language. Even though the Internet of Things may not be a novel concept, it is a major topic all around world (Ghazal et al., 2022c). It's not unexpected that 16.2 billion objects are connected to

A. A. Alzoubi
Public Security Directorate, Amman, Jordan

S. Shammas
School of Information Technology, Skyline University College, Sharjah, UAE

H. M. Alzoubi (✉)
School of Business, Skyline University College, Sharjah, UAE
e-mail: haitham.alzoubi@skylineuniversity.ac.ae

Applied Science Research Center, Applied Science Private University, Amman, Jordan

the web of things all through the world (IoT). This applies to all types of IoT from around world (Lee et al., 2022b). IoT can be defined as the connectivity of electronic devices that allow information to be exchanged between them for particular domain applications (Alshurideh et al., 2020; Islam et al., 2020). The internet of things (IoT) concept of computer networks makes human life so much easier than before (Alzoubi et al., 2022c; Obaid, 2021). According to the World Health Organization, Pakistan has medical problems, with circumcised males an average lifespan of 64.5 years and females possessing an average lifespan of 67.3 years in 2015 (Ghazal & Taleb, 2022).

This is what has attracted our focus to the Internet of Things (IoT), and is the most attractive solution for the health-care industry (Hamadneh et al., 2021) because it enables individuals to monitor their own conditions and receive benefits in the case of an attack via mobile (Fig. 1). Personal health market is anticipated to see a significant growth in the market (Al-Hamadi et al., 2015a, 2015b; Ali et al., 2021; Alzoubi et al., 2021a, 2021b). The quality and variety of medical services offered in the traditional medical paradigm are grossly inadequate of patients (Alkeem et al., 2017). The development of a family-oriented remote health surveillance network based on mobile Internet is important (Kurdi et al., 2022a). M-health pertains to the delivery of health care via mobile devices (Ghazal et al., 2021a). It's being used to assess, capture, transmit, and store health collected from a range of sources, incorporating sensors and other biomedicine data acquisition (Alsharari, 2022).

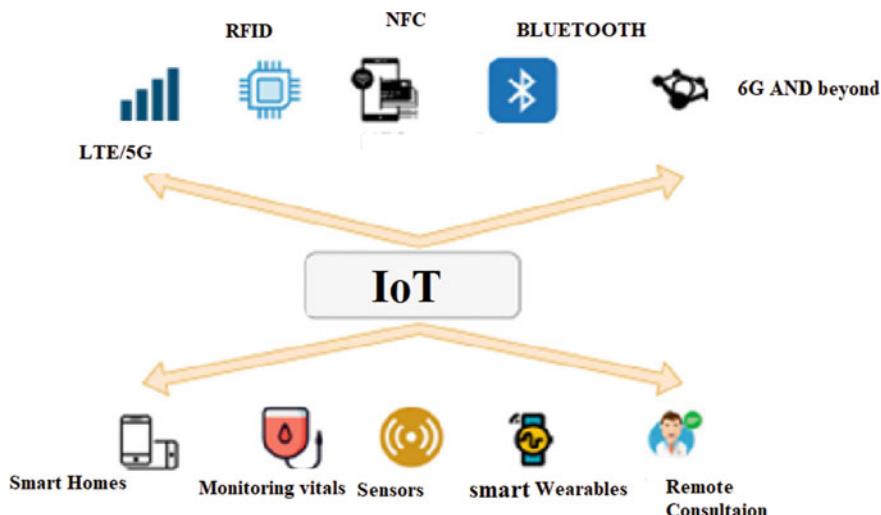


Fig. 1 IoMT devices (Ghazal et al., 2022f)

1.1 Problem Statement

Connectivity issues have indeed been underscored in last several IoT-related studies (Alnazer et al., 2017). For instance, each manufacturing company characterizes its own architectural features (Lee et al., 2022a), guidelines, and different data; as a consequence, applications must always be renovated or modified to collaborate with each IoT platform (IoMT platform in the health sector) (Alzoubi et al., 2022b; Ghazal et al., 2021c). In the Internet of Things, such problems are characterized as “Vertical Silos” (VSs) (Al-Dmour, 2020). A VS is indeed an IoT system that provides an internal information proposed modeling, devices, and protocols and requires the process of generating information to ensure support needs (Alzoubi & Ahmed, 2019). Other problems concerning compatibility with existing healthcare systems, apart from the VSs issue, remain unknown. Electronic Health Records (EHR) contain patients’ clinical information and institutional administrative data (Ghazal et al., 2022f), yet public healthcare overlook the presence of IoMT technologies and integration with others (Alzoubi et al., 2022d; Ghazal et al., 2022e). Standards have already been suggested for the development of EHR models as per a standard health terminology (Alzoubi et al., 2022e), including such Open EHR, whereas others, such as HL, have indeed been established for the information exchange between organizations (Alzoubi et al., 2021a, 2021b; Eli, 2021).

Because observations gathered by IoMT platforms can include an areas covered of large datasets (Gul et al., 2012), the absence of conceptual integration among EHRs and IoMT systems seems to have a significant effects on the growth of modern health services (Alzoubi et al., 2020; Ghazal et al., 2022e; Hasan et al., 2021a, 2021b). Additionally, as investigated by Ghazal et al., showed out, physicians are still unable to manage such raw data, stressing the importance of just using big data techniques for extraction of knowledge (Ghazal et al., 2022b). The application of big data techniques might well be delayed (Ghazal et al., 2022e; Ratkovic, 2022) if the data really aren’t established on a framework that promotes interoperation (Ghazal et al., 2022a; Mehmood et al., 2019), since data can be unreadable, incorrectly parsed, or misunderstood.

1.2 Proposed Solution

Sensors and devices that are connected via a system of internet ecosystems with high-speed connectivity among each module in IoT systems (Victoria, 2022). The data collected by these devices/sensors is delivered directly to cloud services for storage. This data is processed and afterwards examined in order to obtain additional understanding into it (Joghee et al., 2020). This requires its use of additional apps, tools, and apps to assist in data visualization (Al-Hamadi et al., 2021; Ghazal et al., 2022i), interpretation, treatment, and administration (Al-Nashashibi et al., 2021).

Some many wireless technologies, including such RFID (Radio Frequency Identification) (Andoni et al., 2019), NFC (Near Field Communication systems), Bluetooth, LTE (Medium Term Advancement), and 5G/6G (and well beyond), are interrelated with a number of devices (Ghazal et al., 2022f), which include mobile phones, monitoring devices, detectors, wearable technologies, and some other medical devices, as seen in the graph below (Fig. 1).

The healthcare industry has experienced tremendous growth over the last decade, greatly contributing to income and employment (Alzoubi et al., 2022b). Until a few years ago, illnesses and irregularities in the human body could've been diagnosed only by undergoing a physical examination in a hospital (Al-Hamadi et al., 2015a, 2015b; Alzoubi, 2021). The proportion of patients had to stay in the hospital for the remainder of their treatment. This resulted in increased healthcare spending and also stressing healthcare facilities in rural and isolated regions (Alzoubi et al., 2022f). The development in technology in recent years has already enabled for the diagnosis and management of various disease using smaller devices (Hasan et al., 2021a, 2021b) including such smartwatches. The Internet of Things has created increased freedom while still increasing their capacity to correctly interpret external data (Hanaysha et al., 2022). And with help of contemporary protocols in terms, the Internet of Things is becoming a key contributor to seamless connectivity (Alzoubi & Aziz, 2021; Ghazal et al., 2021b). It links a vast quantity of pieces to the Internet, includes wireless sensor nodes, household appliances, and electrical devices (Hanaysha et al., 2021; Hujran et al., 2020). The Internet of Things is growing in popularity due to its advantages of improved accuracy (Vo et al., 2010), reduced cost, and the capacity to accurately anticipate upcoming scenarios (Alzoubi et al., 2022a). Moreover, the speedy IoT revolution has indeed been supported by increased knowledge of software and apps (Eli & Hamou, 2022; Kurdi et al., 2022b), and also the improvement of mobile and computer capabilities, the ubiquitous availability of wireless technology, and the development of the digitalization (Alshurideh et al., 2022; Ha & Choi, 2016; Shehada et al., 2018).

2 Research Methodology

These health programs can help a group of different, such patients' guardians, doctors individuals, doctors, caregivers, and healthy individuals. These healthcare offer superior medical care, economy, and effectiveness of health care plans and solutions, reducing the price of staying healthy. We can easily achieve the standard of medical services and medication grade as per customer requirements with this medical healthcare system. The IoT-based systems have the advantage of the patient's full treatment, and these systems are flexible to the needs of the patient, with parameters which may be modified as per the patient's condition (Fig. 2).

The figure above illustrates how IoT communicates with some other network devices. Physicians, patients, and indeed the remainder of the network infrastructure

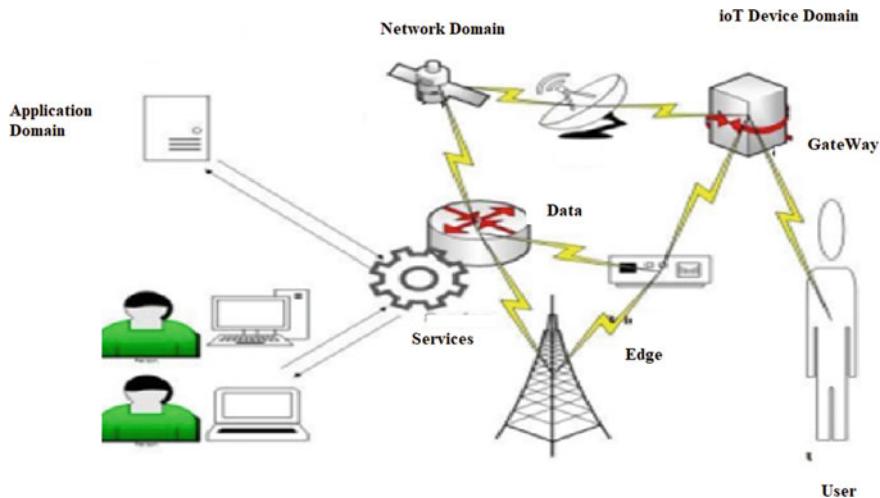


Fig. 2 How IoT communicates with some other network devices (Guergov & Radwan, 2021)

are now all interconnected. All information are digital and are stored in databases that seem to be accessible to doctors and clinical professionals.

2.1 *Architecture Design of IoMT*

Several works have indeed been produced that analyze and suggest potential IoMT architectures, which also are based primarily on multi-layering. Two to four layers had already been suggested to extract the complexities of IoMT designs (Shamout et al., 2022), with both the assumption that even a three-layered structure composed of Things, Intermediate, and Integrating Layer and application layer would presumably suitable for a logical fragmentation of IoMT structures (Ghazal et al., 2022e). The Things layer is comprised of a variety of IoMT objects which interact through with a variety of interfaces and connections (Alzoubi et al., 2022a). Multi-agent, Provider, or Publicly release architectures are being used to implement fog cloud technology (Ghazal et al., 2022d). The Integrated Application level stores enormous amount of big data and analyzes this through a range of applications for medical control engineering (Ghazal et al., 2022h, 2022k; Ramakrishna & Alzoubi, 2022). The relevant paragraphs discuss some of the approaches which utilize a three-layer pattern. an internet-of-things-based wellness system with both the following components (Ghazal et al., 2022g): Smart Devices, which include Sensor Networks and IoMT gadgets; Edge/Fog, that comprises Gateways (Kasem & Al-Gasaymeh, 2022), which biggest project is to forward health data to a Cloud and provide capabilities for IoMT device assessment and detection (Alnuaimi et al., 2021); and Cloud, where

information is recorded, stored, and consumable by applications (Al Hamadi et al., 2017).

As per the table above, many studies have utilized customized datatypes for information exchange among sensors and systems (Kurdi et al., 2022c), culminating in compatibility issues because the shortage of uniformity inhibits the development of sensors which are specifically tailored to the particular platform (Mondol, 2022). SenML was deemed a mature standard, and IoT-related research was done. Furthermore, companies do not tackle the simplicity of clinical data sharing between healthcare systems through use of conventional EHRs (Alzoubi & Yanamandra, 2020; Ghazal et al., 2022j) when it came to its use of EHRs for presentation and preservation of clinical records (Mondol, 2021).

3 Discussion

The IoMT platform is explained in just this subsection, and also the concerns made as during development phase. A proposal is submitted to enhance the ETSI M2M functionality framework in order to just provide semantic comparability at the Gateway and Proper labeling. The chapter also discusses the system behaviors and also how SenML has been used to enable data model interchange here between Gateway and Network layers. As per the ETSI12 M2M Functional Infrastructure specification, the concept for a Multimodal IoMT Platform for eHealth included network technologies, up with advances, and services, and also was implemented to the e-Health use cases specified by ETSI. Gateway, Network, and Healthcare are the three domains considered in the architecture. This platform is similar to the one proposed. The Gateway domain is made up of IoMT devices that monitor various parameters of patients who are connected to Gateways via the M2M Area Network (i.e. Bluetooth, WiFi, or ZigBee). A gateway provides Internet connectivity as well as device controller (i.e. device detection and administration) and sensed data handling capabilities.

Through into the network infrastructure and communication infrastructure, the network domains allows communication among Gateways and M2M Programs (i.e. Internet). The Healthcare Domain is responsible for the information preservation, meaning, and accessibility for consuming by final programs. This also requires consideration historical EHRs and whether they'll be managed. The recommended building is characterized in blues and brown, with blue indicating the unmodified ETSI M2M objects and brown showing the conceptually allowed ones, correspondingly. IoMT devices/platforms which collect patient-related information and communicate to a smartphone Gateway through the M2M Network Connection are termed as M2M e-Health devices.

4 Conclusion

This research on this topic an IoMT system that supports Semantic Web concepts and M2M interactions to simplify and regulate healthcare system integration of new. Unlike some other ideas, it includes a lot data structures for the collection and transfer of messages connected to healthcare observations, enabling for comparability in terms of the data representation formats, IoMT systems, and subject terminology (healthcare vocabularies, in our study). The openEHR-Extended ontology, that aligns the Healthcare domain (openEHR) with the IoMT technical domain, is the system's key contribution (SSN). This not only acts as a digital storage model that focuses on a semantic Search approach, but that also detects sensors and immediately transforms SenML sensed data to OWL people, guaranteeing consistent experience between the two zones. Another essential feature of this work is the semantic extended version of the openEHR framework to the M2M Gateway Domain, that also permitted for the description of heterogeneous IoMT devices in a single database schema via a link here between openEHR Observation archetype ID witnessed by the machine and the device description within SSN. Future research will include performance appraisal and applications to future circumstances, including such (Ghazal et al., 2021a, 2021b, 2021c, 2021d) (SC), wherein healthcare data has been used to generate statistical indicators of standard of living and city effectiveness. Additionally, for a SC implementation, the connection and interconnection of multiple verticals (transport, energy, environmental, medical, defense, and so on) is indeed an area that now the development of our proposal would tackle.

References

- Al-Dmour, N. A. (2020). Using unstructured search algorithms for data collection in iot-based WSN. *International Journal of Engineering Research and Technology*, 13, 1992–1998.
- Al-Hamadi, H., Gawanmeh, A., & Al-Qutayri, M. (2015a). Formal validation of QRS wave within ECG. In *2015 International Conference on Information and Communication Technology Research, ICTRC 2015* (Vol. 9, pp. 190–193).
- Al-Hamadi, H., Gawanmeh, A., Baek, J., & Al-Qutayri, M. (2015b). Lightweight security protocol for ECG bio-sensors". *Wireless Personal Communications*, 95, 5097–5120.
- Al Hamadi, H., Gawanmeh, A., & Al-Qutayri, M. (2017). Guided test case generation for enhanced ECG bio-sensors functional verification. *International Journal of E-Health and Medical Communications*, 8, 1–20.
- Al-Hamadi, H., Nasir, N., Yeun, C. Y., & Damiani, E. (2021). A verified protocol for secure autonomous and cooperative public transportation in smart cities. In I. June (Ed.), *2021 IEEE International Conference on Communications Workshops (ICC Workshops)* (pp. 1–6).
- Al-Nashashibi, M., Hadi, W., El-Khalili, N., Issa, G., & Al Banna, A. A. (2021). A new two-step ensemble learning model for improving stress prediction of automobile. *The International Arab Journal of Information Technology*, 6.
- Ali, N., Ahmed, A., Anum, L., Ghazal, T. M., Abbas, S., Khan, M. A., Alzoubi, H. M., & Ahmad, M. (2021). Modelling supply chain information collaboration empowered with machine learning technique. *Intelligent Automation & Soft Computing*, 30, 243–257.

- Alkeem, E. A., Shehada, D., Yeun, C. Y., Zemerly, M. J., & Hu, J. (2017). New secure healthcare system using cloud of things. *Cluster Computing*, 20(3), 2211–2229.
- Alnazer, N. N., Alnuaimi, M. A., & Alzoubi, H. M. (2017). Analysing the appropriate cognitive styles and its effect on strategic innovation in Jordanian universities. *International Journal of Business Excellence*, 13, 127–140.
- Alnuaimi, M., Alzoubi, H. M., Ajelat, D., & Alzoubi, A. A. (2021). Towards intelligent organisations: An empirical investigation of learning orientation's role in technical innovation. *International Journal of Innovation and Learning*, 29, 207–221.
- Alsharari, N. (2022). The implementation of enterprise resource planning (Erp) in the United Arab Emirates: A case of musanada corporation. *International Journal of Technology, Innovation and Management*, 2, 1.
- Alshurideh, M., Gasaymeh, A., Ahmed, G., Alzoubi, H., & Kurd, B. A. (2020). Loyalty program effectiveness: Theoretical reviews and practical proofs. *Uncertain Supply Chain Management*, 8, 599–612.
- Alshurideh, M., Kurdi, B., Alzoubi, H., Obeidat, B., Hamadneh, S., & Ahmad, A. (2022). The influence of supply chain partners' integrations on organizational performance: The moderating role of trust. *Uncertain Supply Chain Management*, 10, 1191–1202.
- Alzoubi, A. (2021). Renewable Green hydrogen energy impact on sustainability performance. *International Journal of Computations, Information and Manufacturing*, 1, 94–105.
- Alzoubi, H., & Ahmed, G. (2019). Do TQM practices improve organisational success? A case study of electronics industry in the UAE. *International Journal of Economics and Business Research*, 17, 459–472.
- Alzoubi, H. M., & Yanamandra, R. (2020). Investigating the mediating role of information sharing strategy on agile supply chain. *Uncertain Supply Chain Management*, 8, 273–284.
- Alzoubi, H. M., Ahmed, G., Al-Gasaymeh, A., & Al Kurdi, B. (2020). Empirical study on sustainable supply chain strategies and its impact on competitive priorities: The mediating role of supply chain collaboration. *Management Science Letters*, 10, 703–708.
- Alzoubi, H. M., & Aziz, R. (2021). Does emotional intelligence contribute to quality of strategic decisions? The mediating role of open innovation. *Journal of Open Innovation: Technology, Market, and Complexity*, 7, 130.
- Alzoubi, H., Alhamad, A. Q. M., Akour, I., Alshurideh, M., Al-Hamad, A. Q., Kurdi, B. A., & Alzoubi, H. (2021a). Predicting the intention to use google glass: A comparative approach using machine learning models and PLS-SEM. *International Journal of Data and Network Science*, 5, 311–320.
- Alzoubi, H. M., Vij, M., Vij, A., & Hanaysha, J. R. (2021b). What leads guests to satisfaction and loyalty in UAE five-star hotels? AHP analysis to service quality dimensions. *Enlightening Tourism*, 11, 102–135.
- Alzoubi, H., Alhamad, A., Alshurideh, M., Alomari, K., Al Kurdi, B., Hamouche, S., & Al-Hawary, S. (2022a). The effect of electronic human resources management on organizational health of telecommunications companies in Jordan. *International Journal of Data and Network Science*, 6, 429–438.
- Alzoubi, H., Alshurideh, M., Kurdi, B. A., Akour, I., & Aziz, R. (2022b). Does BLE technology contribute towards improving marketing strategies, customers' satisfaction and loyalty? The role of open innovation. *International Journal of Data and Network Science*, 6, 449–460.
- Alzoubi, H. M., Ahmed, G., & Alshurideh, M. (2022c). An empirical investigation into the impact of product quality dimensions on improving the order-winners and customer satisfaction. *International Journal of Productivity and Quality Management*, 36, 169–186.
- Alzoubi, H. M., Ali, N., Ghazal, T. M., Ahmed, A., Abbas, S., Khan, M. A., Farooq, U., Ahmad, M., & Khan, M. A. (2022d). Fusion-based supply chain collaboration using machine learning techniques. *Intelligent Automation & Soft Computing*, 31, 1671–1687.
- Alzoubi, H. M., Alshurideh, M. T., Al Kurdi, B., Ghazal, T. M., Said, R. A., AlHamad, A. Q., Hamadneh, S., Sahawneh, N., & Al-kassem, A. H. (2022e). Fuzzy assisted human resource management for supply chain management issues. *Annals of Operations Research*, 1–19.

- Alzoubi, H. M., Alshurideh, M. T., Kurdi, B. A., Alhyasat, K. M. K., & Ghazal, T. M. (2022f). The effect of e-payment and online shopping on sales growth: Evidence from banking industry. *International Journal of Data and Network Science*, 6, 1369–1380.
- Andoni, M., Robu, V., Flynn, D., Abram, S., Geach, D., Jenkins, D., McCallum, P., & Peacock, A. (2019). Blockchain technology in the energy sector: A systematic review of challenges and opportunities. *Renewable and Sustainable Energy Reviews*, 100, 143–174.
- Mondol, E. P. (2022). The role of Vr games to minimize the obesity of video gamers. *International Journal of Computations, Information and Manufacturing*, 2, 1.
- Eli, T. (2021). Students perspectives on the use of innovative and interactive teaching methods at the University of Nouakchott Al Aasriya, Mauritania: English department as a case study. *International Journal of Technology, Innovation and Management*, 1, 90–104.
- Eli, T., & Hamou, L. A. S. (2022). Investigating the factors that influence students' choice of english studies as a major: The case of University of Nouakchott Al Aasriya, Mauritania. *International Journal of Technology, Innovation and Management*, 2, 1.
- Ghazal, T., Hasan, M., Alshurideh, M., Alzoubi, M. H., Ahmad, M., Akbar, S., Al Kurdi, B., & Akour, I. (2021a). IoT for smart cities: machine learning approaches in smart healthcare-a review. *Future Internet*, 13, 218.
- Ghazal, T. M., Bibi, R., Saeed, Y., Zeb, A., Rahman, T., Said, R. A., Abbas, S., Ahmad, M., & Khan, M. A. (2021b). Edge AI-based automated detection and classification of road anomalies in VANET using deep learning. *Computational Intelligence and Neuroscience* 1–19.
- Ghazal, T. M., Hasan, M. K., Alkhalfah, A., Abu Bakar, K. A., Omidvar, A., Nafi, N. S., & Agbinya, J. I. (2021c). *Fischer linear discrimination and quadratic discrimination analysis-based data mining technique for internet of things framework for healthcare* (p. 9). Public Heal.
- Ghazal, T. M., Siddiqui, S. Y., Haider, A., Khan, M. A., Naseer, I., Abbas, S., Rahman, M., Khan, J. A., Ahmad, M., Hasan, M. K., Mohammed, A., & Ateeq, K. (2021d). IoMT cloud-based intelligent prediction of breast cancer stages empowered with deep learning. *IEEE Access*, 9, 146478–146491.
- Ghazal, T. M., Abbas, S., Ahmad, M., & Aftab, S. (2022a). An IoMT based ensemble classification framework to predict treatment response in hepatitis C patients. In *2022 International Conference on Business Analytics for Technology and Security, ICBATS 2022* (pp. 1–4).
- Ghazal, T. M., Abbas, S., Munir, S., Khan, M. A., Ahmad, M., Issa, G. F., Zahra, S. B., Khan, M. A., & Hasan, M. K. (2022b). Alzheimer disease detection empowered with transfer learning. *Computers, Materials & Continua*, 70, 5005–5019.
- Ghazal, T. M., Ahmed, Z. E., Hasan, M. K., Hashim, A. A., Saeed, R. A., Mokhtar, R. A., & Singh, S. P. (2022c). Optimization procedure for intelligent internet of things applications. In *2022 International Conference on Business Analytics for Technology and Security, ICBATS 2022* (pp. 1–6).
- Ghazal, T. M., Bukhari, M. M., Abbas, S., Khan, M. A., Farooq, U., Wahbah, H., Ahmad, M., & Adnan, K. M. (2022d). An intelligent proposed model for task offloading in fog-cloud collaboration using logistics regression. *Computational Intelligence and Neuroscience*.
- Ghazal, T. M., Hasan, M. K., Abdullah, S. N. H., Abubakkar, K. A., & Afifi, M. A. M. (2022e). IoMT-enabled fusion-based model to predict posture for smart healthcare systems. *Computers, Materials & Continua*, 71, 2579–2597.
- Ghazal, T. M., Hasan, M. K., Saeed, R. A., Pandey, B., Gohel, H., Eshmawi, A. A., Abdel-Khalek, S., & Alkhassawneh, H. M. (2022f). A review on security threats, vulnerabilities, and counter measures of 5G enabled internet-of-medical-things. *IET Communications*, 16, 421–432.
- Ghazal, T. M., Khan, M. A., Lee, S. W., & Rehman, A. (2022g). Data fusion-based machine learning architecture for intrusion detection. *Computers, Materials & Continua*, 70, 3399–3413.
- Ghazal, T. M., Mehmood, S., Khan, M. A., Zubair, M., Naseem, M. T., Faiz, T., & Ahmad, M. (2022h). Malignancy detection in lung and colon histopathology images using transfer learning with class selective image processing. *IEEE Access*, 10, 25657–25668.

- Ghazal, T. M., Noreen, S., Said, R. A., Khan, M. A., Siddiqui, S. Y., Abbas, S., Aftab, S., & Ahmad, M. (2022i). Energy demand forecasting using fused machine learning approaches. *Intelligent Automation and Soft Computing*.
- Ghazal, T. M., Rehman, A. U., Saleem, M., Ahmad, M., Ahmad, S., & Mahmood, F. (2022j). Intelligent model to predict early liver disease using machine learning technique. In *2022 International Conference on Business Analytics for Technology and Security, ICBATS 2022* (pp. 1–5).
- Ghazal, T. M., Zafar, S., Asif, M., Ahmad, M. B., Faiz, T., Ahmad, M., & Khan, M. A. (2022k). Assistive devices analysis for visually impaired persons: A review on taxonomy. *IEEE Access*, 10, 13354–13366.
- Ghazal, T. M., & Taleb, N. (2022). Feature optimization and identification of ovarian cancer using internet of medical things. *Expert Systems*.
- Guergov, S., & Radwan, N. (2021). Blockchain convergence: Analysis of issues affecting IoT, AI and blockchain. *International Journal of Computations, Information and Manufacturing*, 1, 1–17.
- Gul, O., Al-Qutayri, M., Yeun, C. Y. & Vu, Q. H. (2012). Framework of a national level electronic health record system. In *Proceedings of 2012 International Conference on Cloud Computing Technologies, Applications and Management, ICCCTAM 2012. Applications and Management (ICCCTAM), Dubai, UAE, December* (pp. 60–65).
- Ha, S., & Choi, S. (2016). Convolutional neural networks for human activity recognition using multiple accelerometer and gyroscope sensors. In *Proceedings of International Journal Conference Neural Networks 2016-October* (pp. 381–388).
- Hamadneh, S., Pedersen, O., Alshurideh, M., Kurdi, B. A., & Alzoubi, H. M. (2021). An investigation of the role of supply chain visibility into the scottish blood supply chain. *Journal of Legal, Ethical and Regulatory Issues*, 24, 1–12.
- Hanaysha, J., Al-Shaikh, M., & Alzoubi, M. H. (2021). Importance of marketing mix elements in determining consumer purchase decision in the retail market. *International Journal of Service Science, Management, Engineering, and Technology*, 12, 56–72.
- Hanaysha, J. R., Al-Shaikh, M. E., Joghee, S., & Alzoubi, H. M. (2022). Impact of Innovation Capabilities on Business Sustainability in Small and Medium Enterprises. *FIIB Business Review*, 11, 67–78.
- Hasan, M. K., Islam, S., Sulaiman, R., Khan, S., Hashim, A. H. A., Habib, S., Islam, M., Alyahya, S., Ahmed, M. M., Kamil, S., & Hassan, M. A. (2021a). Lightweight encryption technique to enhance medical image security on internet of medical things applications. *IEEE Access*, 9, 47731–47742.
- Hasan, M. K., Ahmed, M. M., Musa, S. S., Islam, S., Abdullah, S. N. H. S., Hossain, E., Nafi, N. S., & Vo, N. (2021b). An improved dynamic thermal current rating model for PMU-based wide area measurement framework for reliability analysis utilizing sensor cloud system *IEEE Access*, 9, 14446–14458.
- Hujran, O., Alikaj, A., Durrani, U. K., & Al-Dmour, N. (2020). Big data and its effect on the music industry. In *ACM International Conference Proceeding Series* (pp. 5–9).
- Islam, S., Khalifa, O. O., Hashim, A. H. A., Hasan, M. K., Razzaque, M. A., & Pandey, B. (2020). Design and evaluation of a multihoming-based mobility management scheme to support inter technology handoff in PNEMO. *Wireless Personal Communications*, 114, 1133–1153.
- Joghee, S., Alzoubi, H. M., & Dubey, A. R. (2020). Decisions effectiveness of FDI investment biases at real estate industry: Empirical evidence from Dubai smart city projects. *International Journal of Scientific & Technology Research*, 9, 3499–3503.
- Kasem, J., & Al-Gasaymeh, A. (2022). A cointegration analysis for the validity of purchasing power parity: Evidence From middle east countries. *International Journal of Technology, Innovation and Management*, 2, 1.
- Kurdi, B. A., Alshurideh, M., Akour, I., Alzoubi, H. M., Obeidat, B., & Alhamad, A. (2022a). The role of digital marketing channels on consumer buying decisions through eWOM in the Jordanian markets. *International Journal of Data and Network Science*, 6, 1175–1185.

- Kurdi, B. A., Alshurideh, M., Akour, I., Tariq, E., Alhamad, A., & Alzoubi, H. M. (2022b). The effect of social media influencers' characteristics on consumer intention and attitude toward Keto products purchase intention. *International Journal of Data and Network Science*, 6, 1135–1146.
- Kurdi, B. A., Alzoubi, H. M., Akour, I., & Alshurideh, M. T. (2022c). The effect of blockchain and smart inventory system on supply chain performance: Empirical evidence from retail industry. *Uncertain Supply Chain Management*, 10, 1111–1116.
- Lee, K. L., Azmi, N. A. N., Hanaysha, J. R., Alzoubi, H. M., & Alshurideh, M. T. (2022a). The effect of digital supply chain on organizational performance: An empirical study in Malaysia manufacturing industry. *Uncertain Supply Chain Management*, 10, 495–510.
- Lee, K. L., Romzi, P. N., Hanaysha, J. R., Alzoubi, H. M., & Alshurideh, M. (2022b). Investigating the impact of benefits and challenges of IOT adoption on supply chain performance and organizational performance: An empirical study in Malaysia. *Uncertain Supply Chain Management*, 10, 537–550.
- Mehmood, T., Alzoubi, H. M., Alshurideh, M., Al-Gasaymeh, A., & Ahmed, G. (2019). Schumpeterian entrepreneurship theory: Evolution and relevance. *Academy of Entrepreneurship Journal*, 25, 1–10.
- Mondol, E. P. (2021). The impact of block chain and smart inventory system on supply chain performance at retail industry. *International Journal of Computations, Information and Manufacturing*, 1, 56–76.
- Obaid, A. J. (2021). Assessment of smart home assistants as an IoT. *International Journal of Computations, Information and Manufacturing*, 1, 18–38.
- Ratkovic, N. (2022). Improving home security using blockchain. *International Journal of Computations, Information and Manufacturing*, 2, 1.
- Ramakrishna, Y., & Alzoubi, H. M. (2022). Empirical investigation of mediating role of six sigma approach in rationalizing the COQ in service organizations. *Operations and Supply Chain Management: An International Journal*, 15, 122–135.
- Shamout, M., Ben-Abdallah, R., Alshurideh, M., Alzoubi, H., Al Kurdi, B., & Hamadneh, S. (2022). A conceptual model for the adoption of autonomous robots in supply chain and logistics industry. *Uncertain Supply Chain Management*, 10, 577–592.
- Shehada, D., Yeun, C. Y., Zemerly, M. J., Al-Qutayri, M., Al-Hammadi, Y., & Hu, J. (2018). A new adaptive trust and reputation model for mobile agent systems. *Journal of Network and Computer Application*, 124, 33–43.
- Vo, D. L., Lee, H., Yeun, C. Y., & Kim, K. (2010). Enhancements of authenticated multiple key exchange protocol based on bilinear pairings. *Computers & Electrical Engineering*, 36, 155–159.
- Victoria, V. (2022). Impact of process visibility and work stress to improve service quality: Empirical evidence from dubai retail industryimpact of process visibility and work stress to improve service quality: Empirical evidence from dubai retail industry. *International Journal of Technology, Innovation and Management*, 2, 1.

Investigating Benefits of Using IoT and Its Effect on Our Daily Life



Ali A. Alzoubi and Haitham M. Alzoubi 

Abstract Internet of things (IoT), is a structure of correlated mechanical, computing and digital machines or devices, human or animal, objects which contributed with specific identities and the capability to transmit information through network without using human to computer or human to human interactivity. A person with an implanted heart monitor, an animal with a transponder, a vehicle with an implanted sensor for warning the driver when the gasoline level is low, or any other man-made or natural thing that may be used as an internet protocol (IP) address, are all examples of IoT systems. As a result, most businesses across a wide range of industries are leveraging the Internet of Things to better understand their consumers, provide better customer service, increase company quality, and improve decision-making ability. An IoT ecosystem is made up of connected that use embedded systems such as sensors, processors, and hardware communications to store, send, and process data from their surroundings. The IoT, devices share the sensory information they collect by connection to an edge device or IoT gateway where the information is sent to the cloud data or analysed. At times those devices communicates to one another or to other related devices and work on data they get from each other. These systems work mostly without the help of human; however, people connect with these devices when time of installation, access the data, set up or giving instructions. The networking, connectivity and connection protocols used in these web enabled devices largely confide in the distinct IoT applications installed. IoT uses Machine Learning and Artificial Intelligence to aid making collecting data processes more dynamic and easier.

Keywords IoT · Smart devices · Automated houses

A. A. Alzoubi
Public Security Directorate, Amman, Jordan

H. M. Alzoubi 
School of Business, Skyline University College, Sharjah, UAE
e-mail: haitham.alzoubi@skylineuniversity.ac.ae

Applied Science Research Center, Applied Science Private University, Amman, Jordan

1 Introduction

IoT helps human to work and live smarter, as well as control their life with single touch (Ghazal et al., 2022d). In automated houses when using smart devices, IoT is very important (Khan, 2021). IoT uses companies to be robotic processes to reduce manpower and labour cost. And reduce the waste and increase delivery service, making it lower cost for production and distribute products as well as offering translucent to customer transactions (Shamout et al., 2022; Vo et al., 2010). The IoT (Internet of things) provide several advantages to an organization (Alzoubi et al., 2022c; Guntur et al., 2018). Some interest are distinct and few are useful across multiple firms. Some of the common advantages to businesses are (Lee & Ahmed, 2021):

- Increase quality in customer service (Kurdi et al., 2022a).
- Save time, energy and money (Alzoubi et al., 2022f).
- Control overall processes.
- Increase employee productivity.
- Adapt new business models.
- For decision making in business.
- Increased revenue.

Internet of Things make feel organizations to re-decide the ways in which they can advance their businesses (Radwan & Farouk, 2021) and provide the tools to increase the business terms (Kim et al., 2019). Generally, IoT is most relieving in production (Alzoubi et al., 2020), utility organization, transportation and other IoT devices (Ghazal et al., 2022k). It has use cases for firms like infrastructure (Lee et al., 2022a; Rehman et al., 2022), home automation, agriculture is all leading toward automation with help of Internet of Things (Farouk, 2022). IoT enables peasant in agriculture making their task much smoother (Al-Naymat et al., 2021; Hasan et al., 2021a, 2021b). Sensors can gather data like rainfall, temperature, pest attack, soil humidity, humidity in atmosphere that can robotize farming techniques (Ali et al., 2022; Joghee et al., 2020; Lee et al., 2022b).

Capability to get access data from anywhere or from any other device that is connected (Neyara Radwan, 2022), transferring packets of data through connected networks saving time and money (Alzoubi & Ahmed, 2019; Ghazal et al., 2022e), Improved data transfer between electronic devices connected (Abu-Arqoub et al., 2020), It also helps to aid in business services and reducing human intervention (Alnuaimi et al., 2021) (Fig. 1).

1.1 Problem Definition

A concern in the IoT system will be a person with implanted heart monitor, farm animal with transponder, and a vehicle with in built sensor to alert the driver when

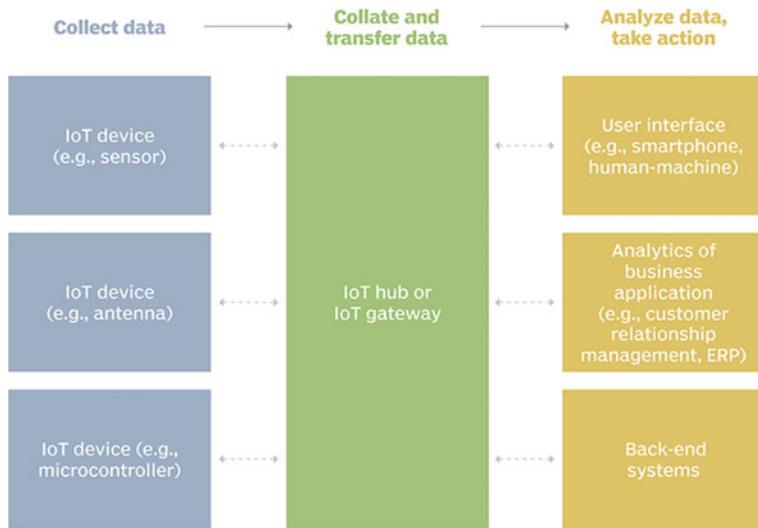


Fig. 1 Working of IoT (Ghazal et al., 2022g)

the petrol level is reduced or any other man made or natural object which can be used as Internet Protocol (IP) address (Islam et al., 2020) is able to send information through the network (Teahan et al., 2012). Provided, most organizations in a variety of industries are using IoT more efficiently (Alzoubi et al., 2022b), for better understanding of customers to deliver good customer service (Alzoubi et al., 2021a, 2021b; Ghazal et al., 2022h), deliver quality customer service, grow the quality of business, improve decision making capacity (Hanaysha et al., 2022). IoT helps human to work and live smarter, as well as control their life with single touch (Mejia et al., 2019). In automated houses when using smart devices, IoT is very important (Alsharari, 2021; Ghazal et al., 2022c). IoT uses companies to be robotic processes to reduce manpower and labour cost (Ali et al., 2021). And also decrease the waste and increase service delivery (Alzoubi et al., 2022e), making it less cost for production and deliver products (Alzoubi et al., 2022b) as well as offering translucent to customer transactions (Alzoubi et al., 2022a). The IoT is growing fast to massive part of how human beings communicate, live and do business (Shehada et al., 2017). There are a lot challenges in front of IoT (Guergov & Radwan, 2021).

- Insufficient testing and updating: With the increase in business, IoT manufactures are eager in developing IoT devices as much as faster so products do not get adequate testing and updating and are prone to hacker's attack and may have security issues (Al-Tahat & Moneim, 2020).
- Lack of Encryption: Even though encryption is a better way to avoid attackers from getting data, it is also one of the factor that leads IoT security challenge (Hasan et al., 2021a, 2021b). In traditional computers it drives the storage and processing

capabilities, provided it leads to more attacks from hackers to manipulate easily the algorithms (Alzoubi & Aziz, 2021).

- IoT malware and ransomware: it Increase with increase in devices. Ransomware practices encryption to effectively put out the users from various platforms and devices and still uses users' valuable info and data (Al-Hamadi et al., 2015a, 2015b; Ghazal et al., 2022j). The ransomware attacks focus on disabling functionality and hacking user data at the same instance (Ghazal & Taleb, 2022).
- Risk of default passwords: Less strength login credentials nearly leaves IoT devices to hack passwords (Alzoubi et al., 2022f, 2022g, 2022h). Anybody who is using default credentials then they are risking the details of customer's, user's, company details of being ready for hacking (Al Ali, 2021; Ghazal et al., 2022f; Kurdi et al., 2022b).
- Increased price and time to marketing: Embedded systems are normally costly. The need originates with good approach (Hussam Al-Hamadi et al., 2015a, 2015b) when designing the IoT devices in order to handle the cost optimally and cost modelling with digital components (Ghazal et al., 2021b).
- System security: Systems are designed and used to be reliable and robust and have to be secure with security procedures and algorithms. It needs more processes to save all components of system from the start to deployment (Alzoubi et al., 2022d).
- Lack Of skills: All the challenges can be tackled only with the help of a skilled worker on IoT development (Alzoubi et al., 2022a). The right skill can always get above the challenges and will be important IoT apps development asset (Ahmed & Al Amiri, 2022).
- Gap in IoT Skills: In recent times many companies have claimed that there is a huge gap in the skills of IoT professionals (Ghazal et al., 2022a). The skill gap is preventing firms from using the workers to the fullest (Alshurideh et al., 2020).

As shown in the Table 1, areas demonstrated and summarized of the served challenges proposed solutions:

2 Literature Review

In fast moving world, improved and new technologies are rapidly being developed. With many areas of IoT needs talented tech professionals-network, software coding, hardware design, validation, security analysis, database programming, technical documentation (Zitar et al., 2021). A thing in IoT system may be a person having implanted heart monitor, a farm animal with transponder, a vehicle with implanted sensor to alert the driver when the petrol level is low or any other man made or natural object that can be used as IP address (Internet protocol) is able to send data over a network (Kurdi et al., 2022c).

- IoT in Traffic System-IoT device brings a lot of value into our life's. With the use of many sensors, wireless networks, computing devices, IoT can be leading for coming years (Ghazal et al., 2021a). IoT are trusted to put up everyday objects with

Table 1 Summary of challenges and proposed solutions

Challenges	Solution
Insufficient testing and updating	For protecting the users against attacks, every device needs appropriate testing before they are launched into companies and public. And need to update the device regularly
Lack of encryption	When data sent over the network like sensory data's input and outputs to the IoT devices. All these data are supposed to be encrypted. These data are safe when encryption is done
IoT Malware and ransomware	With the use of software tool that can recover deleted files in pc. During the ransomware attack original files are deleted by the virus and will be replaced by a replica. So that they can retrieve lost data using data recovery apps/software
Risk of default passwords	Use a strong password or captcha to restrict sensitive privacy issues. Also they can get the IP address or Range
Increase cost and time	They can reduce cost by giving more concern and decreasing network congestion by doing process analysing and optimization to ensure machine and human work correctly
Security of the system	Use more dedicated and privacy rules for sensitive data before disassociating and storing IoT data loads from data that can be used to personally use. Data that is not needed or cached can be left securely
Lack of skill set	The firm can hire skilled workers with qualifications that meets the IoT needs
Gap in IoT skills	For this tuning and increase the skills of gradation procedures need to be in place. Bulletins, newsletters, Workshops can make tremendous difference

relativity and human intelligent quotient (Alnazer et al., 2017). We can consider a monitoring camera which can gather data like traffic congestion, weather conditions, accidents, traffic and pass the data to the midway office, which in turn can send data wide traffic analysing system. A traffic system can easily predict and learn in traffic with Machine learning. The smart camera system can so analyse the traffic congestion and report it to further cities through which that highway connects (Saleem et al., 2022).

- IoT Wearables-It is one of the first services that was available from IoT. Smart watches, heart rate monitors are some among the wearables that has took up the market (Neaimi et al., 2020). Glucose monitor is also one among the IoT device which is less popular. This is to help people suffering from diabetes. It finds blood sugar level in the body using a electrode which is placed under skin and sends data using radio signals to a monitoring system (Hamadneh et al., 2021) (Fig. 2).
- IoT Apps in Smart cities-Smart traffic systems discussed above is an example of IoT devices in smart cities, each city and its needs are different from one another (Ghazal et al., 2022). IoT can aid in areas like waste management, water management, traffic control etc. (Ghazal et al., 2022b). Provided, most organizations in a variety of industries are using IoT more efficiently, to better understand customers to deliver good customer service, deliver quality customer service (Hanaysha et al.,

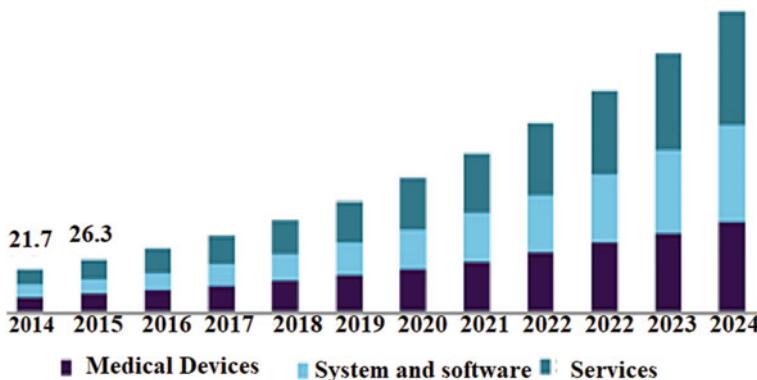


Fig. 2 Increase in no of devices in coming years in medical field (Ghazal et al., 2022f)

2021), grow the quality of business, improve decision making capacity (Ghazal et al., 2021c).

Listed following are some more challenges faced IoT system.

- Security problems in device update management-Software can also be one of the resources that affect software security. However, a developer provides most modern item. But there are chances that security issues might occur because of these updating. Also, if such automated updating takes place, it is sent back to the cloud which in turn sometimes suffer from downtime. If the connection is unencrypted then there are chances for the hacker to gulp the data (Alzoubi et al., 2021a, 2021b).
- Insufficient data protection-Lack of proper data protection can be one among the critical IoT security breach. This might occur due to data storage or irregular communication. One of the main vulnerabilities of IoT security is compromised devices can be used to access secured data. To address these data securing challenges, we can upgrade the potential of cryptography (Mehmood et al., 2019).
- High jacking of IoT devices-Ransomware is one of the most vulnerable malware types. It restricts the access to your critical files through encryption. Then the hacker will demand for Ransom fee in order to decrypt the data (Ghazal et al., 2022i). Sometimes it locks the complete functionality of the device.
- IoT security Risks-IoT enabling does a lot security issues for their users. Even though there is trending connectivity for devices the challenges of IoT security are not new (Alzoubi & Yanamandra, 2020). Security is a main issue when it comes to IoT. If you are using Phone then the sim can be soldered to the hardware then the hacker it will be harder to create any problem (Ghazal et al., 2022g).

3 Research Methodology

One of the trending words in IT is IoT. The future of IoT is it converts real object to virtual ones. The IoT tries to put everything under one umbrella, not only controlling things around us but also keeping informed about the system. IoT is important thing in computing system. IoT is based on things and intelligence interconnected. It is normally identified by small things in real world with less storage and capacity. Ubiquitous computing has more capabilities regarding storage and capacity in Processing. The IoT is an algorithm shift in IT arena. The word “Internet of Things” coined is actually two words. Internet is network of networks where thousands of countries are joined together that use standard protocol suit TCP/IP to serve the whole globe. It is a network of network which consist of zillions of publics, private, academic, business, government networks which is connected through broad array of electronic optical networking technologies, wireless.

The IoT is a technology that allows to connect countless number of devices at a time from any point, IoT is a chain of physical objects that transfer data over the internet using Application program interfaces and Sensors. This modern trend brings up new business models and therefore new models. IoT brings incredible opportunities for firms to offer actual time sensor info and data services. It is effective for automating business and producing processes. As well as remotely controlling operations. IoT boots the productivity and efficiency of the workforce in different ways because more automating daily tasks, it also gear up the processes of decision making and communication. Sometimes these devices communicate to one another or to other related devices and work on information they get from each other. These systems work mostly without the help of human; however, people connect with these devices when time of installation, access the data, set up or giving instructions. The networking, connectivity and connection protocols used in these web-enabled devices largely depend on the specific IoT applications installed. IoT uses Machine Learning and Artificial Intelligence to aid making collecting data processes more dynamic and easier. A thing in the IoT system can a person with implanted heart monitor, farm animal with transponder, a vehicle with built in sensor to alert the driver when the petrol level is low or any other man made or natural object that can be used as IP address (Internet protocol) is able to send data over a network. Provided, most organizations in a variety of industries are using IoT more efficiently, to better understand customers to deliver good customer service, deliver quality customer service, grow the quality of business, improve decision making capacity. The following is the graph for increasing IoT over years (Fig. 3).

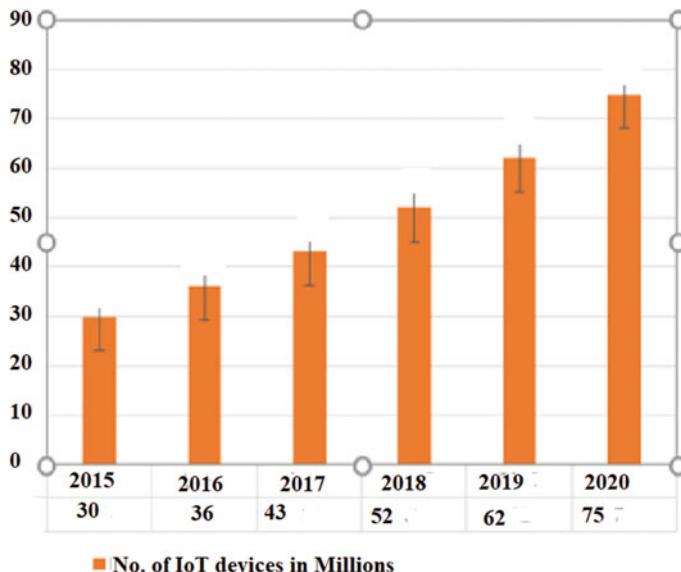


Fig. 3 Increasing no of IoT devices (Ghazal et al., 2022g)

4 Conclusion

In conclusion, an IoT security system has many entry points and loop holes with proper checking and data, it can be finely used with apt hardware and techniques. Along with growth in connected devices, each attribute in IoT communicates packets of information that require storage and security. The term refers to collection of networks of inter related devices and the technology that does connection between devices and cloud, as well as the devices itself. It describes physical things with sensors, software, processing ability that receive, transfer and connect data.

References

- Abu-Arqoub, M., Issa, G., Banna, A. E., & Saadeh, H. (2020). Interactive multimedia-based educational system for children using interactive book with augmented reality. *Journal of Computer Science*, 15, 1648–1658.
- Ahmed, G., & Amiri, N. A. (2022). The transformational leadership of the founding leaders of the United Arab Emirates: Sheikh Zayed Bin Sultan Al Nahyan and Sheikh Rashid Bin Saeed Al Maktoum. *International Journal of Technology and Innovation Management*, 2, 1.
- Al-Hamadi, H., Gawanmeh, A., & Al-Qutayri, M. (2015a). Formal validation of QRS wave within ECG. In *2015 International Conference on Information and Communication Technology Research, ICTRC 2015* (Vol. 9, pp. 190–193).
- Al-Hamadi, H., Gawanmeh, A., Baek, J., & Al-Qutayri, M. (2015b). Lightweight security protocol for ECG bio-sensors. *Wireless Personal Communications*, 95, 5097–5120.

- Al-Naymat, G., Hussain, H., Al-Kasassbeh, M., & Al-Dmour, N. (2021). Accurate detection of network anomalies within SNMP-MIB data set using deep learning. *International Journal of Computer Applications in Technology*, 66, 74–85.
- Al-Tahat, S., & Moneim, O. A. (2020). The impact of artificial intelligence on the correct application of cyber governance in Jordanian commercial banks. *International Journal of Scientific & Technology Research*, 9, 7138–7144.
- Al Ali, A. (2021). The impact of information sharing and quality assurance on customer service at UAE banking sector. *International Journal of Technology and Innovation Management*, 1, 01–17.
- Ali, N., Ahmed, A., Anum, L., Ghazal, T. M., Abbas, S., Khan, M. A., Alzoubi, H. M., & Ahmad, M. (2021). Modelling supply chain information collaboration empowered with machine learning technique. *Intelligent Automation & Soft Computing*, 30, 243–257.
- Ali, A., Septyanto, A. W., Chaudhary, I., Hamadi, H. A., Alzoubi, H. M., & Khan, Z. F. (2022). Applied artificial intelligence as event horizon of cyber security. In *2022 International Conference on Business Analytics for Technology and Security (ICBATS)* (pp. 1–7).
- Alnazer, N. N., Alnuaimi, M. A., & Alzoubi, H. M. (2017). Analysing the appropriate cognitive styles and its effect on strategic innovation in Jordanian universities. *International Journal of Business Excellence*, 13, 127–140.
- Alnuaimi, M., Alzoubi, H. M., Ajelat, D., & Alzoubi, A. A. (2021). Towards intelligent organisations: An empirical investigation of learning orientation's role in technical innovation. *International Journal of Innovation and Learning*, 29, 207–221.
- Alshurideh, M., Gasaymeh, A., Ahmed, G., Alzoubi, H., & Kurd, B. A. (2020). Loyalty program effectiveness: Theoretical reviews and practical proofs. *Uncertain Supply Chain Management*, 8, 599–612.
- Alsharari, N. (2021). Integrating blockchain technology with internet of things to efficiency. *International Journal of Technology and Innovation Management*, 1, 01–13.
- Alzoubi, H., & Ahmed, G. (2019). Do TQM practices improve organisational success? A case study of electronics industry in the UAE. *International Journal of Economics and Business Research*, 17, 459–472.
- Alzoubi, H. M., & Yanamandra, R. (2020). Investigating the mediating role of information sharing strategy on agile supply chain. *Uncertain Supply Chain Management*, 8, 273–284.
- Alzoubi, H. M., Ahmed, G., Al-Gasaymeh, A., & Al Kurdi, B. (2020). Empirical study on sustainable supply chain strategies and its impact on competitive priorities: The mediating role of supply chain collaboration. *Managements Science Letters*, 10, 703–708.
- Alzoubi, H. M., & Aziz, R. (2021). Does emotional intelligence contribute to quality of strategic decisions? The mediating role of open innovation. *Journal of Open Innovation Technology, Market, and Complex*, 7, 130.
- Alzoubi, H. M., Vij, M., Vij, A., & Hanaysha, J. R. (2021a). What leads guests to satisfaction and loyalty in UAE five-star hotels? AHP analysis to service quality dimensions. *Enlightening Tourism*, 11, 102–135.
- Alzoubi, H., Alhamad, A. Q. M., Akour, I., Alshurideh, M., Al-Hamad, A. Q., Kurdi, B. A., & Alzoubi, H. (2021b). Predicting the intention to use google glass: A comparative approach using machine learning models and PLS-SEM. *International Journal of Data and Network Science*, 5, 311–320.
- Alzoubi, H., Alhamad, A., Alshurideh, M., Alomari, K., Al Kurdi, B., Hamouche, S., & Al-Hawary, S. (2022a). The effect of electronic human resources management on organizational health of telecommunications companies in Jordan. *International Journal of Data and Network Science*, 6, 429–438.
- Alzoubi, H., Alshurideh, M., Kurdi, B. A., Akour, I., & Aziz, R. (2022b). Does BLE technology contribute towards improving marketing strategies, customers' satisfaction and loyalty? The role of open innovation. *International Journal of Data and Network Science*, 6, 449–460.

- Alzoubi, H. M., Alshurideh, M. T., Al Kurdi, B., Ghazal, T. M., Said, R. A., AlHamad, A. Q., Hamadneh, S., Sahawneh, N., & Al-kassem, A. H. (2022c). Fuzzy assisted human resource management for supply chain management issues. *Annals of Operations Research*, 1–19.
- Alzoubi, H. M., Alshurideh, M. T., Kurdi, B. A., Alhyasat, K. M. K., & Ghazal, T. M. (2022d). The effect of e-payment and online shopping on sales growth: Evidence from banking industry. *International Journal of Data and Network Science*, 6, 1369–1380.
- Alzoubi, H. M., Elrehaile, H., Hanaysha, J. R., Al-Gasaymeh, A., & Al-Adaileh, R. (2022e). The role of supply chain integration and agile practices in improving lead time during the COVID-19 crisis. *International Journal of Service Science, Management, Engineering, and Technology*, 13, 1–11.
- Alzoubi, H. M., In'airat, M., & Ahmed, G. (2022f). Investigating the impact of total quality management practices and six sigma processes to enhance the quality and reduce the cost of quality: The case of Dubai. *International Journal of Business Excellence*, 27, 94–109.
- Alzoubi, H. M., Ahmed, G., & Alshurideh, M. (2022g). An empirical investigation into the impact of product quality dimensions on improving the order-winners and customer satisfaction. *International Journal of Productivity and Quality Management*, 36, 169–186.
- Alzoubi, H. M., Ali, N., Ghazal, T. M., Ahmed, A., Abbas, S., Khan, M. A., Farooq, U., Ahmad, M., & Khan, M. A. (2022h). Fusion-based supply chain collaboration using machine learning techniques. *Intelligent Automation & Soft Computing*, 31, 1671–1687.
- Farouk, M. (2022). Studying human robot interaction and its characteristics. *International Journal of Computations, Information and Manufacturing*, 2, 1.
- Ghazal, T. M., Bibi, R., Saeed, Y., Zeb, A., Rahman, T., Said, R. A., Abbas, S., Ahmad, M., & Khan, M. A. (2021a). Edge AI-based automated detection and classification of road anomalies in VANET using deep learning. *Computational Intelligence and Neuroscience*, 2021, 1–19.
- Ghazal, T. M., Hasan, M. K., Alkhalfah, A., Abu Bakar, K. A., Omidvar, A., Nafi, N. S., & Agbinya, J. I. (2021b). Fischer linear discrimination and quadratic discrimination analysis-based data mining technique for internet of things framework for healthcare. *Frontiers in Public Health*, 9.
- Ghazal, T. M., Siddiqui, S. Y., Haider, A., Khan, M. A., Naseer, I., Abbas, S., Rahman, M., Khan, J. A., Ahmad, M., Hasan, M. K., Mohammed, A., & Ateeq, K. (2021c). IoMT cloud-based intelligent prediction of breast cancer stages empowered with deep learning. *IEEE Access*, 9, 146478–146491.
- Ghazal, T. M., & Taleb, N. (2022). Feature optimization and identification of ovarian cancer using internet of medical things. *Expert Systems*.
- Ghazal, T. M., Abbas, S., Ahmad, M., & Aftab, S. (2022a). An IoMT based ensemble classification framework to predict treatment response in hepatitis C patients. In *2022 International Conference on Business Analytics for Technology and Security, ICBATS 2022* (pp. 1–4).
- Ghazal, T. M., Abbas, S., Alhwaiti, Y., Fatima, A., Khan, M. A., Khan, M. A., Kanwal, A., Ahmad, M., & Elmitwally, N. S. (2022b). Convolutional neural network based intelligent handwritten document recognition. *Computers, Materials & Continua*, 70, 4563–4581.
- Ghazal, T. M., Abbas, S., Munir, S., Khan, M. A., Ahmad, M., Issa, G. F., Zahra, S. B., Khan, M. A., & Hasan, M. K. (2022c). Alzheimer disease detection empowered with transfer learning. *Computers, Materials & Continua*, 70, 5005–5019.
- Ghazal, T. M., Ahmed, Z. E., Hasan, M. K., Hashim, A. A., Saeed, R. A., Mokhtar, R. A., & Singh, S. P. (2022d). Optimization procedure for intelligent internet of things applications. In *2022 International Conference on Business Analytics for Technology and Security, ICBATS 2022* (pp. 1–6).
- Ghazal, T. M., Bukhari, M. M., Abbas, S., Khan, M. A., Farooq, U., Wahbah, H., Ahmad, M., & Adnan, K. M. (2022e). An intelligent proposed model for task offloading in fog-cloud collaboration using logistics regression. *Computational Intelligence and Neuroscience*.
- Ghazal, T. M., Hasan, M. K., Abdullah, S. N. H., Abubakkar, K. A., & Afifi, M. A. M. (2022f). IoMT-enabled fusion-based model to predict posture for smart healthcare systems. *Computers, Materials & Continua*, 71, 2579–2597.

- Ghazal, T. M., Hasan, M. K., Saeed, R. A., Pandey, B., Gohel, H., Eshmawi, A. A., Abdel-Khalek, S., & Alkhassawneh, H. M. (2022g). A review on security threats, vulnerabilities, and counter measures of 5G enabled Internet-of-Medical-Things. *IET Communications*, 16, 421–432.
- Ghazal, T. M., Khan, M. A., Lee, S. W., & Rehman, A. (2022h). Data fusion-based machine learning architecture for intrusion detection. *Computers, Materials & Continua*, 70, 3399–3413.
- Ghazal, T. M., Mehmood, S., Khan, M. A., Zubair, M., Naseem, M. T., Faiz, T., & Ahmad, M. (2022i). Malignancy detection in lung and colon histopathology images using transfer learning with class selective image processing. *IEEE Access*, 10, 25657–25668.
- Ghazal, T. M., Noreen, S., Said, R. A., Khan, M. A., Siddiqui, S. Y., Abbas, S., Aftab, S., & Ahmad, M. (2022j). Energy demand forecasting using fused machine learning approaches. *Intelligent Automation and Soft Computing*.
- Ghazal, T. M., Rehman, A. U., Saleem, M., Ahmad, M., Ahmad, S., & Mehmood, F. (2022k). Intelligent model to predict early liver disease using machine learning technique. In 2022 International Conference on Business Analytics for Technology and Security, ICBATS 2022 (pp. 1–5).
- Ghazal, T. M., Zafar, S., Asif, M., Ahmad, M. B., Faiz, T., Ahmad, M., & Khan, M. A. (2022l). Assistive devices analysis for visually impaired persons: A review on taxonomy. *IEEE Access*, 10, 13354–13366.
- Guergov, S., & Radwan, N. (2021). Blockchain convergence: Analysis of issues affecting IoT, AI and blockchain. *International Journal of Computations, Information and Manufacturing*, 1, 1–17.
- Guntur, S. R., Gorrepati, R. R., & Dirisala, V. R. (2018). Internet of medical things. *Medical Big Data and Internet of Medical Things*, 4, 271–297.
- Hamadneh, S., Pedersen, O., Alshurideh, M., Kurdi, B. A., & Alzoubi, H. M. (2021). An investigation of the role of supply chain visibility into the Scottish blood supply chain. *Journal of Legal, Ethical and Regulatory*, (24), 1–12.
- Hanaysha, J., Al-Shaikh, M., & Alzoubi, M. H. (2021). Importance of marketing mix elements in determining consumer purchase decision in the retail market. *International Journal of Service Science, Management, Engineering, and Technology*, 12, 56–72.
- Hanaysha, J. R., Al-Shaikh, M. E., Joghee, S., & Alzoubi, H. M. (2022). Impact of innovation capabilities on business sustainability in small and medium enterprises. *FIIB Business Review*, 11, 67–78.
- Hasan, M. K., Islam, S., Sulaiman, R., Khan, S., Hashim, A. H. A., Habib, S., Islam, M., Alyahya, S., Ahmed, M. M., Kamil, S., & Hassan, M. A. (2021a). Lightweight encryption technique to enhance medical image security on internet of medical things applications. *IEEE Access*, 9, 47731–47742.
- Hasan, M. K., Ahmed, M. M., Musa, S. S., Islam, S., Abdullah, S. N., Hossain, E., Nafi, N. S., & Vo, N. (2021b) An improved dynamic thermal current rating model for PMU-based wide area measurement framework for reliability analysis utilizing sensor cloud system. *IEEE Access*, 9, 14446–14458.
- Islam, S., Khalifa, O. O., Hashim, A. H. A., Hasan, M. K., Razzaque, M. A., & Pandey, B. (2020). Design and evaluation of a multihoming-based mobility management scheme to support inter technology handoff in PNEMO. *Wireless Personal Communications*, 114, 1133–1153.
- Joghee, S., Alzoubi, H. M., & Dubey, A. R. (2020). Decisions effectiveness of FDI investment biases at real estate industry: Empirical evidence from Dubai smart city projects. *International Journal of Scientific & Technology Research*, 9, 3499–3503.
- Khan, M. A. (2021). Challenges facing the application of IoT in medicine and healthcare. *International Journal of Computations, Information and Manufacturing*, 1, 39–55.
- Kim, S.-K., Yeun, C. Y., Damiani, E., & Lo, N.-W. (2019). A machine learning framework for biometric authentication using electrocardiogram. *IEEE Access*, 7, 94858–94868.
- Kurdi, B. A., Alshurideh, M., Akour, I., Alzoubi, H. M., Obeidat, B., & Alhamad, A. (2022a). The role of digital marketing channels on consumer buying decisions through eWOM in the Jordanian markets. *International Journal of Data and Network Science*, 6, 1175–1185.

- Kurdi, B. A., Alshurideh, M., Akour, I., Tariq, E., Alhamad, A., & Alzoubi, H. M. (2022b). The effect of social media influencers' characteristics on consumer intention and attitude toward Keto products purchase intention. *International Journal of Data and Network Science*, 6, 1135–1146.
- Kurdi, B. A., Alzoubi, H. M., Akour, I., & Alshurideh, M. T. (2022c). The effect of blockchain and smart inventory system on supply chain performance: Empirical evidence from retail industry. *Uncertain Supply Chain Management*, 10, 1111–1116.
- Lee, C., & Ahmed, G. (2021). Improving IoT privacy, data protection and security concerns. *International Journal of Technology and Innovation Management*, 1, 18–33.
- Lee, K. L., Azmi, N. A. N., Hanaysha, J. R., Alzoubi, H. M., & Alshurideh, M. T. (2022a). The effect of digital supply chain on organizational performance: An empirical study in Malaysia manufacturing industry. *Uncertain Supply Chain Management*, 10, 495–510.
- Lee, K. L., Romzi, P. N., Hanaysha, J. R., Alzoubi, H. M., & Alshurideh, M. (2022b). Investigating the impact of benefits and challenges of IOT adoption on supply chain performance and organizational performance: An empirical study in Malaysia. *Uncertain Supply Chain Management*, 10, 537–550.
- Mehmood, T., Alzoubi, H. M., Alshurideh, M., Al-Gasaymeh, A., & Ahmed, G. (2019). Schumpeterian entrepreneurship theory: Evolution and relevance. *Academy of Entrepreneurship Journal*, 25, 1–10.
- Mejia, C., Ciarlante, K., & Chheda, K. (2019). A wearable technology solution and research agenda for housekeeper safety and health. *International Journal of Contemporary Hospitality Management*, 1–3.
- Neaimi, M., Al Hamadi, H., Al, Yeun, C. Y., & Jamal Zemerly, M. (2020). Digital forensic analysis of files using deep learning. In *2020 3rd International Conference on Signal Processing and Information Security, ICSPIS 2020* (pp. 1–4). IEEE.
- Radwan, N. (2022). The internet's role in undermining the credibility of the healthcare industry. *International Journal of Computations, Information and Manufacturing*, 2, 1.
- Radwan, N., & Farouk, M. (2021). The growth of internet of things (IoT) in the management of healthcare issues and healthcare policy development. *International Journal of Technology and Innovation Management*, 1, 69–84.
- Rehman, A. U., Saleem, R. M., Shafi, Z., Imran, M., Pradhan, M., & Alzoubi, H. M. (2022). Analysis of income on the basis of occupation using data mining. In *2022 International Conference on Business Analytics for Technology and Security, ICBATS 2022* (pp. 1–4).
- Saleem, M., Abbas, S., Ghazal, T. M., Adnan Khan, M., Sahawneh, N., & Ahmad, M. (2022). Smart cities: Fusion-based intelligent traffic congestion control system for vehicular networks using machine learning techniques. *Egyptian Informatics Journal*.
- Shamout, M., Ben-Abdallah, R., Alshurideh, M., Alzoubi, H., Al Kurdi, B., & Hamadneh, S. (2022). A conceptual model for the adoption of autonomous robots in supply chain and logistics industry. *Uncertain Supply Chain Management*, 10, 577–592.
- Shehada, D., Yeun, C. Y., Zemerly, M. J., Qutayri, M., Al Hammadi, Y., Al Damiani, E., & Hu, J. (2017). BROSMAP: A novel broadcast based secure mobile agent protocol for distributed service applications. In *Security and communication networks* (Vol. 2017). Wiley.
- Teahan, W. J., Al-Dmour, N. A., & Tuff, P. G. (2012). Knowledge distribution in multi agent systems. *Asian Journal of Information Technology*, 11, 300–311.
- Vo, D. L., Lee, H., Yeun, C. Y., & Kim, K. (2010). Enhancements of authenticated multiple key exchange protocol based on bilinear pairings. *Computers & Electrical Engineering*, 36, 155–159.
- Zitar, R. A., Al-Dmour, N., Nachouki, M., Hussain, H., & Alzboun, F. (2021). Hashing generation using recurrent neural networks for text documents. *ICIC Express Letters, Part B: Applications*, 12, 231–241.

Invistigating Benefits of Digitalized in Home Systems



Ali A. Alzoubi, Ibrahim Ahmed Almarzooqi, and Haitham M. Alzoubi 

Abstract Despite the benefits of smart home technology, a majority of people are still unaware of its advantages and risks. Many of the devices and systems that make up a smart home are connected to the internet. A home with a smart home network can control multiple appliances and devices remotely, making the process of getting a smart home up and running easier and safer than ever. The benefits of a digitalized home can be immense which will be highlight in this research project. In contemporary research the idea of converting a home into a smart one is an attractive one. These homes can be programmed to meet the preferences of the homeowners. A user may want to program their garage door to open when he or she enters or leaves the home. The owner can set an alarm system to sound in the event of a water leak. Other people may want to program their fireplace to play their favorite tunes.

Keywords Smart cities · Internet of things · Systems

1 Introduction

Researchers believe planning to build a new smart home, you can easily install sensors and controllers to make it smarter. These will work by sending information to the devices' computers. They will also enable you to control the devices that need to be controlled (Alshurideh et al., 2022a, 2022b; Shehada et al., 2018). A smart home is a more comfortable place to live and a smart home can save you money on energy bills.

A. A. Alzoubi
Public Security Directorate, Amman, Jordan

I. A. Almarzooqi
School of Information Technology, Skyline University College, Sharjah, UAE

H. M. Alzoubi (✉)
School of Business, Skyline University College, Sharjah, UAE
e-mail: haitham.alzoubi@skylineuniversity.ac.ae

Applied Science Research Center, Applied Science Private University, Amman, Jordan

Creating a smart home system is not easy (Alnazer et al., 2017). You'll need a lot of patience and know-how. There are a few key steps you should take to create a smart home (Gul et al., 2012). However, once you've made these decisions, the process won't be as difficult as you may think, it requires technological implementation with innovative ideas (Alzoubi et al., 2022a, 2022b, 2022c, 2022d, 2022e). If you're not sure what to do, consider hiring a professional to do the job for you (Mehmood, 2021). It is not easy to convert a non-smart home to a smart one by yourself as it consists of huge digitization (Alhamad et al., 2022; Al-Hamadi et al., 2015a, 2015b). For one, the installation of sensors and controllers needs to be done at the same time (Alzoubi, 2022). In retrofitting a not-smart-home, it's not easy to make the changes in time (Bibi et al., 2021). For this reason, a smart home should be built from scratch, not retrofitted (Alzoubi et al., 2022d; Khan et al., 2022).

1.1 Problem Definition

There are many different components that can be used to turn a home into a smart one. The first is a smart speaker, which can be controlled by voice (Hujran et al., 2020). Once the device is connected to the hub, you can control the rest of the smart home with a single app on your phone (Islam et al., 2020; Miller, 2021). In some cases, you may not even need a single device to control all your devices to maintain the progress (Joghee et al., 2020). Secondly, a smart home is an important part of the home security system (Alshurideh et al., 2020; Cruz, 2021). In addition to the sensors, there are also controllers and sensors that can be built into walls (Alzoubi & Ahmed, 2019). While it may be easier to build a smart house from scratch, retrofitting a non-smart home requires you to put all the devices on the walls that may require the material in bulk (Al-Nashashibi et al., n.d.; Kurdi et al., 2022b; Mehmood et al., 2022). However, when you are converting an existing home (Ghazal & Taleb, 2022; Hanaysha et al., 2021), you have to install all the smart features at the time of renovation (Alhamad et al., 2021).

Despite the fact that the technology is already available to anyone (Alzoubi, 2021), most people have no idea how to convert their non-smart home into a smart one (Alzoubi et al., 2021; Ghazal et al., 2022a). While there are many companies and brands launching smart speakers and lighting systems with innovative ideas (Lee et al., 2022a), there are also a lot of options that aren't available to the average person (Al-Hamadi et al., 2021; Hasan et al., 2021a, 2021b). In this problem, we will look at some of the more interesting options that make a home smart.

1.2 Proposed Solution

A smart home can be more than just an automated house (Ghazal et al., 2022c). It can have a whole ecosystem of connected devices (Shamout et al., 2022). The hub

is the central hub of this ecosystem. It connects all the devices together and allows you to program and control them (Saleem et al., 2022). In addition, smart devices can be controlled remotely via apps and the Internet (Ghazal et al., 2021, 2022d; Kurdi et al., 2022c). This makes it easier for you to stay safe at night. There are many other benefits of a smart home (Alzoubi, 2022). A smart home can be a lot of fun. It can improve your convenience and security that has a significant contribution of innovation (Alnuaimi et al., 2021; Hasan et al., 2021a, 2021b), and it can even help you save money on utilities (Akhtar et al., 2021). However, it is important to realize that these systems aren't perfect and that there are still problems and hiccups (Ghazal et al., 2022f; Hanaysha et al., 2022). Here are a few ways to overcome some of these problems and make your home smarter. If you have a new home, consider upgrading to a smart one (Ghazal et al., 2022e). One of the best ways to make your home smarter is to buy smart devices (Alzoubi et al., 2022a; Ghazal et al., 2022b; Kashif et al., 2021). Many of these devices will enable you to set a "home" or an "away" mode, which mimics real life (Ali et al., 2021). While many people will keep lights on all day to make it look like they're in, this won't be accurate (Siddiqui et al., 2021). That's why you should use the away mode, which simulates the way you live more closely (Al-Hamadi et al., 2015a, 2015b; Ali et al., 2022). In a normal home, some devices will be off, while others will be on.

2 Literature Review

A smart home system is a set of electronic devices, appliances, and lighting that are connected to the Internet (Alzoubi, 2022). These devices are designed to enable remote monitoring and control (Al-Dmour, 2020; Hamadneh et al., 2021). The home-owner of one of my test homes said that her heating bill was one third lower than the usual one (Al-Hamadi et al., 2015a, 2015b; Farouk, 2021; Mehmood et al., 2019), and her home was able to track her energy usage and command power hogs to use less (Hasan et al., 2022; Vo et al., 2010). It was truly a revolutionary idea for a home. The most important feature of a smart home is its adaptability (Alshurideh et al., 2022a, 2022b; Kurdi et al., 2022a). You can program the garage door to open automatically (Al-Hamadi et al., 2015a, 2015b; Alzoubi et al., 2020; Aziz & Aftab, 2021), the lights to turn on automatically, and the fireplace to start playing your favorite music (Alkeem et al., 2017). It is possible to control every aspect of your home from your smartphone (Alzoubi & Aziz, 2021; Bukhari et al., 2022). A smart home can also be programmed with your preferences, as smart devices can be installed in other areas such as, hospital, different organizations to strengthen security system (Alzoubi et al., 2022c; Saad Masood Butt, 2022), so you can have your home operate according to your preference.

3 Research Methodology

Theoretical evaluation involves a systematic study of the factors that drive the adoption of smart homes. Theoretical evaluation is an approach that analyzes the factors influencing the intention of consumers to adopt new technologies (Lee et al., 2022b). It is particularly important because previous studies have failed to consider the entire ecosystem. It has also been shown that if the adoption rate is high, then the technology will become a popular choice (Zafar et al., 2022).

In this study, the researcher employed a survey method to collect data from smart homes users. The respondents were invited to fill out questionnaires about their own experiences with smart technology. Questions included their socio-demographic characteristics, use of smart home devices, and experience of staying in a "smart home" accommodation. In total, 128 valid responses were collected by using online survey. Histogram can help analyze a wide range of variables. The main advantage of histograms is that they help us visualize the distribution of values and can help you detect outliers. We can create a histogram using a CSV data file using SPSS12.0. The data will be analyzing is normally distributed, but we can make bins and label them differently to see the outliers. The users considered that a smart home is connected and all the devices are controlled through a central hub, such as a mobile phone, laptop, or game console (Alzoubi et al., 2022b). The device will be able to control doors, lights, televisions, thermostats, and security cameras. There are several strengths and weaknesses of converting a home that is neither smart nor connected to the internet into a smart home. The technology will allow you to adjust everything in the house with just a few simple controls, which can help you save money and increase your security. However, not all homeowners can afford to invest in all the necessary devices and software. These products can be very expensive and may not be worth it for some people (Abbas et al., 2022). When repairs or maintenance are needed. This is particularly useful for people who are out of town for a long period of time.

4 Conclusion

While there are many benefits of a smart home, it's important to know that there are some limitations. One of the most common is that the devices required to build a connected system are expensive. It's also important to have a stable internet connection. You might have trouble operating these devices remotely. There are some things you should do before you start converting your house to a smart one. Developing a smart home is an important step for modernizing a home. There are a number of challenges, including energy-efficient lighting, processing resources, privacy, and information security. Developing a smart home is a major investment, so it is imperative that the technology is affordable. Fortunately, today's low-cost, low-power devices and communication platforms have made this process much easier. One of the future prospects in converting a non-smart home to a smart one is time and money

and DIY projects you can do to turn your house into a smart home without hiring a professional.

References

- Abbas, S., Alhwaiti, Y., Fatima, A., Khan, M. A., Khan, M. A., Ghazal, T. M., Kanwal, A., Ahmad, M., & Elmitwally, N. S. (2022). Convolutional neural network based intelligent handwritten document recognition. *Computers, Materials & Continua*, 70, 4563–4581.
- Akhtar, A., Akhtar, S., Bakhtawar, B., Kashif, A. A., Aziz, N., Muhammad, &, Javeid, S. (2021). COVID-19 detection from CBC using machine learning techniques. *International Journal of Technology and Innovation Management*, 1, 65–78.
- Al-Dmour, N. A. (2020). Using unstructured search algorithms for data collection in iot-based WSN. *International Journal of Engineering Research & Technology*, 13, 1992–1998.
- Al-Hamadi, H., Gawanmeh, A., & Al-Qutayri, M. (2015a). Formal validation of QRS wave within ECG. In *2015 International Conference on Information and Communication Technology Research, ICTRC 2015* (Vol. 9, pp. 190–193).
- Al-Hamadi, H., Gawanmeh, A., Baek, J., & Al-Qutayri, M. (2015b). Lightweight security protocol for ECG bio-sensors. *Wireless Personal Communications*, 95, 5097–5120.
- Al-Hamadi, H., Nasir, N., Yeun, C. Y., & Damiani, E. (2021). A verified protocol for secure autonomous and cooperative public transportation in smart cities. In I. June (Ed.), *2021 IEEE International Conference on Communications Workshops (ICC Workshops)* (pp. 1–6).
- Al-Nashashibi M., Hadi, W., El-Khalili, N., Ghassan, I. (n.d.) A new two-step ensemble Learn. Model Improv. Stress Predict. Automob. Drivers. *The International Arab Journal of Information Technology*, 6 (2021).
- Alhamad, A. Q. M., Akour, I., Alshurideh, M., Al-Hamad, A. Q., Kurdi, B. A., & Alzoubi, H. (2021). Predicting the intention to use google glass: A comparative approach using machine learning models and PLS-SEM. *International Journal of Data and Network Science*, 5, 311–320.
- Alhamad, A., Alshurideh, M., Alomari, K., Al Kurdi, B., Alzoubi, H., Hamouche, S., & Al-Hawary, S. (2022). The effect of electronic human resources management on organizational health of telecommunications companies in Jordan. *International Journal of Data and Network Science*, 6, 429–438.
- Ali, N., Ahmed, A., Anum, L., Ghazal, T. M., Abbas, S., Khan, M. A., Alzoubi, H. M., & Ahmad, M. (2021). Modelling supply chain information collaboration empowered with machine learning technique. *Intelligent Automation & Soft Computing*, 30, 243–257.
- Ali, N., Ghazal, T. M., Ahmed, A., Abbas, S., Khan, M. A., Alzoubi, H. M., Farooq, U., Ahmad, M., & Khan, M. A. (2022). Fusion-based supply chain collaboration using machine learning techniques. *Intelligent Automation & Soft Computing*, 31, 1671–1687.
- Alkeem, E. A., Shehada, D., Yeun, C. Y., Zemerly, M. J., & Hu, J. (2017). New secure healthcare system using cloud of things. *Cluster Computing*, 20(3), 2211–2229.
- Alnazer, N. N., Alnuaimi, M. A., & Alzoubi, H. M. (2017). Analysing the appropriate cognitive styles and its effect on strategic innovation in Jordanian universities. *International Journal of Business Excellence*, 13, 127–140.
- Alnuaimi, M., Alzoubi, H. M., Ajelat, D., & Alzoubi, A. A. (2021). Towards intelligent organisations: An empirical investigation of learning orientation's role in technical innovation. *International Journal of Innovation and Learning*, 29, 207–221.
- Alshurideh, M., Gasaymeh, A., Ahmed, G., Alzoubi, H., & Kurd, B. A. (2020). Loyalty program effectiveness: Theoretical reviews and practical proofs. *Uncertain Supply Chain Management*, 8, 599–612.

- Alshurideh, M., Al Kurdi, B., Alzoubi, H. M., Ghazal, T. M., Said, R. A., AlHamad, A. Q., Hamadneh, S., Sahawneh, N., & Al-kassem, A. H. (2022a). Fuzzy assisted human resource management for supply chain management issues. *Annals of Operations Research*, 1–19.
- Alshurideh, M. T., Al Kurdi, B., Alzoubi, H. M., Obeidat, B., Hamadneh, S., & Ahmad, A. (2022b). The influence of supply chain partners' integrations on organizational performance: The moderating role of trust. *Uncertain Supply Chain Management*, 10, 1191–1202.
- Alzoubi, H., & Ahmed, G. (2019). Do TQM practices improve organisational success? A case study of electronics industry in the UAE. *International Journal of Economics and Business Research*, 17, 459–472.
- Alzoubi, H. M., Ahmed, G., Al-Gasaymeh, A., & Al Kurdi, B. (2020). Empirical study on sustainable supply chain strategies and its impact on competitive priorities: The mediating role of supply chain collaboration. *Managements Science Letters*, 10, 703–708.
- Alzoubi, A. (2021). The Impact of process quality and quality control on organizational competitiveness at 5-star hotels in Dubai. *International Journal of Technology, Innovation and Management*, 1, 54–68.
- Alzoubi, H. M., & Aziz, R. (2021). Does emotional intelligence contribute to quality of strategic decisions? The mediating role of open innovation. *Journal of Open Innovation Technology, Market, and Complex*, 7, 130.
- Alzoubi, H. M., Vij, M., Vij, A., & Hanaysha, J. R. (2021). What leads guests to satisfaction and loyalty in UAE five-star hotels? AHP analysis to service quality dimensions. *Enlightening Tourism A Pathmaking Journal*, 11, 102–135.
- Alzoubi, A. (2022). Machine learning for intelligent energy consumption in smart homes. *International Journal of Computations, Information and Manufacturing*, 2, 2022.
- Alzoubi, H. M., Ahmed, G., & Alshurideh, M. (2022a). An empirical investigation into the impact of product quality dimensions on improving the order-winners and customer satisfaction. *International Journal of Productivity and Quality Management*, 36, 169–186.
- Alzoubi, H. M., Alshurideh, M. T., Kurdi, B. A., Alhyasat, K. M. K., & Ghazal, T. M. (2022b). The effect of e-payment and online shopping on sales growth: Evidence from banking industry. *International Journal of Data and Network Science*, 6, 1369–1380.
- Alzoubi, H. M., Elrehail, H., Hanaysha, J. R., Al-Gasaymeh, A., & Al-Adaileh, R. (2022c). The role of supply chain integration and agile practices in improving lead time during the COVID-19 crisis. *International Journal of Service Science, Management, Engineering, and Technology*, 13, 1–11.
- Alzoubi, H. M., In'airat, M., & Ahmed, G. (2022d). Investigating the impact of total quality management practices and six sigma processes to enhance the quality and reduce the cost of quality: The case of Dubai. *International Journal of Business Excellence*, 27, 94–109.
- Alzoubi, H., Alshurideh, M., Kurdi, B. A., Akour, I., & Aziz, R. (2022e). Does BLE technology contribute towards improving marketing strategies, customers' satisfaction and loyalty? The role of open innovation. *International Journal of Data and Network Science*, 6, 449–460.
- Aziz, N., & Aftab, S. (2021). Data mining framework for nutrition ranking: Methodology: SPSS modeller. *International Journal of Technology and Innovation Management*, 1, 85–95.
- Bibi, R., Saeed, Y., Zeb, A., Ghazal, T. M., Rahman, T., Said, R. A., Abbas, S., Ahmad, M., & Khan, M. A. (2021). Edge AI-based automated detection and classification of road anomalies in VANET using deep learning. *Computational Intelligence and Neuroscience*, 2021, 1–19.
- Bukhari, M. M., Ghazal, T. M., Abbas, S., Khan, M. A., Farooq, U., Wahbah, H., Ahmad, M., & Adnan, K. M. (2022). An intelligent proposed model for task offloading in fog-cloud collaboration using logistics regression. *Computational Intelligence and Neuroscience*.
- Butt, S. M. (2022). Management and treatment of type 2 diabetes. *International Journal of Computations, Information and Manufacturing*, 2, 1.
- Cruz, A. (2021). Convergence between blockchain and the internet of things. *International Journal of Technology and Innovation Management*, 1, 34–53.
- Farouk, M. (2021). The universal artificial intelligence efforts to face coronavirus COVID-19. *International Journal of Computations, Information and Manufacturing*, 1, 77–93.

- Ghazal, T. M., Hasan, M. K., Alkhalfah, A., Abu Bakar, K. A., Omidvar, A., Nafi, N. S., & Agbinya, J. I. (2021). Fischer linear discrimination and quadratic discrimination analysis-based data mining technique for internet of things framework for healthcare. *Frontiers in Public Health*, 9.
- Ghazal, T. M., & Taleb, N. (2022). Feature optimization and identification of ovarian cancer using internet of medical things. *Expert Systems*.
- Ghazal, T. M., Abbas, S., Ahmad, M., & Aftab, S. (2022a). An IoMT based ensemble classification framework to predict treatment response in hepatitis C patients. In *2022 International Conference on Business Analytics for Technology and Security, ICBATS 2022* (pp. 1–4).
- Ghazal, T. M., Abbas, S., Munir, S., Khan, M. A., Ahmad, M., Issa, G. F., Zahra, S. B., Khan, M. A., & Hasan, M. K. (2022b). Alzheimer disease detection empowered with transfer learning. *Computers, Materials & Continua*, 70, 5005–5019.
- Ghazal, T. M., Ahmed, Z. E., Hasan, M. K., Hashim, A. A., Saeed, R. A., Mokhtar, R. A., & Singh, S. P. (2022c). Optimization procedure for intelligent internet of things applications. In *2022 International Conference on Business Analytics for Technology and Security, ICBATS 2022* (pp. 1–6).
- Ghazal, T. M., Hasan, M. K., Abdullah, S. N. H., Abubakkar, K. A., & Afifi, M. A. M. (2022d). IoMT-enabled fusion-based model to predict posture for smart healthcare systems. *Computers, Materials & Continua*, 71, 2579–2597.
- Ghazal, T. M., Noreen, S., Said, R. A., Khan, M. A., Siddiqui, S. Y., Abbas, S., Aftab, S., & Ahmad, M. (2022e). Energy demand forecasting using fused machine learning approaches. *Intelligent Automation & Soft Computing*, 31, 539–553.
- Ghazal, T. M., Rehman, A. U., Saleem, M., Ahmad, M., Ahmad, S., & Mahmood, F. (2022f). Intelligent model to predict early liver disease using machine learning technique. In *2022 International Conference on Business Analytics for Technology and Security, ICBATS 2022* (pp. 1–5).
- Gul, O., Al-Qutayri, M., Yeun, C. Y., Vu, Q. H. (2012). Framework of a national level electronic health record system. In *Proceedings of 2012 International Conference on Cloud Computing Technologies, Applications and Management, ICCCTAM 2012. Applications and Management (ICCCTAM)* (pp. 60–65).
- Hamadneh, S., Pedersen, O., Alshurideh, M., Kurdi, B. A., & Alzoubi, H. M. (2021). An investigation of the role of supply chain visibility into the Scottish blood supply chain. *Journal of Legal, Ethical and Regulatory*, 24, 1–12.
- Hanaysha, J., Al-Shaikh, M., & Alzoubi, M. H. (2021). Importance of marketing mix elements in determining consumer purchase decision in the retail market. *International Journal of Service Science, Management, Engineering, and Technology*, 12, 56–72.
- Hanaysha, J. R., Al-Shaikh, M. E., Joghee, S., & Alzoubi, H. M. (2022). Impact of innovation capabilities on business sustainability in small and medium enterprises. *FIIB Business Review*, 11, 67–78.
- Hasan, M. K., Islam, S., Sulaiman, R., Khan, S., Hashim, A. H. A., Habib, S., Islam, M., Alyahya, S., Ahmed, M. M., Kamil, S., & Hassan, M. A. (2021a). Lightweight encryption technique to enhance medical image security on internet of medical things applications. *IEEE Access*, 9, 47731–47742.
- Hasan, M. K., Ahmed, M. M., Musa, S. S., Islam, S., Abdullah, S. N., Hossain, E., Nafi, N. S., & Vo, N. (2021b). An improved dynamic thermal current rating model for PMU-based wide area measurement framework for reliability analysis utilizing sensor cloud system. *IEEE Access*, 9, 14446–14458.
- Hasan, M. K., Ghazal, T. M., Saeed, R. A., Pandey, B., Gohel, H., Eshmawi, A. A., Abdel-Khalek, S., & Alkhassawneh, H. M. (2022). A review on security threats, vulnerabilities, and counter measures of 5G enabled internet-of-medical-things. *IET Communications*, 16, 421–432.
- Hujran, O., Alikaj, A., Durrani, U. K., & Al-Dmour, N. (2020). Big data and its effect on the music industry. In *ACM International Conference Proceeding Series* (pp. 5–9).

- Islam, S., Khalifa, O. O., Hashim, A. H. A., Hasan, M. K., Razzaque, M. A., & Pandey, B. (2020). Design and evaluation of a multihoming-based mobility management scheme to support inter technology handoff in PNEMO. *Wireless Personal Communications*, 114, 1133–1153.
- Joghee, S., Alzoubi, H. M., & Dubey, A. R. (2020). Decisions effectiveness of FDI investment biases at real estate industry: Empirical evidence from Dubai smart city projects. *International Journal of Scientific & Technology Research*, 9, 3499–3503.
- Kashif, A. A., Bakhtawar, B., Akhtar, A., Akhtar, S., Aziz, N., & Javeid, M. S. (2021). Treatment response prediction in hepatitis C patients using machine learning techniques. *International Journal of Technology and Innovation Management*, 1, 79–89.
- Khan, M. A., Ghazal, T. M., Lee, S. W., & Rehman, A. (2022). Data fusion-based machine learning architecture for intrusion detection. *Computers, Materials & Continua*, 70, 3399–3413.
- Kurdi, B. A., Alshurideh, M., Akour, I., Alzoubi, H. M., Obeidat, B., & Alhamad, A. (2022a). The role of digital marketing channels on consumer buying decisions through eWOM in the Jordanian markets. *International Journal of Data and Network Science*, 6, 1175–1185.
- Kurdi, B. A., Alshurideh, M., Akour, I., Tariq, E., Alhamad, A., & Alzoubi, H. M. (2022b). The effect of social media influencers' characteristics on consumer intention and attitude toward Keto products purchase intention. *International Journal of Data and Network Science*, 6, 1135–1146.
- Kurdi, B. A., Alzoubi, H. M., Akour, I., & Alshurideh, M. T. (2022c). The effect of blockchain and smart inventory system on supply chain performance: Empirical evidence from retail industry. *Uncertain Supply Chain Management*, 10, 1111–1116.
- Lee, K. L., Azmi, N. A. N., Hanaysha, J. R., Alzoubi, H. M., & Alshurideh, M. T. (2022a). The effect of digital supply chain on organizational performance: An empirical study in Malaysia manufacturing industry. *Uncertain Supply Chain Management*, 10, 495–510.
- Lee, K. L., Romzi, P. N., Hanaysha, J. R., Alzoubi, H. M., & Alshurideh, M. (2022b). Investigating the impact of benefits and challenges of IOT adoption on supply chain performance and organizational performance: An empirical study in Malaysia. *Uncertain Supply Chain Management*, 10, 537–550.
- Mehmood, T., Alzoubi, H. M., Alshurideh, M., Al-Gasaymeh, A., & Ahmed, G. (2019). Schumpeterian entrepreneurship theory: Evolution and relevance. *Academy of Entrepreneurship Journal*, 25, 1–10.
- Mehmood, T. (2021). Does information technology competencies and fleet management practices lead to effective service delivery? Empirical evidence from E-commerce industry. *International Journal of Technology and Innovation Management*, 1, 14–41.
- Mehmood, S., Ghazal, T. M., Khan, M. A., Zubair, M., Naseem, M. T., Faiz, T., & Ahmad, M. (2022). Malignancy detection in lung and colon histopathology images using transfer learning with class selective image processing. *IEEE Access*, 10, 25657–25668.
- Miller, D. (2021). The best practice of teach computer science students to use paper prototyping. *International Journal of Technology and Innovation Management*, 1, 42–63.
- Saleem, M., Abbas, S., Ghazal, T. M., Adnan Khan, M., Sahawneh, N., & Ahmad, M. (2022). Smart cities: Fusion-based intelligent traffic congestion control system for vehicular networks using machine learning techniques. *Egyptian Informatics Journal*.
- Shamout, M., Ben-Abdallah, R., Alshurideh, M., Alzoubi, H., Kurdi, B. A., & Hamadneh, S. (2022). A conceptual model for the adoption of autonomous robots in supply chain and logistics industry. *Uncertain Supply Chain Management*, 10, 577–592.
- Shehada, D., Yeun, C. Y., Zemerly, M. J., Al-Qutayri, M., Al-Hammadi, Y., & Hu, J. (2018). A new adaptive trust and reputation model for mobile agent systems. *Journal of Network and Computer Application*, 124, 33–43.
- Siddiqui, S. Y., Haider, A., Ghazal, T. M., Khan, M. A., Naseer, I., Abbas, S., Rahman, M., Khan, J. A., Ahmad, M., Hasan, M. K., Mohammed, A., & Ateeq, K. (2021). IoMT cloud-based intelligent prediction of breast cancer stages empowered with deep learning. *IEEE Access*, 9, 146478–146491.

- Vo, D. L., Lee, H., Yeun, C. Y., & Kim, K. (2010). Enhancements of authenticated multiple key exchange protocol based on bilinear pairings. *Computers & Electrical Engineering*, 36, 155–159.
- Zafar, S., Asif, M., Ahmad, M. B., Ghazal, T. M., Faiz, T., Ahmad, M., & Khan, M. A. (2022). Assistive devices analysis for visually impaired persons: A review on taxonomy. *IEEE Access*, 10, 13354–13366.

Investigating Impact of Ethical Considerations on IoMT Medical Devices of UAE Healthcare System



Ali A. Alzoubi, Mohammed Khalid Alhammadi, Khalid Abdalla Alhammadi, AbdAlla Alhammadi, and Haitham M. Alzoubi 

Abstract The investigation of the effect of ethical considerations on medical aspects of the UAE economy is analyzed here in terms of the use of ethics and security in IoMT. The research problem dealing with consumer protection is discussed here in terms of the loopholes or lags in ethical and security issues of IoMT. The solution of the research is centred on this problem.

Keywords IoMT · Ethical · UAE · Health care

1 Introduction

The use of ethical considerations in medical aspects of a developed economy like the UAE is linked with the ethical and security issue of protecting consumers or patients against the risks connected with IoMT (Ghazal et al., 2022f). The problem is of a high level dealing with the Internet of Medical Things. The aspect is important, keeping the value of using present technologies connected with medicare, such as in UAE (Al-Hamadi et al., 2015a, 2015b). The secondary research approach is suited to the topic and fits well with the elaborate concept of the study of the issues in medicare in terms of IoMT (Lee et al., 2022b). The research deals in depth with the aspects of ethical and security problems connected with protecting patients or consumers from faulty performances of the IoMT devices (Guntur et al., 2018; Hasan et al., 2021a, 2021b). The use of medicare in terms of IoMT performance produces repercussions

A. A. Alzoubi
Public Security Directorate, Amman, Jordan

M. Alhammadi · K. A. Alhammadi · A. Alhammadi
School of Information Technology, Skyline University College, Sharjah, UAE

H. M. Alzoubi (✉)
School of Business, Skyline University College, Sharjah, UAE
e-mail: haitham.alzoubi@skylineuniversity.ac.ae

Applied Science Research Center, Applied Science Private University, Amman, Jordan

on patients' health in the UAE (Ali et al., 2021). The discussion below deals with the impact of ethical considerations in UAE depending upon issues of ethical and security origin on the Internet of Medical Things (Ghazal et al., 2021b).

1.1 Problem Definition

The problem definition circulates the issue of ethical and security drawbacks in (Internet of Medical Things (IoMT)-related services in the developed economy of UAE (Shamout et al., 2022), which is proving to be burdensome for the patients (Al-Hamadi et al., 2015a, 2015b). The inputs of the problem are the different types of technological services and provisions associated with IoMT (El Khatib et al., 2022; Obaid, 2021), and the outputs are the health outcomes depending on the patient's cure (Mejia et al., 2019). The strategies used to develop the intensity of patient care in the economy of UAE circulate the concept of providing safe health services with the use of modernised technology in the economy (Alzoubi et al., 2021a, 2021b). The internet brought revolutions in connectivity, and some regulations are put on them (Kurdi et al., 2022a; Teahan et al., 2012).

The aspect of dealing with the concepts of healthcare about IoM deals with the fragments of secure and ethical services provided to the consumers or the patients in terms of well-developed health norms (Alzoubi et al., 2022d; Ghazal et al., 2022j). Hence, the consumer protection problem is a major challenge in managing health services related to medical aspects in the UAE economy (Eli, 2021; Mehmood et al., 2019). The basic concepts of the research problem circulate the constraints in the use of technologies connected with IoMT in UAE (Ghazal et al., 2021a), which gives birth to ethical and security loopholes in the medical corridors of the economy (Alnazer et al., 2017). The research problem is hence interesting and significant, depending on the demands of IoMT in the medicare of patients in the modern era.

2 Proposed Solution

The best solution for solving the problem revolving around consumer safety related to ethical and security issues of use of IoMT links with developing a code of ethics supported by the growth of digital education (Lee et al., 2022a). More the use of strategy around the code of ethics in medical corridors of a developed economy like that of the UAE, the easier it is to provide health and safety to the patients (Kim et al., 2019). Large-scale interactive operations are required in medicare to solve the problem of consumer safety in the UAE in the context of protection from lags in IoMT practices (Alzoubi et al., 2022e, 2022g, 2022h; Vo et al., 2010). In the past few decades, the healthcare system has developed with improvements in the use of technologies and methods (Ghazal et al., 2022d; Kurdi et al., 2022b). The goals of health units like hospitals, nursing homes and other medical units in UAE should be

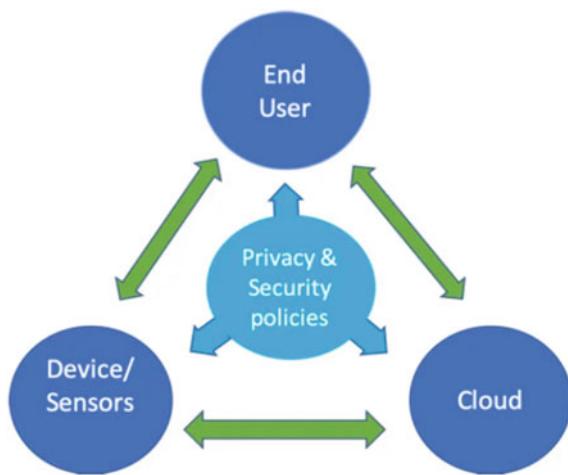
bent upon the proposition of policies dealing with upgrading and updating the code of conduct in healthcare segments developed and used based on uses of the Internet of Medical Things (Ghazal et al., 2022a; Hanaysha et al., 2021). The protection of the secure connection in digital networks of health systems in UAE is necessary requisite for managing medical devices and tools connected with IoMT (Alzoubi, 2021; Alzoubi & Ahmed, 2019). The use of training of health workers and patients in services of IoMT is a necessary process to solve the issue of consumer protection based on these aspects (Ghazal et al., 2022k; Ratkovic, 2022). The health benefits of the patients in healthcare units of UAE are related to this aspect depending on the tenets of the utilization of technological processes of medicare (Neaimi et al., 2020) as per the needs and necessities of patients (Alzoubi et al., 2022a; Hanaysha et al., 2021). For instance, (Alnuaimi et al., 2021) proposed a solution that is related to a better code of ethics and education in terms of using services of measuring blood pressure or insulin of patients with the aid of IoMT devices.

3 Literature Review

The Internet of Medical Things (IoMT) concept relates to the process of ethical consideration in medicare in the UAE (Alzoubi et al., 2021a, 2021b; Guntur et al., 2018). According to (Ghazal et al., 2022g), the internet of things, as related to medicare, deals with digitally collaborating devices, applications and other things. The author used a secondary research method to study the prospects of IoMT. This aspect is related to the present research in terms of linkages with the perspectives of the Internet of Medical Things (Hasan et al., 2021a, 2021b) about security and ethical concepts used in this research (Islam et al., 2020). The use of data analysis processes depending on smart concepts is associated with this scenario (Abu-Arqoub et al., 2020; Ghazal et al., 2022i). As per the view of Alzoubi et al., the market focuses on innovative prospects (Alshurideh et al., 2022; Alzoubi et al., 2022b). The author used a survey-related primary method and a secondary method to study the block chain-related prospects of IoMT (Joghee et al., 2020; Mondol, 2021). This aspect relates to our research in terms of depth analysis of the modern technological aspects of IoMT (Alzoubi & Aziz, 2021; Zitar et al., 2021) as related to the criteria of ethics and security in our work (Alzoubi et al., 2022a; Kasem & Al-Gasaymeh, 2022). About 1.4 million patient records are available to Dubai health authorities in the UAE depending on using electronic medical methods in pre-Covid periods (Alzoubi et al., 2022b; Ghazal et al., 2022b, 2022i). The business of healthcare organisations in the UAE is related to the problems of health care needs related to modern technological services (Al-Naymat et al., 2021; Alshurideh et al., 2022). The development of primary healthcare processes in the economy is supported by the use of ethics and security management in terms of the modern aspects of IoMT (Alzoubi et al., 2022c; Ghazal & Taleb, 2022).

The healthcare market in UAE is expected to grow by 12.7% in 2020. Hence, any security loophole related to them can bring drastic changes in the management

Fig. 1 Prospects of linkages in IoMT in healthcare (Guntur et al., 2018)



of the healthcare needs of the patients. The quality of healthcare services may face a negative impact if drawbacks in ethics and security are witnessed in the medical infrastructure of the UAE economy. Hence, proper development of codes related to healthcare ethics should be used in UAE. The process should be supported by digital healthcare education as developed in the context of the generation of awareness of both the healthcare professionals and the patients (Fig. 1).

Predictions depict that the market size of IoMT will be worth \$142.45 billion in 2026 (Ghazal et al., 2022c). Hence, developing IOT services is crucial in the present healthcare infrastructure, such as in UAE (Hamadneh et al., 2021). According to (Eli & Hamou, 2022), the emergence of medical devices brought transformations in the perspectives of healthcare. The author used a secondary qualitative approach to dealing with the security and privacy considerations in IoMT (Alzoubi & Yana-mandra, 2020; Ghazal et al., 2022h). The aspect is related to the present criteria of the research performed here dealing with security concepts of the Internet of Medical Things (Alshurideh et al., 2020). The rising levels of immigration in the UAE being attracted by the speedy economic development made it urgent for the UAE to upgrade its present network of medical infrastructure (Edward Probir Mondol, 2022).

The pros and cons of healthcare subjected to the modern needs of IoMT practices soundly links with this prospect. A growth rate of 5% is expected in the health (Alzoubi et al., 2022f). Hence, the improvement is related to the intense use of IoMT-backed health services. The lag in the use of healthcare devices like those used for measuring insulin level or blood pressure (Ghazal et al., 2022e; Kurdi et al., 2022c) produces adverse effects on health outcomes of care evaluated in terms of the patients served in UAE (Ghazal et al., 2022g). The accuracy and diagnosis of patients' health records depend on the reliability of IoMT services in the UAE (Ramakrishna & Alzoubi, 2022). Hence ethical and security issues connected with them must be corrected with adherence to the code of things bolstered by awareness

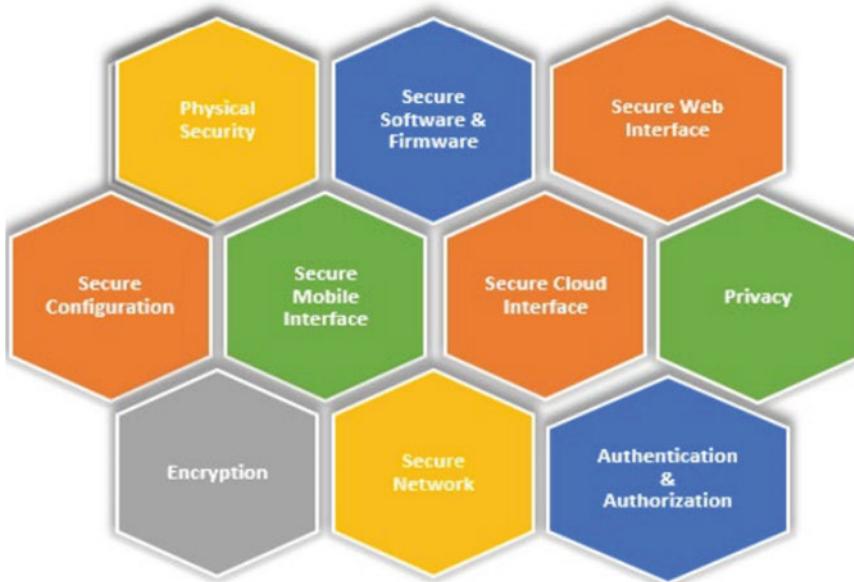


Fig. 2 Domains of security of IoMT (Ghazal et al., 2022g)

(Victoria, 2022) in terms of digital knowledge in medical fields of the UAE enhances the medical progress (Alzoubi et al., 2020) (Fig. 2).

4 Research Methodology

The method used in this research to study the impact of ethical considerations on the medical aspects of the UAE economy related to the ethics and security of IoMT is secondary qualitative. The research hypothesis is the impact of the ethical considerations on medical aspects concerning patients in the UAE related to the perspectives of IoMT. Developing thematic analysis based on this hypothesis is well-suited to the research problem of consumer protection regarding the lags and drawbacks of IoMT (Saleem et al., 2022).

According to (Alsharari, 2022), the concept of validity is often questioned in research. The validity of the secondary research here relies on the aspects of information analysed in the secondary mode. Compiling existing data from various channels of pre-existing origin is the main basis for this research. Pre-existing information from journals collected from internet sources forms the pillars of the research work done here about the research topic. The descriptive or thematic mode of research supports the details of the research in the secondary qualitative mode.

Data from the secondary analysis is greatly useful even though it comes with vital caveats. The proper process of recognising the research topic and developing a descriptive analysis of qualitative origin in their context supports the research hypothesis's ideals. The aspects of ethics and security in the context of IoMT are related to article-supported discussions using original data from pre-existing sources. The process of filtering, ordering and combining data is maintained in this qualitative research performed in secondary mode. The support from externally gathered data strengthens the research analysis. This descriptive analysis model thoroughly observes the possibility of overlapping trends in collected data.

Stepwise data analysis in terms of detailed explorations in terms of the idea of the research topic forms the crucial aspects of the analysis in major manners. Ordering and sensibility of data used in secondary research form the main basis of the research process. Using narrations dependent on descriptive processes of accounting of the data forms the chief feature of the qualitative analysis as done here with precision. The main reason for supporting the claims of the use of secondary qualitative research in descriptive mode is linked with the attributes of the affordability criterion in terms of the use of the data.

5 Discussion

The ideas of the research hypothesis are soundly linked with the results of the research conducted here. According to, deliveries regarding the treatment of patients are a major issue in aspects of healthcare services linked with patients in the UAE. The relation provided in terms of the use of the Internet of Medical Things gauging the criteria of health outcomes of the patients in UAE relates to the research hypothesis. The use of technological trends in pharmaceutical and other medical sectors like those connected with diagnostics is associated with the conditions of performance of healthcare. Adherence to medicare ethics in the UAE is related with this aspect.

For instance, the global market of IoMT in the MENA region, including the UAE, is expected to increase to US\$158.1 billion in 2022. The secondary research analysis, as indicated above, depicting the number of healthcare patients in a pre-Covid era in UAE via electronic method is related to this aspect. Smart policies are linked with improvements in public access. Hence, the result supports the strength of the data analysed in the research above, depicting the method's strength. However, the weakness of the method compared to other methods is reflected in the lack of scope of discussion regarding the findings of the data as collected from sample respondents directly. The compound annual growth rate of 35% is estimated for healthcare services related to IoMT in 2022 in the MENA region, including the UAE. The secondary research on the growth of healthcare services in the UAE in the Covid era is linked with this aspect.

The structural shifts in the healthcare market of UAE are soundly linked with the secondary analysis results as performed here. The role played by using artificial intelligence in facets of IoMT-supported healthcare service is linked with the result

of supporting the proponents of the hypotheses in critical manners. As per the view of workers' departures brings enhancement in operational costs and create economic costs. The linkage is linked with the health outcomes of patients of the UAE by the use of these technologically driven medical services in the economy. Any lag or shortfall in their effective use due to a lack of knowledge regarding their use can lead to the generation of serious health hazards in the economy. UAE accounts for about 26% of healthcare expenditures in the GCC. The secondary research here depicting the expected market size of IoMT in 2026 can be linked with this aspect. The ethical and security issues create drawbacks in the economy's performance of IoMT devices and digital applications. The conditions of health of patients depend a lot on the emergence of these issues in the UAE.

UAE spends around AED 4400 per capita on the generation of its healthcare services by ranking itself among the top 20 nations concerning the criterion of the globe. The aspect is linked with the secondary process of discussion above regarding the growth of healthcare prospects by 2022. The aspects of ethics and security are related to these discussions depending on the use of the Internet of Medical Things. Patients of the coronavirus pandemic faced more serious conditions for their hospitalizations. Any failure witnessed may lead to severe consequences on the health results of UAE patients related to the medical aspects. The results support the strengths and weaknesses of the hypotheses critically. The results are demonstrated in terms of underlying features of the data used in the analysis.

6 Conclusion and Future Recomendations

The major aspect of the research conducted here deals with the ethical and security considerations of IoMT in medical aspects in the UAE. The importance of the services depending on their market size and growth potential is analysed in this research with a focus on the generation of issues for failure and performance of the technological services. The impact on UAE patients is depicted in terms of adversities borne out by them. The importance of IoMT and the significance of the failure of the technological process depending on the effect on patients' health in UAE is the most significant point of discussion in the research. The research conducted here will give impetus to the future scope of research dealing with the subject of IoMT perspectives by giving them a sound knowledge of the aspect covered in the discussion here. The research can be extended to specifics of health outcomes of every healthcare segment of varied origin in the UAE if more time is available. The major limitations of the report are linked with the narrowed scope of the research study conducted in terms of generalised effects catered to patients in the UAE depending on the ethics and security components of UAE's healthcare. Proper strategies dealing with the interview or survey-related research can help overcome these limitations.

References

- Abu-Arqoub, M., Issa, G., Banna, A. E., & Saadeh, H. (2020). Interactive multimedia-based educational system for children using interactive book with augmented reality. *Journal of Computer Science*, 15, 1648–1658.
- Al-Hamadi, Hussam, Gawanmeh, A., & Al-Qutayri, M. (2015a). Formal validation of QRS wave within ECG. In *2015 International Conference on Information and Communication Technology Research, ICTRC* (Vol. 9, pp. 190–193).
- Al-Hamadi, H., Gawanmeh, A., Baek, J., & Al-Qutayri, M. (2015b). Lightweight security protocol for ECG bio-sensors. *Wireless Personal Communications*, 95, 5097–5120.
- Al-Naymat, G., Hussain, H., Al-Kasassbeh, M., & Al-Dmour, N. (2021). Accurate detection of network anomalies within SNMP-MIB data set using deep learning. *International Journal of Computer Applications in Technology*, 66, 74–85.
- Ali, N., Ahmed, A., Anum, L., Ghazal, T. M., Abbas, S., Khan, M. A., Alzoubi, H. M., & Ahmad, M. (2021). Modelling supply chain information collaboration empowered with machine learning technique. *Intelligent Automation & Soft Computing*, 30, 243–257.
- Alnazer, N. N., Alnuaimi, M. A., & Alzoubi, H. M. (2017). Analysing the appropriate cognitive styles and its effect on strategic innovation in Jordanian universities. *International Journal of Business Excellence*, 13, 127–140.
- Alnuaimi, M., Alzoubi, H. M., Ajelat, D., & Alzoubi, A. A. (2021). Towards intelligent organisations: An empirical investigation of learning orientation's role in technical innovation. *International Journal of Innovation and Learning*, 29, 207–221.
- Alsharari, N. (2022). The Implementation of enterprise resource planning (Erp) in the United Arab Emirates: A case of Musanada Corporation. *International Journal of Technology and Innovation Management*, 2, 1.
- Alshurideh, M., Gasaymeh, A., Ahmed, G., Alzoubi, H., & Kurd, B. A. (2020). Loyalty program effectiveness: Theoretical reviews and practical proofs. *Uncertain Supply Chain Management*, 8, 599–612.
- Alshurideh, M., Kurdi, B., Alzoubi, H., Obeidat, B., Hamadneh, S., & Ahmad, A. (2022). The influence of supply chain partners' integrations on organizational performance: The moderating role of trust. *Uncertain Supply Chain Management*, 10, 1191–1202.
- Alzoubi, H., & Ahmed, G. (2019). Do TQM practices improve organisational success? A case study of electronics industry in the UAE. *International Journal of Economics and Business Research*, 17, 459–472.
- Alzoubi, H. M., & Yanamandra, R. (2020). Investigating the mediating role of information sharing strategy on agile supply chain. *Uncertain Supply Chain Management*, 8, 273–284.
- Alzoubi, H. M., Ahmed, G., Al-Gasaymeh, A., & Al Kurdi, B. (2020). Empirical study on sustainable supply chain strategies and its impact on competitive priorities: The mediating role of supply chain collaboration. *Managements Science Letters*, 10, 703–708.
- Alzoubi, A. (2021). Renewable green hydrogen energy impact on sustainability performance. *International Journal of Computations, Information and Manufacturing*, 1, 94–105.
- Alzoubi, H. M., & Aziz, R. (2021). Does emotional intelligence contribute to quality of strategic decisions? The mediating role of open innovation. *Journal of Open Innovation Technology, Market, and Complex*, 7, 130.
- Alzoubi, H. M., Vij, M., Vij, A., & Hanaysha, J. R. (2021a). What leads guests to satisfaction and loyalty in UAE five-star hotels? AHP analysis to service quality dimensions. *Enlightening Tourism*, 11, 102–135.
- Alzoubi, H., Alhamad, A. Q. M., Akour, I., Alshurideh, M., Al-Hamad, A. Q., Kurdi, B. A., & Alzoubi, H. (2021b). Predicting the intention to use google glass: A comparative approach using machine learning models and PLS-SEM. *International Journal of Data and Network Science*, 5, 311–320.
- Alzoubi, H., Alhamad, A., Alshurideh, M., Alomari, K., Al Kurdi, B., Hamouche, S., & Al-Hawary, S. (2022a). The effect of electronic human resources management on organizational health of

- telecommunications companies in Jordan. *International Journal of Data and Network Science*, 6, 429–438.
- Alzoubi, H., Alshurideh, M., Kurdi, B. A., Akour, I., & Aziz, R. (2022b). Does BLE technology contribute towards improving marketing strategies, customers' satisfaction and loyalty? The role of open innovation. *International Journal of Data and Network Science*, 6, 449–460.
- Alzoubi, H. M., Alshurideh, M. T., Al Kurdi, B., Ghazal, T. M., Said, R. A., AlHamad, A. Q., Hamadneh, S., Sahawneh, N., & Al-kassem, A. H. (2022c). Fuzzy assisted human resource management for supply chain management issues. *Annals of Operations Research*, 1–19.
- Alzoubi, H. M., Alshurideh, M. T., Kurdi, B. A., Alhyasat, K. M. K., & Ghazal, T. M. (2022d). The effect of e-payment and online shopping on sales growth: Evidence from banking industry. *International Journal of Data and Network Science*, 6, 1369–1380.
- Alzoubi, H. M., Elrehail, H., Hanaysha, J. R., Al-Gasaymeh, A., & Al-Adaileh, R. (2022e). The role of supply chain integration and agile practices in improving lead time during the COVID-19 crisis. *International Journal of Service Science, Management, Engineering, and Technology*, 13, 1–11.
- Alzoubi, H. M., In'airat, M., & Ahmed, G. (2022f). Investigating the impact of total quality management practices and six sigma processes to enhance the quality and reduce the cost of quality: The case of Dubai. *International Journal of Business Excellence*, 27, 94–109.
- Alzoubi, H. M., Ahmed, G., & Alshurideh, M. (2022g). An empirical investigation into the impact of product quality dimensions on improving the order-winners and customer satisfaction. *International Journal of Productivity and Quality Management*, 36, 169–186.
- Alzoubi, H. M., Ali, N., Ghazal, T. M., Ahmed, A., Abbas, S., Khan, M. A., Farooq, U., Ahmad, M., & Khan, M. A. (2022h). Fusion-based supply chain collaboration using machine learning techniques. *Intelligent Automation & Soft Computing*, 31, 1671–1687.
- El Khatib, M. M., Alzoubi, H. M., Ahmed, G., Kazim, H. H., Falasi, S. A. A. Al Mohammed, F., Al Mulla, M. (2022). Digital transformation and SMART-the analytics factor. In *2022 International Conference on Business Analytics for Technology and Security, ICBATS 2022* (pp. 1–11).
- Eli, T. (2021). Students' perspectives on the use of innovative and interactive teaching methods at the University of Nouakchott Al Aasriya, Mauritania: English department as a case study. *International Journal of Technology and Innovation Management*, 1, 90–104.
- Eli, T., & Hamou, L. A. S. (2022). Investigating the factors that influence students' choice of English studies as a major: The case of University of Nouakchott Al Aasriya, Mauritania. *International Journal of Technology and Innovation Management*, 2, 1.
- Ghazal, T. M., Bibi, R., Saeed, Y., Zeb, A., Rahman, T., Said, R. A., Abbas, S., Ahmad, M., & Khan, M. A. (2021a). Edge AI-based automated detection and classification of road anomalies in VANET using deep learning. *Computational Intelligence and Neuroscience*, 2021, 1–19.
- Ghazal, T. M., Siddiqui, S. Y., Haider, A., Khan, M. A., Naseer, I., Abbas, S., Rahman, M., Khan, J. A., Ahmad, M., Hasan, M. K., Mohammed, A., & Ateeq, K. (2021b). IoMT cloud-based intelligent prediction of breast cancer stages empowered with deep learning. *IEEE Access*, 9, 146478–146491.
- Ghazal, T. M., & Taleb, N. (2022). Feature optimization and identification of ovarian cancer using internet of medical things. *Expert Systems*.
- Ghazal, T. M., Abbas, S., Ahmad, M., Aftab, S. (2022a). An IoMT based ensemble classification framework to predict treatment response in hepatitis C patients. In *2022 International Conference on Business Analytics for Technology and Security, ICBATS 2022* (pp. 1–4).
- Ghazal, T. M., Abbas, S., Alhwaiti, Y., Fatima, A., Khan, M. A., Khan, M. A., Kanwal, A., Ahmad, M., & Elmitwally, N. S. (2022b). Convolutional neural network based intelligent handwritten document recognition. *Computers, Materials & Continua*, 70, 4563–4581.
- Ghazal, T. M., Abbas, S., Munir, S., Khan, M. A., Ahmad, M., Issa, G. F., Zahra, S. B., Khan, M. A., & Hasan, M. K. (2022c). Alzheimer disease detection empowered with transfer learning. *Computers, Materials & Continua*, 70, 5005–5019.
- Ghazal, T. M., Ahmed, Z. E., Hasan, M. K., Hashim, A. A., Saeed, R. A., Mokhtar, R. A., & Singh, S.P. (2022d). Optimization procedure for intelligent internet of things applications. In *2022*

- International Conference on Business Analytics for Technology and Security, ICBATS 2022* (pp. 1–6).
- Ghazal, T. M., Bukhari, M. M., Abbas, S., Khan, M. A., Farooq, U., Wahbah, H., Ahmad, M., & Adnan, K. M. (2022e). An intelligent proposed model for task offloading in fog-cloud collaboration using logistics regression. *Computational Intelligence and Neuroscience*.
- Ghazal, T. M., Hasan, M. K., Abdullah, S. N. H., Abubakkar, K. A., & Afifi, M. A. M. (2022f). IoMT-enabled fusion-based model to predict posture for smart healthcare systems. *Computers, Materials & Continua*, 71, 2579–2597.
- Ghazal, T. M., Hasan, M. K., Saeed, R. A., Pandey, B., Gohel, H., Eshmawi, A. A., Abdel-Khalek, S., & Alkhassawneh, H. M. (2022g). A review on security threats, vulnerabilities, and counter measures of 5G enabled internet-of-medical-things. *IET Communications*, 16, 421–432.
- Ghazal, T. M., Khan, M. A., Lee, S. W., & Rehman, A. (2022h). Data fusion-based machine learning architecture for intrusion detection. *Computers, Materials & Continua*, 70, 3399–3413.
- Ghazal, T. M., Mehmood, S., Khan, M. A., Zubair, M., Naseem, M. T., Faiz, T., & Ahmad, M. (2022i). Malignancy detection in lung and colon histopathology images using transfer learning with class selective image processing. *IEEE Access*, 10, 25657–25668.
- Ghazal, T. M., Noreen, S., Said, R. A., Khan, M. A., Siddiqui, S. Y., Abbas, S., Aftab, S., & Ahmad, M. (2022j). Energy demand forecasting using fused machine learning approaches. *Intelligent Automation and Soft Computing*.
- Ghazal, T. M., Rehman, A. U., Saleem, M., Ahmad, M., Ahmad, S., & Mehmood, F. (2022k). Intelligent model to predict early liver disease using machine learning technique. In 2022 *International Conference on Business Analytics for Technology and Security, ICBATS 2022* (pp. 1–5).
- Ghazal, T. M., Zafar, S., Asif, M., Ahmad, M. B., Faiz, T., Ahmad, M., & Khan, M. A. (2022l). Assistive devices analysis for visually impaired persons: A review on taxonomy. *IEEE Access*, 10, 13354–13366.
- Guntur, S. R., Gorrepati, R. R., & Dirisala, V. R. (2018). Internet of medical things. *Medical Big Data Internet of Medical Things*, 4, 271–297.
- Hamadneh, S., Pedersen, O., Alshurideh, M., Kurdi, B. A., & Alzoubi, H. M. (2021). An Investigation of the role of supply chain visibility into the Scottish blood supply chain. *Journal of Legal, Ethical and Regulatory*, 24, 1–12.
- Hanaysha, J., Al-Shaikh, M., Alzoubi, M. H. (2021). Importance of marketing mix elements in determining consumer purchase decision in the retail market. *International Journal of Service Science, Management, Engineering, and Technology*, 12, 56–72.
- Hasan, M. K., Islam, S., Sulaiman, R., Khan, S., Hashim, A. H. A., Habib, S., Islam, M., Alyahya, S., Ahmed, M. M., Kamil, S., & Hassan, M. A. (2021a). Lightweight encryption technique to enhance medical image security on internet of medical things applications. *IEEE Access*, 9, 47731–47742.
- Hasan, M. K., Ahmed, M. M., Musa, S. S., Islam, S., Abdullah, S. N., Hossain, E., Nafi, N. S., & Vo, N. (2021b) An improved dynamic thermal current rating model for PMU-based wide area measurement framework for reliability analysis utilizing sensor cloud system. *IEEE Access*, 9, 14446–14458.
- Islam, S., Khalifa, O. O., Hashim, A. H. A., Hasan, M. K., Razzaque, M. A., & Pandey, B. (2020). Design and evaluation of a multihoming-based mobility management scheme to support inter technology handoff in PNEMO. *Wireless Personal Communications*, 114, 1133–1153.
- Joghee, S., Alzoubi, H. M., & Dubey, A. R. (2020). Decisions effectiveness of FDI investment biases at real estate industry: Empirical evidence from Dubai smart city projects. *International Journal of Scientific & Technology Research*, 9, 3499–3503.
- Kasem, J., & Al-Gasaymeh, A. (2022). A cointegration analysis for the validity of purchasing power parity: Evidence from middle east countries. *International Journal of Technology and Innovation Management*, 2, 1.
- Kim, S.-K., Yeun, C. Y., Damiani, E., & Lo, N.-W. (2019). A machine learning framework for biometric authentication using electrocardiogram. *IEEE Access*, 7, 94858–94868.

- Kurdi, B. A., Alshurideh, M., Akour, I., Alzoubi, H. M., Obeidat, B., & Alhamad, A. (2022a). The role of digital marketing channels on consumer buying decisions through eWOM in the Jordanian markets. *International Journal of Data and Network Science*, 6, 1175–1185.
- Kurdi, B. A., Alshurideh, M., Akour, I., Tariq, E., Alhamad, A., & Alzoubi, H. M. (2022b). The effect of social media influencers' characteristics on consumer intention and attitude toward Keto products purchase intention. *International Journal of Data and Network Science*, 6, 1135–1146.
- Kurdi, B. A., Alzoubi, H. M., Akour, I., & Alshurideh, M. T. (2022c). The effect of blockchain and smart inventory system on supply chain performance: Empirical evidence from retail industry. *Uncertain Supply Chain Management*, 10, 1111–1116.
- Lee, K. L., Azmi, N. A. N., Hanaysha, J. R., Alzoubi, H. M., & Alshurideh, M. T. (2022a). The effect of digital supply chain on organizational performance: An empirical study in Malaysia manufacturing industry. *Uncertain Supply Chain Management*, 10, 495–510.
- Lee, K. L., Romzi, P. N., Hanaysha, J. R., Alzoubi, H. M., & Alshurideh, M. (2022b). Investigating the impact of benefits and challenges of IOT adoption on supply chain performance and organizational performance: An empirical study in Malaysia. *Uncertain Supply Chain Management*, 10, 537–550.
- Mehmood, T., Alzoubi, H. M., Alshurideh, M., Al-Gasaymeh, A., & Ahmed, G. (2019). Schumpeterian entrepreneurship theory: Evolution and relevance. *Academy of Entrepreneurship Journal*, 25, 1–10.
- Mejia, C., Ciarlante, K., & Chheda, K. (2019). A wearable technology solution and research agenda for housekeeper safety and health. *International Journal of Contemporary Hospitality Management*, 1, 1–3.
- Mondol, E. P. (2021). The impact of block chain and smart inventory system on supply chain performance at retail industry. *International Journal of Computations, Information and Manufacturing*, 1, 56–76.
- Mondol, E. P. (2022). The role of Vr games to minimize the obesity of video gamers. *International Journal of Computations, Information and Manufacturing*, 2, 1.
- Neaimi, M., Al Hamadi, H., Al Yeun, C. Y., Jamal Zemerly, M. (2020). Digital forensic analysis of files using deep learning. In *2020 3rd International Conference on Signal Processing and Information Security, ICSPIS 2020* (pp. 1–4). IEEE.
- Obaid, A. J. (2021). Assessment of smart home assistants as an IoT. *International Journal of Computations, Information and Manufacturing*, 1, 18–38.
- Ramakrishna, Y., & Alzoubi, H. M. (2022). Empirical investigation of mediating role of six sigma approach in rationalizing the COQ in service organizations. *Operations and Supply Chain Management*, 15, 122–135.
- Ratkovic, N. (2022). Improving home security using blockchain. *International Journal of Computations, Information and Manufacturing*, 2, 1.
- Saleem, M., Abbas, S., Ghazal, T. M., Adnan Khan, M., Sahawneh, N., & Ahmad, M. (2022). Smart cities: Fusion-based intelligent traffic congestion control system for vehicular networks using machine learning techniques. *Egyptian Informatics Journal*.
- Shamout, M., Ben-Abdallah, R., Alshurideh, M., Alzoubi, H., Al Kurdi, B., & Hamadneh, S. (2022). A conceptual model for the adoption of autonomous robots in supply chain and logistics industry. *Uncertain Supply Chain Management*, 10, 577–592.
- Teahan, W. J., Al-Dmour, N. A., & Tuff, P. G. (2012). Knowledge distribution in multi agent systems. *Asian Journal of Information Technology*, 11, 300–311.
- Vo, D. L., Lee, H., Yeun, C. Y., & Kim, K. (2010). Enhancements of authenticated multiple key exchange protocol based on bilinear pairings. *Computers & Electrical Engineering*, 36, 155–159.
- Victoria, V. (2022). Impact of process visibility and work stress to improve service quality: Empirical evidence from Dubai retail industry impact of process visibility and work stress to improve service quality: Empirical evidence from Dubai retail industry. *International Journal of Technology and Innovation Management*, 2, 1.

- Zitar, R. A., Al-Dmour, N., Nachouki, M., Hussain, H., & Alzboun, F. (2021). Hashing generation using recurrent neural networks for text documents. *ICIC Express Letters, Part B: Applications*, 12, 231–241.

Analyzing Effect of Cloud Computing on IoMT Applications



Ali A. Alzoubi, Khalifa Al Ali, and Haitham M. Alzoubi 

Abstract Everything is now converting in to the digital world, same as with medical area as several digital apps are introduced with the increase in technology issues in security of digital applications are also increasing. There are several ethical and the security issues are faced by the medical applications and its effecting their market and usage. There is a need to consider this issue and to propose a considerable solution. Cloud computing is the most secure platform for applications and several applications are turning towards it. A remote health and safety application is introduced will adopt a private model of cloud computing which is handled by a third party and this usage will make it more secure then another application. There are several works done in this field yet which will be evaluated thoroughly.

Keywords Cloud computing · IoMT · Remote health · Privacy

1 Introduction

Internet of things is the most used technology in every department of world, medical health is one of the most serving areas and internet of things is also playing its role in this (Chong et al., 2021). There are several apps introduced in IoT who are working efficiently however they have several issues with them (Guntur et al., 2018). The main issues are security and ethical issues with several apps which are creating several privacy issues and also decreasing the trust of customers (Al-Tahat & Moneim, 2020;

A. A. Alzoubi
Public Security Directorate, Amman, Jordan

K. Al Ali
School of Information Technology, Skyline University College, Sharjah, UAE

H. M. Alzoubi (✉)
School of Business, Skyline University College, Sharjah, UAE
e-mail: haitham.alzoubi@skylineuniversity.ac.ae

Applied Science Research Center, Applied Science Private University, Amman, Jordan

Lee et al., 2022a). Keeping this issue in mind, in this research we are going to produce a new apps in which these two quality attributes security and ethics are given special emphasis (Ghazal et al., 2022c). And this application is produced in a way that it can be integrated into other apps (Alhamad et al., 2022; Hasan et al., 2021a, 2021b) which also helps other apps to control these issues.

To begin with, it's important to comprehend the problems (Alzoubi et al., 2020). Data security and privateers are two of the IoT's biggest hurdles (Alsharari, 2021). Real-time statistics are captured by IoT-enabled mobile devices (Hujran et al., 2020), however most of them do not follow the protocols and standards for data collection (Al-Nashashibi et al., n.d.; Alzoubi & Ahmed, 2019). Regarding record ownership and regulation, there may be a great deal of uncertainty (Alshurideh et al., 2022a, 2022b; Shehada et al., 2018). In turn, this puts the data kept in IoT-enabled devices at danger of information theft and increases the likelihood that cybercriminals may jeopardize personal health information by breaking into the system (Lee et al., 2022b). Fraudulent fitness statements and the development of fake IDs for the purpose of purchasing and promoting medications (Alhamad et al., 2021; Bibi et al., 2021) are two examples of how IoT gadget information has been misused.

One of most popular networks today is cloud computing (Alkeem et al., 2017). When data is processed, stored, or processed online or even on a network, it is also known as cloud technology or cloud-based networking (Ali et al., 2022; Siddiqui et al., 2021). For dealing with security issues cloud computing will provide a safe platform (Ali et al., 2021) which will help application to function safely (Al-Hamadi et al., 2015a, 2015b). The next section will define the problem going to be addressed in this assessment (Ghazal et al., 2022f), the next will be the analysis of related works according to this assessment (Khan, 2021; Shamout et al., 2022), and then a methodology is going to be discussed which was used for the research going to be conducted.

1.1 Problem Statement

Ethical and security challenges are being faced by several applications in the digital world (Alzoubi et al., 2022a, 2022b, 2022c, 2022d), a medical world is the one which is the most in use and also the most sensitive one so for its usage (Alzoubi & Aziz, 2021; Radwan & Farouk, 2021). Hackers try to attack several applications in which Patients and doctors data is on stake (Hasan et al., 2022). Data can be leaked on several platforms which user's data on stake and also the medications are on stake as the hackers try to steal sensitive data. So keeping in view these issues there is a need to secure these applications. The inputs going to be added in the assessment were the data of the patients and the doctors who are going to deal with these apps. And the output will be cloud based system in which all the data posted by the patients will be safe and secure and will work everywhere and at any time (Al-Dmour, 2020).

There are numerous security dangers associated with the use of IoMT devices (Al-Hamadi et al., 2021). These variety from compromising device safety (Hasan

et al., 2022), information privacy violation, and facts robbery and destruction (Joghee et al., 2020) to abuse and misuse of customer healthcare statistics (Radwan, 2022). The security needed to defend these related gadgets (Farouk, 2022) has no longer been capable of preserve up with the technological advancements that allow attackers to compromise the gadgets (Ali, 2021; Ramakrishna & Alzoubi, 2022). One document shows that during 2017 the healthcare enterprise saw a median “of just about 32,000 intrusion assaults in step with day” with the IoMT representing of the pinnacle ten vulnerability exploits of attackers (Alshurideh et al., 2020; Ghazal et al., 2021). One of the maximum publicized cyber-assaults against the enterprise become the “WannaCry” ransom ware in 2017 (Ghazal et al., 2022d) which led to a sizable disruption in clinical carrier to patients inclusive of the cancellation of surgeries and ambulances being diverted from areas of want (Alzoubi et al., 2022b).

Attackers also can goal wearable IoMT devices of distinguished public or political figures or pose a country wide safety risk in a few conditions 35 (Guergov & Radwan, 2021). For example, the big apple instances. Strava is a fitness wearable that tracks athletic activity (Abbas et al., 2022). It makes use of satellites via which human beings can proportion their health sports together with whereabouts (Alzoubi et al., n.d.). In this point of time, human beings, particularly young generation (Mehmood et al., 2019), revel in connectivity, and the agency that may provide it is able to boast its electricity (Alnuaimi et al., 2021). But, that can be an extreme trouble. In Strava’s the worldwide “warmth map,” the places of its 8 million participants are tracked. Since the app is popular some of the U.S. navy, the U.S. bases in Afghanistan, Iraq, and Syria are uncovered in detail, underscoring the a ways-achieving consequences (Alnazer et al., 2017) of IoMT security breaches which could have an effect on even country wide security (Ghazal et al., 2022a).

1.2 Proposed Solution

The proposed solution for this assessment will be a cloud based system in which apps will be operating, by using the private model of cloud computing data will remain safe from the outside world and a company itself or a third party will deal private cloud (Ghazal et al., 2022b). An application named as digital doctor was facing several issues in terms of security and ethics. Keeping in view the issues companies stakeholders have contacted with the several experts and by viewing market trends they decided to shift there system to cloud computing which is the most secure system to work these days (Bukhari et al., 2022; Hamadneh et al., 2021).

Customers are given access to all requested services via the internet, and it interacts with applications provide the storage, security, and other associated services (Al-Dmour & Teahan, 2005; Kurdi et al., 2022b). Local servers are replaced by it. The local servers of the smaller business are adequate to control, save, and process information (Al-Hamadi et al., 2015a, 2015b), give data a full memory, save it in the databases, and offer full security (Ahmed and Al Amiri, 2022). These local servers, however, are unable to manage such vast amounts of data and cannot process data

securely for larger enterprises or when a corporation expands (Al Hamadi et al., 2017; Hanaysha et al., 2021). These problems are addressed by cloud computing since it offers all services (Alzoubi et al., 2022c), including several servers, disk drives, database, other big data, and intelligence, through the internet (Alzoubi & Yanamandra, 2020).

2 Literature Review

There are several works done in these field yet a discussion is going to be made on the researches made in this field with respect to the proposed solution of this assessment. A research declare that a distant computer software package verification for actual-time constrained embedded devices developed into proposed in (Alshurideh et al., 2022a, 2022b; Alzoubi et al., 2021). The authors of presented farfetched software-based Authentication (RealSWATT) application far off stringent for actual-time critical devices which works on carrier minimal price embedded gadgets (Islam et al., 2020). Their design employed distinct cpu middle for checking to make sure that the entire proper planning and timing for real-time motions. In addition, they presented an ou pas validation and a network architecture again for software-based fully verification of embedded systems to block both excessive temporal limits and hardware requirements. They employed 32-bit embedded systems (ESP32) that was using on exact typical IoT gadgets (Ghazal et al., 2022e; Gul et al., 2012; Kurdi et al., 2022c).

According to (Hanaysha et al., 2022; Khan et al., 2022), an E-health care system with two restricted protocols—limited technologies Adoption (CoAP) and message query telemetry transports (MQTT)—was presented in. In the suggested framework, RESTful HTTPs are utilize to allow comfortable communication over the internet while CoAP and MQTT are used to give peer 2 peer protection in an E-fitness controlled environment. CoAP with RESTful HTTPs have indeed been utilized in tandem to ensure durable and comfortable give-up-to-stop communication (Ghazal & Taleb, 2022; Zafar et al., 2022). As scientific data from fitness sensors is transmitted to the cloud for storage and future analysis, the internet's comfy connectivity has become essential.

IMDs that are independent and connected and the security risks they pose were mentioned. They looked at attacks on implantable drug delivery systems, implantable cardioverter defibrillators, cardiac pacemakers, and neurostimulators, among other assaults.

According to (Kurdi et al., 2022a; Mehmood et al., 2022), the use of IoT in conjunction with cloud-based electronic medical records (EMRs) in the healthcare industry is enhancing top-notch healthcare environment offers (Al-Hamadi et al., 2015a, 2015b). But the author discovered that while healthcare companies are still vulnerable to a number of well-known IoT security dangers, a new element has emerged: “the anxiety of still not understanding what IoT devices work” (Vo et al., 2010). The author looked into how that factor affected the decision-making process for the security policy (Alzoubi et al., 2022a). Even while the number of participants

in the study (ten senior data security engineers from the largest organisation of hospitals) may seem limited, the author made an effort to get opinions from the most key considerations at each institution (Hasan et al., 2021a, 2021b). The findings show that obsolete firmware, staff members who are unsure of how to safeguard out-of-date software and hardware, a few different types of connectivity, and concern over IoT devices pose the biggest risks. The fear of the unexplained is tied to IoT devices because of how quickly both EMRs and IoT devices are improving. The authors of developed a structure with an exclusive models to make the patient information in cloud servers more comfortable (security and prediction).

With the decryption key, the doctor remotely decrypts the records. The both personal (non-keys are constructed using the created matrix as a base under smoothing circumstances using the logarithmic probability. The proposed version can be used, in particular, to integrate IoT and cloud-based fitness structures. Many IMDs today operate without the most fundamental defenses because of insufficient energy. The authors of presented a device model in an effort to solve this issue. The authors support a device version that has 4 levels: belief, community, data processing, and alertness layer. The proposed device is primarily based on power hurdles and the supply of each device. The efficiency of handling keys on power-constrained devices to encryption or decode the communications is shown in a case study from the proposed model, in which each tool maintains keys in an asymmetric manner based on the strength constraints of the device.

3 Research Methodology

The research methodology used for this research is theoretical research methodology. A collection of beliefs and presumptions is logically explored in general theory. This kind of research entails theorizing or describing how a computer system behaves in relation to its environment, followed by examining or simulating the ramifications of that definition. Cloud computing will secure all ethical and security issues faced by the medical applications who are working digitally. Yes the hypothesis and the claims made in this research that cloud computing will secure all IoMT applications is correct and it will secure all the issues related to it. By viewing several research papers and making the claims in this research, it is evitable that cloud computing will secure all these issues.

The cloud computing for security and cloud hosting (with its accompanying enormous storage capability) for storing EHR have been the hottest research trends lately. IoMT is becoming a more well-known tool to improve patient experience and the effectiveness of healthcare systems as a result of recent advancements in electronics. Wearable IoMT devices can collect patient data for condition monitoring and signaling, while implanted devices can be used to remotely administer medication. For transmitters and receivers medical data, an IoMT is a system of embedded devices

sensors, and actuators. However, when it comes to wi-fi communication technologies, security and privacy are major issues. The two main issues with the IoMT-cloud-based system continue to be data protection and compute overhead. Cryptography, authentication, and authorization are traditionally used to provide network security. However, these methods won't work for IoMT devices with significant power limitations. We looked into and studied the factors that can have a detrimental impact on safety and privacy, keeping in mind the significance of security and privacy aspects in IoMT. Therefore, a review of the literature on IoMT security issues has identified a number of problems that have been solved using cryptographic techniques, algorithms, and methods put out by contemporary researchers. This study sought to find new dangers and trends that emerge due to the increased use of IoMT devices, both technological and behavioral.

4 Conclusion and Future Work

Cloud computing will secure the remote and safe health application which will then become a secure app to use by doctors and the patients. By analyzing several related works and the cloud computing system it is concluded that a system will efficiently work by using private cloud and a system will be safe and secure. Several future works needed in this field as cloud computing has several limitations. The significant advancements in IoT and communication technologies have improved healthcare and may save patients' lives by providing remote healthcare providers with information on the condition of the patient. IoMT did have some limitations, primarily with relation to scientific sources privateers and data protection during transit or storage. Since the past few years, many studies have been conducted, with the initial studies focusing on the design of the IoMT, BAN, and wearable scientific devices. The transmission of data was then protected, scientific instruments and implantable technology were able to have a few security features, and new, lightweight encrypt and authentication mechanisms were being developed for devices with limited resources.

References

- Abbas, S., Alhwaiti, Y., Fatima, A., Khan, M. A., Khan, M. A., Ghazal, T. M., Kanwal, A., Ahmad, M., & Elmitwally, N. S. (2022). Convolutional neural network based intelligent handwritten document recognition. *Computers, Materials & Continua*, 70, 4563–4581.
- Ahmed, G., & Al Amiri, N. (2022). The Transformational leadership of the founding leaders of the United Arab Emirates: Sheikh Zayed Bin Sultan Al Nahyan and Sheikh Rashid Bin Saeed Al Maktoum. *International Journal of Technology and Innovation Management*, 2, 1.
- Al-Dmour, N., & Teahan, W. (2005). The blackboard resource discovery mechanism for distributed computing over P2P networks. In T. International (Ed.), *PDCN. Conference on Parallel and Distributed Computing and Networks* (pp. 15–17).

- Al-Dmour, N. A. (2020). Using unstructured search algorithms for data collection in iot-based WSN. *International Journal of Engineering Research & Technology*, 13, 1992–1998.
- Al-Hamadi, Hussam, Gawanmeh, A., & Al-Qutayri, M. (2015a). Formal validation of QRS wave within ECG. In 2015 International Conference on Information and Communication Technology Research, ICTRC (Vol. 9, pp. 190–193).
- Al-Hamadi, H., Gawanmeh, A., Baek, J., & Al-Qutayri, M. (2015b). Lightweight security protocol for ECG bio-sensors. *Wireless Personal Communications*, 95, 5097–5120.
- Al Hamadi, H., Gawanmeh, A., & Al-Qutayri, M. (2017). Guided test case generation for enhanced ECG bio-sensors functional verification. *The International Journal of E-Health and Medical Communications*, 8, 1–20.
- Al-Hamadi, H., Nasir, N., Yeun, C. Y., & Damiani, E. (2021). A verified protocol for secure autonomous and cooperative public transportation in smart cities. In I. June (Ed.), 2021 IEEE International Conference on Communications Workshops (ICC Workshops) (pp. 1–6).
- Al-Nashashibi M., Hadi, W., El-Khalili, N., Ghassan, I. (n.d.) A new two-step ensemble Learn. Model Improv. Stress Predict. Automob. Drivers. *The International Arab Journal of Information Technology*, 6 (2021).
- Al-Tahat, S., & Moneim, O. A. (2020). The impact of artificial intelligence on the correct application of cyber governance in Jordanian commercial banks. *International Journal of Scientific & Technology Research*, 9, 7138–7144.
- Alhamad, A. Q. M., Akour, I., Alshurideh, M., Al-Hamad, A. Q., Kurdi, B. A., & Alzoubi, H. (2021). Predicting the intention to use google glass: A comparative approach using machine learning models and PLS-SEM. *International Journal of Data and Network Science*, 5, 311–320.
- Alhamad, A., Alshurideh, M., Alomari, K., Al Kurdi, B., Alzoubi, H., Hamouche, S., & Al-Hawary, S. (2022). The effect of electronic human resources management on organizational health of telecommunications companies in Jordan. *International Journal of Data and Network Science*, 6, 429–438.
- Ali, A. A. (2021). The impact of information sharing and quality assurance on customer service at UAE banking sector. *International Journal of Technology and Innovation Management*, 1, 01–17.
- Ali, N., Ahmed, A., Anum, L., Ghazal, T. M., Abbas, S., Khan, M. A., Alzoubi, H. M., & Ahmad, M. (2021). Modelling supply chain information collaboration empowered with machine learning technique. *Intelligent Automation & Soft Computing*, 30, 243–257.
- Ali, N., Ghazal, T. M., Ahmed, A., Abbas, S., Khan, M. A., Alzoubi, H. M., Farooq, U., Ahmad, M., & Khan, M. A. (2022). Fusion-based supply chain collaboration using machine learning techniques. *Intelligent Automation & Soft Computing*, 31, 1671–1687.
- Alkeem, E. A., Shehada, D., Yeun, C. Y., Zemerly, M. J., & Hu, J. (2017). New secure healthcare system using cloud of things. *Cluster Computing*, 20(3), 2211–2229.
- Alnazer, N. N., Alnuaimi, M. A., & Alzoubi, H. M. (2017). Analysing the appropriate cognitive styles and its effect on strategic innovation in Jordanian universities. *International Journal of Business Excellence*, 13, 127–140.
- Alnuaimi, M., Alzoubi, H. M., Ajelat, D., & Alzoubi, A. A. (2021). Towards intelligent organisations: An empirical investigation of learning orientation's role in technical innovation. *International Journal of Innovation and Learning*, 29, 207–221.
- Alshurideh, M., Gasaymeh, A., Ahmed, G., Alzoubi, H., & Kurd, B. A. (2020). Loyalty program effectiveness: Theoretical reviews and practical proofs. *Uncertain Supply Chain Management*, 8, 599–612.
- Alsharari, N. (2021). Integrating blockchain technology with internet of things to efficiency. *International Journal of Technology and Innovation Management*, 1, 01–13.
- Alshurideh, M., Al Kurdi, B., Alzoubi, H. M., Ghazal, T. M., Said, R. A., AlHamad, A. Q., Hamadneh, S., Sahawneh, N., Al-kassem, A. H. (2022a). Fuzzy assisted human resource management for supply chain management issues. *Annals of Operations Research*, 1–19.

- Alshurideh, M. T., Al Kurdi, B., Alzoubi, H. M., Obeidat, B., Hamadneh, S., & Ahmad, A. (2022b). The influence of supply chain partners' integrations on organizational performance: The moderating role of trust. *Uncertain Supply Chain Management*, 10, 1191–1202.
- Alzoubi, H., & Ahmed, G. (2019). Do TQM practices improve organisational success? A case study of electronics industry in the UAE. *International Journal of Economics and Business Research*, 17, 459–472.
- Alzoubi, H. M., & Yanamandra, R. (2020). Investigating the mediating role of information sharing strategy on agile supply chain in supply chain performance. *Uncertain Supply Chain Management*, 8, 273–284.
- Alzoubi, H. M., Ahmed, G., Al-Gasaymeh, A., & Al Kurdi, B. (2020). Empirical study on sustainable supply chain strategies and its impact on competitive priorities: The mediating role of supply chain collaboration. *Managements Science Letters*, 10, 703–708.
- Alzoubi, H. M., & Aziz, R. (2021). Does emotional intelligence contribute to quality of strategic decisions? The mediating role of open innovation. *Journal of Open Innovation Technology, Market, and Complex*, 7, 130.
- Alzoubi, H. M., Vij, M., Vij, A., & Hanaysha, J. R. (2021). What leads guests to satisfaction and loyalty in UAE five-star hotels? AHP analysis to service quality dimensions. *Enlightening Tourism A Pathmaking Journal*, 11, 102–135.
- Alzoubi, H., Alshurideh, M., Kurdi, B. A., Akour, I., & Aziz, R. (2022a). Does BLE technology contribute towards improving marketing strategies, customers' satisfaction and loyalty? The role of open innovation. *International Journal of Data and Network Science*, 6, 449–460.
- Alzoubi, H. M., Ahmed, G., & Alshurideh, M. (2022b). An empirical investigation into the impact of product quality dimensions on improving the order-winners and customer satisfaction. *International Journal of Productivity and Quality Management*, 36, 169–186.
- Alzoubi, H. M., Elrehail, H., Hanaysha, J. R., Al-Gasaymeh, A., & Al-Adaileh, R. (2022c). The role of supply chain integration and agile practices in improving lead time during the COVID-19 crisis. *International Journal of Service Science, Management, Engineering, and Technology*, 13, 1–11.
- Alzoubi, H. M., In'airat, M., & Ahmed, G. (2022d). Investigating the impact of total quality management practices and six sigma processes to enhance the quality and reduce the cost of quality: The case of Dubai. *International Journal of Business Excellence*, 27, 94–109.
- Bibi, R., Saeed, Y., Zeb, A., Ghazal, T. M., Rahman, T., Said, R. A., Abbas, S., Ahmad, M., & Khan, M. A. (2021). Edge AI-based automated detection and classification of road anomalies in VANET using deep learning. *Computational Intelligence and Neuroscience*, 2021, 1–19.
- Bukhari, M. M., Ghazal, T. M., Abbas, S., Khan, M. A., Farooq, U., Wahbah, H., Ahmad, M., & Adnan, K. M. (2022). An intelligent proposed model for task offloading in fog-cloud collaboration using logistics regression. *Computational Intelligence and Neuroscience*.
- Chong, C., Lee, K., & Ahmed, G. (2021). Improving IoT privacy, data protection and security concerns. *International Journal of Technology and Innovation Management*, 1, 18–33.
- Farouk, M. (2022). Studying human robot interaction and its characteristics. *International Journal of Computations, Information and Manufacturing*, 2, 1.
- Ghazal, T. M., Hasan, M. K., Alkhalfah, A., Abu Bakar, K. A., Omidvar, A., Nafi, N. S., & Agbinya, J. I. (2021). Fischer linear discrimination and quadratic discrimination analysis-based data mining technique for internet of things framework for healthcare. *Frontiers in Public Health*, 9.
- Ghazal, T. M., & Taleb, N. (2022). Feature optimization and identification of ovarian cancer using internet of medical things. *Expert Systems*.
- Ghazal, T. M., Abbas, S., Ahmad, M., & Aftab, S. (2022a). An IoMT based ensemble classification framework to predict treatment response in hepatitis C patients. In *2022 International Conference on Business Analytics for Technology and Security, ICBATS 2022* (pp. 1–4).
- Ghazal, T. M., Abbas, S., Munir, S., Khan, M. A., Ahmad, M., Issa, G. F., Zahra, S. B., Khan, M. A., & Hasan, M. K. (2022b). Alzheimer disease detection empowered with transfer learning. *Computers, Materials & Continua*, 70, 5005–5019.

- Ghazal, T. M., Ahmed, Z. E., Hasan, M. K., Hashim, A. A., Saeed, R. A., Mokhtar, R. A., & Singh, S. P. (2022c). Optimization procedure for intelligent internet of things applications. In *2022 International Conference on Business Analytics for Technology and Security, ICBATS 2022* (pp. 1–6).
- Ghazal, T. M., Hasan, M. K., Abdullah, S. N. H., Abubakkar, K. A., & Afifi, M. A. M. (2022d). IoMT-enabled fusion-based model to predict posture for smart healthcare systems. *Computers, Materials & Continua*, 71, 2579–2597.
- Ghazal, T. M., Noreen, S., Said, R. A., Khan, M. A., Siddiqui, S. Y., Abbas, S., Aftab, S., & Ahmad, M. (2022e). Energy demand forecasting using fused machine learning approaches. *Intelligent Automation & Soft Computing*, 31, 539–553.
- Ghazal, T. M., Rehman, A. U., Saleem, M., Ahmad, M., Ahmad, S., & Mehmood, F. (2022f). Intelligent model to predict early liver disease using machine learning technique. In *2022 International Conference on Business Analytics for Technology and Security, ICBATS 2022* (pp. 1–5).
- Guergov, S., & Radwan, N. (2021). Blockchain convergence: Analysis of issues affecting IoT, AI and blockchain. *International Journal of Computations, Information and Manufacturing*, 1, 1–17.
- Gul, O., Al-Qutayri, M., Yeun, C. Y., & Vu, Q. H. (2012). Framework of a national level electronic health record system. In *Proceedings of 2012 International Conference on Cloud Computing Technologies, Applications and Management, ICCCTAM 2012. Applications and Management (ICCCTAM)* (pp. 60–65).
- Guntur, S. R., Gorrepati, R. R., & Dirisala, V. R. (2018). Internet of medical things. *Medical Big Data and Internet of Medical Things*, 4, 271–297.
- Hamadneh, S., Pedersen, O., Alshurideh, M., Kurdi, B. A., & Alzoubi, H. M. (2021). An investigation of the role of supply chain visibility into the Scottish blood supply chain. *Journal of Legal, Ethical and Regulatory*, 24, 1–12.
- Hanaysha, J., Al-Shaikh, M., & Alzoubi, M. H. (2021). Importance of marketing mix elements in determining consumer purchase decision in the retail market. *International Journal of Service Science, Management, Engineering, and Technology*, 12, 56–72.
- Hanaysha, J. R., Al-Shaikh, M. E., Joghee, S., & Alzoubi, H. M. (2022). Impact of innovation capabilities on business sustainability in small and medium enterprises. *FIIB Business Review*, 11, 67–78.
- Hasan, M. K., Islam, S., Sulaiman, R., Khan, S., Hashim, A. H. A., Habib, S., Islam, M., Alyahya, S., Ahmed, M. M., Kamil, S., & Hassan, M. A. (2021a). Lightweight encryption technique to enhance medical image security on internet of medical things applications. *IEEE Access*, 9, 47731–47742.
- Hasan, M. K., Ahmed, M. M., Musa, S. S., Islam, S., Abdullah, S. N., Hossain, E., Nafi, N. S., & Vo, N. (2021b). An improved dynamic thermal current rating model for PMU-based wide area measurement framework for reliability analysis utilizing sensor cloud system. *IEEE Access*, 9, 14446–14458.
- Hasan, M. K., Ghazal, T. M., Saeed, R. A., Pandey, B., Gohel, H., Eshmawi, A. A., Abdel-Khalek, S., & Alkhassawneh, H. M. (2022). A review on security threats, vulnerabilities, and counter measures of 5G enabled internet-of-medical-things. *IET Communications*, 16, 421–432.
- Hujran, O., Alikaj, A., Durrani, U. K., & Al-Dmour, N. (2020). Big data and its effect on the music industry. In *ACM International Conference Proceeding Series* (pp. 5–9).
- Islam, S., Khalifa, O. O., Hashim, A. H. A., Hasan, M. K., Razzaque, M. A., & Pandey, B. (2020). Design and evaluation of a multihoming-based mobility management scheme to support inter technology handoff in PNEMO. *Wireless Personal Communications*, 114, 1133–1153.
- Joghee, S., Alzoubi, H. M., & Dubey, A. R. (2020). Decisions effectiveness of FDI investment biases at real estate industry: Empirical evidence from Dubai smart city projects. *International Journal of Scientific & Technology Research*, 9, 3499–3503.
- Khan, M. A. (2021). Challenges facing the application of IoT in medicine and healthcare. *International Journal of Computations, Information and Manufacturing*, 1, 39–55.

- Khan, M. A., Ghazal, T. M., Lee, S. W., & Rehman, A. (2022). Data fusion-based machine learning architecture for intrusion detection. *Computers, Materials & Continua*, 70, 3399–3413.
- Kurdi, B. A., Alshurideh, M., Akour, I., Alzoubi, H. M., Obeidat, B., & Alhamad, A. (2022a). The role of digital marketing channels on consumer buying decisions through eWOM in the Jordanian markets. *International Journal of Data and Network Science*, 6, 1175–1185.
- Kurdi, B. A., Alshurideh, M., Akour, I., Tariq, E., Alhamad, A., & Alzoubi, H. M. (2022b). The effect of social media influencers' characteristics on consumer intention and attitude toward Keto products purchase intention. *International Journal of Data and Network Science*, 6, 1135–1146.
- Kurdi, B. A., Alzoubi, H. M., Akour, I., & Alshurideh, M. T. (2022c). The effect of blockchain and smart inventory system on supply chain performance: Empirical evidence from retail industry. *Uncertain Supply Chain Management*, 10, 1111–1116.
- Lee, K. L., Azmi, N. A. N., Hanaysha, J. R., Alzoubi, H. M., & Alshurideh, M. T. (2022a). The effect of digital supply chain on organizational performance: An empirical study in Malaysia manufacturing industry. *Uncertain Supply Chain Management*, 10, 495–510.
- Lee, K. L., Romzi, P. N., Hanaysha, J. R., Alzoubi, H. M., & Alshurideh, M. (2022b). Investigating the impact of benefits and challenges of IOT adoption on supply chain performance and organizational performance: An empirical study in Malaysia. *Uncertain Supply Chain Management*, 10, 537–550.
- Mehmood, S., Ghazal, T. M., Khan, M. A., Zubair, M., Naseem, M. T., Faiz, T., & Ahmad, M. (2022). Malignancy detection in lung and colon histopathology images using transfer learning with class selective image processing. *IEEE Access*, 10, 25657–25668.
- Mehmood, T., Alzoubi, H. M., Alshurideh, M., Al-Gasaymeh, A., & Ahmed, G. (2019). Schumpeterian entrepreneurship theory: Evolution and relevance. *Academy of Entrepreneurship Journal*, 25, 1–10.
- Radwan, N. (2022). The internets role in undermining the credibility of the healthcare industry. *International Journal of Computations, Information and Manufacturing*, 2, 1.
- Radwan, N., & Farouk, M. (2021). The growth of internet of things (IoT) in the management of healthcare issues and healthcare policy development. *International Journal of Technology and Innovation Management*, 1, 69–84.
- Ramakrishna, Y., & Alzoubi, H. M. (2022). Empirical investigation of mediating role of six sigma approach in rationalizing the COQ in service organizations. *Operations and Supply Chain Management*, 15, 122–135.
- Shamout, M., Ben-Abdallah, R., Alshurideh, M., Alzoubi, H., Kurdi, B. A., & Hamadneh, S. (2022). A conceptual model for the adoption of autonomous robots in supply chain and logistics industry. *Uncertain Supply Chain Management*, 10, 577–592.
- Shehada, D., Yeun, C. Y., Zemerly, M. J., Al-Qutayri, M., Al-Hammadi, Y., & Hu, J. (2018). A new adaptive trust and reputation model for mobile agent systems. *Journal of Network and Computer Application*, 124, 33–43.
- Siddiqui, S. Y., Haider, A., Ghazal, T. M., Khan, M. A., Naseer, I., Abbas, S., Rahman, M., Khan, J. A., Ahmad, M., Hasan, M. K., Mohammed, A., & Ateeq, K. (2021). IoMT cloud-based intelligent prediction of breast cancer stages empowered with deep learning. *IEEE Access*, 9, 146478–146491.
- Vo, D. L., Lee, H., Yeun, C. Y., & Kim, K. (2010). Enhancements of authenticated multiple key exchange protocol based on bilinear pairings. *Computers & Electrical Engineering*, 36, 155–159.
- Zafar, S., Asif, M., Ahmad, M. B., Ghazal, T. M., Faiz, T., Ahmad, M., & Khan, M. A. (2022). Assistive devices analysis for visually impaired persons: A review on taxonomy. *IEEE Access*, 10, 13354–13366.

Data Sharing with a Third-Party Within IoMT Environment: Challenges and Opportunities



Ali A. Alzoubi, Abdulrahman Alhossani, and Haitham M. Alzoubi 

Abstract This paper is set to understand and analyze the controversy surrounding a mental health application called BetterHelp and what the organization could have done to prevent losing people's trust and data leakage. A proper understanding of the Internet of Things in healthcare systems was required, along with understanding the concepts of data-sharing and data-leakage as both have different meanings. Data-sharing being the company willingly sharing their users' data to other companies, and data-leakage being data that is leaked unwillingly by hackers. Both cases were apparent in BetterHelp, hence finding suitable solutions that cater to the two main issues. The first solution is to change the terms, policies and core values within BetterHelp, and determine whether they see users as patients or as products for other companies. The second solution is to be aware of where the key sensitive data resides in which system, for BetterHelp there are several sensitive data like credit card credentials, names, addresses, sessions, and diagnoses. Evaluating and prioritizing the key sensitive data is vital through the use of Data Loss Prevention software. Second is to use the Lepide Data Security Platform to emphasize the importance of auditing, monitoring and alerting critical changes within a system by either training a certain team for such tasks or hiring a third-party organization that specializes in it. Lastly, it is to encrypt the data. BetterHelp is not alone when it comes to controversies and scandals dealing with data-sharing and data-leakage, in the related-work there are four other organizations that dealt with similar issues but had different approaches that they used, all of which were taken into consideration for the benefit of BetterHelp and how to attain the people's trust again.

A. A. Alzoubi
Public Security Directorate, Amman, Jordan

A. Alhossani
School of Information Technology, Skyline University College, Sharjah, UAE

H. M. Alzoubi (✉)
School of Business, Skyline University College, Sharjah, UAE
e-mail: haitham.alzoubi@skylineuniversity.ac.ae

Applied Science Research Center, Applied Science Private University, Amman, Jordan

Keywords BetterHelp · IoMT · Security and privacy

1 Introduction

The term Internet of Things (IoT) is a global transition towards using networks of connected objects that have the ability to exchange and collect data seamlessly using embedded sensors in an attempt to increase our overall quality of life and introduce concepts like smart and future-ready cities (Ghazal et al., 2021). Which entails there is always a possibility that in any given moment that all of our interconnected devices or objects will be able to process (Kashif et al., 2021) and transmit data autonomously without the permission or intervention from the said operator (Al-Naymat et al., 2021), which includes data regarding the individual's valuable health related information that can be left vulnerable without the proper safety measures (Hasan et al., 2021a, 2021b; Lee et al., 2022b).

According to a recent study (Cruz, 2021), it is projected that there will be an increase of around 1.3 billion subscriptions in 2023, which includes the 35 billion IoT devices that already connected around the world (Alzoubi & Ahmed, 2019), the number are beyond impressive. Given the widespread use IoT devices (Ghazal & Taleb, 2022), more and more healthcare research studies have shown their concerns about the potential ethical dilemmas that can be caused in the near future (Neaimi et al., 2020), will it reach to the point where privacy is under threat as a resulting factor (Ramakrishna & Alzoubi, 2022). However, other researchers would oppose that argument because it has immensely transformed health (Mejia et al., 2019) and social care best practice in recent times by creating more economical and social benefits (Alshurideh et al., 2022a, 2022b; Ghazal et al., 2022d).

Therefore, those research studies have caused a debate by investigating the downside of being overloaded (Khan et al., 2022) with technology in the context of data security and privacy (Mehmood, 2021). The current objective of this research is to explore those concerns by taking an in-depth analysis of the BetterHelp and Talkspace controversy in 2020 (Alzoubi et al., 2022b), and use it as a case study to provide much needed solutions such as creating data security standards.

The basic approach used for the purpose of this report uses the inductive approach in which the topic does not involve the formulation of a hypothesis, but rather focuses on initiating the study with aims and objectives that are needed to attain the research processes (Islam et al., 2020). Furthermore, studying and analyzing the case study of Better Help, along with other organizations with similar issues and how they overcame it (Alnuaimi et al., 2021), or succumbed to it, was used as a method—so 17, in other words, through the use of observation and patterns (Alzoubi et al., 2022a; Kim et al., 2019).

1.1 Problem Statement

In the ideal world, applying IoT to a clinical setting is a great way to transform an industries best practices such as; MRI scans (Hasan et al., 2022), wearable monitoring sensors, mental health records and many more information without any fear that your data is shared with third-party organizations (Alzoubi & Aziz, 2021). However, because some organizations like BetterHelp follow concerning privacy practices such as sharing data with Meta and other third parties, this valuable information can be used and transferred in dangerous ways without the user's permission (Alzoubi et al., 2021; Bibi et al., 2021).

A solution that can remotely improve this situation is by creating a world renown institution that regulates data collected by healthcare organizations (Akhtar et al., 2021; Joghee et al., 2020) and to prevent any future third-party data sharing transactions or create a legislation to ban data-sharing in clinical settings without the permission of the users (Ramakrishna & Alzoubi, 2022; Siddiqui et al., 2021).

1.2 Proposed Solution

The proposed solution to minimize and end data-sharing of private information with major corporations is to set up or hire an institution that regulates the data collected from patients in healthcare organizational applications like BetterHelp (Alzoubi et al., 2022a, 2022b, 2022c; Hasan et al., 2022). The institute specializes in regulating of any future third-party data from being shared, along with creating a legislation ban on data-sharing within healthcare scenes (Hamadneh et al., 2021) when the patients are not aware of it or given permission in the healthcare sector (Ghazal et al., 2022e; Shamout et al., 2022).

There is a difference between data being leaked and leaking your own data, BetterHelp did the latter (Alnazer et al., 2017; Farouk, 2021). So, the most ideal solution for BetterHelp is to re-evaluate their standards and morality (Ali et al., 2021), whether they see patients as people or as transactions to other and bigger corporations like Meta (Vo et al., 2010). There are definitely ethical issues the company faced, despite having the privacy policy state that "people's information may be shared for business purposes and advertisements (Shehada et al., 2017)," which is stacked in-between a lengthy terms and condition text which most, if not all, people skip through to carry on with the application (Aziz & Aftab, 2021). No one would have assumed that a healthcare application that is centered around mental health would dare to leak private information and therapy sessions to other businesses (Alhamad et al., 2022; Ghazal et al., 2022b).

Although data-sharing enables an alignment of data governance and analytical personas to have an objective of accelerating data (Hanaysha et al., 2022), it is important to differentiate how data-sharing may differ from an ordinary organization to a healthcare-related organization (Saleem et al., 2022). In terms of BetterHelp, re-evaluating their policies and terms and conditions is highly suggested, and to evaluate whether they see their users as patients or just as customers (Alzoubi,

2021). Removing the terms of sharing information to businesses and to actively avoid data-sharing will build trust with the users and the people (Alzoubi et al., 2022d). Starting new with a clean slate to build trust and relationship with their users, because once trust is broken—it is deemed difficult to mend without the proper tools and genuineness (Miller, 2021).

After changing your policy and core values, how could you prevent data from being leaked within the organization (Alshurideh et al., 2020)? There are a few key steps an organization could take to prevent data leakage (Mehmood et al., 2019; Zitar et al., 2021). The first step is to be aware of where the sensitive data is located, then adding a prioritizing system to identify which data requires the most protection (Alhamad et al., 2021; Rehman et al., 2022)—such as the details of patient to therapist sessions and diagnoses, addresses and credit card credentials (Teahan et al., 2012). Upon classifying the data, the DLP software (Data Loss Prevention) can be used to strengthen the security for the data (Alzoubi et al., 2020; Zafar et al., 2022).

Having teams for auditing, monitoring and alerting on critical shifts, or hiring companies that offer those services is vital to prevent data from being leaked as it acts as a proactive strategy (Abu-Arqoub et al., 2020), instead of firefighting or taking action after the damage has been done (Kurdi et al., 2022c). This way, it will be easier to identify any issues prior to the data being leaked (Al-Hamadi et al., 2015a, 2015b). A platform that BetterHelp could use to monitor and audit every shift and changes within the sensitive data and permissions of the end-users (Hanaysha et al., 2021) would be the Lepide Data Security Platform. Lastly, although not the most efficient, it is to encrypt the data (Alshurideh et al., 2022a, 2022b; Bukhari et al., 2022). Encryption, in simple terms, adds another layer of protection surrounding the strategy previously laid out. It is like building a dome within a dome, for double protection.

2 Literature Review

A recent study covered the topic of ethical concerns in IoMT in the following statement “Problems as the lack of transparency in the use of data and contextual metadata, weak security methods implemented in medical devices, probability of human errors and software or hardware malfunctions (Hasan et al., 2021a, 2021b), autonomous, ambiguous and unpredictable behavior of the interconnected things expose both the health institutions and their clients to significant risks, from harming the privacy of patients to actual health damage” (Abbas et al., 2022; Ghazal et al., 2022a; Kurdi et al., 2022b).

The research goes on to highlight that organizations can provide researchers access to the biometric data of their users to test hypotheses which also leaves the user’s data from their smart watch and mobile in the hands of an external party without the understanding of the users (Ali et al., 2022). Furthermore, the paper also has concerns over the human errors aspect in hospitals that are caused a lack of awareness of medical staff and patients in the cybersecurity world (Hasan et al., 2021a, 2021b), as well mentioning hospital’s lack of informational security features for old or new

equipment, which have no built-in security measures intact (Ghazal et al., 2022f; Lee et al., 2022a). To support that argument, the research paper used alarming figures from a recent cyber security report that discloses the rise of malware attacks and breached patient records being the result of insider attacks on the healthcare sector. The research paper concludes suggests adequate training on the topic of privacy and cyber security risks to all staff member while also encourage the government to apply appropriate standards towards information security into medical institutions (Ghazal et al., 2022c).

Furthermore, a study conducted in England by the Royal Academy of Engineering also showed major concerns on cyber safety and highlighted the importance of improving digital systems that support the current economy, mainly blaming how outdated the European legislations are in the current IoMT reality (Ghazal et al., 2022a; Mehmood et al., 2022). Their suggested solution is to update the current laws by protecting the right of the patients to decide to whom their valuable information is being transferred to an academic study conducted in Cornell University cited possible unethical privacy issues from modern processors as they use branch prediction and speculative execution to speed up their performance. In laymen's terms (Al-Hamadi et al., 2015a, 2015b), CPUs are able to guess the destination according to its archived memory which is often described as "unfaithful" as it can access to information and perform operations automatically. These attacks are called Spectre attacks because its ability to attract victims to leak their confidential information through a side channel. According to this study, these attacks clearly violate ethical and security boundaries and is a major threat towards society. The study demands a fix to the processor designs and update its instruction to what computation state CPU operations are allowed to and not allowed to leak.

The Journal of Healthcare Ethics & Administration (JHEA) published a report to evaluate the current ethical standards and regulatory statues of the internet of Medical Thing because its constant violation of privacy and information misuse (Alshurideh et al., 2022a, 2022b; Guntur et al., 2018). The report goes on to highlight that it is no longer acceptable for it to be the only protection offered to users is the Terms of Service as it is always disregarded because of how riddled it is with legalese which often more than not lead the user to sign away their privacy and sell information like personal health records (Kurdi et al., 2022a; Saad Masood Butt, 2022). The report recommends A New Regulation to Protect Universal Health Information legislation.

3 Discussion

The research paper concluded by Popescul and Bayer in 2018 suggests mandatory training on the topic of privacy and cyber security risks to all staff member into all medical institutions, which is a similar to my solution of establishing a co-operation that regulates and instills those very standards. In my opinion, this idea is considered to be very vague as it fails to mention prevention or regulating unethical third party data sharing policies.

The studies conducted in England by the Royal Academy of Engineering revealed that their solution is to protect the right of the patients to decide to whom their information is being transferred to, this solution fails to mention the downside of adjusting or creating new regulations which is the duration. The report that was conducted by The Journal of Healthcare Ethics & Administration also faces the same issue as it usually takes years if not decades to create a universal bill. While the study conducted in Cornell University regarding Spectre Attacks is more of a processing design flaw than can only solved by fixes.

The research methodology used for this research paper includes a theoretical evaluation of a real-life case study surrounding BetterHelp, along with studying the concept of data-sharing and data-leakage within companies. The information gathered come from YouTube channels that have experienced the downside of BetterHelp, along with various articles and online interviews of ex-users. The articles, videos and interviews are used as secondary data for the purpose of this paper. To find proper solutions and understanding to the current situation with BetterHelp, other similar cases were taken into consideration and accounted for, along with how those other organizations dealt with data-sharing, data-leakage and building trust again with their users, especially within the healthcare community.

This research paper's novel idea and contribution is introducing the concept of creating an institute that specializes in regulating of any future third-party data from being shared in the healthcare sectors, of course the Data Protection Authority exists however I believe it is logical to create a sub-division that is responsible to be the main regulator for data protection in the healthcare sector, with more and more IoT devices created every day, having more than one national regulator will help in sharing the responsibility of the institution.

4 Conclusion and Future Recommendations

There is a high probability that healthcare will be extended in the near future through the addition of smart healthcare facilities, AI and robotics and many other things. In these settings, it would be inevitable that IoT will fully apply itself in healthcare which unfortunately leaves the door for it being a liability towards our privacy. To combat those deficiency, the logical and realistic solution is to establish a new universal regulator that instills clear and effective standards that protects the client's privacy from any form of cross organization data sharing or breaches in an attempt to avoid any future controversies similar to BetterHelp in 2020. The primary limitation of this research study is that it does provide a thorough review of privacy issues within the internet of medical things, as its main objective is to shine the light on data sharing with a third-parties. A further insight for all of the ethical and security concerns are very necessary as I fail to see how these issues will be prevented without any intervention.

References

- Abbas, S., Alhwaiti, Y., Fatima, A., Khan, M. A., Khan, M. A., Ghazal, T. M., Kanwal, A., Ahmad, M., & Elmitwally, N. S. (2022). Convolutional neural network based intelligent handwritten document recognition. *Computers, Materials & Continua*, 70, 4563–4581.
- Abu-Arqoub, M., Issa, G., Banna, A. E., & Saadeh, H. (2020). Interactive multimedia-based educational system for children using interactive book with augmented reality. *Journal of Computer Science*, 15, 1648–1658.
- Akhtar, A., Akhtar, S., Bakhtawar, B., Kashif, A.A., Aziz, N., Muhammad, &, Javeid, S. (2021). COVID-19 detection from CBC using machine learning techniques. *International Journal of Technology and Innovation Management*, 1, 65–78.
- Al-Hamadi, Hussam, Gawanmeh, A., & Al-Qutayri, M. (2015a). Formal validation of QRS wave within ECG. In 2015 International Conference on Information and Communication Technology Research, ICTRC (Vol. 9, pp. 190–193).
- Al-Hamadi, H., Gawanmeh, A., Baek, J., & Al-Qutayri, M. (2015b). Lightweight security protocol for ECG bio-sensors. *Wireless Personal Communications*, 95, 5097–5120.
- Al-Naymat, G., Hussain, H., Al-Kasassbeh, M., & Al-Dmour, N. (2021). Accurate detection of network anomalies within SNMP-MIB data set using deep learning. *International Journal of Computer Applications in Technology*, 66, 74–85.
- Alhamad, A. Q. M., Akour, I., Alshurideh, M., Al-Hamad, A. Q., Kurdi, B. A., & Alzoubi, H. (2021). Predicting the intention to use google glass: A comparative approach using machine learning models and PLS-SEM. *International Journal of Data and Network Science*, 5, 311–320.
- Alhamad, A., Alshurideh, M., Alomari, K., Al Kurdi, B., Alzoubi, H., Hamouche, S., & Al-Hawary, S. (2022). The effect of electronic human resources management on organizational health of telecommunications companies in Jordan. *International Journal of Data and Network Science*, 6, 429–438.
- Ali, N., Ahmed, A., Anum, L., Ghazal, T. M., Abbas, S., Khan, M. A., Alzoubi, H. M., & Ahmad, M. (2021). Modelling supply chain information collaboration empowered with machine learning technique. *Intelligent Automation & Soft Computing*, 30, 243–257.
- Ali, N., Ghazal, T. M., Ahmed, A., Abbas, S., Khan, M. A., Alzoubi, H. M., Farooq, U., Ahmad, M., & Khan, M. A. (2022). Fusion-based supply chain collaboration using machine learning techniques. *Intelligent Automation & Soft Computing*, 31, 1671–1687.
- Alnazer, N. N., Alnuaimi, M. A., & Alzoubi, H. M. (2017). Analysing the appropriate cognitive styles and its effect on strategic innovation in Jordanian universities. *International Journal of Business Excellence*, 13, 127–140.
- Alnuaimi, M., Alzoubi, H. M., Ajelat, D., & Alzoubi, A. A. (2021). Towards intelligent organisations: An empirical investigation of learning orientation's role in technical innovation. *International Journal of Innovation and Learning*, 29, 207–221.
- Alshurideh, M., Gasaymeh, A., Ahmed, G., Alzoubi, H., & Kurd, B. A. (2020). Loyalty program effectiveness: Theoretical reviews and practical proofs. *Uncertain Supply Chain Management*, 8, 599–612.
- Alshurideh, M., Al Kurdi, B., Alzoubi, H. M., Ghazal, T. M., Said, R. A., AlHamad, A. Q., Hamadneh, S., Sahawneh, N., & Al-kassem, A. H. (2022a). Fuzzy assisted human resource management for supply chain management issues. *Annals of Operations Research*, 1–19.
- Alshurideh, M., Kurdi, B., Alzoubi, H., Obeidat, B., Hamadneh, S., & Ahmad, A. (2022b). The influence of supply chain partners' integrations on organizational performance: The moderating role of trust. *Uncertain Supply Chain Management*, 10, 1191–1202.
- Alzoubi, H., & Ahmed, G. (2019). Do TQM practices improve organisational success? A case study of electronics industry in the UAE. *International Journal of Economics and Business Research*, 17, 459–472.
- Alzoubi, H. M., Ahmed, G., Al-Gasaymeh, A., & Al Kurdi, B. (2020). Empirical study on sustainable supply chain strategies and its impact on competitive priorities: The mediating role of supply chain collaboration. *Managements Science Letters*, 10, 703–708.

- Alzoubi, A. (2021). The impact of process quality and quality control on organizational competitiveness at 5-star hotels in Dubai. *International Journal of Technology and Innovation Management*, 1, 54–68.
- Alzoubi, H. M., & Aziz, R. (2021). Does emotional intelligence contribute to quality of strategic decisions? The mediating role of open innovation. *Journal of Open Innovation Technology, Market, and Complex*, 7, 130.
- Alzoubi, H. M., Vij, M., Vij, A., & Hanayasha, J. R. (2021). What leads guests to satisfaction and loyalty in UAE five-star hotels? AHP analysis to service quality dimensions. *Enlightening Tourism A Pathmaking Journal*, 11, 102–135.
- Alzoubi, H. M., Ahmed, G., & Alshurideh, M. (2022a). An empirical investigation into the impact of product quality dimensions on improving the order-winners and customer satisfaction. *International Journal of Productivity and Quality Management*, 36, 169–186.
- Alzoubi, H. M., Alshurideh, M. T., Kurdi, B. A., Alhyasat, K. M. K., & Ghazal, T. M. (2022b). The effect of e-payment and online shopping on sales growth: Evidence from banking industry. *International Journal of Data and Network Science*, 6, 1369–1380.
- Alzoubi, H. M., In'airat, M., & Ahmed, G. (2022c). Investigating the impact of total quality management practices and six sigma processes to enhance the quality and reduce the cost of quality: The case of Dubai. *International Journal of Business Excellence*, 27, 94–109.
- Alzoubi, H., Alshurideh, M., Kurdi, B. A., Akour, I., & Aziz, R. (2022d). Does BLE technology contribute towards improving marketing strategies, customers' satisfaction and loyalty? The role of open innovation. *International Journal of Data and Network Science*, 6, 449–460.
- Aziz, N., & Aftab, S. (2021). Data mining framework for nutrition ranking: methodology: SPSS modeller. *International Journal of Technology and Innovation Management*, 1, 85–95.
- Bibi, R., Saeed, Y., Zeb, A., Ghazal, T. M., Rahman, T., Said, R. A., Abbas, S., Ahmad, M., & Khan, M. A. (2021). Edge AI-based automated detection and classification of road anomalies in VANET using deep learning. *Computational Intelligence and Neuroscience*, 2021, 1–19.
- Bukhari, M. M., Ghazal, T. M., Abbas, S., Khan, M. A., Farooq, U., Wahbah, H., Ahmad, M., & Adnan, K. M. (2022). An intelligent proposed model for task offloading in fog-cloud collaboration using logistics regression. *Computational Intelligence and Neuroscience*.
- Butt, S. M. (2022). Management and treatment of type 2 diabetes. *International Journal of Computations, Information and Manufacturing*, 2, 1.
- Cruz, A. (2021). Convergence between blockchain and the internet of things. *International Journal of Technology and Innovation Management*, 1, 34–53.
- Farouk, M. (2021). The universal artificial intelligence efforts to face coronavirus COVID-19. *International Journal of Computations, Information and Manufacturing*, 1, 77–93.
- Ghazal, T. M., Hasan, M. K., Alkhalifah, A., Abu Bakar, K. A., Omidvar, A., Nafi, N. S., & Agbinya, J. I. (2021). Fischer linear discrimination and quadratic discrimination analysis-based data mining technique for internet of things framework for healthcare. *Frontiers in Public Health*, 9.
- Ghazal, T. M., & Taleb, N. (2022). Feature optimization and identification of ovarian cancer using internet of medical things. *Expert Systems*.
- Ghazal, T. M., Abbas, S., Ahmad, M., & Aftab, S. (2022a). An IoMT based ensemble classification framework to predict treatment response in hepatitis C patients. In *2022 International Conference on Business Analytics for Technology and Security, ICBATS 2022* (pp. 1–4).
- Ghazal, T. M., Abbas, S., Munir, S., Khan, M. A., Ahmad, M., Issa, G. F., Zahra, S. B., Khan, M. A., & Hasan, M. K. (2022b). Alzheimer disease detection empowered with transfer learning. *Computers, Materials & Continua*, 70, 5005–5019.
- Ghazal, T. M., Ahmed, Z. E., Hasan, M. K., Hashim, A. A., Saeed, R. A., Mokhtar, R. A., & Singh, S. P. (2022c). Optimization procedure for intelligent internet of things applications. In *2022 International Conference on Business Analytics for Technology and Security, ICBATS 2022* (pp. 1–6).

- Ghazal, T. M., Hasan, M. K., Abdullah, S. N. H., Abubakkar, K. A., & Afifi, M. A. M. (2022d). IoMT-enabled fusion-based model to predict posture for smart healthcare systems. *Computers, Materials & Continua*, 71, 2579–2597.
- Ghazal, T. M., Noreen, S., Said, R. A., Khan, M. A., Siddiqui, S. Y., Abbas, S., Aftab, S., & Ahmad, M. (2022e). Energy demand forecasting using fused machine learning approaches. *Intelligent Automation & Soft Computing*, 31, 539–553.
- Ghazal, T. M., Rehman, A. U., Saleem, M., Ahmad, M., Ahmad, S., & Mahmood, F. (2022f). Intelligent model to predict early liver disease using machine learning technique. In *2022 International Conference on Business Analytics for Technology and Security, ICBATS 2022* (pp. 1–5).
- Guntur, S. R., Gorrepati, R. R., & Dirisala, V. R. (2018). Internet of medical things. *Medical Big Data and Internet of Medical Things*, 4, 271–297.
- Hamadneh, S., Pedersen, O., Alshurideh, M., Kurdi, B. A., & Alzoubi, H. M. (2021). An investigation of the role of supply chain visibility into the Scottish blood supply chain. *Journal of Legal, Ethical and Regulatory*, 24, 1–12.
- Hanaysha, J., Al-Shaikh, M., & Alzoubi, M. H. (2021). Importance of marketing mix elements in determining consumer purchase decision in the retail market. *International Journal of Service Science, Management, Engineering, and Technology*, 12, 56–72.
- Hanaysha, J. R., Al-Shaikh, M. E., Joghee, S., & Alzoubi, H. M. (2022). Impact of innovation capabilities on business sustainability in small and medium enterprises. *FIIB Business Review*, 11, 67–78.
- Hasan, M. K., Islam, S., Sulaiman, R., Khan, S., Hashim, A. H. A., Habib, S., Islam, M., Alyahya, S., Ahmed, M. M., Kamil, S., & Hassan, M. A. (2021a). Lightweight encryption technique to enhance medical image security on internet of medical things applications. *IEEE Access*, 9, 47731–47742.
- Hasan, M. K., Ahmed, M. M., Musa, S. S., Islam, S., Abdullah, S. N., Hossain, E., Nafi, N. S., & Vo, N. (2021b). An improved dynamic thermal current rating model for PMU-based wide area measurement framework for reliability analysis utilizing sensor cloud system. *IEEE Access*, 9, 14446–14458.
- Hasan, M. K., Ghazal, T. M., Saeed, R. A., Pandey, B., Gohel, H., Eshmawi, A. A., Abdel-Khalek, S., & Alkhassawneh, H. M. (2022). A review on security threats, vulnerabilities, and counter measures of 5G enabled internet-of-medical-things. *IET Communications*, 16, 421–432.
- Islam, S., Khalifa, O. O., Hashim, A. H. A., Hasan, M. K., Razzaque, M. A., & Pandey, B. (2020). Design and evaluation of a multihoming-based mobility management scheme to support inter technology handoff in PNEMO. *Wireless Personal Communications*, 114, 1133–1153.
- Joghee, S., Alzoubi, H. M., & Dubey, A. R. (2020). Decisions effectiveness of FDI investment biases at real estate industry: Empirical evidence from Dubai smart city projects. *International Journal of Scientific & Technology Research*, 9, 3499–3503.
- Kashif, A. A., Bakhtawar, B., Akhtar, A., Akhtar, S., Aziz, N., & Javeid, M. S. (2021). Treatment response prediction in hepatitis C patients using machine learning techniques. *International Journal of Technology and Innovation Management*, 1, 79–89.
- Khan, M. A., Ghazal, T. M., Lee, S. W., & Rehman, A. (2022). Data fusion-based machine learning architecture for intrusion detection. *Computers, Materials & Continua*, 70, 3399–3413.
- Kim, S.-K., Yeun, C. Y., Damiani, E., & Lo, N.-W. (2019). A machine learning framework for biometric authentication using electrocardiogram. *IEEE Access*, 7, 94858–94868.
- Kurdi, B. A., Alshurideh, M., Akour, I., Alzoubi, H. M., Obeidat, B., & Alhamad, A. (2022a). The role of digital marketing channels on consumer buying decisions through eWOM in the Jordanian markets. *International Journal of Data and Network Science*, 6, 1175–1185.
- Kurdi, B. A., Alshurideh, M., Akour, I., Tariq, E., Alhamad, A., & Alzoubi, H. M. (2022b). The effect of social media influencers' characteristics on consumer intention and attitude toward Keto products purchase intention. *International Journal of Data and Network Science*, 6, 1135–1146.
- Kurdi, B. A., Alzoubi, H. M., Akour, I., & Alshurideh, M. T. (2022c). The effect of blockchain and smart inventory system on supply chain performance: Empirical evidence from retail industry. *Uncertain Supply Chain Management*, 10, 1111–1116.

- Lee, K. L., Azmi, N. A. N., Hanaysha, J. R., Alzoubi, H. M., & Alshurideh, M. T. (2022a). The effect of digital supply chain on organizational performance: An empirical study in Malaysia manufacturing industry. *Uncertain Supply Chain Management*, 10, 495–510.
- Lee, K. L., Romzi, P. N., Hanaysha, J. R., Alzoubi, H. M., & Alshurideh, M. (2022b). Investigating the impact of benefits and challenges of IOT adoption on supply chain performance and organizational performance: An empirical study in Malaysia. *Uncertain Supply Chain Management*, 10, 537–550.
- Mehmood, T., Alzoubi, H. M., Alshurideh, M., Al-Gasaymeh, A., & Ahmed, G. (2019). Schumpeterian entrepreneurship theory: Evolution and relevance. *Academy of Entrepreneurship Journal*, 25, 1–10.
- Mehmood, T. (2021). Does information technology competencies and fleet management practices lead to effective service delivery? Empirical evidence from e-commerce industry. *International Journal of Technology and Innovation Management*, 1, 14–41.
- Mehmood, S., Ghazal, T. M., Khan, M. A., Zubair, M., Naseem, M. T., Faiz, T., & Ahmad, M. (2022). Malignancy detection in lung and colon histopathology images using transfer learning with class selective image processing. *IEEE Access*, 10, 25657–25668.
- Mejia, C., Ciarlante, K., & Chheda, K. (2019). A wearable technology solution and research agenda for housekeeper safety and health. *International Journal of Contemporary Hospitality Management*, 1–3.
- Miller, D. (2021). The best practice of teach computer science students to use paper prototyping. *International Journal of Technology and Innovation Management*, 1, 42–63.
- Neaimi, M., Al Hamadi, H., Al Yeun, C. Y., Jamal Zemerly, M. (2020). Digital forensic analysis of files using deep learning. In *2020 3rd International Conference on Signal Processing and Information Security, ICSPIS 2020* (pp. 1–4). IEEE.
- Ramakrishna, Y., & Alzoubi, H. M. (2022). Empirical investigation of mediating role of six sigma approach in rationalizing the COQ in service organizations. *Operations and Supply Chain Management*, 15, 122–135.
- Rehman, A. U., Saleem, R. M., Shafi, Z., Imran, M., Pradhan, M., & Alzoubi, H. M. (2022). Analysis of income on the basis of occupation using data mining. In *2022 International Conference on Business Analytics for Technology and Security, ICBATS 2022* (pp. 1–4).
- Saleem, M., Abbas, S., Ghazal, T. M., Adnan Khan, M., Sahawneh, N., & Ahmad, M. (2022). Smart cities: Fusion-based intelligent traffic congestion control system for vehicular networks using machine learning techniques. *Egyptian Informatics Journal*.
- Shamout, M., Ben-Abdallah, R., Alshurideh, M., Alzoubi, H., Kurdi, B. A., & Hamadneh, S. (2022). A conceptual model for the adoption of autonomous robots in supply chain and logistics industry. *Uncertain Supply Chain Management*, 10, 577–592.
- Shehada, D., Yeun, C. Y., Zemerly, M. J., Qutayri, M., Al Hammadi, Y., Al Damiani, E., & Hu, J. (2017). BROSMAP: A novel broadcast based secure mobile agent protocol for distributed service applications. In *Security and communication networks* (Vol. 2017). Wiley.
- Siddiqui, S. Y., Haider, A., Ghazal, T. M., Khan, M. A., Naseer, I., Abbas, S., Rahman, M., Khan, J. A., Ahmad, M., Hasan, M. K., Mohammed, A., & Ateeq, K. (2021). IoT cloud-based intelligent prediction of breast cancer stages empowered with deep learning. *IEEE Access*, 9, 146478–146491.
- Teahan, W. J., Al-Dmour, N. A., & Tuff, P. G. (2012). Knowledge distribution in multi agent systems. *Asian Journal of Information Technology*, 11, 300–311.
- Vo, D. L., Lee, H., Yeun, C. Y., & Kim, K. (2010). Enhancements of authenticated multiple key exchange protocol based on bilinear pairings. *Computers & Electrical Engineering*, 36, 155–159.
- Zafar, S., Asif, M., Ahmad, M. B., Ghazal, T. M., Faiz, T., Ahmad, M., & Khan, M. A. (2022). Assistive devices analysis for visually impaired persons: A review on taxonomy. *IEEE Access*, 10, 13354–13366.
- Zitar, R. A., Al-Dmour, N., Nachouki, M., Hussain, H., & Alzoubi, F. (2021). Hashing generation using recurrent neural networks for text documents. *ICIC Express Letters, Part B: Applications*, 12, 231–241.

Contemporary Security Concerns in IoT-Based Devices with Healthcare System



Ali A. Alzoubi, Reem ALKaabi, Sara ALAmeri, and Haitham M. Alzoubi 

Abstract Numerous opportunities are emerging due to the Internet of Things' (IoT) rapid development, which has the potential to significantly improve human quality of life in many areas. The healthcare industry is the main place where IoT can enhance our quality of lives. Security and privacy concerns, however, take center stage in electronic health (eHealth) systems, and the incorporation of IoT makes them increasingly difficult to address. Due to the numerous stakeholders in its broader ecosystem, the majority of IoMT which raises security concerns. The IoT-based healthcare system has various security features. This search provides an Identity-Based Cryptography cornerstone management technique that uses collaborative authentication and a secret passcode to protect transformation of data between any IoT health device and any other entity from a different company or domain (IBC).

Keywords Ethics · IoM · Security · Healthcare

1 Introduction

The delivery of health care services has changed as a result of the IT and medical industries' convergence, or eHealth. E-Health provides a fresh method of using health resources, such as data, cash, pharmaceuticals (Ghazal et al., 2021c). It assists all concerned parties in making better use of those resources. According to the McKinsey Global Institute, IoT-based hospitals applications will have the greatest economic

A. A. Alzoubi
Public Security Directorate, Amman, Jordan

R. ALKaabi · S. ALAmeri
School of Information Technology, Skyline University College, Sharjah, UAE

H. M. Alzoubi (✉)
School of Business, Skyline University College, Sharjah, UAE
e-mail: haitham.alzoubi@skylineuniversity.ac.ae

Applied Science Research Center, Applied Science Private University, Amman, Jordan

impact compared to other IoT apps by 2025, growing the global economy by between 1.1 and 2.5 trillion dollars annually (Guntur et al., 2018). It demonstrates that IoT hospitals has a highly promising result (Lee et al., 2022b). In terms of the advantages it will bring to individuals, technology, and the economy (Alzoubi & Ahmed, 2019). Despite all the positive information regarding IoT-based healthcare solutions, security and privacy remain major issues (Eli and Hamou, 2022).

IoT-based hospital systems face numerous security plus privacy challenges, including hackers attack (Al-Dmour, 2020), security of the communication channel and ecosystem (such as multi-factor authentication, key management (Mehmood et al., 2019), and cryptographic support), and stealing attempts of the stored information, etc. (Ratkovic, 2022). Yet, the Health Insurance Portability and Accountability must be complied with any IoT device that transmits patient health information (HIPAA) (Al-Hamadi et al., 2015a, 2015b; Alzoubi et al., 2022a). The limited power, processing, and memory capabilities of IoT devices also indicate that the security mechanism must make effective use of those resources (Ghazal et al., 2022c; Gul et al., 2012). Additionally, the design of IoT-based health care systems generally comprises a number of stakeholders (Lee et al., 2022a) that are members of several organizations with varying security domains and policies (Hanaysha et al., 2022), which makes the security work more challenging (Ghazal et al., 2022j). In light of the above-described conditions, it is crucial to offer serious management that facilitates multiple methods and safe data transfer among devices within the IoT-based health care system (Alzoubi et al., 2022b).

This search provides an IBC-based security system that help all previously mentioned functionalities (Eli and Hamou, 2022). The Identity Based encryption topic was selected considering it is essentially an asymmetric key scheme (Alzoubi et al., 2021a, 2021b), which is simpler to distribute keys for. Additionally, unlike other asymmetric key schemes, such as Elliptic Curve Cryptography, it does not need a certificate for practical key distribution (Ghazal et al., 2022h; Kasem and Al-Gasaymeh, 2022). The method, which was created using a variation of Identity Based Encryption that fixes the key escrow issue in the Identity Based cryptography (Ghazal et al., 2022k), offers mutual authentication and agreement for secure connection entities across various companies or domains (Ghazal et al., 2022e; Kurdi et al., 2022c).

The remaining parts of this search are orderly as: Sect. 2 reviews security and privacy problems, particularly in the light of an IoT-based healthcare system (Ghazal et al., 2021c). The Sect. 3 of this article presents the IoT-based health care system outline which is mentioned in this study (Ghazal et al., 2022f). Section 4 explains the suggested key safety, authentication, and key agreement scheme (Alsharari, 2021). Section 5 discusses the proposed scheme's security and effectiveness analyses (Ghazal & Taleb, 2022; Hanaysha et al., 2021; Obaid, 2021). Section 6 concludes with a few suggestions for further development.

2 Literature Review

2.1 Safety Challenges and Solutions

The security issues with the IoT-based healthcare system are discussed in this section (Ghazal et al., 2021a). There are two primary kinds of challenges: those relating to the inherent nature of the IoT, which has an influence on security solutions (Ramakrishna & Alzoubi, 2022); and those relating to IoT system security (Alshurideh et al., 2020), particularly in the domain of health care (Al-Hamadi et al., 2015a, 2015b). Additionally, a few potential answers to the problems discussed are offered based on some related publications (Ghazal et al., 2022g). Low-speed CPUs are built into Internet of Things health devices. Such gadgets have a slow central processing unit (CPU) that isn't particularly powerful (Guntur et al., 2018; Islam et al., 2020). Additionally, computationally intensive operations cannot be carried out by these devices (Shamout et al., 2022). They only serve as a sensor or actuator, in other words. Therefore, it might be difficult to identify a security solution that enhances security performance (Hasan et al., 2021a, 2021b) while minimizing resource usage (Alzoubi et al., 2022e). However, as the number of IoT devices has increased steadily, more and more devices are joining the world data network (Ghazal et al., 2021b). Therefore, creating a highly scalable security system without sacrificing security standards is a different difficult task (Joghee et al., 2020; Victoria, 2022). Medical records include extremely confidential information regarding a patient's data and health statuses that needs to be kept safe and secret from any hackers (Alzoubi & Yanamandra, 2020). In order to comply with HIPAA, hospitals and other healthcare organizations must securely communicate patients' sensitive information (Shehada et al., 2018). If the automated data gathering isn't validated and handled appropriately (Alzoubi et al., 2022d), security breaches and privacy violations are quite likely due to the widespread and omnipresent nature of IoT (Ali et al., 2021). Without real-time monitoring, patients' private and sensitive medical information may be altered, misused, or compromised (Al-Hamadi et al., 2021). This poses a grave threat to infrastructure in addition to having a devastating effect on people's lives (Alzoubi et al., 2022a). Apps and wearable technology might be taken over by malicious users, who could then access users' sensitive information and pose grave security and health threats (Alsharari, 2022). In order to comply with HIPAA, hospitals and other healthcare organizations must securely communicate patients' sensitive information (Alnazer et al., 2017). If the automated data gathering isn't validated and handled appropriately, security breaches and privacy violations are quite likely due to the widespread and omnipresent nature of IoT (Ali et al., 2022; Alzoubi et al., 2022b; Ghazal et al., 2022f).

Without real-time monitoring, patients' private and sensitive medical information may be altered, misused 43, or compromised. This poses a grave threat to infrastructure in addition to having a devastating effect on people's lives (Alzoubi & Aziz, 2021). Apps and wearable technology might be taken over by malicious users, who could then access users' sensitive information and pose grave security and health threats (Alnuaimi et al., 2021; Ghazal et al., 2022a) (Fig. 1).

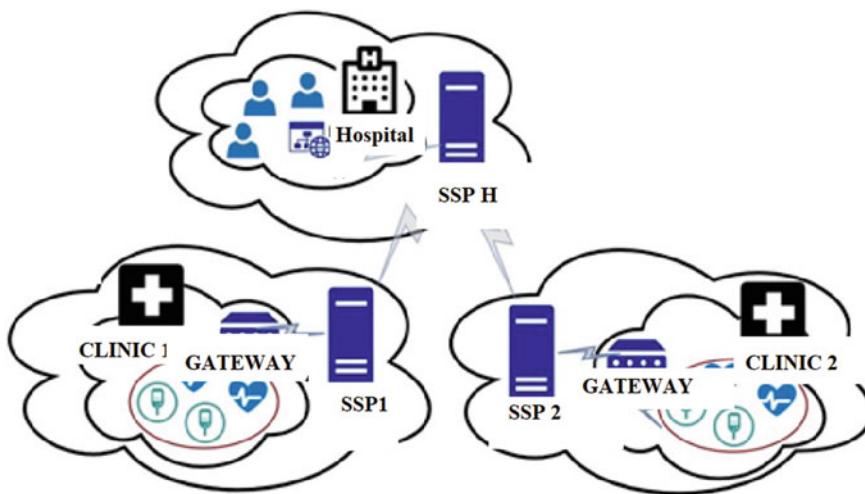


Fig. 1 Reference architecture of IoT based health care (Alsharari, 2021)

The management of passwords and access to applications and private patient data presents another difficulty. When a patient's sensor gadget asks for access, for example, medical care providers are permitted to do so, but the internet connection sources may be an insecure Wi-Fi network that is readily compromised (Alkeem et al., 2017).

Numerous authentication approaches might be used to enable patients to confirm their identities and grant doctors' access to their internally implanted gadgets, but suddenly they lost consciousness and are still in severe need of medical treatment and direction. Some manufacturers of IoT healthcare products offer a lifetime difficult password to managing IoT devices, the device documentation contains passwords that are accessible to the general public and might be used to incorrectly set the device, endangering the lives of patients (Vo et al., 2010). Correctly establishing and executing cryptography methods in IoT health is another difficulty. Due to the ubiquitous and ongoing capabilities of the IoT, Cryptographic key management is necessary yet complex (Al-Dmour & Teahan, 2005).

The IoT platform necessitates the use of concurrent authentication processes with real-time answers. Health information about patients should be encrypted and decrypted whenever it is judged necessary, according to HIPAA regulations regarding Transmission Security Encryption (TSE) (Hasan et al., 2021a, 2021b). Entities are required to create documentation of the installed encryption technology, including rules and protocols, the exchange of cryptographic key management, and limiting who has access to generate and modify cryptographic keys. Additionally, it's important to audit and enforce policies for keeping and sharing keys that really are secret (Al-Nashashibi et al., n.d.; Mondol, 2021).

A lot of security measures have been developed to solve IoT-related issues in various apps; these plans may also be used in the healthcare industry. Given that IoT

comprises of constrained-devices (e.g., limited processing) (Ghazal et al., 2022d). The issue of secure transmission in IoT as specified by HIPAA law is inextricably linked with cryptographic methods, as are huge numbers of IoT nodes, which has expanding issues. Furthermore, proper encryption management is critical in secure communication and is tied to authentication.

Due to its tiny key size and ability to meet the needs of constrained devices, symmetric key cryptography-based schemes were first the subject of in-depth research. However, it has a significant scalability flaw. There have also been various attempts to implement a Public Key Cryptography (PKC)-based system on restricted devices in order to overcome the scalability issue. It has been demonstrated that it is possible to implement PKC with restricted hardware, particularly when utilizing ECC, which necessitates a smaller key size than RSA-based PKC (Hujran et al., 2020).

However, standard PKC requires credentials, which take up more memory and are difficult to handle. A certificate less PKC system called IBC has been developed to address this issue. The fundamental concept of the original IBE is as follows: initially, a central entity known as the Private Key Generator (PKG) is in charge of producing some public consideration and a core key that is kept a secret (Ghazal et al., 2022i). Following that, all other people that trust the specific PKG given their Identifications users can produce their own private keys using the master key. With the exception that the public key can be created by any entity using a known ID, the encryption-decryption procedure can now be carried out in the same way as the conventional PKG. Due to its advantages, e.g. Some IBC-based security approaches, such as certificate less ad minimal resource needs, have also been deployed for restricted devices, including Mobile Ad-hoc Networks. random strings, such as the identity of a communicating party, can be used as a public key in IBC, taking the certificate in conventional PKC place.

IBC plan has been put out for the Internet of Things. It is suggested to use a proxy and a key setup mechanism for two interacting entities, one of which is a restricted device 69. Machine-to-Machine (M2M) IBC protocol design pattern was put out in reference.

2.2 Safety Challenges and Solutions (Part 2)

This chapter explores potential IoT-based hospital system design from multiple aspects. Another searcher said that the interaction of four parties—sensor owners, sensor publishers, extended service providers, and sensor data consumers is the foundation for how IoT sensing devices work in general. SO might be a business that sells sensors, a government agency, a private individual, or another SO (Al Hamadi et al., 2017; Ghazal et al., 2022i).

If the SO concludes that data produced by these sensors will really be accessed on the cloud, it must define the data access policy that all SPs should implement and potential users should follow. When an SDC (for example, a government agency, a

business enterprise, an academic institution, or an employee) expresses interest in data exchange from a published sensor, the SP mediates the establishment of a service agreement between the SDC and the relevant SO, outlining the SO's obligations with regard to the importance and accessibility of the submitted sensing data, as well as their adherence to current standards.

Sensing Service Provider (SSP) is a different organization that streamlines communication between SDC and also other organizations that serve its goals, such as SO (for data accessibility, integrity, and quality), SP (for access services to sensor data), and other extended service providers (for value added services) (Ghazal et al., 2022c). In a scenario involving health care, SDC might be any supplier of health care services or a medical facility (such as a hospital, clinic, etc.). Those SDC in the healthcare industry may choose to adopt IoT-based hospital services for addition to their current IT infrastructure or by outsourcing it to specialist providers depending on the financial, human, and technological resources that are available almost always (Hamadneh et al., 2021). Particularly for tiny medical institutes, the second choice might be more preferred (e.g. clinics, general practitioners).

From a practical standpoint, the architecture deployment strategy of an IoT-based hospital system may be done in a variety of ways. According to one of the studies, tele-EKG!, an ongoing tele-health pilot project, is done in such a way that a renowned cardiac hospital serves as the initiative's hub while also providing services to other distantly placed healthcare providers (Alzoubi et al., 2021a, 2021b, 2022c, 2022e, 2022f, 2022g). To get a diagnosis relating to the cardiac difficulties of the patients in the distant region to health care providers who lack cardiology doctors may submit the EKG test data of their patients to other cardiologist who is a member of the referring hospital using tele-EKG (Ghazal et al., 2022b; Kurdi et al., 2022a, 2022b).

The example model is a condensed form in which SP is taken to be the SSP itself, the SO is a component of the healthcare providers (clinics one and two), and hospital 1 is the SDC. Additionally, it is presumable that every healthcare organization hired expert providers to handle the IoT-based healthcare system (e.g., SSP 1, SSP 2 and SSP H).

The reference architecture will feature three PKG for each SSP domain in accordance with the planned IBC security system, which calls for PKG. PKG is only accessible to organizations that are part of its domain for security reasons. They provide public parameters and master secret keys for each domain as PKGs.

3 Methodology

3.1 IBE Scheme

Many persons have already said: the suggested system is based on an IBE variation without key escrow. Franklin's original IBE method uses four randomized algorithms—Setup, Extract, Encrypt, and Decrypt—while the IBE's variation without

key escrow includes a fifth algorithm called Publish. The last table contains a summary of the inputs and outputs for all five methods. And by taking note that the Setup algorithm runs completely in the PKG, which may happen, for example, during system startup. As part of the Extract algorithm, the PKG gets an AI input ID from a communicating entity. Once the algorithm is carried out in the PKG, QID is made public in a directory while dID is provided covertly to the communicating entity. The remainder of the algorithm (Publish, Encrypt, and Decrypt), with the exception of NID being one of the outcomes of the Publish process being published in a public directory, occurs in the communicating entity.

Before describing the other process in the suggested approach, namely key agreement authentication and system and device initialization.

3.2 System and Device Initialization

Framework administration is the operation performed when a gateway and a constrained device join the SSP!, although system initialization is a method performed when an SSPPKG!'s is enabled. The most important step in configuration is generating the master key and parameters, followed by making the parameters public, as mentioned in the prior section. Furthermore, the SSP PKG is dependent on it! to have a unique online identity that can be recognized by anything or anybody. As a result, we recommend that the IoT Service Provider's primary identity be the domain name, to which the device identity will be attached. Even if the access points is in a different domain, having such an identifier scheme is helpful in the lookup process.

Mainly two operations must be carried out: the production and distribution of the gadget by the PKG, and the formation of sub-public and sub-private key pairs by the device itself. In theory, the device's identification and accompanying private key are distributed statically during the flashing period of the device, but the online technique may be done more dynamically. In this situation, an online approach is selected, and a secure method of providing the device's private key is suggested.

Two identical keys, KlnitReq plus KlnitRsp, which are generated one time randomly and will be useless after device initialization, are used to secure the proposed online device initialization. There are several ways to get the keys. One useful method is to register a device via a web interface. After the registration procedure, the registered device will receive a unique device identification, KlnitReq, and KlnitRsp (e.g. they can be loaded to the device by cable data after downloading from PKG). It is now able to add more human-friendly names to the unique device identification, such as the type of device (gateway, EKG, diabetes sensor, etc.). the position of the device (hospital or clinic, etc.). Then, utilizing Authenticated Encryption with Associated Data, the device may safely ask for its identification and associated private key (AEAD). AEAD was chosen because it works quicker than a safe implementation of Hash-based Message Authentication Code (HMAC), which uses two keys for

encryption and authentication, and it is more secure to fully authenticate the cipher text rather than just encrypt it.

3.3 Authentication Mechanism with Key Agreement

Form three depicts a situation when the suggested authentication procedure and key agreement are used. In this example, user A of a mobile app wishes to access sensor B, which is a part of an IoTSP domain. User A and sensor B shall be referred to as A and B, respectively, moving forward for the sake of simplicity. Additionally, the access point to B for A is the IoT Server (IoTS). Since it is anticipated that the mobile app (either the app itself or the server that offers API to the app) performs action A in this situation, it is represented in form 3 as a single entity. Additionally, it may be believed that practically speaking, entities within each domain are unaware of the system parameters and sub-public keys of entities inside other domains, necessitating a lookup operation prior to encryption. Following is an explanation of the authentication technique in detail.

First, using $IDIoT\ S = H1IoT\ SP\ (IDIoT\ S)$, where $H1IoT\ SP$ is a part of $paramsIoT\ SP$, A does a search to acquire $NIoT\ S$ and $paramsIoT\ SP$. For encryption, additional $paramsIoT\ SP$ parameters are also utilized. Then, using $QIoT\ s$, $NIoT\ s$, and tA as keys, IDA , IDB , and timestamp T are encrypted to generate $C1$. Here, T is utilized to stop a counterattack. IDA , $IDIoT\ S$, and $C1$ are then sent to IoTS.

IoTS will conduct a quest depending on the IDA obtained after receiving a message from A in order to acquire the parameters A and NA . After a successful search, it decrypts $C1$ to produce IDA , IDB , and T using $dIoT\ S$, $tIoT\ S$, and $N\ A$. Then T is validated, and IDA is checked to see whether it is comparable to the one that was received. If they are true, the procedure continues; if not, it pauses and notifies A of the problem. A message containing NB is encrypted as $C2$ using QA , NA , and $tIoT\ S$ after successful validation, and $C2$ is then delivered to A. A second message containing the parameters A and NA is encrypted as $C3$ using QB , NB , and $tIoT\ S$ before being delivered to B, letting A know that they want access to it.

After receiving $C2$, A uses dA , tA , and $NioT\ S$ to decode it in order to produce NB . A then creates nonce A , encrypts it with IDA using QB , NB , and tA as $C4$ before sending it to B.

B decrypts $C3$ after receiving it from IoTS in order to get the parameters $M\ A$ and NA utilizing dB , tB , and $NioT\ S$.

B decrypts $C4$ using dB , tB , and NA after receiving it from A in order to produce $nonceA$. Then, using a key derivation function, such as an HMAC-based Key Derivation Function, B creates $nonceB$ and uses it, together with $nonceA$ and IDB , to create the shared secret key with A, kBA (HKDF). After that, IDB and $nonceB$ are encrypted using QA , NA , and tB as $C5$, and a digital $S1$ is made from a message made up of IDB , IDA , and $nonceA$ with key KBA using a message authentication code like HMAC. IDB , IDA , $C5$, and $S1$ are then sent to A.

A receives C5 and S1, decrypts C5 using dA, tA, and NB to derive nonceB, and then generates KBA using nonceA, nonceB, and ID. Next, using the newly constructed kBA, another S/ is formed in the same manner that B did it, and it is then validated against the received S1. Following S1's verification, S2 is produced using IDA, IDB, and nonceA using kBA and delivered to B. S2 is then validated by b when it has been received. Both A and B will use kBA as their shared secret key after successful verification.

User A and sensor B are ultimately together are authenticated. Additionally, they may communicate privately and securely using symmetric key encryption, such as Advanced Encryption Standard (AES), which has kBA and is more compact than public key encryption.

4 Discussion

The security capabilities of the suggested approach are explored in this chapter. The threat model used for the security study is provided first. The suggested scheme's security aspects are next examined. Finally, a discussion on mutual authentication's security is had. Three different categories of attackers will be defined in this chapter.

Every message sent through the system is eavesdropped on by an outside attacker who then replays the previous message to the receiver, breaks up the eavesdropped message into smaller pieces, reassembles the pieces into a new message, and sends the new message to any legal entity. The attacker can also decrypt ciphertext if they have access to the corresponding key, modify the decrypted plaintext, and forge messages using the public key of a legal entity. Compromised equipment, such one that can perform all actions an outside attacker might, uses its own private key, which was given with MSP, to decode intercepted messages or create fake ones. A compromised SSP that uses its own private key to decode intercepted messages or create fake messages and is able to do any action an outside attacker could.

- *Security Feature of The Proposed Scheme*

When a communication is encrypted, it is authenticated: Sender I must use t_i to encrypt the message before sending it to receiver j , and the recipient must use N_i to decode the message. The message could only be properly encrypted and decrypted with the right (t_i, N_i) combination. This indicates that the recipient could only decode the message by the matching N_i if the communication was encrypted by an authorized sender i . Therefore, the encryption serves as the message's authentication, and no more signatures are required. The key escrow issue is solved by using d_j and t_j when a receiver j wishes to decode a message. The receiver is the sole party with knowledge of the d_j , SSP, and t_j . The message could therefore only be decoded by the recipient because to the t_j even if the SSP is hacked or the private key d_j is exposed. The primary escrow issue is thus resolved by the presence of t_j . Likewise, the update of data strengthens the authentication scheme's security.

- *Mutual Authentication*

The authentication technique enables mutual authentication between a hospital user, a medical sensor, and the SSP1! The SSP1! verifies the hospital user's ID. The SSP1 and its associated sub-public key NID could only decipher messages encrypted by authorized hospital users. Additionally, the sub-secret key tID makes sure that only the authorized mobile user may authenticate a message with encryption, and that only the target sensor can decode a message and vice versa.

5 Conclusion

IoMT security and privacy assurance is a really difficult task. The fact that IoT is mostly used to link patients with medical institutions or among a number of health-care providers spread across several sectors with various levels of trust authority makes it more difficult. An IBC-based system has been put forth for the purpose of securing communication in IoMT across several domains. The key contributions are the IBE-based key-escrow-free authentication mechanism, the mechanism to look up IBE system parameters in other domains, the mechanism to generate shared secret keys to secure communication of the presentation of the mutual authentication. A cryptographic identity might be used alternatively of a plain identity to facilitate verification and increase identity security, but this is still up for debate. In order to take into account more stakeholders as described in the suggested model, an extension of the proposed scheme with an expanded IoT-based health care system architecture needs to be taken into consideration. To test the effectiveness and practical viability of the suggested method, it will also be implemented in a prototype or genuine IoT system.

References

- Al-Dmour, N., & Teahan, W. (2005). The blackboard resource discovery mechanism for distributed computing over P2P networks. In T. International (Ed.), *PDCN. Conference on Parallel and Distributed Computing and Networks* (pp. 15–17).
- Al-Dmour, N. A. (2020). Using unstructured search algorithms for data collection in iot-based WSN. *International Journal of Engineering Research & Technology*, 13, 1992–1998.
- Al-Hamadi, H., Gawanmeh, A., & Al-Qutayri, M. (2015a). Formal validation of QRS wave within ECG. In *2015 International Conference on Information and Communication Technology Research, ICTRC* (Vol. 9, pp. 190–193).
- Al-Hamadi, H., Gawanmeh, A., Baek, J., & Al-Qutayri, M. (2015b). Lightweight security protocol for ECG bio-sensors. *Wireless Personal Communications*, 95, 5097–5120.
- Al Hamadi, H., Gawanmeh, A., & Al-Qutayri, M. (2017). Guided test case generation for enhanced ECG bio-sensors functional verification. *The International Journal of E-Health and Medical Communications*, 8, 1–20.

- Al-Hamadi, H., Nasir, N., Yeun, C. Y., & Damiani, E. (2021). A verified protocol for secure autonomous and cooperative public transportation in smart cities. In I. June (Ed.), *2021 IEEE International Conference on Communications Workshops (ICC Workshops)* (pp. 1–6).
- Al-Nashashibi M., Hadi, W., El-Khalili, N., Ghassan, I. (n.d.) A new two-step ensemble Learn. Model Improv. Stress Predict. Automob. Drivers. *The International Arab Journal of Information Technology*, 6 (2021).
- Ali, N., Ahmed, A., Anum, L., Ghazal, T. M., Abbas, S., Khan, M. A., Alzoubi, H. M., & Ahmad, M. (2021). Modelling supply chain information collaboration empowered with machine learning technique. *Intelligent Automation & Soft Computing*, 30, 243–257.
- Ali, A., Septyanto, A. W., Chaudhary, I., Hamadi, H. A., Alzoubi, H. M., & Khan, Z. F. (2022). Applied artificial intelligence as event horizon of cyber security. In *2022 International Conference on Business Analytics for Technology and Security (ICBATS)* (pp. 1–7).
- Alkeem, E. A., Shehada, D., Yeun, C. Y., Zemerly, M. J., & Hu, J. (2017). New secure healthcare system using cloud of things. *Cluster Computing*, 20(3), 2211–2229.
- Alnazer, N. N., Alnuaimi, M. A., & Alzoubi, H. M. (2017). Analysing the appropriate cognitive styles and its effect on strategic innovation in Jordanian universities. *International Journal of Business Excellence*, 13, 127–140.
- Alnuaimi, M., Alzoubi, H. M., Ajelat, D., & Alzoubi, A. A. (2021). Towards intelligent organisations: An empirical investigation of learning orientation's role in technical innovation. *International Journal of Innovation and Learning*, 29, 207–221.
- Alsharari, N. (2021). Integrating blockchain technology with internet of things to efficiency. *International Journal of Technology and Innovation Management*, 1, 01–13.
- Alsharari, N. (2022). The Implementation of enterprise resource planning (Erp) in the United Arab Emirates: A case of Musanada Corporation. *International Journal of Technology and Innovation Management*, 2, 1.
- Alshurideh, M., Gasaymeh, A., Ahmed, G., Alzoubi, H., & Kurd, B. A. (2020). Loyalty program effectiveness: Theoretical reviews and practical proofs. *Uncertain Supply Chain Management*, 8, 599–612.
- Alzoubi, H., & Ahmed, G. (2019). Do TQM practices improve organisational success? A case study of electronics industry in the UAE. *International Journal of Economics and Business Research*, 17, 459–472.
- Alzoubi, H. M., & Yanamandra, R. (2020). Investigating the mediating role of information sharing strategy on agile supply chain. *Uncertain Supply Chain Management*, 8, 273–284.
- Alzoubi, H. M., & Aziz, R. (2021). Does emotional intelligence contribute to quality of strategic decisions? The mediating role of open innovation. *Journal of Open Innovation Technology, Market, and Complex*, 7, 130.
- Alzoubi, H., Alhamad, A. Q. M., Akour, I., Alshurideh, M., Al-Hamad, A. Q., Kurdi, B. A., & Alzoubi, H. (2021a). Predicting the intention to use google glass: A comparative approach using machine learning models and PLS-SEM. *International Journal of Data and Network Science*, 5, 311–320.
- Alzoubi, H. M., Vij, M., Vij, A., & Hanaysha, J. R. (2021b). What leads guests to satisfaction and loyalty in UAE five-star hotels? AHP analysis to service quality dimensions. *Enlightening Tourism*, 11, 102–135.
- Alzoubi, H., Alhamad, A., Alshurideh, M., Alomari, K., Al Kurdi, B., Hamouche, S., & Al-Hawary, S. (2022a). The effect of electronic human resources management on organizational health of telecommunications companies in Jordan. *International Journal of Data and Network Science*, 6, 429–438.
- Alzoubi, H., Alshurideh, M., Kurdi, B. A., Akour, I., & Aziz, R. (2022b). Does BLE technology contribute towards improving marketing strategies, customers' satisfaction and loyalty? The role of open innovation. *International Journal of Data and Network Science*, 6, 449–460.
- Alzoubi, H. M., Alshurideh, M. T., Al Kurdi, B., Ghazal, T. M., Said, R. A., AlHamad, A. Q., Hamadneh, S., Sahawneh, N., & Al-kassem, A. H. (2022c). Fuzzy assisted human resource management for supply chain management issues. *Annals of Operations Research*, 1–19.

- Alzoubi, H. M., Elrehail, H., Hanaysha, J. R., Al-Gasaymeh, A., & Al-Adaileh, R. (2022d). The role of supply chain integration and agile practices in improving lead time during the COVID-19 crisis. *International Journal of Service Science, Management, Engineering, and Technology*, 13, 1–11.
- Alzoubi, H. M., In'airat, M., & Ahmed, G. (2022e). Investigating the impact of total quality management practices and six sigma processes to enhance the quality and reduce the cost of quality: The case of Dubai. *International Journal of Business Excellence*, 27, 94–109.
- Alzoubi, H. M., Ahmed, G., & Alshurideh, M. (2022f). An empirical investigation into the impact of product quality dimensions on improving the order-winners and customer satisfaction. *International Journal of Productivity and Quality Management*, 36, 169–186.
- Alzoubi, H. M., Ali, N., Ghazal, T. M., Ahmed, A., Abbas, S., Khan, M. A., Farooq, U., Ahmad, M., & Khan, M. A. (2022g). Fusion-based supply chain collaboration using machine learning techniques. *Intelligent Automation & Soft Computing*, 31, 1671–1687.
- Eli, T., & Hamou, L. A. S. (2022). Investigating the factors that influence students' choice of English studies as a major: The case of University of Nouakchott Al Aasriya, Mauritania. *International Journal of Technology and Innovation Management*, 2, 1.
- Ghazal, T. M., Bibi, R., Saeed, Y., Zeb, A., Rahman, T., Said, R. A., Abbas, S., Ahmad, M., & Khan, M. A. (2021a). Edge AI-based automated detection and classification of road anomalies in VANET using deep learning. *Computational Intelligence and Neuroscience*, 2021, 1–19.
- Ghazal, T. M., Hasan, M. K., Alkhalfah, A., Abu Bakar, K. A., Omidvar, A., Nafi, N. S., & Agbinuya, J. I. (2021b). Fischer linear discrimination and quadratic discrimination analysis-based data mining technique for internet of things framework for healthcare. *Frontiers in Public Health*, 9.
- Ghazal, T. M., Siddiqui, S. Y., Haider, A., Khan, M. A., Naseer, I., Abbas, S., Rahman, M., Khan, J. A., Ahmad, M., Hasan, M. K., Mohammed, A., & Ateeq, K. (2021c). IoMT cloud-based intelligent prediction of breast cancer stages empowered with deep learning. *IEEE Access*, 9, 146478–146491.
- Ghazal, T. M., & Taleb, N. (2022). Feature optimization and identification of ovarian cancer using internet of medical things. *Expert Systems*.
- Ghazal, T. M., Abbas, S., Ahmad, M., & Aftab, S. (2022a). An IoMT based ensemble classification framework to predict treatment response in hepatitis C patients. In *2022 International Conference on Business Analytics for Technology and Security, ICBATS 2022* (pp. 1–4).
- Ghazal, T. M., Abbas, S., Alhwaiti, Y., Fatima, A., Khan, M. A., Khan, M. A., Kanwal, A., Ahmad, M., & Elmitwally, N. S. (2022b). Convolutional neural network based intelligent handwritten document recognition. *Computers, Materials & Continua*, 70, 4563–4581.
- Ghazal, T. M., Abbas, S., Munir, S., Khan, M. A., Ahmad, M., Issa, G. F., Zahra, S. B., Khan, M. A., & Hasan, M. K. (2022c). Alzheimer disease detection empowered with transfer learning. *Computers, Materials & Continua*, 70, 5005–5019.
- Ghazal, T. M., Ahmed, Z. E., Hasan, M. K., Hashim, A. A., Saeed, R. A., Mokhtar, R. A., & Singh, S. P. (2022d). Optimization procedure for intelligent internet of things applications. In *2022 International Conference on Business Analytics for Technology and Security, ICBATS 2022* (pp. 1–6).
- Ghazal, T. M., Bukhari, M. M., Abbas, S., Khan, M. A., Farooq, U., Wahbah, H., Ahmad, M., & Adnan, K. M. (2022e). An intelligent proposed model for task offloading in fog-cloud collaboration using logistics regression. *Computational Intelligence and Neuroscience*.
- Ghazal, T. M., Hasan, M. K., Abdullah, S. N. H., Abubakkar, K. A., & Afifi, M. A. M. (2022f). IoMT-enabled fusion-based model to predict posture for smart healthcare systems. *Computers, Materials & Continua*, 71, 2579–2597.
- Ghazal, T. M., Hasan, M. K., Saeed, R. A., Pandey, B., Gohel, H., Eshmawi, A. A., Abdel-Khalek, S., & Alkhassawneh, H. M. (2022g). A review on security threats, vulnerabilities, and counter measures of 5G enabled internet-of-medical-things. *IET Communications*, 16, 421–432.
- Ghazal, T. M., Khan, M. A., Lee, S. W., & Rehman, A. (2022h). Data fusion-based machine learning architecture for intrusion detection. *Computers, Materials & Continua*, 70, 3399–3413.

- Ghazal, T. M., Mahmood, S., Khan, M. A., Zubair, M., Naseem, M. T., Faiz, T., & Ahmad, M. (2022i). Malignancy detection in lung and colon histopathology images using transfer learning with class selective image processing. *IEEE Access*, 10, 25657–25668.
- Ghazal, T. M., Noreen, S., Said, R. A., Khan, M. A., Siddiqui, S. Y., Abbas, S., Aftab, S., & Ahmad, M. (2022j). Energy demand forecasting using fused machine learning approaches. *Intelligent Automation and Soft Computing*.
- Ghazal, T. M., Rehman, A. U., Saleem, M., Ahmad, M., Ahmad, S., & Mahmood, F. (2022k). Intelligent model to predict early liver disease using machine learning technique. In *2022 International Conference on Business Analytics for Technology and Security, ICBATS 2022* (pp. 1–5).
- Ghazal, T. M., Zafar, S., Asif, M., Ahmad, M. B., Faiz, T., Ahmad, M., & Khan, M. A. (2022l). Assistive devices analysis for visually impaired persons: A review on taxonomy. *IEEE Access*, 10, 13354–13366.
- Gul, O., Al-Qutayri, M., Yeun, C. Y., & Vu, Q. H. (2012). Framework of a national level electronic health record system. In *Proceedings of 2012 International Conference on Cloud Computing Technologies, Applications and Management, ICCCTAM 2012. Applications and Management (ICCTAM)* (pp. 60–65).
- Guntur, S. R., Gorrepati, R. R., & Dirisala, V. R. (2018). Internet of medical things. *Medical Big Data and Internet of Medical Things*, 4, 271–297.
- Hamadneh, S., Pedersen, O., Alshurideh, M., Kurdi, B. A., & Alzoubi, H. M. (2021). An investigation of the role of supply chain visibility into the Scottish blood supply chain. *Journal of Legal, Ethical and Regulatory*, 24, 1–12.
- Hanaysha, J., Al-Shaikh, M., & Alzoubi, H. M. (2021). Importance of marketing mix elements in determining consumer purchase decision in the retail market. *International Journal of Service Science, Management, Engineering, and Technology*, 12, 56–72.
- Hanaysha, J. R., Al-Shaikh, M. E., Joghee, S., & Alzoubi, H. M. (2022). Impact of innovation capabilities on business sustainability in small and medium enterprises. *FIIB Business Review*, 11, 67–78.
- Hasan, M. K., Islam, S., Sulaiman, R., Khan, S., Hashim, A. H. A., Habib, S., Islam, M., Alyahya, S., Ahmed, M. M., Kamil, S., & Hassan, M. A. (2021a). Lightweight encryption technique to enhance medical image security on internet of medical things applications. *IEEE Access*, 9, 47731–47742.
- Hasan, M. K., Ahmed, M. M., Musa, S. S., Islam, S., Abdullah, S. N., Hossain, E., Nafi, N. S., & Vo, N. (2021b). An improved dynamic thermal current rating model for PMU-based wide area measurement framework for reliability analysis utilizing sensor cloud system. *IEEE Access*, 9, 14446–14458.
- Hujran, O., Alikaj, A., Durrani, U. K., & Al-Dmour, N. (2020). Big data and its effect on the music industry. In *ACM International Conference Proceeding Series* (pp. 5–9).
- Islam, S., Khalifa, O. O., Hashim, A. H. A., Hasan, M. K., Razzaque, M. A., & Pandey, B. (2020). Design and evaluation of a multihoming-based mobility management scheme to support inter technology handoff in PNEMO. *Wireless Personal Communications*, 114, 1133–1153.
- Joghee, S., Alzoubi, H. M., & Dubey, A. R. (2020). Decisions effectiveness of FDI investment biases at real estate industry: Empirical evidence from Dubai smart city projects. *International Journal of Scientific & Technology Research*, 9, 3499–3503.
- Kasem, J., & Al-Gasaymeh, A. (2022). A cointegration analysis for the validity of purchasing power parity: Evidence from middle east countries. *International Journal of Technology and Innovation Management*, 2, 1.
- Kurdi, B. A., Alshurideh, M., Akour, I., Alzoubi, H. M., Obeidat, B., & Alhamad, A. (2022a). The role of digital marketing channels on consumer buying decisions through eWOM in the Jordanian markets. *International Journal of Data and Network Science*, 6, 1175–1185.
- Kurdi, B. A., Alshurideh, M., Akour, I., Tariq, E., Alhamad, A., & Alzoubi, H. M. (2022b). The effect of social media influencers' characteristics on consumer intention and attitude toward Keto products purchase intention. *International Journal of Data and Network Science*, 6, 1135–1146.

- Kurdi, B. A., Alzoubi, H. M., Akour, I., & Alshurideh, M. T. (2022c). The effect of blockchain and smart inventory system on supply chain performance: Empirical evidence from retail industry. *Uncertain Supply Chain Management*, 10, 1111–1116.
- Lee, K. L., Azmi, N. A. N., Hanaysha, J. R., Alzoubi, H. M., & Alshurideh, M. T. (2022a). The effect of digital supply chain on organizational performance: An empirical study in Malaysia manufacturing industry. *Uncertain Supply Chain Management*, 10, 495–510.
- Lee, K. L., Romzi, P. N., Hanaysha, J. R., Alzoubi, H. M., & Alshurideh, M. (2022b). Investigating the impact of benefits and challenges of IOT adoption on supply chain performance and organizational performance: An empirical study in Malaysia. *Uncertain Supply Chain Management*, 10, 537–550.
- Mehmood, T., Alzoubi, H. M., Alshurideh, M., Al-Gasaymeh, A., & Ahmed, G. (2019). Schumpeterian entrepreneurship theory: Evolution and relevance. *Academy of Entrepreneurship Journal*, 25, 1–10.
- Mondol, E. P. (2021). The impact of block chain and smart inventory system on supply chain performance at retail industry. *International Journal of Computations, Information and Manufacturing*, 1, 56–76.
- Ratkovic, N. (2022). Improving home security using blockchain. *International Journal of Computations, Information and Manufacturing*, 2, 1.
- Obaid, A. J. (2021). Assessment of smart home assistants as an IoT. *International Journal of Computations, Information and Manufacturing*, 1, 18–38.
- Ramakrishna, Y., & Alzoubi, H. M. (2022). Empirical investigation of mediating role of six sigma approach in rationalizing the COQ in service organizations. *Operations and Supply Chain Management*, 15, 122–135.
- Shamout, M., Ben-Abdallah, R., Alshurideh, M., Alzoubi, H., Al Kurdi, B., & Hamadneh, S. (2022). A conceptual model for the adoption of autonomous robots in supply chain and logistics industry. *Uncertain Supply Chain Management*, 10, 577–592.
- Shehada, D., Yeun, C. Y., Zemerly, M. J., Al-Qutayri, M., Al-Hammadi, Y., & Hu, J. (2018). A new adaptive trust and reputation model for mobile agent systems. *Journal of Network and Computer Application*, 124, 33–43.
- Vo, D. L., Lee, H., Yeun, C. Y., & Kim, K. (2010). Enhancements of authenticated multiple key exchange protocol based on bilinear pairings. *Computers & Electrical Engineering*, 36, 155–159.
- Victoria, V. (2022). Impact of process visibility and work stress To improve service quality: Empirical evidence from Dubai retail industry impact of process visibility and work stress to improve service quality: Empirical evidence from Dubai retail industry. *International Journal of Technology and Innovation Management*, 2, 1.

Investigating Contemporary Ethical Issues of Using Blockchain in E-Supply Chain in Internet of Medical Things (IOMT)



Ali A. Alzoubi, Seyed Abdollah Nikoo, and Haitham M. Alzoubi 

Abstract For every sector, managing supply chains is a difficult task, but the health-care sector faces complexity and risk since a compromised supply chain may directly affect patient safety and health outcomes. In this assignment we will discuss how blockchain technology is one possible method for enhancing the health E-supply chain's security, integrity, data provenance, and usefulness. With such an importance placed on the pharmacological supply, medical product and supply, Internet of Medical Things (IOMT), and public health sectors, the goal of this assignment is to provide a description of the advantages and drawbacks of using blockchain technology in the medical distribution and supply network. The unfulfilled potential of blockchain technology to enhance the health supply chain requires greater research, analysis, and integration with regulatory frameworks which has been discussed.

Keywords E-Supply · Ethics · IoMT · Blockchain

1 Introduction

A complex and self-replicating health supply chain has emerged because of globalization, greater use of information systems and related technologies (Lee et al., 2022b), and a sector occupied by numerous entities in different jurisdictions. The United States National Strategy for Global Supply Chain Security, a White House

A. A. Alzoubi
Public Security Directorate, Amman, Jordan

S. A. Nikoo
School of Information Technology, Skyline University College, Sharjah, UAE

H. M. Alzoubi (✉)
School of Business, Skyline University College, Sharjah, UAE
e-mail: haitham.alzoubi@skylineuniversity.ac.ae

Applied Science Research Center, Applied Science Private University, Amman, Jordan

project to “promote efficient and secure services” and “encourage resilience (Al-Tahat & Moneim, 2020),” is one of several initiatives to safeguard supply chains in the larger context of all commodities and goods (Alzoubi et al., 2020). While this government plan on supply chain security is crucial for all industries, the healthcare sector is particularly in need of it since a compromised supply chain can have several negative effects on patient safety and health outcomes (Ghazal et al., 2022f). These include chance of failure to store and deliver life-saving supplies (Al-Hamadi et al., 2015a), unfavorable outcomes related to supply chain breaches, and a rise in end-user or patient morbidity and death (Mehmood et al., 2019).

When creating technology-driven solutions and use cases, one of the verticals that is most heavily considered is the pharmaceutical supply chain (Ali et al., 2021). For instance, billions are spent annually on the worldwide market for subpar, counterfeit, and grey market medications (Radwan & Farouk, 2021). Numerous pharmaceuticals, medical devices, and biologics have been shown to be counterfeited in low-, middle, and high-income nations, according to studies (Alhamad et al., 2022). This suggests that the whole drug supply chain is vulnerable to this international type of pharmaceutical crime. The introduction of various types of technology and digital health platforms has given birth to supply chain solutions as well as vulnerabilities (Ghazal et al., 2022d; Islam et al., 2020), along with the expansion of the pharmaceutical business internationally and an increase in worldwide medication sales (Alzoubi et al., 2022a). Up until now, efforts to protect and upgrade the supply chain have mostly concentrated on technology like radio frequency identification (RFID) chips with ownership transfer, smartphone apps to trace pharmaceutical pedigree (for example, m-pedigree), and other item authentication systems (Khan, 2021).

Enhancing security and reducing risks in the space available of healthcare goods and equipment is a priority issue in relation to pharmaceutical counterfeiting. Given the growth of linked devices and mobile health (mHealth) applications (Zitar et al., 2021), the medical device business is particularly significant. Examples of difficulties with the expansion of the Internet of Medical Things (IOMT) and how its advancement and acceptance have greatly surpassed security needs include people with implanted cardiac devices being made susceptible owing to massive security gaps (Guntur et al., 2018; Hanaysha et al., 2021). Governmental organizations and authorities are taking action to raise public awareness of the hazards to the general public and the healthcare ecosystem in the IOMT in response to problems like the cybersecurity vulnerability found in pacemakers (Radwan, 2022). Put another way, escalating medical supply prices are prompting healthcare organizations to reevaluate fundamental operational tenets (Alzoubi & Ahmed, 2019; Vo et al., 2010). Even though these procedures would enable systems to make greater use of a health system setting with abundant distribution network information (Ghazal et al., 2022a), supply management still wouldn’t be entirely facilitated (Alsharari, 2021).

1.1 Problem Definition

In order to solve the concerns, we unite them in this assignment. The penetration of the combination classification of substandard and falsified (SF) medications (Alzoubi & Aziz, 2021), which are generally referred to as fake products but frequently take on a distinct legal meaning, is a severe and well-known danger to the pharmaceutical supply chain (Alzoubi et al., 2022c). Combined, these many types of tainted and fake medications might appear because of the importation of subpar medications without local authorization, poor manufacturing procedures or incorrect storage (Ghazal & Taleb, 2022; Kurdi et al., 2022b), drug theft and diversion, and the penetration of subpar or fake goods into gray markets (Abbas et al., 2022; Alzoubi et al., 2022a; Mehmood et al., 2022). Would blockchain technology be an improvement over current supply chain and anti-counterfeiting systems and databases (Guergov & Radwan, 2021)? These are the first questions that should be asked when understanding the influence of blockchain in protecting and improving supply chain operations for the production, dispersion, and distribution of pharmaceutical products (Alnazer et al., 2017; Mejia et al., 2019). Does it include features or procedures that cannot be found in centralized databases or old systems? What kind of interactions may a blockchain have with pre-existing supply chain data (Bibi et al., 2021), such as RFID, Global Standards One (GS-1), Electronic Product Code Information Services (EPCIS), and anti-counterfeiting technology? And lastly, can it provide a regulatory and compliance solution that can reduce risk while also improving compliance and patient safety (Lee et al., 2022a; Zafar et al., 2022), which can be advantageous to both manufacturers and consumers.

1.2 Proposed Solution

Public health supply chain challenges include crisis and disaster mitigation and management (Hamadneh et al., 2021), which include shielded goods for medical personnel during public health emergencies, access to essential medications, vaccines, and immunizations, as well as essential medication, vaccine, and access issues (Alzoubi & Yanamandra, 2020; Kim et al., 2019). Blockchain technology solutions for preserving ample stock at point of sales (e.g., mitigating stock outs), reducing health systems-related corruption in the procurement of medicines, and accelerating efficient delivery of health services and commodities (Siddiqui et al., 2021) all intermingle with use case scenarios in the healthcare supply chain and combating SF medicines in the context of ensuring access to necessary and high-quality (Alshurideh et al., 2020).

One way to address the issues is through the deployment of blockchain technologies for things like product tracing, verification, detection, and notification as well as source data. Following are some of these problems and their solutions (Ghazal et al., 2022e; Khan et al., 2022; Ramakrishna & Alzoubi, 2022):

- Product identification—The use of block chains is consistent with the requirement for a unique product identity that is validated as a side chain (Al-Naymat et al., 2021; Alshurideh et al., 2022a).
- Product Tracing—With the help of product tracing, producers, distributors, and dispensers may supply tracing data in a common ledger with automated confirmation of crucial data (Hanaysha et al., 2022).
- Product Verification—Product identification and other supplied information are verified using an open system that is created for this purpose (Teahan et al., 2012).
- Detection & Response—Enables both public and private actors to report and discover medications that may be hazardous, illegal, or counterfeit (Neaimi et al., 2020).

Public health supply chain difficulties involve tragedy and crisis management and handling, including availability to necessary drugs, vaccinations, and immunizations, as well as protective materials for healthcare personnel during public health emergencies (Chong et al., 2021). Blockchain technology solutions for keeping enough at distribution point (e.g., mitigating stock outs), reducing health systems-related corruption in the procurement of medicines (Hasan et al. 2021a), and accelerating efficient provision of healthcare and commodities all intersection with use cases in the healthcare supply chain and combating SF medicines in the context of ensuring access to necessary and high-quality medicines (Ali, 2021; Joghee et al., 2020).

In order to establish strong use cases and localize within the context of the myriad challenges encountered by supply chains in different countries, the answers to these questions should serve as the basis for first evaluation of blockchain design features and feasibility studies. Using the Drug Supply Chain Security Act (DSCSA) as an example, each regulatory element must be compatible with bitcoin technology for anything to be a workable solution (Hasan et al. 2021b). By creating use scenarios, simulation studies, and blockchain solution prototypes, a number of enterprises are actively investigating the application of blockchain for medicinal supply chain (Alnuaimi et al., 2021). The Center for Supply Chain Studies a nonprofit organization founded to explore the viability of innovation through a virtual pilot study with participation from various stakeholders from across the pharmaceutical supply chain (Al-Hamadi et al. 2015b), is driving the thought process surrounding this development. Additionally, it is actively doing research on reference models for DSCSA and blockchain scalability and compatibility (Ahmed & Amiri, 2022).

Furthermore, to explore frameworks for standards of interoperability between blockchain and current legacy systems to improve patient safety in both the pharmaceutical supply and clinical trials sectors, technical professional organizations have organized workshops, webinars, and now run a Supply Chain/Clinical Trials Technology Implementation Industry Connections program. Several businesses are concurrently working toward these same objectives, but from various angles, including developing use cases, investigating partnerships with vendors, and extending blockchain models used in other industries (such as food supply chains) to pharmaceuticals and associated healthcare uses (Saleem et al., 2022).

A case study reviewed has been looking at how blockchain technology might increase the security of the pharmaceutical supply chain while at the same time mentioning the need to combat the decades-long clinical challenge of SF medications (Ali et al., 2022). This case study has attracted interest from a variety of stakeholders within this advancements, public health, and healthcare communities of blockchain researchers and entrepreneurs. The practical and real-world application of blockchain to this issue is still unclear and needs additional development, even if a study like MediLedger represents a collaborative approach amongst many organizations (Alzoubi et al., 2022d; Ghazal et al., 2021).

Private blockchain are beginning to emerge in other healthcare specializations that are usually tech-focused and subject to tight regulation, outside of pharmaceutical and the medicinal distribution chain. Clinical trial participants, health information and data processing providers and businesses, and as previously said, the medication supply chain are perhaps the most developed healthcare industries going forward with blockchain implementation (Al-Hamadi et al. 2015b; Farouk, 2022). However, there are applications for medical equipment and supply, IOMT, and public health that are aligned with the core concepts of better data management and the reliability of the wellness supply chain, and these are briefly discussed below (Alshurideh et al., 2022a).

Medical equipment and supplies Due to a security weakness that exposed their device to possible hacker manipulation, over half a million customers with implanted cardiac pacemakers were recently recognized as needing a crucial firmware upgrade. This comes after past incidents, such as the SymbiqTM Infusion System recall, when it was found that Hospira's smart pumps could well be accessed and operated by unauthorized users over a hospital network to adjust patients' doses. The appropriate usage of these technologies along with their risks become increasingly obvious as the use of linked and digitally enabled medical equipment increases (Bukhari et al., 2022).

Due to its efficiency and accountability around trust, blockchain does have potential to save costs, enhance patient safety, and prevent medical device counterfeiting in response to the FDA and EU's regulations that medical equipment has a Unique Device Identifier (UDI). By using automated smart contracts, blockchain technology has the potential to improve preventative maintenance of equipment (Alhamad et al., 2021). An effort is under way to use blockchain technology to support the medical device supply chain and track devices through their lifecycle in one university-industry relationships with community members Edinburgh Napier University, National Health Service (NHS) National Services Scotland, and Spiritus Development with assistance from The Data Lab and Scottish Funding Council (Abu-Arqoub et al., 2020). The pilot's other objective is to keep an eye on the patient care route for chances to use analytics to boost efficiency and safety, such as quicker responses to instrument recalls and field alerts from responsible businesses and authorities.

By enhancing logistics operations and connecting clinical communities, blockchain technology also has the potential to lower costs and increase the value of healthcare. In order to do this, Johns Hopkins Medicine (JHM) established a

supply chain strategy with an emphasis on managing blood, joints, and the spine (Ghazal et al., 2022b). JHM positioned this program as cost-cutting with a “things not staff” mentality to focus on lowering supplier expenses rather than employee cutbacks while maintaining a focus on increasing the value of treatment. One of the most well-known outcomes of this JHM program was the Armstrong Institute for Patient Safety and Quality (AIPSQ), and it was noted that the coordination of these interrelated initiatives was a crucial factor in its success.

With their healthcare clinical communities concentrating on supply management of medical goods, the communities for spine, joint, and blood management collectively contributed to realizing millions in cost reductions (Kurdi et al., 2022c).

The first questions that should be asked are whether blockchain technology would be an improvement over logistics network and ant counterfeiting systems and databases when considering how it might secure and optimize supply chain management for the production, delivery, and dispensing of pharmaceutical products (Ali et al., 2022). Does it include features or procedures that cannot be found in centralized databases or old systems? What kind of interactions may a blockchain have with pre-existing supply chain data, such as RFID, Global Standards One (GS-, Electronic Product Code Information Services (EPCIS), and anti-counterfeiting technology? And lastly, can it provide a regulatory and compliance solution that can reduce risk while also improving compliance and patient safety, which can be advantageous to both manufacturers and consumers?

2 Literature Review

Recently, over 500,000 patients with implanted cardiac pacemakers were recognized as needing a critical firmware upgrade owing to a potential weakness that exposed their implant to potential hacking (Ghazal et al., 2022c). This follows earlier incidents, such as the removal of the SymbiqTM Infusion System when it was revealed that unauthorized individuals could access and manipulate Hospira’s smart pumps over a hospital network to adjust patients’ doses. As the usage of linked and digitally enabled medical equipment grows in popularity, so do their appropriate applications and risks (Hasan et al., 2022; Shamout et al., 2022).

Owing to its benefits and responsibility surrounding trust, blockchain has the potential to cut costs, improve patient safety, and prevent medical device counterfeiting in response to FDA and EU mandates for medical equipment to have a Unique Device Identifier (UDI). The use of blockchain might help improve preventative maintenance of equipment through the implementation of smart contracts (Alshurideh et al., 2022b; Shehada et al., 2017). Recently, over 500,000 patients with implanted cardiac pacemakers were recognized as needing a critical firmware upgrade owing to a security weakness that exposed their device to potential hacking. This follows earlier incidents, such as the recall of the SymbiqTM Infusion System when it was revealed that unauthorized individuals could access and manipulate

Hospira's smart pumps over a hospital network to adjust patients' doses (Alzoubi et al., 2022b).

As the usage of linked and digitalized medical equipment grows in popularity, so do their appropriate applications and vulnerabilities. Owing to its advantages and accountability surrounding trust, blockchain has the potential to cut costs, improve patient safety, and prevent medical device counterfeiting in response to FDA and EU mandates for medical equipment to have a Unique Device Identifier (UDI). The use of blockchain might help improve device preventative maintenance by deploying a medical products supply network to track devices throughout their lives. The pilot will also look for ways to use analytics to improve quality and reliability throughout the patient care route (Alzoubi et al., 2021; Kurdi et al., 2022a). For example, Farma Trust is creating a blockchain solution for the pharmaceutical supply chain, as well as an Initial Coin Offering (ICO) particularly for the European market. A corporation like Walton is in the early stages of using RFID and IoT; with the purpose of scaling to the business ecosystem, a startup named Chronicled has teamed with The LinkLab for a blockchain-enabled DSCSA compliance platform.

3 Research Methodology–A Theoretical Evaluation

The goal of this assignment is to evaluate previous research that uses blockchain technology in the healthcare industry. Research questions were used to group the short-listed papers. A systematic literature review is a sort of review or secondary study that first establishes clear research objectives before gathering, organizing, and extracting all available material to address those concerns. There are several writing guides available for systematic literature reviews. To perform the current research, nevertheless, Barbara Kitchenham's suggestions are followed. Review papers published in journals with high impact factors adhere to this practice. This method was developed expressly for carrying out systematic literature review for computer science research.

In order to identify the technology's greatest potentials in the healthcare industry, this research assignment concentrated on elaborating on its qualities. To totally reform the system, it is also necessary to explore the uses of blockchain technology in-depth with all the stakeholders in the healthcare industry. Furthermore, this review of the literature follows a specific set of steps to obtain findings that set it apart from earlier nanostructured reviews.

The findings of this study are created in response to the first stage of the systematic literature review to fill in the gaps identified, as indicated below.

Motivating the research question.

Q.1 What are the main concerns of the stakeholders in healthcare?

The goal is to draw attention to the significant problems impeding the healthcare sector's performance.

Q.2 What Blockchain functionalities are applied to address the concerns found?

The goal is to investigate cutting-edge technology that advances the relevant concerns and the industry.

Q.3 What are the difficulties and problems in implementing blockchain technology?

The objective is to identify any unresolved implementation concerns using blockchain technology.

In order to find as much material as possible for review, the following search terms were used: “Issues in the Healthcare sector,” “Blockchain,” “Healthcare Blockchain,” and “Systematic Review.” Numerous studies were gathered after rigorous examination of various databases and publications. Throughout this stage, it was discovered that certain papers were fully or partially out of relevance, while others were determined to be precisely connected with the study field (Blockchain and Healthcare). Given their titles and cited keywords were determined to be comparable to popular search, inclusion criteria reduced the studies to a few. Studies from renowned publishers and publications with high impact factors were selected. Prior to categorizing the studies, we first evaluated each study’s abstract considering the publications’ research topics, methodologies, and conclusions. The additional searched documents were disregarded since their titles and abstracts lacked the required keywords. Additionally removed were duplicate or pointless research and articles written in languages other than English.

4 Discussions

This section of the assignment provides details on the study questions listed in the Methodology and further divided into subsections. The subsections include lists of the aspects of the blockchain that can address the issues the healthcare industry is currently experiencing, a breakdown of the common problems in that sector by the numerous participants, and finally research that highlights the issues and challenges with blockchain implementation that would need to be resolved in the future. The Discussions of the assignment are based on the below questions which are precisely answered.

4.1 *Q.1 What are the Principal Concerns Involving Healthcare Stakeholders?*

A system is made up of a number of components or items that interact to produce a useful result. Providers, patients, payers, supply chain bearers (manufacturers, suppliers, pharmacies), and research organizations are the five key participants that make up the healthcare sector. A significant component and typical third party are the provider (hospital, doctor, specialist, etc.). Some problems that are serious topics of worry are being faced by each player. Under each situation, the following concerns are covered:

- *Providers:* A main participant in the healthcare industry is a provider. For doctors and patients to have excellent results, patient information management is crucial. The management and curation of the patient records, however, presents various difficulties. Additional time and resource costs may result from a lack of interoperability standards for sharing patient records among labs and hospitals. For patients, payers, and pharmacies, providers serve as a reliable third party.
- *Patients:* The most significant component of the health sector is the patient. Although providers collect patient health information, patients do not have the legal authority to grant or deny access to medical information as they see fit.
- *Payers:* Insured claim payments made by payers (insurer or employer) on behalf of patients must also be validated from centric IT systems, which are prone to security flaws and deliberate fraud. Records (bills, prescriptions, etc.) can be fabricated using phony credentials for medical professionals, incorrect invoicing, false tests, etc. To track legitimate insurance claim procedures, accounting and data provenance are essential.
- *Research Organizations:* To keep track of emerging ailments, develop therapies for them, and find new drugs, research centers and pharmaceutical corporations need public health data. The exchange of health care data is a requirement for clinical audit, national data collecting, and research. Without the patients' consent, a physician may disclose patient data with these groups, which is against patient privacy.
- *Pharmaceutical Supply Chain Management:* The sellers, agents, processors, and pharmacies are the main participants in the pharmaceutical supply chain. It is a complicated system with a wide variety of manufacturing, storage, distribution, and raw material acquisition-related operations. Reliability must be ensured by proper administration and oversight. The origins and quality of drug ingredients may come from a variety of uncertified sources.

4.2 *Q.2 What Aspects of the Blockchain are Employed to Address the Problems Found?*

The main advantage of blockchain technologies is their adaptability to various situations. By applying the blockchain technology's following capabilities and addressing the industry's key problems, the healthcare sector may progress quickly. The capabilities are addressed and discussed as below:-

- *The problem of record management is solved via Distributed Digital Ledger:* Every firm must maintain its records effectively in order to succeed, and this demands a significant investment in both human and technological resources. Blockchain, a decentralized distributed ledger technology, promises to replace the present expensive systems with less expensive, simpler-to-implement solutions that are more productive and efficient.

- *The problem of data interchange is solved by interoperability:* Blockchain distributed ledger technology may solve the problem of inconsistent fragmented patient health records, which will enhance communication between providers and quality. This coordinated infrastructure will facilitate real-time patient communication, the sharing of the most recent health and treatment information, and quicker product innovation since the flow of data will favorably impact market competitiveness.
- *The problem of safety and privacy is solved via consensus mechanisms and cryptography:* Immutable blockchain capacity to capture consumers' attention by demonstrating accuracy and consistency and transparency is its charm. By utilizing the consensus algorithm and strong encryption in blockchain technology, patient-controlled safe access is ensured because only the private key may decode the data.
- *Lack of data provenance is resolved via traceability and time stamping:* Payers can avoid risky financial loss by using time-stamped, validated records for claim qualifying. Clinical study results must be transparent, free of data eavesdropping, with precise endpoint switching, etc.
- *The monetization problem is solved by digital currency:* In a blockchain-based network, miners receive bitcoin as payment for using their processing power to support and maintain the network.

Now that the healthcare sector has embraced blockchain technology, what issues does it now face?

- Scalability: When a blockchain-powered health care incorporates sensor devices for patient care, storage issues and computationally intensive tasks must be overcome.
- Security (risk of attack of 51%): Consensus powers the blockchain. Malicious miners may control the majority, or more than half, of all nodes, or 51%, and prevent other honest miners from accepting their blocks. Their increased computing power may also let them to steal valuable data or currencies. A bigger network, however, reduces the likelihood of this attack.
- Confidentiality disclosure: Because the blockchain database is open-source platform, it is subject to the restriction that “openness reveals confidentially.” Because patient-related records are so delicate, it is particularly important for patient healthcare records and biomedical applications.
- Confidentiality and identity privacy: The ambiguity and fraud hype that surrounds blockchain is another issue. Criminals may use cryptocurrency while benefiting from the blockchain network’s anonymity. On the Dark Web, individuals may use bitcoins to purchase illicit substances.
- Unsustainability for the environment: Another problem with existing blockchain implementations is their inefficiency and unreliability for the environment. The wattage required by the “proof-of-work” requirements in current blockchain implementations is equivalent to powering a single Bitcoin transaction.

5 Conclusions and Future Recommendations

The potential benefits of blockchain technology for improving supply chain management involve: (1) lowering or abolishing fraud and errors, (2) reducing paperwork delays, (3) enhancing stock control, (4) identifying issues faster, (5) lowering parcel expense, and (6) rising consumer and partner trust. However, bringing these potential advantages to acute health supply chain concerns remains an unfulfilled promise. More research and funding will be required in the future. However, bringing these potential advantages to acute health supply chain concerns remains an unfulfilled promise. Going ahead, further research and investment may be required to improve supply chain performance.

Equally difficult there is a need to identify confidentiality and privacy concerns unique to the healthcare sector, as demonstrated with a need to comply with policy frameworks such as the Health Insurance Portability and Accountability Act (HIPAA) in the United States and the General Data Protection Regulation (GDPR) in the European Union. Although many blockchain initiatives for the health supply chain are still in the Proof of Concept (PoC) or pilot stage, more fully grown installations are all being investigated across other industrial sectors that can be implemented for the healthcare sector and centralized to policy rewards provided by governments (e.g., compatibility with the DSCSA). The possibilities and prospects for the health supply blockchain appear to be limitless, however only time will prove if the highly regulated and complicated healthcare sector can fully exploit everything that blockchain technology has to offer.

The use of blockchain technology in IOMT computation and medical healthcare is also very young. With its characteristics and qualities, this technology offers significant potential to address some of the most pressing problems in the E-supply chain of the healthcare industry. The ecology might undergo a technological revolution. However, the intensive research effort must be done in the health care insurance and pharmacological supply chains. To ensure optimal patient safety and community health level outcomes, the health E-supply chain must be managed effectively. This is a task that paradoxically depends on but does not fully use cutting-edge innovation. Failures in the medical supply chain, such as the international trade in counterfeit drugs, stock outs and shortages of medications, and security flaws in connected medical equipment, highlight how high stakes this industry is in comparison to others. As a result, solutions must consider and strike a balance between E-supply chain management optimization, supply chain efficiency, and risk mitigation. Enhancing the health supply chain's functionality, resilience, integrity, and data provenance is crucial across all healthcare verticals.

Future study, funding, and design of systems that can be thoroughly assessed for their real determinant of patient safety and public health outcomes will be necessary. There will probably also be a lot of use scenarios in the healthcare industry. Medication recall management and combating prescription drug addiction are two other examples from the pharmaceutical industry that highlight special advantages that a blockchain-powered procurement may provide (e.g., opioids).

Another key method through which blockchain technology might aid in improving supply chain performance is the ability to use decentralized applications to automate procedures and cut expenses. As demonstrated by the requirement to adhere to legal frameworks like the Health Insurance Portability and Accountability Act, it is also difficult to manage privacy and data protection issues specific to the E-supply chain of the healthcare industry.

References

- Abbas, S., Alhwaiti, Y., Fatima, A., Khan, M. A., Khan, M. A., Ghazal, T. M., Kanwal, A., Ahmad, M., & Elmitwally, N. S. (2022). Convolutional neural network based intelligent handwritten document recognition. *Computers Materials and Continua*, 70, 4563–4581.
- Abu-Arqoub, M., Issa, G., Banna, A. E., & Saadeh, H. (2020). Interactive multimedia-based educational system for children using interactive book with augmented reality. *Journal of Computer Science*, 15, 1648–1658.
- Ahmed, G., & Amiri, N. A. (2022). The transformational leadership of the founding leaders of the United Arab Emirates: Sheikh Zayed Bin Sultan Al Nahyan and Sheikh Rashid Bin Saeed Al Maktoum. *International Journal of Technology, Innovation and Management*, 2, 1.
- Al-Hamadi, H., Gawanmeh, A., & Al-Qutayri, M. (2015). Formal validation of QRS wave within ECG. In *2015 International Conference on Information and Communication Technology Research, ICTRC 2015* (Vol. 9, pp. 190–193).
- Al-Hamadi, H., Gawanmeh, A., Baek, J., & Al-Qutayri, M. (2015b). Lightweight security protocol for ECG bio-sensors'. *Wireless Personal Communications*, 95, 5097–5120.
- Al-Naymat, G., Hussain, H., Al-Kasassbeh, M., & Al-Dmour, N. (2021). Accurate detection of network anomalies within SNMP-MIB data set using deep learning. *International Journal of Computer Applications in Technology*, 66, 74–85.
- Al-Tahat, S., & Moneim, O. A. (2020). The impact of artificial intelligence on the correct application of cyber governance in Jordanian commercial banks. *International Journal of Scientific & Technology Research*, 9, 7138–7144.
- Alhamad, A., Alshurideh, M., Alomari, K., Al Kurdi, B., Alzoubi, H., Hamouche, S., & Al-Hawary, S. (2022). The effect of electronic human resources management on organizational health of telecommunications companies in Jordan. *International Journal of Data and Network Science*, 6, 429–438.
- Alhamad, A. Q. M., Akour, I., Alshurideh, M., Al-Hamad, A. Q., Kurdi, B. A., & Alzoubi, H. (2021). Predicting the intention to use google glass: A comparative approach using machine learning models and PLS-SEM. *International Journal of Data and Network Science*, 5, 311–320.
- Ali, A. A. (2021). The impact of information sharing and quality assurance on customer service at UAE banking sector. *International Journal of Technology, Innovation and Management*, 1, 01–17.
- Ali, N., Ahmed, A., Anum, L., Ghazal, T. M., Abbas, S., Khan, M. A., Alzoubi, H. M., & Ahmad, M. (2021). Modelling supply chain information collaboration empowered with machine learning technique. *Intelligent Automation & Soft Computing*, 30, 243–257.
- Ali, N., Ghazal, T. M., Ahmed, A., Abbas, S., Khan, M. A., Alzoubi, H. M., Farooq, U., Ahmad, M., & Khan, M. A. (2022). Fusion-based supply chain collaboration using machine learning techniques. *Intelligent Automation & Soft Computing*, 31, 1671–1687.
- Alnazer, N. N., Alnuaimi, M. A., & Alzoubi, H. M. (2017). Analysing the appropriate cognitive styles and its effect on strategic innovation in Jordanian universities. *International Journal of Business Excellence*, 13, 127–140.

- Alnuaimi, M., Alzoubi, H. M., Ajelat, D., & Alzoubi, A. A. (2021). Towards intelligent organisations: an empirical investigation of learning orientation's role in technical innovation. *International Journal of Innovation and Learning*, 29, 207–221.
- Alsharari, N. (2021). Integrating blockchain technology with internet of things to efficiency. *International Journal of Technology, Innovation and Management*, 1, 01–13.
- Alshurideh, M., Al Kurdi, B., Alzoubi, H. M., Ghazal, T. M., Said, R. A., AlHamad, A. Q., Hamadneh, S., Sahawneh, N., & Al-kassem, A. H. (2022). Fuzzy assisted human resource management for supply chain management issues. *Annals of Operations Research* 1–19.
- Alshurideh, M., Gasaymeh, A., Ahmed, G., Alzoubi, H., & Kurd, B. A. (2020). Loyalty program effectiveness: Theoretical reviews and practical proofs. *Uncertain Supply Chain Management*, 8, 599–612.
- Alshurideh, M. T., Al Kurdi, B., Alzoubi, H. M., Obeidat, B., Hamadneh, S., & Ahmad, A. (2022b). The influence of supply chain partners' integrations on organizational performance: The moderating role of trust. *Uncertain Supply Chain Management*, 10, 1191–1202.
- Alzoubi, H., & Ahmed, G. (2019). Do TQM practices improve organisational success? A case study of electronics industry in the UAE. *International Journal of Economics and Business Research*, 17, 459–472.
- Alzoubi, H. M., Ahmed, G., Al-Gasaymeh, A., & Al Kurdi, B. (2020). Empirical study on sustainable supply chain strategies and its impact on competitive priorities: The mediating role of supply chain collaboration. *Management Science Letters*, 10, 703–708.
- Alzoubi, H. M., & Aziz, R. (2021). Does emotional intelligence contribute to quality of strategic decisions? The mediating role of open innovation. *Journal of Open Innovation: Technology, Market, and Complexity*, 7, 130.
- Alzoubi, H., Alshurideh, M., Kurdi, B. A., Akour, I., & Aziz, R. (2022a). Does BLE technology contribute towards improving marketing strategies, customers' satisfaction and loyalty? The role of open innovation. *International Journal of Data and Network Science*, 6, 449–460.
- Alzoubi, H. M., Ahmed, G., & Alshurideh, M. (2022b). An empirical investigation into the impact of product quality dimensions on improving the order-winners and customer satisfaction. *International Journal of Productivity and Quality Management*, 36, 169–186.
- Alzoubi, H. M., Alshurideh, M. T., Kurdi, B. A., Alhyasat, K. M. K., & Ghazal, T. M. (2022c). The effect of e-payment and online shopping on sales growth: Evidence from banking industry. *International Journal of Data and Network Science*, 6, 1369–1380.
- Alzoubi, H. M., Elrehaile, H., Hanaysha, J. R., Al-Gasaymeh, A., & Al-Adaileh, R. (2022d). The role of supply chain integration and agile practices in improving lead time during the COVID-19 crisis. *The International Journal of Service Science, Management, Engineering, and Technology*, 13, 1–11.
- Alzoubi, H. M., Vij, M., Vij, A., & Hanaysha, J. R. (2021). What leads guests to satisfaction and loyalty in UAE five-star hotels? AHP analysis to service quality dimensions. *Enlightening Tourism. A Pathmaking Journal*, 11, 102–135.
- Alzoubi, H. M., & Yanamandra, R. (2020). Investigating the mediating role of information sharing strategy on agile supply chain in supply chain performance. *Uncertain Supply Chain Management*, 8, 273–284.
- Bibi, R., Saeed, Y., Zeb, A., Ghazal, T. M., Rahman, T., Said, R. A., Abbas, S., Ahmad, M., & Khan, M. A. (2021). Edge ai-based automated detection and classification of road anomalies in VANET using deep learning. *Computational Intelligence and Neuroscience*, 2021, 1–19.
- Bukhari, M. M., Ghazal, T. M., Abbas, S., Khan, M. A., Farooq, U., Wahbah, H., Ahmad, M., & Adnan, K. M. (2022). An intelligent proposed model for task offloading in fog-cloud collaboration using logistics regression. *Computational Intelligence and Neuroscience*.
- Chong, C., Lee, K., & Ahmed, G. (2021). Improving IoT privacy, data protection and security concerns. *International Journal of Technology, Innovation and Management*, 1, 18–33.
- Farouk, M. (2022). Studying human robot interaction and its characteristics. *International Journal of Computations, Information and Manufacturing*, 2, 1.

- Ghazal, T. M., Hasan, M. K., Alkhalfah, A., Abu Bakar, K. A., Omidvar, A., Nafi, N. S., & Agbinya, J. I. (2021). Fischer linear discrimination and quadratic discrimination analysis-based data mining technique for internet of things framework for healthcare. *Frontiers in Public Health*, 9.
- Ghazal, T. M., Abbas, S., Ahmad, M., & Aftab, S., (2022a). An IoMT based ensemble classification framework to predict treatment response in hepatitis C patients. In *2022 International Conference on Business Analytics for Technology and Security, ICBATS 2022* (pp. 1–4).
- Ghazal, T. M., Abbas, S., Munir, S., Khan, M. A., Ahmad, M., Issa, G. F., Zahra, S. B., Khan, M. A., & Hasan, M. K. (2022b). Alzheimer disease detection empowered with transfer learning. *Computers, Materials and Continua*, 70, 5005–5019.
- Ghazal, T. M., Ahmed, Z. E., Hasan, M. K., Hashim, A. A., Saeed, R. A., Mokhtar, R. A., & Singh, S. P. (2022c). Optimization procedure for intelligent internet of things applications. In *2022 International Conference on Business Analytics for Technology and Security, ICBATS 2022* (pp. 1–6).
- Ghazal, T. M., Hasan, M. K., Abdullah, S. N. H., Abubakkar, K. A., & Afifi, M. A. M. (2022d). IoMT-enabled fusion-based model to predict posture for smart healthcare systems. *Computers, Materials and Continua*, 71, 2579–2597.
- Ghazal, T. M., Noreen, S., Said, R. A., Khan, M. A., Siddiqui, S. Y., Abbas, S., Aftab, S., & Ahmad, M. (2022e). Energy demand forecasting using fused machine learning approaches. *Intelligent Automation & Soft Computing*, 31, 539–553.
- Ghazal, T. M., Rehman, A. U., Saleem, M., Ahmad, M., Ahmad, S., & Mehmood, F. (2022f). Intelligent model to predict early liver disease using machine learning technique. In: *2022 International Conference on Business Analytics for Technology and Security, ICBATS 2022* (pp. 1–5).
- Ghazal, T. M., & Taleb, N. (2022). Feature optimization and identification of ovarian cancer using internet of medical things. *Expert Systems*.
- Guergov, S., & Radwan, N. (2021). Blockchain convergence: Analysis of issues affecting IoT, AI and blockchain. *International Journal of Computations, Information and Manufacturing*, 1, 1–17.
- Guntur, S. R., Gorrepati, R. R., & Dirisala, V. R. (2018). Internet of medical things. *Medical Big Data and Internet of Medical Things*, 4, 271–297.
- Hamadneh, S., Pedersen, O., Alshurideh, M., Kurdi, B. A., & Alzoubi, H. M. (2021). An investigation of the role of supply chain visibility into the scottish blood supply chain. *Journal of Legal, Ethical and Regulatory Issues*, 24, 1–12.
- Hanaysha, J., Al-Shaikh, M., & Alzoubi, H. M. (2021). Importance of marketing mix elements in determining consumer purchase decision in the retail market. *The International Journal of Service Science, Management, Engineering, and Technology*, 12, 56–72.
- Hanaysha, J. R., Al-Shaikh, M. E., Joghée, S., & Alzoubi, H. M. (2022). Impact of innovation capabilities on business sustainability in small and medium enterprises. *FIIB Business Review*, 11, 67–78.
- Hasan, M. K., Ghazal, T. M., Saeed, R. A., Pandey, B., Gohel, H., Eshmawi, A. A., Abdel-Khalek, S., & Alkhassawneh, H. M. (2022). A review on security threats, vulnerabilities, and counter measures of 5G enabled Internet-of-Medical-Things. *IET Communications*, 16, 421–432.
- Hasan, M. K., Islam, S., Sulaiman, R., Khan, S., Hashim, A. H. A., Habib, S., Islam, M., Alyahya, S., Ahmed, M. M., Kamil, S., & Hassan, M. A. (2021a). Lightweight encryption technique to enhance medical image security on internet of medical things applications. *IEEE Access*, 9, 47731–47742.
- Hasan, M. K., Musse, M. A., Sherfriz, S. M., Shayla, I., Huda Sheikh Abdullah, S. N., Eklas, H., Nazmus, S. N., & Nguyen, V. (2021b). An improved dynamic thermal current rating model for PMU-based wide area measurement framework for reliability analysis utilizing sensor cloud system cloud system. *IEEE Access*, 9, 14446–14458.

- Islam, S., Khalifa, O. O., Hashim, A. H. A., Hasan, M. K., Razzaque, M. A., & Pandey, B. (2020). Design and evaluation of a multihoming-based mobility management scheme to support inter technology handoff in PNEMO. *Wireless Personal Communications*, 114, 1133–1153.
- Joghee, S., Alzoubi, H. M., & Dubey, A. R. (2020). Decisions effectiveness of FDI investment biases at real estate industry: Empirical evidence from Dubai smart city projects. *International Journal of Scientific & Technology Research*, 9, 3499–3503.
- Khan, M. A. (2021). Challenges facing the application of IoT in medicine and healthcare. *International Journal of Computations, Information and Manufacturing*, 1, 39–55.
- Khan, M. A., Ghazal, T. M., Lee, S. W., & Rehman, A. (2022). Data fusion-based machine learning architecture for intrusion detection. *Computers, Materials and Continua*, 70, 3399–3413.
- Kim, S.-K., Yeun, C. Y., Damiani, E., & Lo, N.-W. (2019). A machine learning framework for biometric authentication using electrocardiogram. *IEEE Access*, 7, 94858–94868.
- Kurdi, B. A., Alshurideh, M., Akour, I., Alzoubi, H. M., Obeidat, B., & Alhamad, A. (2022a). The role of digital marketing channels on consumer buying decisions through eWOM in the Jordanian markets. *International Journal of Data and Network Science*, 6, 1175–1185.
- Kurdi, B. A., Alshurideh, M., Akour, I., Tariq, E., Alhamad, A., & Alzoubi, H. M. (2022b). The effect of social media influencers' characteristics on consumer intention and attitude toward Keto products purchase intention. *International Journal of Data and Network Science*, 6, 1135–1146.
- Kurdi, B. A., Alzoubi, H. M., Akour, I., & Alshurideh, M. T. (2022c). The effect of blockchain and smart inventory system on supply chain performance: Empirical evidence from retail industry. *Uncertain Supply Chain Management*, 10, 1111–1116.
- Lee, K. L., Azmi, N. A. N., Hanaysha, J. R., Alzoubi, H. M., & Alshurideh, M. T. (2022a). The effect of digital supply chain on organizational performance: An empirical study in Malaysia manufacturing industry. *Uncertain Supply Chain Management*, 10, 495–510.
- Lee, K. L., Romzi, P. N., Hanaysha, J. R., Alzoubi, H. M., & Alshurideh, M. (2022b). Investigating the impact of benefits and challenges of IOT adoption on supply chain performance and organizational performance: An empirical study in Malaysia. *Uncertain Supply Chain Management*, 10, 537–550.
- Mehmood, S., Ghazal, T. M., Khan, M. A., Zubair, M., Naseem, M. T., Faiz, T., & Ahmad, M. (2022). Malignancy detection in lung and colon histopathology images using transfer learning with class selective image processing. *IEEE Access*, 10, 25657–25668.
- Mehmood, T., Alzoubi, H. M., Alshurideh, M., Al-Gasaymeh, A., & Ahmed, G. (2019). Schumpeterian entrepreneurship theory: Evolution and relevance. *Academy of Entrepreneurship Journal*, 25, 1–10.
- Mejia, C., Ciarlante, K., & Chheda, K. (2019). A wearable technology solution and research agenda for housekeeper safety and health. *International Journal of Contemporary Hospitality Management*, 1–3.
- Neaimi, M. Al, Hamadi, H. Al, Yeun, C. Y., & Jamal Zemerly, M. (2020). Digital forensic analysis of files using deep learning. In *2020 3rd International Conference on Signal Processing and Information Security, ICSPIS 2020* (pp. 1–4). IEEE.
- Radwan, N. (2022). The internet's role in undermining the credibility of the healthcare industry. *International Journal of Computations, Information and Manufacturing*, 2, 1.
- Radwan, N., & Farouk, M. (2021). The growth of internet of things (IoT) in the management of healthcare issues and healthcare policy development. *International Journal of Technology, Innovation and Management*, 1, 69–84.
- Ramakrishna, Y., & Alzoubi, H. M. (2022). Empirical investigation of mediating role of six sigma approach in rationalizing the COQ in service organizations. *Operations and Supply Chain Management*, 15, 122–135.
- Saleem, M., Abbas, S., Ghazal, T. M., Adnan Khan, M., Sahawneh, N., & Ahmad, M. (2022). Smart cities: Fusion-based intelligent traffic congestion control system for vehicular networks using machine learning techniques. *Egyptian Informatics Journal*.

- Shamout, M., Ben-Abdallah, R., Alshurideh, M., Alzoubi, H., Kurdi, B. A., & Hamadneh, S. (2022). A conceptual model for the adoption of autonomous robots in supply chain and logistics industry. *Uncertain Supply Chain Management*, 10, 577–592.
- Shehada, D., Yeun, C. Y., Zemerly, M. J., Qutayri, M. Al, Hammadi, Y. Al, Damiani, E., & Hu, J. (2017). BROSMAP: A novel broadcast based secure mobile agent protocol for distributed service applications. In *Security and Communication Networks*, (Vol. 2017). Wiley.
- Siddiqui, S. Y., Haider, A., Ghazal, T. M., Khan, M. A., Naseer, I., Abbas, S., Rahman, M., Khan, J. A., Ahmad, M., Hasan, M. K., Mohammed, A., & Ateeq, K. (2021). IoMT cloud-based intelligent prediction of breast cancer stages empowered with deep learning. *IEEE Access*, 9, 146478–146491.
- Teahan, W. J., Al-Dmour, N. A., & Tuff, P. G. (2012). Knowledge distribution in multi agent systems. *Asian Journal of Information Technology*, 11, 300–311.
- Vo, D. L., Lee, H., Yeun, C. Y., & Kim, K. (2010). Enhancements of authenticated multiple key exchange protocol based on bilinear pairings. *Computers & Electrical Engineering*, 36, 155–159.
- Zafar, S., Asif, M., Ahmad, M. B., Ghazal, T. M., Faiz, T., Ahmad, M., & Khan, M. A. (2022). Assistive devices analysis for visually impaired persons: A review on taxonomy. *IEEE Access*, 10, 13354–13366.
- Zitar, R. A., Al-Dmour, N., Nachouki, M., Hussain, H., & Alzoubi, F. (2021). Hashing generation using recurrent neural networks for text documents. *ICIC Express Letters, Part b: Application*, 12, 231–241.

Advances of Medical Internet of Things Based Patient Health Monitoring Systems



Ali A. Alzoubi, Mohammed Al-Wahni, and Haitham M. Alzoubi 

Abstract There have been attempts to use modern technology in numerous sectors to improve the quality of human life as technology has improved and sensors have been miniaturized. The healthcare sector is one major field of research that has witnessed technology adoption. People in need of healthcare services find it prohibitively expensive, particularly in developing nations. The IoT - Enabled concepts have been frequently utilized to connect various medical resources and provide patients with smart, dependable, and effective healthcare services. A few of the approaches that could really employ IoT services to enhance the patient's lifestyle is health monitoring for active and supported living. In this research, I introduced an Implementation framework tailored to application domains. The project's objective was to develop a Remote Monitoring Device that could be constructed with locally accessible sensors and would be economical if mass produced. As an outcome, this initiative is an opportunity to rectify a contemporary healthcare issue in society. The project's major goal was to create a virtual healthcare system. It is composed of three layers. The first stage involved using technology to sense the patient's health data, the second uploading data to cloud preservation, and the last delivering the observed data for extrasensory perception. A doctor or guardian can monitor a patient's health development while they are not in the hospital by accessing information remotely. As a result, the suggested architecture captures sensor data via the Arduino micro controller and distributes it to the cloud, where it is gathered and analyzed for remote viewing. In the case of emergency, feedback actions based on the collected data can be communicated back to the doctor or guardian by email and/or SMS.

A. A. Alzoubi
Public Security Directorate, Amman, Jordan

M. Al-Wahni
School of Information Technology, Skyline University College, Sharjah, UAE

H. M. Alzoubi (✉)
School of Business, Skyline University College, Sharjah, UAE
e-mail: haitham.alzoubi@skylineuniversity.ac.ae

Applied Science Research Center, Applied Science Private University, Amman, Jordan

Keywords IoT · Gadgets · Security · Telehealth

1 Introduction

The system is an extension of a typical hospital system that allows for remote monitoring of a patient's entire body status (Guntur et al., 2018). Detection systems were previously only found in hospitals and were distinguished by massive and complicated circuitry that needed a significant power consumption (Ghazal et al., 2021a; Hamadneh et al., 2021; Hanaysha et al., 2022). Continuous advancements in the semiconductor technology industry have resulted in sensors and micro controllers that are smaller in size (Alzoubi et al., 2022b), faster in operation, consume less power, and are less expensive (Alshurideh et al., 2020; Cruz, 2021). This has led to significant advancements in the remote monitoring of patients' vital signs, particularly those who are old (Kashif et al., 2021). The following scenarios can use the system:

- It is recognized that a patient has a medical ailment with an unstable regulatory body system. This occurs when a new medicine is presented to a patient (Alzoubi 2021a; Ghazal et al., 2022j).
- A patient is prone to heart attacks or has had one in the past. The vital signs can be monitored to predict and warn of any changes in the body's condition (Kurdi et al., 2022c).
- A critical organ crisis.
- The circumstance that has resulted in the formation of a potentially fatal life-threatening ailment. This is for persons who are of senior age and may have deteriorating health conditions (Al-Dmour, 2020).
- To determine which training regimens will offer the best results for Athletes in training.

Almost all of the techniques were implemented in industrialized countries where the technology is flawless (Alshurideh et al., 2022; Aziz & Aftab, 2021). Most approaches are allowed to work in underdeveloped countries (Al Hamadi et al., 2017). To address some of these issues [10], ubiquitous identification must be developed from the bottom up to accommodate the lowest minimal parameters (Al-Hamadi et al. 2015a) generally available in developing countries (Al-Nashashibi et al., 2021; Alzoubi & Aziz, 2021). The range of indicators that can still be recognized by a simple tele monitoring proposed system can be assessed (Alnazer et al., 2017). Under certain contexts, observing any component allows the estimation among many estimates (Alzoubi, 2022). Component monitoring is improved for the following purposes:

- Specified input surveillance process: Therefore in approach, an unique measure, as well as a cardiovascular readout, is maintained (Al-Hamadi et al. 2015b; Ghazal et al., 2021b). Depending upon the method applied, several readings can be received from the ECG or cardiac recognition (Ghazal et al., 2022j). An ECG

reading can provide information such as energy levels and oxygen levels (Al Hamadi et al., 2017).

- Monitoring and control system with different factors: Different elements are also being examined at around the same time in this situation (Vo et al., 2010). High Dependency Unit (HDU), Intensive Care Units (ICU), during operations in a healthcare stage (Gul et al., 2012), or post-surgical rehabilitation facilities in clinics are illustrations of such schemes. The ECG, blood pressure, and breathing rates were amongst the characteristics that are analyzed (Ghazal et al., 2021c).

1.1 Problem Statement

In the environment, telehealth would provide significant diagnostic data (Mehmood et al., 2019). This monitoring is important for geriatric or continuously uncomfortable individuals who seek to avoid an extended hospitalization (Ali et al., 2021; Lee et al., 2022b). Smart objects are utilized to collect and transfer information of significance, and a processing is set up to pick up and evaluate the sensor information continuously (Alnuaimi et al., 2021). In this project, you will find specific biosensor based on whatever you want to observe and develop techniques to accomplish your findings. Examples have included the observation of a collapse and the measurement of cardiovascular signals (Ghazal et al., 2022i).

A telemedicine system was introduced that used a parametric tracking system (Akhtar et al., 2021), whereby stretches treatment from either the conventional clinic environment to the care facility (Shamout et al., 2022; Shehada et al., 2017). The program was conducted to collect information from a heartbeat detection system, a fall detection system, ambient temperature, and the few other indicators (Alzoubi, 2021; Islam et al., 2020). Statistics from parametric monitoring equipment were then made accessible for distant monitoring (Alzoubi et al., 2022b).

The relevant possible healthcare application criteria been committed to throughout design:

- Unification with current developments in healthcare management and processes (Ramakrishna & Alzoubi, 2022),
- Authentic, protracted, real-time remote, small, wearable sensors, and high reliability of a specified system (Farouk, 2021).
- Supporting the geriatric and chronically ill individuals. The device should really be simple to use, and with very few key (Alkeem et al., 2017).

1.2 Existing System

In the current status quo, we leverage current network solutions that enable various sensors to an unified PMS (Ghazal et al., 2022f). So many possibly owing of the

individuals are monitored regularly by an unique PMS and relayed to the Doctors or Nurses on duty for immediate care in crisis situations (Alzoubi et al., 2022f).

The gadgets are implanted to the patients' organs without incurring them any stress (Mehmood, 2021). In this PMS, we leverage easily available devices to sense crucial physical attributes such as normal temperature, ECG (Al Hamadi et al., 2017; Hanaysha et al., 2021), respiratory rate (Ghazal et al., 2022c), and pulse rate (Ghazal et al., 2022h). Thus, the physical quantities collected by the sensing devices are fed into a microprocessor linked to it. The microcontroller analyzes these analog voltage values for physiological factors and transfers those to converting digital using an ADC.

1.3 Proposed System

The fundamental plan is to develop a Patient Monitoring Set of two transmission (Lee et al., 2022a), that also means that not only would the patient's statistics be communicated to the doctor over SMS and email in a crisis (Alzoubi et al., 2022a; Ghazal et al., 2022e), but the doctor may also provide essential recommendations towards the patient or caretakers via SMS (Kurdi et al., 2022a; Miller, 2021), call, or email. In additional, the physician or caretaker can monitor the patient's movement at any point through Google Maps, providing vital procedures to be summoned in the interest of safety for quasi patients (Al-Hamadi et al., 2021; Alzoubi et al., 2022b; Ghazal et al., 2022k) (Fig. 1).

1.4 Patient Health Monitoring System

Clinicians essentially make judgements regarding possibly competing ethical claims when balancing therapeutic value and the right to privacy in remote monitoring (Hasan et al., 2021a). Respect for autonomy, no maleficence, beneficence, and justice are the four widely accepted principles of medical ethics (Ghazal & Taleb, 2022; Joghee et al., 2020).

Providing informed consent for remote monitoring constitutes respect for autonomy (Alzoubi & Ahmed, 2019; Alzoubi et al., 2022c; Saad Masood Butt, 2022). The individual patient must give informed consent to perform remote data collection, transmission, and disclosure, and he or she must do so specifically, voluntarily, and have the mental capacity to grasp the implications of their decision (Al-Dmour & Teahan, 2005; Alzoubi et al., 2022d).

The harmlessness of remote monitoring is primarily related to the security and confidentiality of the data and to the responsibility of the person responsible for avoiding data loss, whether accidental or hacked (Ghazal et al., 2022i). As part of informed consent, patients can reasonably expect their information to be kept confidential (Hasan et al., 2021b). Considerations regarding the benefits of remote

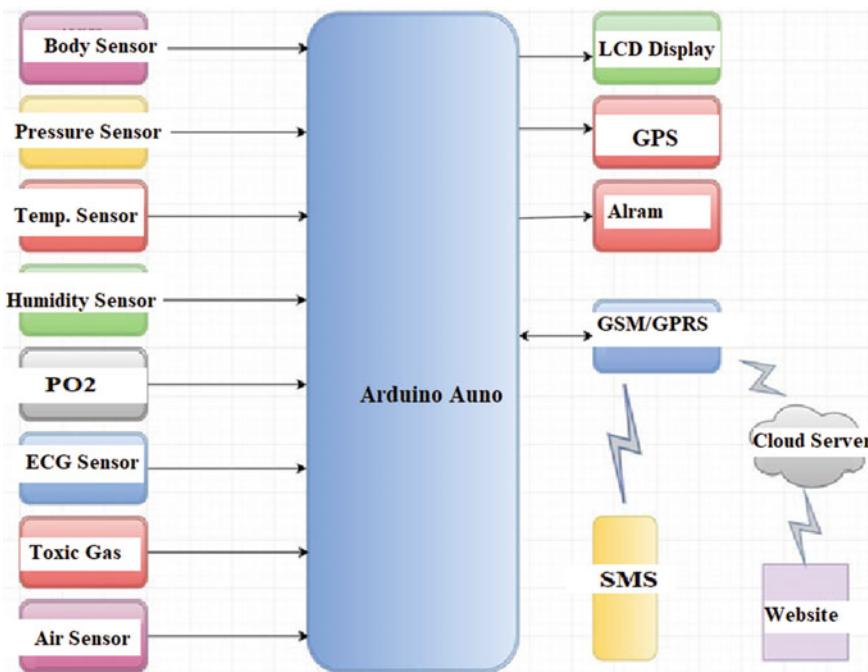


Fig. 1 Block diagram for proposed system (Ghazal et al., 2022f)

monitoring relate to the main benefits of interventions for individual patients (Ghazal et al., 2022g).

In the medical field, justice requires that everyone be treated fairly and have access to equal care as their peers. In health care, equity must take into account that most resources are finite, but distributive criteria are applied equitably to all individuals; in other words, distributive justice is maintained (Alzoubi & Yanamandra, 2020).

Security is one of the most critical parts of any healthcare system, and it must be functional in order to preserve privacy and confidentiality (Alzoubi et al., 2022e; Ghazal et al., 2021d). In other words, inadequate data security has the potential to negate the clinical benefits of remote monitoring (Hujran et al., 2020). Encryption and authentication are two general-level security procedures that can be used to combat serious threats to information (Ghazal et al., 2022b; Kurdi et al., 2022b). It is necessary to exchange encrypted personal health information and data over the network (Alzoubi et al., 2022a).

2 Literature Review

Development and Clinical Evaluation of a Home Healthcare System Measuring in Toilet, Bathtub and Bed without Attachment of Any Biological Sensors. Frequent telemedicine at home is necessary for efficient strategy for clinical prediction, care, and management of way of life conditions such as obesity, diabetes, and cardiovascular disease (Alzoubi et al., 2020; Ghazal et al., 2022d). While many commercially available technologies for telehealth monitoring are routinely used, however are problematic in associated with self and personality of physiological instruments. From this perspective, we have really been focusing on a non-conscious physiologically surveillance system (Ghazal et al., 2022a) that doesn't even necessitate any equipment to be mounted to the patient's psyche or any metrics (Alzoubi et al., 2021b). Researchers invented specific instruments that could be deployed in a toilet, a bath, or a bed and confirmed their exceptional accuracy of this experiment by matching them to contemporaneous observations of conventional organic sensors that were actually connected to a common.

The whole paper proposes the design of a component that delivers accessibility to the therapist and client by using a simple and popular methodology, able to detect malformations in the physician's bio pulse in anticipation and transferring a SMS notification to the doctor via Global System for Mobile (GSM), while also actively taking sensible precautions and bringing down the patient's significant point. The World Health Organization (WHO) has completed nationwide surveys that have established that heart-related disorders are on the rise.

3 Research Methodology

Methodology create a Remote Patient Health Monitoring System (RPHMS) that incorporates heartbeat measurement, fault diagnosis, warmth detection, wetness identification, poisonous gas and air quality detection, and SPO2 measurement. A doctor or health consultant can utilise the technology to monitoring the patient's or individual of convenience's key health indicators. An aims to establish a global health service using commonly accessible resources.

- The SPO2 modules, which include a fall detector, temperature, moisture, pressure, noxious fumes, and air quality assurance, are constituted of a gyroscope, wireless broadcaster, and controller. The data obtained was wirelessly delivered to a receiving antenna.
- An ECG is comprised of a non-invasive thermal finger detection, a Liquid Crystal Display (LCD), a cardiovascular diagnostic device, and a processor. The discovered analogue signal was then transformed and seen on the LCD as a numerical code.
- A simple internet server with a repository where all critical data can be retrieved remotely anytime requested.

4 Discussions

For clinics, since numerous patients' biological states must still be checked constantly as part of either a diagnostic method, an outlay and faster warning technique is important. While such equipment is properly implemented, they can deliver real-time alerts to emergency doctors and doctors, and their operations can be engaged in the event of a medical emergency. Sensors hardwired to a PC nearby to the bed can be used in newer systems. base through which all valuable data can be viewed remotely anytime requested. Sensors monitor the patient's symptoms, and information is collected and even sent using a microcontroller. Medical professionals must check the patient on a frequent basis to evaluate his or her present state. Furthermore, the employment of many microcontroller-based intelligent systems provides higher usefulness in hospitals where too many patients must be monitored on a constant schedule. Proposed system consists of following sensors and modules -Arduino Micro Controller, ECG, GSM/GPRS Module, Temperature sensor, Pressure sensor, Body Movement Sensor, Humidity Sensor, Toxic Gas sensor and Air Quality sensor.

5 Conclusions

The experiment's primary goal was met with success. Many of the individual units, such as the heartbeat detection module, the fall detection module, and the remote viewing module, produced the desired results. The specified necessary elements can then be standardized and assembled as a single circuit. More crucially, while proposed project, it was revealed that many of the switching devices utilized in the tele-health detection system are free and accessible. Micro Electro Mechanical Systems (MEMs) and microcontrollers have been more economical, smaller, and cost efficient as the programmable logic industry has developed. This has resulting in an upsurge in the development of embedded systems, which medical practitioners are adopting.

The Internet of Things-based Remote Medical Monitoring System is increased to identify and collect data on a variety of anomalies for monitoring purposes, including home ultrasonography, neurophysiologic surveillance, target organ damage, and so forth. Further investigation on the issues connected having details online, and data protection, as IoT is administered and operated by many solutions, with various companies participating. Encryption algorithms and user caution will aid towards avoiding safety problems in IoT networks. The dashboard can be meant to control which sensors people can use consumer's needs. Online Interface can be upgraded to accomplish tasks such as physical management, authentic diagrams, record, and evaluation diagrams.

References

- Akhtar, A., Akhtar, S., Bakhtawar, B., Kashif, A. A., Aziz, N., & Javeid, M. S. (2021). COVID-19 detection from CBC using machine learning techniques. *International Journal of Technology, Innovation and Management*, 1, 65–78.
- Al-Dmour, N., & Teahan, W. (2005). The blackboard resource discovery mechanism for distributed computing over P2P networks. In International, T. (Ed.), *PDCN. Conference on Parallel and Distributed Computing and Networks, Innsbruck, Austria, February* (pp. 15–17).
- Al-Dmour, N. A. (2020). Using unstructured search algorithms for data collection in iot-based WSN. *International Journal of Engineering Research & Technology*, 13, 1992–1998.
- Al-Hamadi, H., Gawanmeh, A., & Al-Qutayri, M. (2015). Formal validation of QRS wave within ECG. In *2015 International Conference on Information and Communication Technology Research, ICTRC 2015* (Vol. 9, pp. 190–193).
- Al-Hamadi, H., Gawanmeh, A., Baek, J., & Al-Qutayri, M. (2015b). Lightweight security protocol for ECG bio-sensors. *Wireless Personal Communications*, 95, 5097–5120.
- Al-Hamadi, H., Nasir, N., Yeun, C. Y., Damiani, E. (2021). A verified protocol for secure autonomous and cooperative public transportation in smart cities. In June, I. (Ed.), *2021 IEEE International Conference on Communications Workshops (ICC Workshops)* (pp. 1–6).
- Al-Nashashibi M., Hadi, W., El-Khalili, N., Ghassan, I., & AlBanna, A. (2021). A new two-step ensemble Learn. Model Improv. Stress Predict. Automob. Drivers. *The International Arab Journal of Information Technology*, 6.
- Al Hamadi, H., Gawanmeh, A., & Al-Qutayri, M. (2017). Guided test case generation for enhanced ECG bio-sensors functional verification. *The Journal of E-Health and Medical Communications*, 8, 1–20.
- Ali, N., Ahmed, A., Anum, L., Ghazal, T. M., Abbas, S., Khan, M. A., Alzoubi, H. M., & Ahmad, M. (2021). Modelling supply chain information collaboration empowered with machine learning technique. *Intelligent Automation & Soft Computing*, 30, 243–257.
- Alkeem, E. A., Shehada, D., Yeun, C. Y., Zemerly, M. J., & Hu, J. (2017). New secure healthcare system using cloud of things. *Cluster Computing*, 20(3), 2211–2229.
- Alnazer, N. N., Alnuaimi, M. A., & Alzoubi, H. M. (2017). Analysing the appropriate cognitive styles and its effect on strategic innovation in Jordanian universities. *International Journal of Business Excellence*, 13, 127–140.
- Alnuaimi, M., Alzoubi, H. M., Ajelat, D., & Alzoubi, A. A. (2021). Towards intelligent organisations: An empirical investigation of learning orientation's role in technical innovation. *International Journal of Innovation and Learning*, 29, 207–221.
- Alshurideh, M., Gasaymeh, A., Ahmed, G., Alzoubi, H., & Kurd, B. A. (2020). Loyalty program effectiveness: Theoretical reviews and practical proofs. *Uncertain Supply Chain Management*, 8, 599–612.
- Alshurideh, M., Kurdi, B., Alzoubi, H., Obeidat, B., Hamadneh, S., & Ahmad, A. (2022). The influence of supply chain partners' integrations on organizational performance: The moderating role of trust. *Uncertain Supply Chain Management*, 10, 1191–1202.
- Alzoubi, A. (2021). The impact of process quality and quality control on organizational competitiveness at 5-star hotels in Dubai. *International Journal of Technology, Innovation and Management*, 1, 54–68.
- Alzoubi, H., & Ahmed, G. (2019). Do TQM practices improve organisational success? A case study of electronics industry in the UAE. *International Journal of Economics and Business Research*, 17, 459–472.
- Alzoubi, H., Alhamad, A. Q. M., Akour, I., Alshurideh, M., Al-Hamad, A. Q., Kurdi, B. A., & Alzoubi, H. (2021a). Predicting the intention to use google glass: A comparative approach using machine learning models and PLS-SEM. *International Journal of Data and Network Science*, 5, 311–320.

- Alzoubi, H. M., Vij, M., Vij, A., & Hanaysha, J. R. (2021b). What leads guests to satisfaction and loyalty in UAE five-star hotels? AHP analysis to service quality dimensions. *Enlightening Tourism*, 11, 102–135.
- Alzoubi, H., Alhamad, A., Alshurideh, M., Alomari, K., Al Kurdi, B., Hamouche, S., & Al-Hawary, S. (2022a). The effect of electronic human resources management on organizational health of telecommunications companies in Jordan. *International Journal of Data and Network Science*, 6, 429–438.
- Alzoubi, H., Alshurideh, M., Kurdi, B. A., Akour, I., & Aziz, R. (2022b). Does BLE technology contribute towards improving marketing strategies, customers' satisfaction and loyalty? The role of open innovation. *International Journal of Data and Network Science*, 6, 449–460.
- Alzoubi, H. M., Ahmed, G., & Alshurideh, M. (2022c). An empirical investigation into the impact of product quality dimensions on improving the order-winners and customer satisfaction. *International Journal of Productivity and Quality Management*, 36, 169–186.
- Alzoubi, H. M., Ali, N., Ghazal, T. M., Ahmed, A., Abbas, S., Khan, M. A., Farooq, U., Ahmad, M., & Khan, M. A. (2022d). Fusion-based supply chain collaboration using machine learning techniques. *Intelligent Automation & Soft Computing*, 31, 1671–1687.
- Alzoubi, H. M., Alshurideh, M. T., Al Kurdi, B., Ghazal, T. M., Said, R. A., AlHamad, A. Q., Hamadneh, S., Sahawneh, N., & Al-kassem, A. H. (2022e). Fuzzy assisted human resource management for supply chain management issues. *Annals of Operations Research*, 1–19.
- Alzoubi, H. M., Alshurideh, M. T., Kurdi, B. A., Alhyasat, K. M. K., & Ghazal, T. M. (2022f). The effect of e-payment and online shopping on sales growth: Evidence from banking industry. *International Journal of Data and Network Science*, 6, 1369–1380.
- Alzoubi, H. M., Elrehail, H., Hanaysha, J. R., Al-Gasaymeh, A., & Al-Adaileh, R. (2022g). The role of supply chain integration and agile practices in improving lead time during the COVID-19 crisis. *The International Journal of Service Science, Management, Engineering, and Technology*, 13, 1–11.
- Alzoubi, H. M., In'airat, M., & Ahmed, G. (2022h). Investigating the impact of total quality management practices and Six Sigma processes to enhance the quality and reduce the cost of quality: The case of Dubai. *International Journal of Business Excellence*, 27, 94–109.
- Alzoubi, H. M., Ahmed, G., Al-Gasaymeh, A., & Al Kurdi, B. (2020). Empirical study on sustainable supply chain strategies and its impact on competitive priorities: The mediating role of supply chain collaboration. *Management Science Letters*, 10, 703–708.
- Alzoubi, H. M., & Aziz, R. (2021). Does emotional intelligence contribute to quality of strategic decisions? The mediating role of open innovation. *Journal of Open Innovation: Technology, Market, and Complexity*, 7, 130.
- Alzoubi, H. M., & Yanamandra, R. (2020). Investigating the mediating role of information sharing strategy on agile supply chain. *Uncertain Supply Chain Management*, 8, 273–284.
- Alzoubi, A. (2022). Machine learning for intelligent energy consumption in smart homes. *International Journal of Computations, Information and Manufacturing*, 2, 1.
- Aziz, N., & Aftab, S. (2021). Data mining framework for nutrition ranking: methodology: SPSS modeller. *International Journal of Technology, Innovation and Management*, 1, 85–95.
- Cruz, A. (2021). Convergence between blockchain and the internet of things. *International Journal of Technology, Innovation and Management*, 1, 34–53.
- Farouk, M. (2021). The universal artificial intelligence efforts to face coronavirus COVID-19. *International Journal of Computations, Information and Manufacturing*, 1, 77–93.
- Ghazal, T., Hasan, M., Alshurideh, M., Alzoubi, H. M., Ahmad, M., Akbar, S., Al Kurdi, B., & Akour, I. (2021a). IoT for smart cities: Machine learning approaches in smart healthcare-A review. *Future Internet*, 13, 218.
- Ghazal, T. M., Bibi, R., Saeed, Y., Zeb, A., Rahman, T., Said, R. A., Abbas, S., Ahmad, M., & Khan, M. A. (2021b). Edge AI-based automated detection and classification of road anomalies in VANET using deep learning. *Computational Intelligence and Neuroscience*, 2021, 1–19.

- Ghazal, T. M., Hasan, M. K., Alkhalifah, A., Abu Bakar, K. A., Omidvar, A., Nafi, N. S., & Agbinya, J. I. (2021c). *Fischer Linear discrimination and quadratic discrimination analysis-based data mining technique for internet of things framework for healthcare* (p. 9). Public Heal.
- Ghazal, T. M., Siddiqui, S. Y., Haider, A., Khan, M. A., Naseer, I., Abbas, S., Rahman, M., Khan, J. A., Ahmad, M., Hasan, M. K., Mohammed, A., & Ateeq, K. (2021d). IoMT cloud-based intelligent prediction of breast cancer stages empowered with deep learning. *IEEE Access*, 9, 146478–146491.
- Ghazal, T. M., Abbas, S., Ahmad, M., & Aftab, S. (2022a). An IoMT based ensemble classification framework to predict treatment response in hepatitis C patients. In *2022 International Conference on Business Analytics for Technology and Security, ICBATS 2022* (pp. 1–4).
- Ghazal, T. M., Abbas, S., Alhwaiti, Y., Fatima, A., Khan, M. A., Khan, M. A., Kanwal, A., Ahmad, M., & Elmitwally, N. S. (2022b). Convolutional neural network based intelligent handwritten document recognition. *Computers, Materials and Continua*, 70, 4563–4581.
- Ghazal, T. M., Abbas, S., Munir, S., Khan, M. A., Ahmad, M., Issa, G. F., Zahra, S. B., Khan, M. A., & Hasan, M. K. (2022c). Alzheimer disease detection empowered with transfer learning. *Computers, Materials and Continua*, 70, 5005–5019.
- Ghazal, T. M., Ahmed, Z. E., Hasan, M. K., Hashim, A. A., Saeed, R. A., Mokhtar, R. A., & Singh, S. P. (2022d). Optimization procedure for intelligent internet of things applications. In *2022 International Conference on Business Analytics for Technology and Security, ICBATS 2022* (pp. 1–6).
- Ghazal, T. M., Bukhari, M. M., Abbas, S., Khan, M. A., Farooq, U., Wahbah, H., Ahmad, M., Adnan, K. M. (2022e). An intelligent proposed model for task offloading in fog-cloud collaboration using logistics regression. *Computational Intelligence and Neuroscience*.
- Ghazal, T. M., Hasan, M. K., Abdullah, S. N. H., Abubakkar, K. A., & Afifi, M. A. M. (2022f). IoMT-enabled fusion-based model to predict posture for smart healthcare systems. *Computers, Materials and Continua*, 71, 2579–2597.
- Ghazal, T. M., Hasan, M. K., Saeed, R. A., Pandey, B., Gohel, H., Eshmawi, A. A., Abdel-Khalek, S., & Alkhassawneh, H. M. (2022g). A review on security threats, vulnerabilities, and counter measures of 5G enabled Internet-of-Medical-Things. *IET Communications*, 16, 421–432.
- Ghazal, T. M., Khan, M. A., Lee, S. W., & Rehman, A. (2022h). Data fusion-based machine learning architecture for intrusion detection. *Computers, Materials and Continua*, 70, 3399–3413.
- Ghazal, T. M., Mehmood, S., Khan, M. A., Zubair, M., Naseem, M. T., Faiz, T., & Ahmad, M. (2022i). Malignancy detection in lung and colon histopathology images using transfer learning with class selective image processing. *IEEE Access*, 10, 25657–25668.
- Ghazal, T. M., Noreen, S., Said, R. A., Khan, M. A., Siddiqui, S. Y., Abbas, S., Aftab, S., & Ahmad, M. (2022j). Energy demand forecasting using fused machine learning approaches. *Intelligent Automation and Soft Computing*.
- Ghazal, T. M., Rehman, A. U., Saleem, M., Ahmad, M., Ahmad, S., & Mehmood, F. (2022k). Intelligent model to predict early liver disease using machine learning technique. In *2022 International Conference on Business Analytics for Technology and Security, ICBATS 2022* (pp. 1–5).
- Ghazal, T. M., Zafar, S., Asif, M., Ahmad, M. B., Faiz, T., Ahmad, M., & Khan, M. A. (2022l). Assistive devices analysis for visually impaired persons: A review on taxonomy. *IEEE Access*, 10, 13354–13366.
- Ghazal, T. M., & Taleb, N. (2022). Feature optimization and identification of ovarian cancer using internet of medical things, *Expert Systems*.
- Gul, O., Al-Qutayri, M., Yeun, C. Y., & Vu, Q. H. (2012). Framework of a national level electronic health record system. In *Proceedings of 2012 International Conference on Cloud Computing Technologies, Applications and Management, ICCCTAM 2012. Applications and Management (ICCTAM), Dubai, UAE, December* (pp. 60–65).
- Guntur, S. R., Gorrepati, R. R., & Dirisala, V. R. (2018). Internet of medical things. *Medical Big Data and Internet of Medical Things*, 4, 271–297.

- Hamadneh, S., Pedersen, O., Alshurideh, M., Kurdi, B. A., & Alzoubi, H. M. (2021). An investigation of the role of supply chain visibility into the scottish blood supply chain. *The Journal of Legal, Ethical and Regulatory Issues*, 24, 1–12.
- Hanaysha, J., Al-Shaikh, M., & Alzoubi, M. H. (2021). Importance of marketing mix elements in determining consumer purchase decision in the retail market. *The International Journal of Service Science, Management, Engineering, and Technology*, 12, 56–72.
- Hanaysha, J. R., Al-Shaikh, M. E., Joghee, S., & Alzoubi, H. M. (2022). Impact of innovation capabilities on business sustainability in small and medium enterprises. *FIIB Business Review*, 11, 67–78.
- Hasan, M. K., Islam, S., Sulaiman, R., Khan, S., Hashim, A. H. A., Habib, S., Islam, M., Alyahya, S., Ahmed, M. M., Kamil, S., & Hassan, M. A. (2021a). Lightweight encryption technique to enhance medical image security on internet of medical things applications. *IEEE Access*, 9, 47731–47742.
- Hasan, M. K., Musse, M. A., Sherfriz, S. M., Shayla, I., Huda, S. N. A. S., Eklas, H., Nazmus S. N., & Nguyen, V. (2021). An improved dynamic thermal current rating model for pmu-based wide area measurement framework for reliability analysis utilizing sensor cloud system. *IEEE Access*, 9, 14446–14458.
- Hujran, O., Alikaj, A., Durrani, U. K., Al-Dmour, N. (2020). Big data and its effect on the music industry. In: *ACM International Conference Proceeding Series* (pp. 5–9).
- Islam, S., Khalifa, O. O., Hashim, A. H. A., Hasan, M. K., Razzaque, M. A., & Pandey, B. (2020). Design and evaluation of a multihoming-based mobility management scheme to support inter technology handoff in PNEMO. *Wireless Personal Communications*, 114, 1133–1153.
- Joghee, S., Alzoubi, H. M., & Dubey, A. R. (2020). Decisions effectiveness of FDI investment biases at real estate industry: Empirical evidence from Dubai smart city projects. *International Journal of Scientific & Technology Research*, 9, 3499–3503.
- Kashif, A. A., Bakhtawar, B., Akhtar, A., Akhtar, S., Aziz, N., & Javeid, M. S. (2021). Treatment response prediction in hepatitis C patients using machine learning techniques. *International Journal of Technology, Innovation and Management*, 1, 79–89.
- Kurdi, B. A., Alshurideh, M., Akour, I., Alzoubi, H. M., Obeidat, B., & Alhamad, A. (2022a). The role of digital marketing channels on consumer buying decisions through eWOM in the Jordanian markets. *International Journal of Data and Network Science*, 6, 1175–1185.
- Kurdi, B. A., Alshurideh, M., Akour, I., Tariq, E., Alhamad, A., & Alzoubi, H. M. (2022b). The effect of social media influencers' characteristics on consumer intention and attitude toward Keto products purchase intention. *International Journal of Data and Network Science*, 6, 1135–1146.
- Kurdi, B. A., Alzoubi, H. M., Akour, I., & Alshurideh, M. T. (2022c). The effect of blockchain and smart inventory system on supply chain performance: Empirical evidence from retail industry. *Uncertain Supply Chain Management*, 10, 1111–1116.
- Lee, K. L., Azmi, N. A. N., Hanaysha, J. R., Alzoubi, H. M., & Alshurideh, M. T. (2022a). The effect of digital supply chain on organizational performance: An empirical study in Malaysia manufacturing industry. *Uncertain Supply Chain Management*, 10, 495–510.
- Lee, K. L., Romzi, P. N., Hanaysha, J. R., Alzoubi, H. M., & Alshurideh, M. (2022b). Investigating the impact of benefits and challenges of IOT adoption on supply chain performance and organizational performance: An empirical study in Malaysia. *Uncertain Supply Chain Management*, 10, 537–550.
- Mehmood, T. (2021). Does information technology competencies and fleet management practices lead to effective service delivery? Empirical evidence from E-commerce industry. *International Journal of Technology, Innovation and Management*, 1, 14–41.
- Mehmood, T., Alzoubi, H. M., Alshurideh, M., Al-Gasaymeh, A., & Ahmed, G. (2019). Schumpeterian entrepreneurship theory: Evolution and relevance. *Academic Entrepreneur Journal*, 25, 1–10.
- Miller, D. (2021). The best practice of teach computer science students to use paper prototyping. *International Journal of Technology, Innovation and Management*, 1, 42–63.

- Ramakrishna, Y., & Alzoubi, H. M. (2022). Empirical investigation of mediating role of six sigma approach in rationalizing the COQ in service organizations. *Operations and Supply Chain Management*, 15, 122–135.
- Saad Masood Butt. (2022). Management and treatment of Type 2 diabetes. *International Journal of Computations, Information and Manufacturing*, 2, 1.
- Shamout, M., Ben-Abdallah, R., Alshurideh, M., Alzoubi, H., Al Kurdi, B., & Hamadneh, S. (2022). A conceptual model for the adoption of autonomous robots in supply chain and logistics industry. *Uncertain Supply Chain Management*, 10, 577–592.
- Shehada, D., Yeun, C. Y., Zemerly, M. J., Al Qutayri, M., Al Hammadi, Y., Damiani, E., & Hu, J. (2017). BROSMAP: A novel broadcast based secure mobile agent protocol for distributed service applications. In *Security and communication networks* (Vol. 2017). Wiley.
- Vo, D. L., Lee, H., Yeun, C. Y., & Kim, K. (2010). Enhancements of authenticated multiple key exchange protocol based on bilinear pairings. *Computers & Electrical Engineering*, 36, 155–159.

Investigating the Impact of Ethical Concerns on the Security and Privacy of Medical Devices in the UAE



Ali A. Alzoubi, Shaikha Omar Mubarak, Mahar Khadim Sultan, Ayla Obaid Ali, and Haitham M. Alzoubi

Abstract Ethics is considered the core of health care. Everyone is concerned about their health, and everything in health care requires some level of morality. Moral behavior is required when working in the health industry, developing and delivering healthcare, planning and managing the healthcare environment, and assessing health. Additionally, public health aspects including actions that promote good health, illness prevention, and health protection are included. This article looks at ethical difficulties in health care in the UAE and highlights several ethical issues and challenges. Malpractices and botched operations, insufficient information on procedures and costs to patients, over-the-counter selling of prescription-only medications, designer babies, and doctors being paid on a commission basis are among them. The article concludes that these moral concerns could have a negative effect on the provision, affordability, and accessibility of healthcare. The paper recommends numerous approaches to deal with the problems, including new legislation that forbids commission payments to medical practitioners, enforcement of current laws and professional ethics, education, and public awareness campaigns.

Keywords IoMT · Security · Privacy · Ethical issues · HealthCare · UAE

A. A. Alzoubi
Public Security Directorate, Amman, Jordan

S. O. Mubarak · M. K. Sultan · A. O. Ali
School of Information Technology, Skyline University College, Sharjah, UAE

H. M. Alzoubi (✉)
School of Business, Skyline University College, Sharjah, UAE
e-mail: haitham.alzoubi@skylineuniversity.ac.ae

Applied Science Research Center, Applied Science Private University, Amman, Jordan

1 Introduction

Ethics is considered the core of health care. Everyone is concerned about their health, and everything in health care requires some level of morality (Guntur et al., 2018). Moral behavior is required when working in the health industry, developing and delivering healthcare, planning and managing the healthcare environment, and assessing health (Alzoubi et al., 2022e). The over-the-counter sale of prescription medications, including extremely potent and dangerous drugs that seriously harm lives, doctors and health and medical specialists being paid on a “commission basis,” negligence and mishandled practices (Obaid, 2021), insufficient information to patient and client, the absence of culturally-appropriate health care (Vo et al., 2010), and many other issues are among the most important ethical concerns (Ghazal et al., 2021b).

The fact that various population divisions bring various ethical and cultural values from their home countries to the UAE (Alshurideh et al., 2020). Research supports the idea that ethics is a significant problem in health. In addition, the problem is made worse by the possibility that some population groupings may not view certain actions as morally acceptable. This puts any analysis of health ethics more difficult but also crucial.

1.1 *Problems*

NEHA strives to deliver current and relevant environmental health information while also establishing professional partnerships. To achieve these aims, we feature a column from the Centers for Disease Control and Prevention’s (CDC) Environmental Health Services Branch (EHSB) in each issue of the Journal (Al-Hamadi et al. 2015a; Ghazal & Taleb, 2022). EHSB and guest authors provide ideas and information about environmental health programs, trends, challenges, and resources in these articles (Alzoubi et al., 2022a). The authors’ conclusions in this paper do not necessarily represent the opinions of the CDC. Dee Merriam is worked with the National Center for Environmental Health, and Healthy Community Design Initiative at CDC (Ghazal et al., 2022a).

To estimate the danger to human health or the environment that might arise from exposure to toxic substances, government agencies and private risk assessors apply (quasi) scientific risk assessment processes. If such hazards already exist, they can be eliminated (Alzoubi et al., 2022b).

1.2 **Solution**

1.2.1 **Community-Based Assessment and Planning**

The Protocol for Assessing Community Excellence in Environmental Health (PACE EH) was evaluated for its efficacy in developing competency in key environmental health services and renewing efforts to include the community in issue solutions (Ghazal et al., 2022i). Environmental health professionals have recognized competence and community engagement as crucial components in addressing emerging public health hazards (Ali et al., 2021). A countrywide survey was undertaken, as well as 24 case studies of public health institutions (Islam et al., 2020).

(PACE EH) was discovered to have a good impact on community and professional networks, boosting leadership (Alzoubi & Aziz, 2021), developing workforce competency, and broadening definitions of environmental health practice (Teahan et al., 2012).

The current state of the scientific, political, and ethical issues surrounding global climate change (GCC) shows how universities have lagged in responding to the urgent need to reduce the current state of the scientific, political, and ethical issues surrounding global climate change (GCC) (Eli, 2021) and show how universities have lagged in responding to the urgent need to reduce the issues. Saleem et al. (2022), Shamount et al. (2022) investigated the causes behind the response and come to the conclusion that there is an urgent need for extensive and wide-ranging change in universities to assist reduce GCC.

1.2.2 **Occupational Safety and Health**

Socio-demographic and professional characteristics, training, activity evaluation, exercise restrictions, and ten key recommendations to enhance the situation are the five sections that are included (Al-Naymat et al., 2021). Because of the low pay and challenging working circumstances faced by physicians, maritime medicine remains to be an unattractive field of study (Lee et al., 2022b). This study, which revealed various dysfunctions and gaps that impede the promotion of workers' health in this sector (Hasan et al. 2021a), was carried out due to the lack of current synthetic data on safety and health in the marine sectors (Ghazal et al., 2022i; Ramakrishna & Alzoubi, 2022). The physicians' advice should serve as the foundation for any improvement in occupational health and safety.

1.2.3 **Security and Privacy Issues on the Internet of Medical Things (IoMT)**

Security and Privacy Concerns on the Internet of Medical Things focus on the security issues that healthcare professionals and patients face (Alnazer et al., 2017;

Ghazal et al., 2022f, 2022h). Because IoMT devices are vulnerable to cyber-attacks, a security breach by IoMT devices may serve as a gateway for hackers to access hospital networks. The usage of blockchain in healthcare has given rise to the Internet of Medical Things (IoMT), which is a collection of healthcare systems that espouse groundbreaking technologies (Alzoubi & Ahmed, 2019; Ghazal et al., 2022g). Systems consist of interlinked sensors, wearable technology devices (Edward Probir Mondol, 2022), and clinical frameworks that perform explicit, secure machine-to-machine and cloud platform communications (Kasem & Al-Gasaymeh, 2022).

Through technological advancements and a collection of analytics that aid in improved diagnosis and treatment, the importance of IoMT in the field of healthcare is a win-win situation for patients (Alzoubi et al., 2021a; Ghazal et al., 2022k). IoMT devices are more reliable in reporting and data tracking due to improved accuracy levels, which also assist prevent human mistakes and inaccurate reporting (Abu-Arqoub et al., 2020; Alzoubi et al., 2022a).

1.2.4 Key Features

- Methods for building unique IoMT architectures and middleware services are provided for healthcare applications to safeguard patient data and privacy.
- Information security and privacy models for the (IoMT), such as those for artificial intelligence and deep learning, data storage security, cloud, fog, and edge computing security, and wireless sensor device security, are presented to readers (Ghazal et al., 2021a, 2022l; Hanaysha et al., 2021).
- Case studies for practical IoMT security applications are given, including risk assessment for IoMT, IoMT ethical concerns, IoMT security assessment frameworks, and IoMT threat-based security analysis (Ghazal et al., 2022f).

1.2.5 Risk Management

Data storage or transmission security was not a consideration throughout the development of the internet (Joghee et al., 2020). The majority of current approaches to addressing cyber threats center on remediation or steps performed by data owners and users, such as data encryption, regulation, organizational support, access control measures, awareness campaigns, risk assessment, blocking, and similar methods (Victoria, 2022).

Through reports like Fire Eye and the Experian Security Report, which claim that healthcare organizations are susceptible to hackers (Alzoubi et al., 2022d; Zitar et al., 2021), the Ponemon Institute has been warning about data breaches on an annual basis (Alzoubi et al., 2022f). It should define how the organization's security risks will be monitored, controlled, and implemented. Organizational risks should be evaluated in the same way as monetary, medical, or operational risks (Alzoubi et al., 2022b;

Hasan et al. 2021b). Additionally, it must describe attacks, identify vulnerabilities, suggest particular vulnerability controls, and implement control plans (Alzoubi & Yanamandra, 2020; Shehada et al., 2017).

1.2.6 Growing Concern on Healthcare Cyberattacks and Need for Cybersecurity

Healthcare is one of the most targeted sectors by attackers owing to its amount of valuable data and inadequate security posture. According to the SANS Cyber Threat Report, 94 percent of healthcare companies reported cyber-attacks, but only a small fraction of those was made public while the majority went unnoticed or unreported (Ghazal et al., 2022d; Kurdi et al., 2022a).

Despite the incredible advancements in medical technology, not all areas of the healthcare industry have kept up with this pace (Al-Hamadi et al. 2015b). The health industry lacks funds for IT infrastructure due to a greater focus on patient care and continues to employ old systems, such as Windows XP, whose support has been stopped since 2014 (Ghazal et al., 2021c, 2022j). This ignoring of system security and software upgrades helps hackers and malware avoid being detected early.

Attackers from the Nation-states vary from other attackers in terms of their motivations and sophistication level (Alzoubi et al., 2022g). Along with the abundance of patient information, the vulnerabilities present in e-Health make the healthcare industry profitable for attackers (Alzoubi et al., 2022a; Ghazal et al., 2022c; Mondol, 2021). In the case of e-Health, patient records include a lot of information, and unlike financial data, it is still hard to reset some identifiers, such as name, address, and SSN (Ghazal et al., 2022b; Kurdi et al., 2022b).

Disgruntled employees, unintentional data leaks, and low-level malicious data breaches are a few examples of this. Financial gain is the primary driver behind compromising healthcare systems, according to the huge supply of useful information included in health data (Eli & Hamou, 2022; Mejia et al., 2019).

Over the previous several years, there has been a rise in cyberattacks, with a 300% increase between 2014 and 2017. It does occur in many aspects of daily life, including airports and other crucial infrastructures that depend on cloud computing. Cyberattacks against healthcare organizations can ruin medical equipment and infrastructure, endangering the lives of patients as well as causing data and financial loss (Alshurideh et al., 2022; Hamadneh et al., 2021).

The statement on the struggle to obtain a new computer brings the painful fact that in contrast to other sectors, such the financial services, the healthcare sector has consistently underinvested in IT infrastructure. Compared to 4–10% in other sectors, many NHS companies spend as low as 1–2% of their yearly budget on IT. As a result, there are incentives for hospitals to unite the departments and request information about them. The second category concerns the degree of connection of medical devices. This is accomplished by asking four questions about the current and projected future levels of connectivity (Ghazal et al., 2022g).

2 Data Analysis

2.1 Cyber Security Threat

Information security problems are primarily referred to as cyber threats. Stealing Information, data destruction, and other forms of digital life disruption are crimes. Phishing, spying, DoS attacks, data leaks, cyberfraud, politically motivated assaults, and other practices are examples of risks to cyber security (Ali et al., 2021; Alzoubi et al., 2020; Ratkovic, 2022). Some cyber-attacks seek to cause human injury, steal personal data, or damage intellectual property. Threats to cyber security, their effects on the international security of the UAE, and solutions will all be covered in this talk.

- **Hacker:** This sort of cybercrime involves interfering with and altering software or hardware that is not sufficiently secured by the creators.
- **Data breaches:** It means the unauthorized stealing of some important data from a system. Both companies may experience data breaches.
- **Cyber Threats in the United Arab Emirates:** Cyber-attacks have recently been a source of many worries in the UAE. According to The National UAE, there were 230 cyberattacks on the UAE's public and private sectors in 2018. This report is extremely alarming. The 2019 statistics specifically note 80,000 cyberattacks daily in 2018. Therefore, quick action is required to fight cybercrime in the UAE.

As shown in Table 1, the country vise common cyber crimes.

2.2 Preparedness of the Middle East

2.2.1 Common Cybercrimes in the UAE

Several different kinds of cybercrimes seem to be common right now in the UAE. Financial fraud is the one that occurs the most common among these. The degree of

Table 1 0 = High preparedness; 4 = Low preparedness

Country	Score
Qatar	0
Oman	0
UAE	1
Bahrain	2
Saudi Arabia	2
Kuwait	3

cyber security must be upgraded as a result to protect UAE companies from the bad intentions of some of its less trusted employees.

2.2.2 Laws that Ensure Cyber Security in the UAE

When discussing the UAE government's response to cyber threats, it is critical to note its cyber legislation. In the UAE, two key laws ensure cyber security (Alsharari, 2022). Federal Law No. 5, passed in 2012 with the intention of assisting in the acts of cyber security, and Federal Law No. 1, which regulates transactions and e-commerce, are among them. According to Law No. 5, any unauthorized access to websites or data is recognized as a criminal act under liability standards. Penalties are imposed on anybody who attempts to gain unauthorized access to websites, systems, or sensitive data (Alzoubi et al., 2022c; Ghazal et al., 2022e). Other cyber offenses include promoting pornography, disrespecting religious traditions, casting blame on public leaders, forging documents, and stealing passwords, pin codes, and other financial information.

2.3 Cybercrime Threat Analysis

2.3.1 National Interest Scale

With the increased focus on cyber security issues, the view of the subject of national importance has grown significantly. On a national interest scale the need for cyber security and the lowering of cybercrime levels may be viewed as quite high. However, the UAE government implemented rules 2006 and 2012 to protect its people.

2.3.2 Use of History

Assessing the current problem of cyber-attacks by using retrospective analysis, it is clear that the degree of threat from cybercrime rises as digital technologies are more complex. However, current UAE legislation has not been updated in this regard, creating further barriers to enhancing cyber security rates. For example, in 2011, there were 588 cyber-attacks in the UAE; however, by 2020, the figure has increased to 70,000 for mobile phone only.

2.4 UAE and U.S.

The threat of cyberattacks is already prevalent worldwide, and the information provided is highly troubling. There are similarities in concerns between the existing methods for combating cybercrime in the UAE and those of other nations, especially those in Europe and the U.S. The increase in reported cybercrimes in the U.S (Mondol, 2021). (around 1,300 per day) and the resulting damage to companies of more than \$3.5 billion have demonstrated the need for stricter cybercrime rules and an improved framework for cyber security.

2.5 Issues in Addressing Cybersecurity

- **Ad Hominem:** The ad hominem fallacy asserts that mistakes are common among humans, especially those they make when managing online contacts. It is particularly common when discussing the issue of cyber security. As a result, the mentioned assumption implies that enhancing cyber security further or attempting to inform people about cyber security is useless.
- **Onus Probandi:** Onus probandi is another form of a fallacy that is commonly applied to minimize the perception of the threat that the presence of cyber security problems involves. A variety of information sources frequently lack sufficient proof to support their statements about the high-security rates of digital data, which causes misunderstanding. This problem frequently arises in the UAE, and the issue of cyber security is rarely addressed by newspapers.
- **Educational institutions:** The UAE's educational institutions play an important role in improving cyber security. Their goal to prepare future workers in cyber security to defend the country against cyberattacks. The UAE has already established many research facilities dedicated to cyber security. Building a cyber security academy is one of the long-term educational projects the UAE is working on.
- **Society:** Citizens of the UAE should be educated on how to avoid and handle any cyber-attacks. The younger generations have to understand how to use the Internet properly and secure their personal data.
- **Industry:** It is essential to train staff in safe technology usage and safety practices. Cybersecurity training may reduce potential hazards and possibly boost effectiveness and productivity (Alnuaimi et al., 2021). Enhancing cooperation between international and national entities is also essential. Thus, several cutting-edge technologies may be included in private businesses to raise their level of safety and security. The UAE is also one of the most promising and advanced Middle Eastern nations (Alzoubi, 2021; Alzoubi et al., 2021b).

2.6 New UAE Cyber Crime Law

- **Access to an electronic site:** According to Federal Law No. 2 of 2006, If anybody willfully violates the law by visiting an electronic site unlawfully faces a jail sentence or fine. Article 2 of the New Cyber Crime Law does away with the necessity of purpose and forbids anybody from accessing an electronic site unlawfully, without authorization, or by exceeding the parameters of such authorization. It also specifies a fine of AED 100 to AED 300 (Mehmood et al., 2019; Neaimi et al., 2020). According to Article 4 of the New Cyber Crime Law, anyone who accesses an electronic site without authorization in order to obtain government data or private information from a financial trade or economic establishment will be fined up to AED 1,500,000 and/or a term of temporary jail sentences.
- **Medical-related data:** Article 7 of the New Cyber Crime Law now broadens the scope of respect for healthcare information and data by stating that anybody who accesses, modifies, damages, or exposes information obtained online relating to medical records, exams, diagnoses, treatments, or care without authorization may be subject to a temporary prison (Kim et al., 2019).
- **Bank account numbers and Electronic card:** A person who illegally accesses account information, electronic card numbers, bank account statements, or details of electronic payment methods is imprisonable and/or a fine under Article 12 which broadens the category of private information. A minimum six-month sentence in jail and/or a fine of AED 200,000 to AED 1,000,000 are the penalties for having the purpose to use and using such information to get funds belonging to 3rd parties. Article 14 of the New Cyber Crime Law also says it's illegal to get a confidential number, code, or password that is used to enter any electronic site without authorization, imprisonment, and/or a fine of 200,000 AED to 500,000 AED.
- **Electronic communication:** Article 10 forbids the interruption of electronic communication by abusing electronic mail to protect the privacy and integrity of electronic communications. Article 15 of the New Cyber Crime Law additionally makes it a crime to purposefully and without authorization collect and/or intercept online communications. A fine of between 150,000 and 500,000 AED will be imposed as punishment for the offense (Lee et al., 2022a).
- **Gambling activities and materials that prejudice public morals:** According to Article 17 of the New Cyber Crime Law, anybody who creates, distributes, publishes, or exploits using an electronic site gambling or pornographic content, or other content that may harm public morals shall be imprisoned and a fine between AED 250,000 to AED 500,000.
- **Defamation:** According to Article 20, anybody who uses an electronic site to insult others or to impute to another an event that might expose him to punishment or scorn by others is guilty to imprisonment or a fine between AED 250,000 to AED 500,000.
- **Contempt of religion:** For anyone who uses electronic sites to show disrespect for any holy symbols, characters, figures, and rituals of Islam, such as the Divinity

(Allah, God), and the Prophets, as well as for any other beliefs or religions, Article 35 specifies punishments of imprisonment and a fine between AED 250,000 to AED 1,000,000.

- ***Human trafficking:*** According to Article 23 of the New Cyber Crime Law, it is a crime to create, operate, or manage an electronic site for the aim of organ or human trafficking, and it is sentenced to a year in jail (up to a year) and a fine of up to AED 1,000,000.
- ***Sedition, sectarianism, and harming national unity:*** According to Article 24, anybody who establishes or maintains an online publication or uses other information technology to disseminate programs or ideas that harm social harmony, public order, public morality, or national unity is subject to punishment.
- ***Weapon trade and terrorist activities:*** The operation of an electronic site for advertising or trafficking in weapons, bullets, or explosives is prohibited under Article 25. Establishing, running, or managing an electronic site or publishing anything online for a terrorist organization or any other illegal group, association, or body is banned, according to Article 26.
- ***Donation collection without a license:*** Article 27 bans anybody from developing or managing an online platform to collect donations without receiving a license from the respective authority.
- ***State security:*** The New Cyber Crime Law's Article 29 also establishes prison terms and fines of up to AED 1,000,000 for anyone found guilty of using an electronic site or other information technology to insult the state, any of its institutions, the President, the Vice President, and Ruler of an emirate, that Ruler's Crown Prince. Article 28 bans the publication of any knowledge, news, caricatures, or other types of images that might endanger the security of the state. In violation of Article 30, anybody who establishes or operates an electronic with the intent to undermine the state's system of government, or control it, will be subjected to punishment.
- ***Without a licensee promoting demonstrations:*** Without a license from the respective authority, anybody operating or controlling an electronic site for organizing, preparing, supporting, or calling demonstrations or protests is subject to penalties under Article 32 of the New Cyber Crime Law. The penalty for violators is either imprisonment or a fine that is between AED 500,000 to AED 1,000,000.
- ***Trade of antiquities without a right:*** According to Article 33, Any individual who uses electronics to deal in the unlicensed trading of antiquities and works of art is punished with imprisonment and a fine between AED 500,000 to AED 1,000,000. Additionally, Article 34 establishes penalties for anyone using an electronic site to engage in unauthorized use of or provide unauthorized services to anyone to use communication services or video and audio channels, including imprisonment and fines of AED 250,000 to AED 1,000,000.
- ***Communication services online:*** According to Article 34, establishes punishment for illegally using or receiving communications services online on behalf of oneself or a third party. A fine range is AED 250,000 to AED 1,000,000 and/or jail for a time of not less than one year.

- **Narcotics and money laundering:** The New Cyber Crime Law makes it a crime to promote narcotics and psychotropic drugs online or on electric site. It imposes a punishment of temporary jail and a fine between AED 500,000 to AED 1,000,000.

3 Conclusion

To summarize the findings, instruments like the national interest scale will be required. During examining current statistical data, the analytical tool enables measuring the level of the threat. According to recent data on the rate of cybercrime detection, the UAE's cyber security has greatly improved. Furthermore, an examination of cybercrime prevention data reveals that the issue constitutes a significant gap in the UAE's cyber security policy.

Additionally, looking back on the analysis done above, it is important to remember that the historical analysis and the introduction of logical fallacies helped to understand the factors that increase cyber security threats in the UAE. Specifically, the historical study revealed gaps in the progression of cyber security policies in the UAE. The use of logical fallacies to the issue, in turn, has demonstrated why a large fraction of people frequently fail to take security concerns while applying digital technology.

References

- Abu-Arqoub, M., Issa, G., Banna, A. E., & Saadeh, H. (2020). Interactive multimedia-based educational system for children using interactive book with augmented reality. *Journal of Computer Science*, 15, 1648–1658.
- Al-Hamadi, H., Gawanmeh, A., & Al-Qutayri, M. (2015a). Formal validation of QRS wave within ECG. In *2015 International Conference on Information and Communication Technology Research, ICTRC 2015* (Vol. 9, pp. 190–193).
- Al-Hamadi, H., Gawanmeh, A., Baek, J., & Al-Qutayri, M. (2015b). Lightweight security protocol for ECG bio-sensors'. *Wireless Personal Communications*, 95, 5097–5120.
- Al-Naymat, G., Hussain, H., Al-Kasassbeh, M., & Al-Dmour, N. (2021). Accurate detection of network anomalies within SNMP-MIB data set using deep learning. *International Journal of Computer Applications in Technology*, 66, 74–85.
- Ali, N., Ahmed, A., Anum, L., Ghazal, T. M., Abbas, S., Khan, M. A., Alzoubi, H. M., & Ahmad, M. (2021). Modelling supply chain information collaboration empowered with machine learning technique. *Intelligent Automation & Soft Computing*, 30, 243–257.
- Alnazer, N. N., Alnuaimi, M. A., & Alzoubi, H. M. (2017). Analysing the appropriate cognitive styles and its effect on strategic innovation in Jordanian universities. *International Journal of Business Excellence*, 13, 127–140.
- Alnuaimi, M., Alzoubi, H. M., Ajelat, D., & Alzoubi, A. A. (2021). Towards intelligent organisations: An empirical investigation of learning orientation's role in technical innovation. *International Journal of Innovation and Learning*, 29, 207–221.
- Alsharari, N. (2022). The implementation of enterprise resource planning (Erp) in the United Arab Emirates: A case of Musanada corporation. *International Journal of Technology, Innovation and Management*, 2, 1.

- Alshurideh, M., Gasaymeh, A., Ahmed, G., Alzoubi, H., & Kurd, B. A. (2020). Loyalty program effectiveness: Theoretical reviews and practical proofs. *Uncertain Supply Chain Management*, 8, 599–612.
- Alshurideh, M., Kurdi, B., Alzoubi, H., Obeidat, B., Hamadneh, S., & Ahmad, A. (2022). The influence of supply chain partners' integrations on organizational performance: The moderating role of trust. *Uncertain Supply Chain Management*, 10, 1191–1202.
- Alzoubi, A. (2021). Renewable Green hydrogen energy impact on sustainability performance. *International Journal of Computations, Information and Manufacturing*, 1, 94–105.
- Alzoubi, H., & Ahmed, G. (2019). Do TQM practices improve organisational success? A case study of electronics industry in the UAE. *International Journal of Economics and Business Research*, 17, 459–472.
- Alzoubi, H. M., Ahmed, G., Al-Gasaymeh, A., & Al Kurdi, B. (2020). Empirical study on sustainable supply chain strategies and its impact on competitive priorities: The mediating role of supply chain collaboration. *Management Science Letters*, 10, 703–708.
- Alzoubi, H., Alhamad, A. Q. M., Akour, I., Alshurideh, M., Al-Hamad, A. Q., Kurdi, B. A., & Alzoubi, H. (2021a). Predicting the intention to use google glass: A comparative approach using machine learning models and PLS-SEM. *International Journal of Data and Network Science*, 5, 311–320.
- Alzoubi, H. M., Vij, M., Vij, A., & Hanaysha, J. R. (2021b). What leads guests to satisfaction and loyalty in UAE five-star hotels? AHP analysis to service quality dimensions. *Enlightening Tourism*, 11, 102–135.
- Alzoubi, H., Alhamad, A., Alshurideh, M., Alomari, K., Al Kurdi, B., Hamouche, S., & Al-Hawary, S. (2022a). The effect of electronic human resources management on organizational health of telecommunications companies in Jordan. *International Journal of Data and Network Science*, 6, 429–438.
- Alzoubi, H., Alshurideh, M., Kurdi, B. A., Akour, I., & Aziz, R. (2022b). Does BLE technology contribute towards improving marketing strategies, customers' satisfaction and loyalty? The role of open innovation. *International Journal of Data and Network Science*, 6, 449–460.
- Alzoubi, H. M., Ahmed, G., & Alshurideh, M. (2022c). An empirical investigation into the impact of product quality dimensions on improving the order-winners and customer satisfaction. *International Journal of Productivity and Quality Management*, 36, 169–186.
- Alzoubi, H. M., Ali, N., Ghazal, T. M., Ahmed, A., Abbas, S., Khan, M. A., Farooq, U., Ahmad, M., & Khan, M. A. (2022d). Fusion-based supply chain collaboration using machine learning techniques. *Intelligent Automation & Soft Computing*, 31, 1671–1687.
- Alzoubi, H. M., Alshurideh, M. T., Al Kurdi, B., Ghazal, T. M., Said, R. A., AlHamad, A. Q., Hamadneh, S., Sahawneh, N., & Al-kassem, A. H. (2022e). Fuzzy assisted human resource management for supply chain management issues. *Annals of Operations Research*, 1–19.
- Alzoubi, H. M., Alshurideh, M. T., Kurdi, B. A., Alhyasat, K. M. K., & Ghazal, T. M. (2022f). The effect of e-payment and online shopping on sales growth: Evidence from banking industry. *International Journal of Data and Network Science*, 6, 1369–1380.
- Alzoubi, H. M., Elrehaile, H., Hanaysha, J. R., Al-Gasaymeh, A., & Al-Adaileh, R. (2022g). The role of supply chain integration and agile practices in improving lead time during the COVID-19 crisis. *The International Journal of Service Science, Management, Engineering, and Technology*, 13, 1–11.
- Alzoubi, H. M., & Aziz, R. (2021). Does emotional intelligence contribute to quality of strategic decisions? The mediating role of open innovation. *Journal of Open Innovation: Technology, Market, and Complexity*, 7, 130.
- Alzoubi, H. M., & Yanamandra, R. (2020). Investigating the mediating role of information sharing strategy on agile supply chain. *Uncertain Supply Chain Management*, 8, 273–284.
- Edward Probir Mondol. (2022). The role of Vr games to minimize the obesity of video gamers. *International Journal of Computations, Information and Manufacturing*, 2, 1.

- Eli, T. (2021). Students' perspectives on the use of innovative and interactive teaching methods at the university of Nouakchott Al Aasriya, Mauritania: English department as a case study. *International Journal of Technology, Innovation and Management*, 1, 90–104.
- Eli, T., & Hamou, L. A. S. (2022). Investigating the factors that influence students' choice of english studies as a major: The case of university of Nouakchott Al Aasriya, Mauritania. *International Journal of Technology, Innovation and Management*, 2, 1.
- Ghazal, T. M., Bibi, R., Saeed, Y., Zeb, A., Rahman, T., Said, R. A., Abbas, S., Ahmad, M., & Khan, M. A. (2021a). Edge AI-based automated detection and classification of road anomalies in VANET using deep learning. *Computational Intelligence and Neuroscience*, 2021, 1–19.
- Ghazal, T. M., Hasan, M. K., Alkhalfah, A., Abu Bakar, K. A., Omidvar, A., Nafi, N. S., & Agbinya, J. I. (2021b). *Fischer linear discrimination and quadratic discrimination analysis-based data mining technique for internet of things framework for healthcare* (p. 9). Public Heal.
- Ghazal, T. M., Siddiqui, S. Y., Haider, A., Khan, M. A., Naseer, I., Abbas, S., Rahman, M., Khan, J. A., Ahmad, M., Hasan, M. K., Mohammed, A., & Ateeq, K. (2021c). IoMT cloud-based intelligent prediction of breast cancer stages empowered with deep learning. *IEEE Access*, 9, 146478–146491.
- Ghazal, T. M., Abbas, S., Ahmad, M., & Aftab, S. (2022a). An IoMT based ensemble classification framework to predict treatment response in hepatitis C patients. In *2022 International Conference on Business Analytics for Technology and Security, ICBATS 2022* (pp. 1–4).
- Ghazal, T. M., Abbas, S., Alhwaiti, Y., Fatima, A., Khan, M. A., Khan, M. A., Kanwal, A., Ahmad, M., & Elmitwally, N. S. (2022b). Convolutional neural network based intelligent handwritten document recognition. *Computers, Materials and Continua*, 70, 4563–4581.
- Ghazal, T. M., Abbas, S., Munir, S., Khan, M. A., Ahmad, M., Issa, G. F., Zahra, S. B., Khan, M. A., & Hasan, M. K. (2022c). Alzheimer disease detection empowered with transfer learning. *Computers, Materials and Continua*, 70, 5005–5019.
- Ghazal, T. M., Ahmed, Z. E., Hasan, M. K., Hashim, A. A., Saeed, R. A., Mokhtar, R. A., & Singh, S. P. (2022d). Optimization procedure for intelligent internet of things applications. In *2022 International Conference on Business Analytics for Technology and Security, ICBATS 2022* (pp. 1–6).
- Ghazal, T. M., Bukhari, M. M., Abbas, S., Khan, M. A., Farooq, U., Wahbah, H., Ahmad, M., Adnan, K. M. (2022e). An intelligent proposed model for task offloading in fog-cloud collaboration using logistics regression. *Computational Intelligence and Neuroscience*.
- Ghazal, T. M., Hasan, M. K., Abdullah, S. N. H., Abubakkar, K. A., & Afifi, M. A. M. (2022f). IoMT-enabled fusion-based model to predict posture for smart healthcare systems. *Computers, Materials and Continua*, 71, 2579–2597.
- Ghazal, T. M., Hasan, M. K., Saeed, R. A., Pandey, B., Gohel, H., Eshmawi, A. A., Abdel-Khalek, S., & Alkhassawneh, H. M. (2022g). A review on security threats, vulnerabilities, and counter measures of 5G enabled Internet-of-Medical-Things. *IET Communications*, 16, 421–432.
- Ghazal, T. M., Khan, M. A., Lee, S. W., & Rehman, A. (2022h). Data fusion-based machine learning architecture for intrusion detection. *Computers, Materials and Continua*, 70, 3399–3413.
- Ghazal, T. M., Mehmood, S., Khan, M. A., Zubair, M., Naseem, M. T., Faiz, T., & Ahmad, M. (2022i). Malignancy detection in lung and colon histopathology images using transfer learning with class selective image processing. *IEEE Access*, 10, 25657–25668.
- Ghazal, T. M., Noreen, S., Said, R. A., Khan, M. A., Siddiqui, S. Y., Abbas, S., Aftab, S., & Ahmad, M. (2022j). Energy demand forecasting using fused machine learning approaches. *Intelligent Automation and Soft Computing*.
- Ghazal, T. M., Rehman, A. U., Saleem, M., Ahmad, M., Ahmad, S., & Mehmood, F. (2022k). Intelligent model to predict early liver disease using machine learning technique. In *2022 International Conference on Business Analytics for Technology and Security, ICBATS 2022* (pp. 1–5).
- Ghazal, T. M., & Taleb, N. (2022). Feature optimization and identification of ovarian cancer using internet of medical things. *Expert Systems*.

- Ghazal, T. M., Zafar, S., Asif, M., Ahmad, M. B., Faiz, T., Ahmad, M., & Khan, M. A. (2022l). Assistive devices analysis for visually impaired persons: A review on taxonomy. *IEEE Access*, 10, 13354–13366.
- Guntur, S. R., Gorrepati, R. R., & Dirisala, V. R. (2018). Internet of medical things. *Medical Big Data and Internet of Medical Things*, 4, 271–297.
- Hamadneh, S., Pedersen, O., Alshurideh, M., Kurdi, B. A., & Alzoubi, H. M. (2021). An investigation of the role of supply chain visibility into the scottish blood supply chain. *The Journal of Legal, Ethical and Regulatory Issues*, 24, 1–12.
- Hanaysha, J., Al-Shaikh, M., & Alzoubi, M. H. (2021). Importance of marketing mix elements in determining consumer purchase decision in the retail market. *International Journal of Service Science Management Engineering and Technology*, 12, 56–72.
- Hasan, M. K., Islam, S., Sulaiman, R., Khan, S., Hashim, A. H. A., Habib, S., Islam, M., Alyahya, S., Ahmed, M. M., Kamil, S., & Hassan, M. A. (2021a). Lightweight encryption technique to enhance medical image security on internet of medical things applications. *IEEE Access*, 9, 47731–47742.
- Hasan, M. K., Musse, M. A., Sherfriz, S. M., Shayla, I., Huda, S. N. A. S., Eklas, H., Nazmus S. N., & Nguyen, V. (2021b). An improved dynamic thermal current rating model for pmu-based wide area measurement framework for reliability analysis utilizing sensor cloud system. *IEEE Access*, 9, 14446–14458.
- Islam, S., Khalifa, O. O., Hashim, A. H. A., Hasan, M. K., Razzaque, M. A., & Pandey, B. (2020). Design and evaluation of a multihoming-based mobility management scheme to support inter technology handoff in PNEMO. *Wireless Personal Communications*, 114, 1133–1153.
- Joghee, S., Alzoubi, H. M., & Dubey, A. R. (2020). Decisions effectiveness of FDI investment biases at real estate industry: Empirical evidence from Dubai smart city projects. *International Journal of Scientific & Technology Research*, 9, 3499–3503.
- Kasem, J., & Al-Gasaymeh, A. (2022). A cointegration analysis for the validity of purchasing power parity: Evidence from Middle East Countries. *International Journal of Technology, Innovation and Management*, 2, 1.
- Kim, S.-K., Yeun, C. Y., Damiani, E., & Lo, N.-W. (2019). A machine learning framework for biometric authentication using electrocardiogram. *IEEE Access*, 7, 94858–94868.
- Kurdi, B. A., Alshurideh, M., Akour, I., Alzoubi, H. M., Obeidat, B., & Alhamad, A. (2022a). The role of digital marketing channels on consumer buying decisions through eWOM in the Jordanian markets. *International Journal of Data and Network Science*, 6, 1175–1185.
- Kurdi, B. A., Alshurideh, M., Akour, I., Tariq, E., Alhamad, A., & Alzoubi, H. M. (2022b). The effect of social media influencers' characteristics on consumer intention and attitude toward Keto products purchase intention. *International Journal of Data and Network Science*, 6, 1135–1146.
- Lee, K. L., Azmi, N. A. N., Hanaysha, J. R., Alzoubi, H. M., & Alshurideh, M. T. (2022a). The effect of digital supply chain on organizational performance: An empirical study in Malaysia manufacturing industry. *Uncertain Supply Chain Management*, 10, 495–510.
- Lee, K. L., Romzi, P. N., Hanaysha, J. R., Alzoubi, H. M., & Alshurideh, M. (2022b). Investigating the impact of benefits and challenges of IOT adoption on supply chain performance and organizational performance: An empirical study in Malaysia. *Uncertain Supply Chain Management*, 10, 537–550.
- Mehmood, T., Alzoubi, H. M., Alshurideh, M., Al-Gasaymeh, A., & Ahmed, G. (2019). Schumpeterian entrepreneurship theory: Evolution and relevance. *Academic Entrepreneur Journal*, 25, 1–10.
- Mejia, C., Ciarlante, K., & Chheda, K. (2019). A wearable technology solution and research agenda for housekeeper safety and health. *International Journal of Contemporary Hospitality Management*, 1–3.
- Mondol, E. P. (2021). The impact of block chain and smart inventory system on supply chain performance at retail industry. *International Journal of Computations, Information and Manufacturing*, 1, 56–76.

- Ratkovic, N. (2022). Improving home security using blockchain. *International Journal of Computations, Information and Manufacturing*, 2, 1.
- Neaimi, M. Al, Hamadi, H. Al, Yeun, C. Y., Jamal Zemerly, M. (2020). Digital forensic analysis of files using deep learning. In *2020 3rd International Conference on Signal Processing and Information Security, ICSPIS 2020* (pp. 1–4). IEEE.
- Obaid, A. J. (2021). Assessment of smart home assistants as an IoT. *International Journal of Computations, Information and Manufacturing*, 1, 18–38.
- Ramakrishna, Y., & Alzoubi, H. M. (2022). Empirical investigation of mediating role of six sigma approach in rationalizing the COQ in service organizations. *Operations and Supply Chain Management*, 15, 122–135.
- Saleem, M., Abbas, S., Ghazal, T. M., Adnan Khan, M., Sahawneh, N., & Ahmad, M. (2022). Smart cities: Fusion-based intelligent traffic congestion control system for vehicular networks using machine learning techniques. *Egyptian Informatics Journal*.
- Shamout, M., Ben-Abdallah, R., Alshurideh, M., Alzoubi, H., Al Kurdi, B., & Hamadneh, S. (2022). A conceptual model for the adoption of autonomous robots in supply chain and logistics industry. *Uncertain Supply Chain Management*, 10, 577–592.
- Shehada, D., Yeun, C. Y., Zemerly, M. J., Al Qutayri, M., Al Hammadi, Y., Damiani, E., & Hu, J. (2017). BROSMAP: A novel broadcast based secure mobile agent protocol for distributed service applications. In *Security and communication networks* (Vol. 2017). Wiley.
- Teahan, W. J., Al-Dmour, N. A., & Tuff, P. G. (2012). Knowledge distribution in multi agent systems. *Asian Journal of Information Technology*, 11, 300–311.
- Vo, D. L., Lee, H., Yeun, C. Y., & Kim, K. (2010). Enhancements of authenticated multiple key exchange protocol based on bilinear pairings. *Computers & Electrical Engineering*, 36, 155–159.
- Victoria, V. (2022). Impact of process visibility and work stress to improve service quality: Empirical evidence from Dubai Retail Industry. *International Journal of Technology, Innovation and Management*, 2, 1.
- Zitar, R. A., Al-Dmour, N., Nachouki, M., Hussain, H., & Alzboun, F. (2021). Hashing generation using recurrent neural networks for text documents. *ICIC Express Letters, Part B: Application*, 12, 231–241.

Employee Empowerment and Organizational Behavior

The Impact of Employee Empowerment and Organizational Citizenship Behavior with Mediating Role of Job Satisfaction at Amman Private Hospitals



Ala'a Emad Ahmad Kharabsheh, Mohamed A. Alnuaimi,
and Haitham M. Alzoubi 

Abstract This research attempts to explain the relationship between employee empowerment and organizational citizenship behaviour (OCB) with mediating role of job satisfaction at Amman Private Hospitals. A 212 valid questionnaires were used for quantitative analysis, yielding 25.83% response rate. Structural equation modeling was used along with inferential statistical analysis techniques to test the hypotheses. It was observed that employee empowerment has a significant effect on OCB as well as on job satisfaction. Whereby, job satisfaction has a significant effect on OCB. Besides, job satisfaction also had a mediating effect on employee empowerment and OCB. This research is limited to job satisfaction, employee empowerment and OCB conducted only in private hospitals with the adoption of quantitative approach. Moreover, this research contributes empirical evidence about the nature of the relationship between employee empowerment and OCB via job satisfaction in Jordanian private hospitals. Thus, managers from private hospital industry can reap benefit out of it.

Keywords Employee empowerment · Organizational citizenship behaviour · Job satisfaction · Private Hospitals

A. E. A. Kharabsheh
MBA Scholar, Middle East University, Amman, Jordan

M. A. Alnuaimi
University of Jordan, Amman, Jordan
e-mail: drmohamedalnaimi@yahoo.com

H. M. Alzoubi (✉)
School of Business, Skyline University College, Sharjah, UAE
e-mail: haitham.alzoubi@skylineuniversity.ac.ae

Applied Science Research Center, Applied Science Private University, Amman, Jordan

1 Introduction

Business organizations are a vital tool in contemporary human societies, seeking to achieve three objectives: survival, development, and well-being. For this purpose, they pay great attention to everything that would achieve these objectives. The employee is a crucial resource to achieving success and competitive advantage to organizations (Salman & Sankar, 2021) and people are considered the biggest and the most valuable asset to the organization (Putra & Riana, 2020); as a result, their focus and interest shifted to all activities that would help them grow and improve their performance, which is critical for any organization's success (Alhamad et al., 2022). Relationships between employees' attitudes towards the organization can lead to organizational citizenship behavior (OCB) (Putra & Riana, 2020). Besides, managers, entrepreneurs, and scholars in the management field believe that the empowerment of employees is extremely important to the success of any organization (Abdullahi et al., 2020). Some scholars believe that empowerment is an antidote to organizational performance (Turnipseed & VandeWaa, 2020).

On the other side, job satisfaction is defined as the set of feelings and beliefs that employees have towards their job (AlShehhi et al., 2021). Job satisfaction is important for organizations that provide healthcare (Khan, 2021) and is considered a significant determinant of the quality and efficiency of the health system and OCB (Dong & Phuong, 2018). There is an important relationship between an employee's performance and his or her job satisfaction, and it is important to improve productivity level (Hanaysha et al., 2021b). One of the most critical factors in a company's success is OCB. So, it is important to know the factors that contribute to build OCB within the organization. Human resources are considered the core and essential component of any business (Alshurideh et al., 2022) and they affect organizational performance (Dong & Phuong, 2018), productivity, and job satisfaction.

2 Theoretical Framework

2.1 *Employee Empowerment*

Empowerment is a rich term that ranges from the delegation, giving power, responsibility, and decision-making autonomy to employees, providing strategic resources to employees (Ali Salahat, 2021) and enhancing employees' self-efficacy. Empowerment refers to the degree to which employees are encouraged to make particular decisions and self-guide behaviour (Alzoubi et al., 2020) without returning to managers and supervisors (Lee et al., 2022a), so that it is initiated at the lower organizational levels (Turnipseed & VandeWaa, 2020). It is estimated that more than two-thirds (70%) of organizations use a form of empowerment for at least some of their employees. Currently, empowerment has become a part of the global business philosophy (Joghee et al., 2020). So, the responsibility of leaders is not only to give

authority and power to employees but also to make sure that they feel psychologically empowered.

2.2 Organizational Citizenship Behavior

Organ (1988) defined Organizational Citizenship Behavior (OCB) as “individual behaviour that is discretionary, not directly or explicitly recognized by the formal reward system, and in the aggregate promotes the effective functioning of the organization”. OCB is an important factor that helps and contributes to the survival of an organization and an important indicator of an employee’s performance (Singh & Singh, 2019). Ocampo et al. (2018) indicated that OCB is a behavior not officially required of employees. OCB is divided into five categories: conscientiousness, sportsmanship, civic virtue, courtesy and altruism. In the review of previous studies on OCB, (Abdullahi et al., 2020) found that OCB influences employee behavior affirmatively (Hamadneh et al., 2021). Thus, it increases the level of customer satisfaction, the level of commitment among employees (Hanaysha et al., 2021a), and the performance of the businesses with help of technological adoption in the organization (Lee et al., 2022b). Katz and Kahn were the first to notice employees’ extra-role behavior in the workplace in 1966 (Ocampo et al., 2018). Organ and his colleagues coined the term OCB, which first appeared in the organizational behavior and management literature in the 1980s (Abdullahi et al., 2020). Since then, OCB research has seen a rapid increase in researchers’ interest in studying and examining it, as well as implementing it in a variety of fields such as IT, Information Sharing, robotics (Alzoubi & Yanamandra, 2020; Shamout et al., 2022) and organizations in context of innovation, technological developments within the organizational system (Alzoubi et al., 2022a). OCB is defined in terms of individual actions or contributions that go above and beyond the requirements of the job and contribute to the growth and success of the organization. OCB is cooperative behavior with the organization, but it is not a precondition for an official job.

2.3 Job Satisfaction

Job satisfaction is one of the most important variables studied in the fields of organizational behavior and applied psychology, and it has been the main focus since the beginning of the scientific management approach until the present time (Ashraf, 2020). Job satisfaction is considered a significant indicator of an employee’s performance, productivity, organizational commitment, and organization’s profitability attain by cognitive styles on the employees working (Alnazer et al., 2017) reduces absenteeism and turnover (Alzoubi et al., 2022b), plays a critical part in the success and effectiveness of an organization (Ajlouni et al., 2021), and is also seen as a

Table 1 The operation Definitions

Variables	Definition	References
Employee empowerment	An exchange of power and control between an organization and its employees	Salman and Sankar (2021)
Organizational citizenship behavior	An individual's behavior that collectively and effectively improves and increases the performance of any organization	Abdullahi et al. (2020)
Job satisfaction	Pleasurable or positive feelings about an individual's job resulting from his or her experiences	Dong and Phuong (2018)

significant part of an employee's life satisfaction (Alzoubi et al., 2022c) and subjective well-being that is influenced by advanced technological working areas (Farouk, 2022). Job satisfaction is a significant element in achieving recognition, compensation, and promotion that creates a feeling of achievement and enhances employee loyalty with organization (Alshurideh et al., 2020). There are five dimensions of work that reflect the key work characteristics, namely the work itself, wages, promotion opportunities, supervision, and co-workers, and affect how the employees feel about their jobs. Job satisfaction is generated from an evaluation of these characteristics. Employees' attitudes toward their work can be measured by job satisfaction; if an employee is dissatisfied with his or her work, his or her attitude will be negative. When an employee is satisfied with his or her work, his or her attitude will be positive. Employee behavior toward their work, coworkers, and organizations is heavily influenced by job satisfaction (Ocampo et al., 2018).

2.4 *Operational Definitions*

Table 1 give the definitions of the key variables and constructs of this research.

2.5 *Industry Description*

The Private Hospitals Association is a voluntary and non-profitable organization which got established in the year 1984. All Jordan's private hospitals have the membership of PHA. The private association applies quality standards on all its members. General guidelines are implemented to all the hospitals in Amman, Jordan; so, as to maintain and raise health care sectors' repute. National Accreditation Program has recently been applied by the association to the sector high-tech infirmaries (such as Arab Medical Centre, Specialty Hospital and Al Khalidi Medical

Center etc.). PHA goal for Jordan's hospitals especially Amman are now globally recognized. Because of their highly competitive services provided at advanced hospitals. Amman hospital sector is attempting to make their hospitals medical service leaders through effective services and widely acclaimed achievements. Amman's hospitals are proving to influential the population under the guidance of SABEQ Program which is initiated by the USAID-funds. The program is introduced to train medical professionals (Mehmood et al., 2019), increase market access and to enhance the overall services quality of Amman's hospitals.

3 Literature Review

3.1 Relationship and Impact of Employee Empowerment on Job Satisfaction

Research evidence demonstrates that employee empowerment has a significant positive association with job satisfaction. Ashraf (2020) examined the influence of empowerment on job satisfaction in five-star hotels in Jordan. The findings of the past study revealed that both psychological and structural empowerment have significant individual effects on job satisfaction, but the significance increases when psychological and structural empowerment are combined (Singh & Singh, 2019). Employee empowerment has an important role that could play in increasing employees' job satisfaction. (Singh & Singh, 2019) investigated the influence of psychological empowerment on job satisfaction. The results of their studies indicate that psychological empowerment positively and significantly influences job satisfaction. The findings of Martínez and Tindale (2015) stated that structural empowerment has a significant and positive effect on job satisfaction. Similar results that employee empowerment has a significant positive impact on job satisfaction and is considered a good predictor of job satisfaction. Previous literature has affirmed two dimensions of empowerment, namely: structural empowerment (a macro perspective) and psychological empowerment (a micro perspective) (Turnipseed & VandeWaa, 2020). I has identified the three scenarios of empowerment that result from combining psychological and structural empowerment: When employees have high levels of psychological empowerment but low levels of structural empowerment, this is known as illusory empowerment. When employees have high levels of structural empowerment but low levels of psychological empowerment, this is known as obstructed empowerment. Finally, when employees have a high level of psychological empowerment and structural empowerment, they are said to be authentically empowerment (Afram et al., 2022).

Based on the above discussion, we come to develop the following hypothesis.

H₀₁: Employee Empowerment has significant impact on Job Satisfaction.

3.2 Relationship and Impact of Employee Empowerment on Organizational Citizenship Behavior

Previous studies have confirmed the effect of employee empowerment and its two dimensions, psychological and structural empowerment, on organizational citizenship behavior (OCB). For instance, (Ali Salahat, 2021) examined the relationship between employee empowerment and the dimensions of OCB. The findings of a study from manufacturing industries; indicated that there was a positive and significant relationship between employee empowerment and all dimensions of OCB, as employee empowerment would increase employee work voluntarily and reduce complaints (Alzoubi et al., 2022a) that also has discussed within the organizational management (Alzoubi et al., 2021) that acquires the innovative platform to empower the employee to gain employee performance (Kurdi et al., 2022b). Past studies has investigated the relationship between structural empowerment and OCB. (Turnipseed & VandeWaa, 2020) examined the relationships between the dimensions of psychological empowerment and organizational citizenship behavior (OCB). The results indicate that empowered employees discretionarily engage in citizenship behaviors that benefit work colleagues and their organization in terms of market competitive advantage and customer retention that counted as employees loyalty to work (Kurdi et al., 2022c), without increasing the direct labor cost and cost of work quality (Alzoubi et al., 2022c).

As noted by Salman and Sankar (2021), Employee empowerment leads to increased organizational commitment, employee satisfaction, customer satisfaction, and customer loyalty, as well as lower employee turnover and job-related stress (Kasem & Al-Gasaymeh, 2022). Empowerment is an organizational initiative that aims to provide workers with control to reduce their feelings of powerlessness, eliminate traditional management patterns (Alzoubi et al., n.d.), as well as minimize needless workplace anxieties by upgrading the workplace with use of AI technological equipment's, software's and machine learning that results in improved productivity (Guergov & Radwan, 2021). Kanter coined the term “employee empowerment” four decades ago (Turnipseed & VandeWaa, 2020). Employee empowerment is one of the important concepts related to the field of management and contemporary management theories (Alnuaimi et al., 2021). Empowerment has been defined as the meltdown of traditional hierarchical structures in which individuals are empowered to solve problems technically and make decisions with innovation ideas that can enhance the organizational productivity and competitiveness (Alzoubi & Aziz, 2021).

Based on the above discussion, we come to develop the following hypothesis.

H_{O2} : Employee Empowerment has significant impact on Organizational Citizenship Behavior.

3.3 Relationship and Impact of Job Satisfaction on Organizational Citizenship Behavior

Putra and Riana (2020) conducted an empirical investigation of the effect of job satisfaction and OCB relationship and found that job satisfaction has a significant effect on OCB and that satisfied employees have higher OCB, because they want to respond similarly to the organization that treats them well. These results generally and consistently go with the previous research (Afram et al., 2022).

Job satisfaction is defined as pleasurable or positive feelings about an individual's job resulting from his or her experiences. Job satisfaction as a set of feelings and beliefs that people have about their job. (Ashraf, 2020) identified job satisfaction as an affective reaction of individuals that occurs caused by comparing actual and desired outcomes (Alzoubi, 2021). Job satisfaction is linked to an employee's intellectual attitude toward a working environment (Alzoubi & Ahmed, 2019) that satisfies the needs and values of employees and the individual's response to that environment; for instance, applications and software use can motivate employees to work efficiently in time effective way (Radwan, 2022). It also reflects the extent of compatibility between the individual's expectations of the job and the rewards granted by it. For example, employee's satisfaction influenced by the workplace environment as defined in a healthcare case of managing COVID-19 with artificial Intelligence helped the workers to get the data of patients from previous record and feedback. It can enhance the employee work efficiency (Farouk, 2021). Job satisfaction is characterized as a positive emotional state coming about because of a cognitive (Alhamad et al., 2021), emotional, and positive evaluation of the job (Kurdi et al., 2022a) that leads to meeting the needs, goals, and values of the employee (Putra & Riana, 2020).

Based on the above discussion, we come to develop the following hypothesis.

H_{O3} : Job Satisfaction has significant impact on Organizational Citizenship Behavior.

3.4 Relationship and Impact of Employee Empowerment on Organizational Citizenship Behavior with Mediating Role of Job Satisfaction

Previous research confirms the role of job satisfaction as a mediator in the relationship between employee empowerment and OCB. The results shed light on the mediating role of structural empowerment, while the other type of empowerment, which is psychological empowerment, wasn't found as a mediator in the context of the Jordanian private hospital that may authenticate various technological use and employees training toward technological advancement in hospitals management (Kashif et al., 2021). Nevertheless, this result will raise questions about the justification about what the reasons led to this result in future studies in the same context and other contexts such as AI, blockchain, data management implication to enhance

employees experience and experties in today's era (Ali et al., 2022). Thus, there is a need for further research on the mediating effects of job satisfaction on the relationship between employee empowerment (psychological empowerment and structural empowerment) and OCB in a single study. In addition, a previous study by Afram et al. (2022) proved that job satisfaction significantly mediates between structural empowerment and OCB. The significant mediating effect of job satisfaction on the effect of employee empowerment on OCB is compatible with the results of the study of Alsheikh and Sobihah (2019). The insignificant mediating effect of job satisfaction on the relationship between psychological empowerment and OCB is close to the result of the study by (Singh & Singh, 2019). The mediating effect of job satisfaction in the relationship between structural empowerment and OCB is close to the studies of Ajlouni et al., (2021) in Jordan.

Based on the above discussion, we come to develop the following hypothesis.

H_{04} : Employee Empowerment has significant impact on Organizational Citizenship Behavior with mediating role of Job Satisfaction.

3.5 Problem Statement and Research Gap

According to Alsheikh (2020), OCB is a key aspect of behavior and is used with job satisfaction to pursue organizational excellence. Besides, some managers believe that empowering employees will reduce their authority. According to Salman and Sankar (2021) recommendations, further studies could be conducted on the analysis between empowerment and job satisfaction. The vast majority of past studies were conducted in Western contexts, with little conducted in the Middle East context in general, and Jordan in particular. There is a need for research on the mediating effects of job satisfaction on the relationship between employee empowerment (psychological empowerment and structural empowerment) and OCB in a single study (Ali Salahat, 2021).

Based on the above discussion from previous studies, this research identifies the gap in previous literature and aims to address it by focusing on the following study questions for investigation. This research will understand and evaluate the possible effect of employee empowerment and organizational citizenship behavior with mediating role of job satisfaction at Amman Private Hospitals.

3.6 General Research Model

The research model prepared by the authors, please see (Fig. 1).

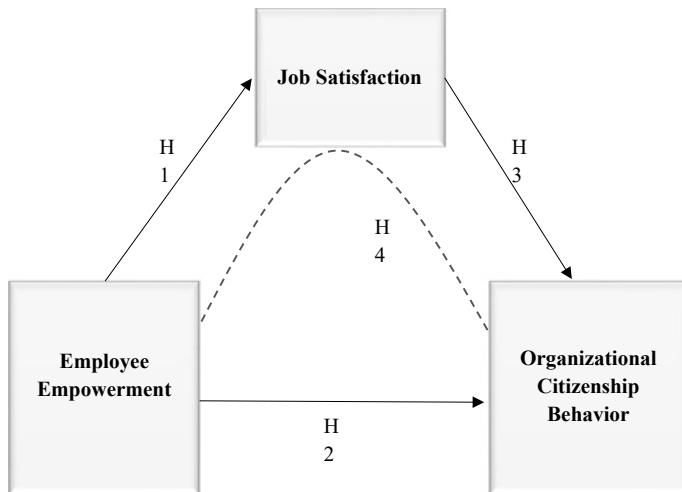


Fig. 1 Research proposed model

3.7 *Research Methodology and Design*

Two sources were relied on for data collection, which are secondary and primary sources. Primary and empirical data were collected through a survey. The questionnaire was designed based on the theoretical previous research, and was evaluated by experts in the field to ensure the reliability and validity of the constructs. The 5-point Likert scale was adopted as a measurement type.

3.8 *Population, Sample and Unit of Analysis*

The study population consists of all private hospitals in the capital of Jordan, Amman, which totals 44 hospitals according to the information taken from the annual statistical report of the Ministry of Health for 2019/2020. A clustered purposive sample has followed, only hospitals its capacity of more than 150 beds has been chosen. The sample consisted of seven hospitals. The unit of analysis included heads of departments, doctors, nurses, technical, and administrative.

4 Data Analysis

4.1 Demographic Analysis

This section provides information about the demographic profile of the respondents to this study: their gender, age, educational level, work experience, and job position.

Table 2 shows that most of the respondents were female aging less than 35 years with an educational background of Bachelors. Besides, most respondents had a work experience of at least 10 years. Nevertheless, percentage of participants with job positions such as administrative positions and nurses were comparatively high.

Table 2 Demographics of the participants

No	Respondent profile	Frequency (N = 212)	Total	%	Total (%)
1	Gender		212		100
	Male	97		44.8	
	Female	117		55.2	
2	Age		212		100
	Less than 25	35		16.5	
	From 25–less than 35	87		41	
	From 35–less than 45	53		25	
	Over 45	37		17.5	
3	Education Level		212		100
	Diploma	46		21.7	
	Bachelors	142		67	
	Masters	19		8.9	
	Doctorate	5		2.4	
4	Work Experience		212		100
	1–5 years	61		28.8	
	6–10 years	58		27.4	
	11–15 years	31		14.6	
	16–20 years	29		13.6	
	Over 21 years	33		15.6	
5	Job Position		212		100
	Head of department	35		16.5	
	Doctor	37		17.4	
	Nurse	50		23.6	
	Technical	33		15.6	
	Administrative	57		26.9	

Table 3 Reliability analysis

No	Construct	Cronbach's alpha before EFA
1	Employee empowerment	0.841
2	Job satisfaction	0.899
3	Organisational citizenship behavior	0.776

Table 4 Exploratory Factor Analysis

No.	Construct	KMO	Bartlett's test of sphericity P value
1	Employees empowerment	0.869	0.000
2	Job satisfaction	0.891	0.000
3	Organizational citizenship behavior	0.875	0.000

4.2 Reliability Analysis

Internal reliability can be tested using Cronbach's Alpha value. Reliability of less than 0.60 is regarded as weak, a coefficient of 0.70 is appropriate, and the reliability of a coefficient higher than 0.80 has been regarded as strong. As one of the guide researchers who discussed reliability, (Hair et al., 2010) recommended that Cronbach's Alpha values greater than 0.70 are acceptable. Table 3 shows the results of the reliability analysis where it is concluded that all the variable in this regard are reliable.

4.3 Exploratory Factor Analysis

The value of the "Kaiser–Meyer–Olkin" (KMO) Measure of sampling adequacy should be higher than 0.60, and "Bartlett's Test of Sphericity" should be statically significant at $p < 0.05$ (Hair et al., 2010). As shown in Table 4, the results of KMO and Bartlett's Test of Sphericity for all constructs satisfied the minimum requirement as suggested by Hair et al. (2010) and were appropriate for EFA.

4.4 Descriptive Analysis of Research Constructs

This section provides a descriptive analysis of the constructs addressed in the present study. In this study, the descriptive analysis was conducted on the individual items to determine the mean, and standard deviation scores on the items were obtained according to the dimensions of employee empowerment, psychological

Table 5 Descriptive analysis of research constructs

Dimension	Mean	Std. Dev
Employee empowerment	3.966	0.8272
Job satisfaction	3.966	0.8272
OCB	4.250	0.5061

Table 6 Measurement models

Name of category	Name of index	Level of acceptance	Constructs fitness indexes
Absolute Fit Index	RMSEA	RMSEA < 0.08	RMSEA = 0.041
	GFI	GFI > 0.90	GFI = 0.962
Incremental Fit Index	AGFI	AGFI > 0.90	AGFI = 0.934
	CFI	CFI > 0.90	CFI = 0.953
	TLI	TLI > 0.90	TLI = 0.973
	NFI	NFI > 0.90	NFI = 0.986

empowerment, structural empowerment, job satisfaction, and OCB can be seen in Table 5.

4.5 Measurement Model

The measurement model of constructs must pass three phases, namely: construct validity, convergent validity, and discriminant validity. Construct validity shall be evaluated utilizing the Measurement Model Fitness Indexes. The specific latent construct is considered valid if its fitness indexes exceed the two categories of model fit, namely Absolute Fit and Incremental Fit. The values of indexes in Table 6 show a perfect fit with models valued <0.9.

4.6 Pooled CFA for All Measurement Models of Constructs

The pooled CFA is a fast, efficient, and accurate procedure. By using the pooled CFA, the researcher could monitor a one set of fitness indexes for all constructs in the model as shown in Fig. 2.

The output in Fig. 2 presented the fitness indexes for all constructs in the model, the factor loading for all items in each variable, and the correlation between variables in the model. The fitness indexes threshold values, the factor holding for every item exceed a minimum of 0.6, and the correlation coefficient also exceed 0.85 (Hair et al., 2010).

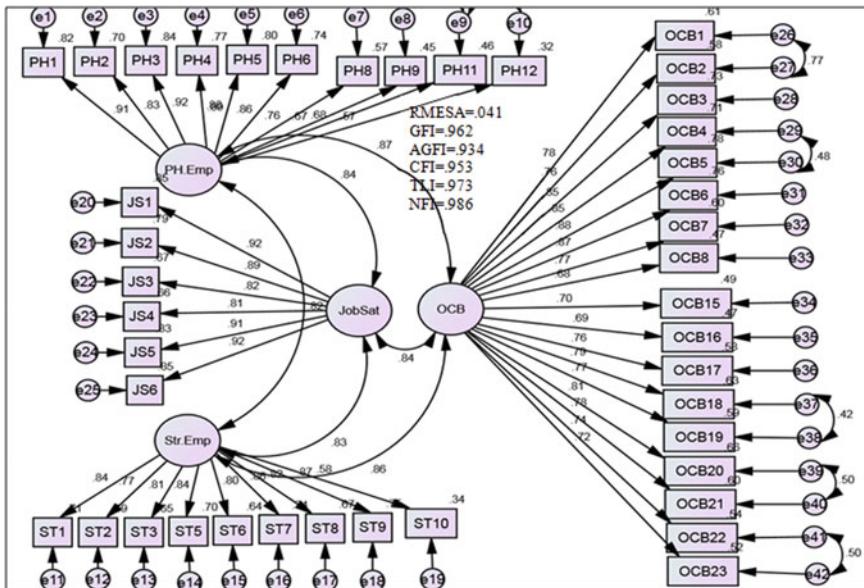


Fig. 2 Pooled CFA model

4.7 Hypothesis Testing

The hypothesis is significant if the P-value obtained is less than the type error value (alpha) of 0.05. The Regression Weights (Unstandardized Model) with a path analysis for all constructs and variables in the model showed the significant level (P-Value) for each relationship in the model. The actual regression coefficient (beta) is shown in Table 7. The value of the regression coefficient indicates the effect of exogenous (independent) constructs on their corresponding endogenous constructs.

The testing of the hypotheses done in Table 8 was decided based on the probability value (p-value). The hypothesis is significant if the P-value obtained is less than the type error value (alpha) of 0.05. H1 result shows that employee empowerment has a significant effect on the OCB. H2 are significant and the result shows that employee empowerment has a significant effect on job satisfaction. Moreover, H3, which is

Table 7 Hypothesis testing using regression coefficients

Hypothesis	Regression Weights	β	R^2	t-value	p-value	Hypothesis
H ₁	DF → SP	0.854	0.730	9.92	0.000	Supported
H ₂	DF → ESC	0.686	0.471	6.75	0.000	Supported
H ₃	SP → ESC	0.619	0.383	12.7	0.000	Supported
H ₄	DF*SP → ESC	0.689	0.475	9.62	0.000	Supported

Note: Significance Level at * P < 0.001, ** P < 0.05

Table 8 Summary of hypotheses testing for direct and indirect effect

	Direct effect hypothesis	P-Value	Decision
H1	Employees empowerment has a significant effect on the organizational citizenship behaviour	<0.05	Supported
H2	Employees empowerment has a significant effect on the job satisfaction	<0.05	Supported
H3	Job satisfaction has a significant effect on the organizational citizenship behaviour	<0.05	Supported
H4	Job satisfaction mediates the relationship between employee empowerment and OCB	Bootstrapping	Supported

related to the effect of job satisfaction on OCB, is significant. Bootstrapping has been applied for H4 to test the indirect effect between variables in order to examine the mediation effect of one variable between two variables. Also, they claimed that if the values of indirect effect (upper bound and lower bound) do not straddle a 0, in between, there is mediation. H4 results supports that job satisfaction has a mediating effect in the relationship between employee empowerment and OCB.

5 Discussion of the Results

Findings support the main hypothesis H1 of this research which are consistent with those of many other studies published in the literature. For example, the significant effect of employee empowerment on the OCB is compatible with the results of the studies by Turnipseed and Vande Waa (2020). The findings of Ajlouni et al. (2021) in Jordan are similar to the findings of this research. The results of the primary hypothesis H2 were examined and compared with previous research to meet the second research objective. The findings support the main hypothesis H2 which were significant direct effects of employee empowerment on job satisfaction (H2). The findings of this research are consistent with those of many other studies published in the literature. The result of the main hypothesis H3 was examined and compared to previous research in order to meet the third research objective. The findings of this research support the main hypothesis H3, which suggests that job satisfaction has a significant direct effect on OCB (H3). The significant effect of job satisfaction on the OCB is consistent with the findings of Barusman, and Habiburrahman (2022), Dong and Phuong (2018). In addition, the findings of Alsheikh and Sobihah (2019) in Jordan are similar to those of our study. The results of the primary hypothesis H4 were examined and compared with previous research to meet the fourth research objective. The findings support the main hypothesis H4 indicating that job satisfaction has an effect on the relationship between psychological empowerment and OCB with no discrepancies observed.

6 Conclusion

Private hospitals in Jordan are regarded as one of the most crucial areas because of their responsibilities to the citizens' health in general and especially during the COVID-19 pandemic. As a result of the changing conditions in the world, the development of private hospitals has become a necessity rather than a choice. As the current standard is the quality of service provided by employees, and as the employees are the most critical assets for any hospital, the management should be concerned with their satisfaction and OCB and empower them to get the best out of them. Accordingly, the focal point of this research is to enhance private hospitals' competitiveness in Jordan by providing high-quality service within an empowered, satisfied, and high-OCB employee base. This research has developed the employee's empowerment-OCB model by examining the relationship among the constructs, namely psychological empowerment, structural empowerment, and job satisfaction, to improve OCB in Jordanian private hospitals in Amman. Overall, the present study found evidence to support the link between employee empowerment (psychological and structural), job satisfaction, and OCB. Thus, this indicates that job satisfaction is vital in influencing OCB and supporting employee empowerment in Jordanian private hospitals by mediating the employee empowerment-OCB relationship.

7 Recommendations/Limitations

This research employed a cross-sectional design of the survey method which is insufficient to prove causal relationships on a longitudinal basis. To overcome such a limitation, path analysis via SEM was used. Secondly, the findings may not be generalized in a broader context across cultures and industries because the data collected from the current study was restricted to the Jordanian 'private hospitals' in Amman, Jordan. To overcome this issue, it would be desirable to test the cross-level model in other industries, other cultures, or other countries. Third, the current study was conducted on private hospitals only. We recommend conducting the study on hospitals in the public sector to compare the results of the study on the private sector with hospitals in the public sector and the possibility of generalizing the results to hospitals in general. Finally, the current study only employed quantitative approach to defining the relationships between all variables which limits the responses in the questionnaire. A qualitative method, On the other hand, could add further insights and understanding of the problem set.

References

- Abdullahi, A. Z., Anarfo, E. B., & Anyigba, H. (2020). The impact of leadership style on organizational citizenship behavior: Does leaders' emotional intelligence play a moderating role? *The Journal of Management Development*, 39, 963–987.
- Afram, J., Manresa, A., & Mas-Machuca, M. (2022). The impact of employee empowerment on organisational performance: The mediating role of employee engagement and organisational citizenship behaviour. *Intangible Capital*, 18, 96–119.
- Ajlouni, W. M. E., Kaur, G., & Alomari, S. A. (2021). The impact of employees' gender and age on organizational citizenship behavior using a fuzzy approach. *Social Science Computer Review*, 39, 1237–1252.
- Alhamad, A., Alshurideh, M., Alomari, K., Al Kurdi, B., Alzoubi, H., Hamouche, S., & Al-Hawary, S. (2022). The effect of electronic human resources management on organizational health of telecommunications companies in Jordan. *International Journal of Data and Network Science*, 6, 429–438.
- Alhamad, A. Q. M., Akour, I., Alshurideh, M., Al-Hamad, A. Q., Kurdi, B. A., & Alzoubi, H. (2021). Predicting the intention to use google glass: A comparative approach using machine learning models and PLS-SEM. *International Journal of Data and Network Science*, 5, 311–320.
- Ali, N., Ghazal, T. M., Ahmed, A., Abbas, S., Khan, M. A., Alzoubi, H. M., Farooq, U., Ahmad, M., & Khan, M. A. (2022). Fusion-based supply chain collaboration using machine learning techniques. *Intelligent Automation & Soft Computing*, 31, 1671–1687.
- Ali Salahat, M. (2021). Employee empowerment, knowledge management and decision-making agility; mediating role of extra-role performance. *International Journal of Academic Research in Business and Social Sciences*, 11.
- Alnazer, N. N., Alnuaimi, M. A., & Alzoubi, H. M. (2017). Analysing the appropriate cognitive styles and its effect on strategic innovation in Jordanian universities. *International Journal of Business Excellence*, 13, 127–140.
- Alnuaimi, M., Alzoubi, H. M., Ajelat, D., & Alzoubi, A. A. (2021). Towards intelligent organisations: An empirical investigation of learning orientation's role in technical innovation. *International Journal of Innovation and Learning*, 29, 207–221.
- AlShehhi, N., AlZaabi, F., Alnahhal, M., Sakhrreh, A., & Tabash, M.I. (2021). The effect of organizational culture on the performance of UAE organizations. *Cogent Business & Management*, 8.
- Alsheikh, G., & Sobihah, M. A. A. (2019). Effect of behavioral variables on organizational citizenship behavior (OCB), with job satisfaction as moderating among Jordanian five-star hotels: A pilot study. *International Journal of Ethics and Systems*, 35, 272–283.
- Alsheikh, L. H. (2020). The impact of purchase type on customer happiness in the presence of social media as a mediating variable: A student perspective in Saudi Arabia. *International Journal of Advanced Science and Technology*, 29, 6551–6561.
- Alshurideh, M., Gasaymeh, A., Ahmed, G., Alzoubi, H. M., & Kurd, B. A. (2020). Loyalty program effectiveness: Theoretical reviews and practical proofs. *Uncertain Supply Chain Management*, 8, 599–612.
- Alshurideh, M., Kurdi, A. B., Alzoubi., H. M., Sahawneh, N., Al-kassem, A. (2022). Fuzzy assisted human resource management for supply chain management issues. *Annals of Operations Research*.
- Alzoubi, H., & Ahmed, G. (2019). Do total quality management (TQM) practices improve organisational success? A case study of electronics industry in the UAE. *International Journal of Economics and Business Research*, 17, 459–472.
- Alzoubi, A. (2021). The impact of process quality and quality control on organizational competitiveness at 5-star hotels in Dubai. *International Journal of Technology, Innovation and Management*, 1, 54–68.

- Alzoubi, H. M., Ahmed, G., Al-Gasaymeh, A., & Al Kurdi, B. (2020). Empirical study on sustainable supply chain strategies and its impact on competitive priorities: The mediating role of supply chain collaboration. *Management Science Letters*, 10, 703–708.
- Alzoubi, H., Alshurideh, M., Kurdi, B. A., Akour, I., & Aziz, R. (2022a). Does BLE technology contribute towards improving marketing strategies, customers' satisfaction and loyalty? The role of open innovation. *International Journal of Data and Network Science*, 6, 449–460.
- Alzoubi, H. M., Ahmed, G., & Alshurideh, M. (2022b). An empirical investigation into the impact of product quality dimensions on improving the order-winners and customer satisfaction. *International Journal of Productivity and Quality Management*, 36, 169–186.
- Alzoubi, H. M., Elrehaeil, H., Hanaysha, J. R., Al-Gasaymeh, A., & Al-Adaileh, R. (2022c). The role of supply chain integration and agile practices in improving lead time during the COVID-19 crisis. *The International Journal of Service Science, Management, Engineering, and Technology*, 13, 1–11.
- Alzoubi, H. M., & Aziz, R. (2021). Does emotional intelligence contribute to quality of strategic decisions? The mediating role of open innovation. *Journal of Open Innovation: Technology, Market, and Complexity*, 7, 130.
- Alzoubi, H. M., Vij, M., Vij, A., & Hanaysha, J. R. (2021). What leads guests to satisfaction and loyalty in UAE five-star hotels? AHP analysis to service quality dimensions. *Enlightening Tourism. A Pathmaking Journal*, 11, 102–135.
- Alzoubi, H. M., & Yanamandra, R. (2020). Investigating the mediating role of information sharing strategy on agile supply chain in supply chain performance. *Uncertain Supply Chain Management*, 8, 273–284.
- Ashraf, M. A. (2020). Demographic factors, compensation, job satisfaction and organizational commitment in private university: An analysis using SEM. *Journal of Global Responsibility*, 11, 407–436.
- Barusman, A. R. P., & Habiburrahman, H. (2022). The role of supply chain management and competitive advantage on the performance of Indonesian SMEs. *Uncertain Supply Chain Management*, 10, 409–416.
- Dong, L. N. T., & Phuong, N. N. D. (2018). Organizational justice, job satisfaction and organizational citizenship behavior in higher education institutions: A research proposition in Vietnam. *Journal of Asian Finance, Economics and Business*, 5, 113–119.
- Farouk, M. (2021). The universal artificial intelligence efforts to face coronavirus COVID-19. *International Journal of Computations, Information and Manufacturing*, 1, 77–93.
- Guergov, S., & Radwan, N. (2021). Blockchain convergence: Analysis of issues affecting IoT, AI and blockchain. *International Journal of Computations, Information and Manufacturing*, 1, 1–17.
- Hair, J. F., Black, W. C., & Babin, B. J. (2010). *Multivariate data analysis* (7th ed.). Prentice Hall.
- Hamadneh, S., Pedersen, O., Alshurideh, M., Kurdi, B. A., & Alzoubi, H. M. (2021). An investigation of the role of supply chain visibility into the Scottish blood supply chain. *The Journal of Legal, Ethical and Regulatory Issues*, 24, 1–12.
- Hanaysha, J. R., Al-Shaikh, M. E., Joghee, S., & Alzoubi, H. M. (2021a). Impact of innovation capabilities on business sustainability in small and medium enterprises. *FIIB Business Review*, 12, 55–68.
- Hanaysha, J. R., Shaikh, A., & Alzoubi, H. M. (2021b). Importance of marketing mix elements in determining consumer purchase decision in the retail market. *International Journal of Service Science Management Engineering and Technology*, 2, 56–72.
- Joghee, S., Alzoubi, H. M., & Dubey, A. R. (2020). Decisions effectiveness of FDI investment biases at real estate industry: Empirical evidence from Dubai smart city projects. *International Journal of Scientific & Technology Research*, 9, 3499–3503.
- Kasem, J., & Al-Gasaymeh, A. (2022). A Cointegration analysis for the validity of purchasing power parity: Evidence from Middle East Countries. *International Journal of Technology, Innovation and Management*, 2, 1.

- Kashif, A. A., Bakhtawar, B., Akhtar, A., Akhtar, S., Aziz, N., & Javeid, M. S. (2021). Treatment response prediction in hepatitis C patients using machine learning techniques. *International Journal of Technology, Innovation and Management*, 1, 79–89.
- Khan, M. A. (2021). Challenges facing the application of IoT in medicine and healthcare. *International Journal of Computations, Information and Manufacturing*, 1, 39–55.
- Kurdi, B. A., Alshurideh, M., Akour, I., Alzoubi, H. M., Obeidat, B., & Alhamad, A. (2022a). The role of digital marketing channels on consumer buying decisions through eWOM in the Jordanian markets. *International Journal of Data and Network Science*, 6, 1175–1185.
- Kurdi, B. A., Alzoubi, H. M., Akour, I., & Alshurideh, M. T. (2022b). The effect of blockchain and smart inventory system on supply chain performance: Empirical evidence from retail industry. *Uncertain Supply Chain Management*, 10, 1111–1116.
- Kurdi, B. A., Alshurideh, M., Akour, I., Tariq, E., Alhamad, A., & Alzoubi, H. M. (2022c). The effect of social media influencers' characteristics on consumer intention and attitude toward Keto products purchase intention. *International Journal of Data and Network Science*, 6, 1135–1146.
- Lee, K. L., Azmi, N. A. N., Hanaysha, J. R., Alzoubi, H. M., & Alshurideh, M. T. (2022a). The effect of digital supply chain on organizational performance: An empirical study in Malaysia manufacturing industry. *Uncertain Supply Chain Management*, 10, 495–510.
- Lee, K. L., Romzi, P. N., Hanaysha, J. R., Alzoubi, H. M., & Alshurideh, M. (2022b). Investigating the impact of benefits and challenges of IOT adoption on supply chain performance and organizational performance: An empirical study in Malaysia. *Uncertain Supply Chain Management*, 10, 537–550.
- Farouk, M. (2022). Studying human robot interaction and its characteristics. *International Journal of Computations, Information and Manufacturing*, 2, 1.
- Martínez, R. N., & Tindale, R. S. (2015). Impact of organizational citizenship behavior on performance in women's sport teams. *Journal of Applied Sport Psychology*, 27, 200–215.
- Mehmood, T., Alzoubi, H., Alshurideh, M., Al-Gasaymeh, A., & Ahmed, G. (2019). Schumpeterian entrepreneurship theory: Evolution and relevance. *Academic Entrepreneur*, 25, 1–10.
- Radwan, N. (2022). The internet's role in undermining the credibility of the healthcare industry. *International Journal of Computations, Information and Manufacturing*, 2, 1.
- Ocampo, L., Acedillo, V., Bacunador, A. M., Balo, C. C., Lagdameo, Y. J., & Tupa, N. S. (2018). A historical review of the development of organizational citizenship behavior (OCB) and its implications for the twenty-first century. *Personnel Review*, 47, 821–862.
- Putra, A., & Riana, I. G. (2020). The role of organizational commitment mediate the effect of job satisfaction on organizational citizenship behavior. *American Journal of Humanities and Social Sciences Research*, 4, 371–378.
- Salman, S. F. A., & Sankar, J. P. (2021). The relationship between employee empowerment and perceived employee job performance among the hospitality sector in the Kingdom of Bahrain: The iKSP. *J. Innov. Writings*, 1, 12–22.
- Shamout, M., Ben-Abdallah, R., Alshurideh, M., Alzoubi, H., Kurdi, B. A., & Hamadneh, S. (2022). A conceptual model for the adoption of autonomous robots in supply chain and logistics industry. *Uncertain Supply Chain Management*, 10, 577–592.
- Singh, S. K., & Singh, A. P. (2019). Interplay of organizational justice, psychological empowerment, organizational citizenship behavior, and job satisfaction in the context of circular economy. *Management Decision*, 57, 937–952.
- Turnipseed, D. L., & VandeWaa, E. A. (2020). The little engine that could: The impact of psychological empowerment on organizational citizenship behavior. *The International Journal of Organization Theory & Behavior*, 23, 281–296.

Developing Rescue Mobile Application



Jasim Faisal Almidfa, Saif E. A. Alnawayseh, Waleed T. Al-Sit,
and Haitham M. Alzoubi 

Abstract Helping and protecting human life had always been and will always be the major concern. Everything in the world could change but the human centred concern would always stay core. This concern leads us to the development of the user friendly and technical friendly designed application “Rescue Smart App” which could provide the possible services for human’s life protection and for taking the possible measures regarding the emergency situations to accomplish the tasks. Based on our research we found that different systems in the mobile application form are working for rescuing human’s lives but people are encountering a lot of problems using them. Rescue Smart App is a Deigned mobile application following the rules important to be followed in Human Computer Interaction designing principles which serve specifically for the rescue mobile app throughout the UAE and across the region. This application would be responsible for providing the services through which the recuing work would become more efficient in serving the human beings and for protection of human’s lives. This application would be a great experience in the world of mobile applications.

Keywords Rescue Smart App · Mobile application

J. F. Almidfa

School of Computing, Skyline University College, Sharjah, UAE

S. E. A. Alnawayseh

Electrical Engineering Department, Faculty of Engineering, Mutah Univesity, Mutah, Jordan
e-mail: saif982@mutah.edu.jo

W. T. Al-Sit

Department of Computer Engineering, Mutah University, Al-Karak, Jordan

Higher Colleges of Technology, Dubai, UAE

W. T. Al-Sit

e-mail: w_sitt@mutah.edu.jo

H. M. Alzoubi 

School of Business, Skyline University College, Sharjah, UAE

e-mail: haitham.alzoubi@skylineuniversity.ac.ae

Applied Science Research Center, Applied Science Private University, Amman, Jordan

© The Author(s), under exclusive license to Springer Nature Switzerland AG 2024

501

H. M. Alzoubi et al. (eds.), *Technology Innovation for Business Intelligence and Analytics (TIBIA)*, Studies in Big Data 147,

https://doi.org/10.1007/978-3-031-55221-2_35

1 Introduction

The inhabitants' lives and property were being jeopardized due to a lack of preparedness for emergencies and disasters (Al-Tahat & Moneim, 2020). This was demonstrated by the fact that in the event of an emergency, there was a greater than 95% likelihood that the sufferer would not be transported by ambulance, let alone receive timely emergency care from trained specialists. As a result, it was evident that emergency management in the UAE had been neglected for a long time (Alzoubi et al., 2022f), and that there are no trained emergency paramedics even in teaching hospitals' emergency departments (Ghazal et al., 2022g). Furthermore, there was essentially no pre-hospital emergency ambulance (Al-Hamadi et al., 2015a), rescue and skilled fire services, or a disaster response force, which was blatantly revealed (Lee et al., 2022a). The NGOs had a few ambulances accessible, but they needed vital equipment and skilled personnel (Mejia et al., 2019). As a result, UAE's citizens were refused access to even basic services. This major problem was the major push for us to develop an application (Hanaysha et al., 2022) that would help in providing the services (Kurdi et al., 2022a) and to be developed as such to be easily used by the ones with little technical literacy or understanding (Radwan, 2022).

The UAE Emergency Service (Rescue 900 and 901) was founded in 2004 on the belief that if you aren't prepared for an emergency, you shouldn't expect a miracle in the event of a disaster. Rescue 900 and 901 has grown into the UAE's largest humanitarian service, with strong infrastructure in all cities, not just in the UAE but throughout the region, as well as offering help and training to the personnel of other adjacent major states (Alzoubi et al., 2022b). However, the difficulty it has always had was with the inappropriate application of technology (Al-Hamadi et al., 2015b), which might have greatly increased and improved their services. Rescue 900 and 901 are the solutions to the challenges; they were created with the same fundamental implementation as the others. The Rescue Smart App provides a solution to the issues (Lee & Ahmed, 2021). With the help of this application, Rescue Smart App will be able to earn the trust of its users by rescuing millions of victims of emergencies through its emergency ambulance, rescue, and fire services (Alnuaimi et al., 2021). Rescue Smart App would also be bolstering its disaster readiness and response capabilities in partnership with the National Disaster Management Authorities by demonstrating their ambulance services, which would be indirectly aided by the application's services (Alzoubi & Aziz, 2021).

1.1 Problem Definition

The lacking of the technical knowledge and the increasing dependency of people on the technology is a major problem that is creating an odd equation with no possible realistic solution (Shehada et al., 2017). The major states departments that are responsible for human services that are to be provided specially in state of emergencies needs

an instant solution (Alshurideh et al., 2020) that needs to be catered and the most accessible gadgets that is immensely accessible and used by all is the mobile phones (Shehada et al., 2018). Therefore, this application that we will develop for this very instant and major human cause will provide with the unique solution (Joghee et al., 2020) without any major changes that would otherwise be impossible to be accepted by the end user (Guergov & Radwan, 2021).

The world is drifting more towards the flexible technological changes (Alzoubi et al., 2022b) and specifically in mobile phones majorly towards different applications that are to be supported by the operating systems of these gadgets (Hasan et al., 2021a; Kim et al., 2019). Android phones are more inclined towards applications that are supportive towards the application developed in these languages (Alzoubi et al., 2021a) and so as the different mobile applications are more supportive towards the applications developed in their specific mobile languages. The HCI rules are them to be used accordingly in these developed mobile applications so as to be used and supported by the mobile gadgets without any major crashing or run time errors (Kurdi et al., 2022b). The research that is followed here throughout is for the cross platform mobile application and named as “Rescue Smartapp”, it is through the name cross platform that inter and intra mobile services will be provided (Islam et al., 2020; Mejia et al., 2019) and the application will be supported by the different mobile operating systems without any hindrance and without the implementation overhead (Alzoubi & Yanamandra, 2020). There are rare mobile applications that provide single HCI user friendly interfaces and Rescue Smartapp is one of them (Al-Tahat & Moneim, 2020). As the proposed application is a cross platform app therefore a unique development will be used for its implementation and that is ‘React Native’. React Native will be implemented with the JAVA SCRIPT and this language will then be converted to the specific machine language (Alzoubi et al., 2022d) that will easily be understood by the operating systems of different mobile phones either Android, Apple, Microsoft any other.

1.2 *Solution Overview*

When the operator receives an ambulance request, he gathers information from the caller about the occurrence (Ghazal et al., 2022c). The Rescue Smart App receives this information. This information comprises the caller’s phone number, name and address (Ali et al., 2021) (any combination of street name and zip code), event description/nature, and the number of people involved (Alsharari, 2022). The ambulance dispatch system creates a new incident with all the data based on this information. “Occurrence information” refers to the information that has been added to this incident (Al-Hamadi et al., 2021). The dispatcher will assign the ambulance/s to the incident and enter the ambulance details into the system based (Hasan et al., 2021b; Lee et al., 2022b) on the number of people engaged in the incident (Alzoubi & Ahmed, 2019). The injured are taken care of by an ambulance. The dispatcher will use the system to communicate the notification, incident information (Hujran et al., 2020),

and the location of the nearest hospital to ambulance staff once the ambulance has been assigned to the incident (Al-Dmour, 2020; Hamadneh et al., 2021). This data is frequently referred to as “allocation data” (Al-Nashashibi et al., n.d.). The dispatcher will be able to locate the nearest hospital using the tracking feature (Alzoubi et al., 2022a). Locating the location of the occurrence (Teahan et al., 2012), logging and reporting incidents, displaying timing data, and reporting errors (Shamout et al., 2022). Ambulance staff would next utilize Google Maps to locate the incident site (Al-Dmour & Teahan, 2005). When the work is finished, the system notifies the dispatcher that it has been completed. Also, every ambulance’s state is then updated as needed because every location requires updated details that can be utilized according to the need of use and satisfaction (Alzoubi et al., 2021b).

2 Literature Review

Because today’s world is made up of technology (Alzoubi et al., 2022f), we can’t state that businesses don’t have automated processes (Radwan & Farouk, 2021), and Rescue Smart App is no exception in any field whether healthcare or any other (Ghazal et al., 2022a; Mehmood et al., 2019). The following tables offer a comparison of numerous applications on the Play Store that are similar to Rescue Smart App (Zitar et al., 2021) and their various features (Vo et al., 2010), also the following tabular data shown is the summary of what the mobile application have been developed in different languages (Ghazal et al., 2022i) and what were the problems in those that are somehow tried to be addressed in the work proposed by us in this research project as shown in Tables 1, and 2.

Table 2 offers a comparison of numerous applications on the Play Store that are similar to Rescue Smart App.

“Where Are U” is the app that calls the European Emergency Number 112, where the service is implemented, automatically sending your location information and all the other information you provided in the app (Mehmood et al., 2019). However, it lacks providing the claimed tracking in the App (Ghazal & Taleb, 2022; Oyelami et al., n.d.)

In proper route specification and being platform specific makes it technical (Alzoubi et al., 2020). It is through technical advancement if not properly implemented and provided within the working application specifically those of the emergency nature would lead to technical advancement in true sense (Alshurideh et al., 2022; Ghazal et al., 2022j; Rehman et al., 2022), the mobile apps needs to be technically modulated and should be developed with user friendly interfaces to be enhanced usability for the end users and for the smooth functional understanding of the application itself that can lean the developer to the efficient performance as well as the efficient business performance (Alzoubi et al., 2022a; Ghazal et al., 2022b, 2022e; Islam et al., 2020). The development approach could have been more alluring and flexible (Ahmed & Amiri, 2022; Ghazal et al., 2021b) rather than the modular approach without making any technical resistance in the responsive rigidity (Alzoubi

Table 1 Emergency response of 112 system

Features	112 Where are your app	Rescue 1122 monitoring system	1122 Pak-app	112 BE	112 Georgia
Tracking	✓	✗	✓	✓	✗
Routes specification	✗	✗	✗	✗	✗
Platform specific	✓	✓	✓	✓	✓
Un-necessary notifications	✓	✓	✗	✓	✓
Un-necessary storage permission	✓	✓	✗	✗	✓
Website	✗	✗	✗	✗	✗
Nearest hospital finding	✗	✗	✓	✗	✗
Traffic police collaboration		✗	✗	✗	✗

Table 2 Emergency response of St. John system

Features	St. John ambulance first aid	Echo 112-The pocket life save	JHelp 113
Tracking	✓	✗	✓
Routes specification	✗	✗	✗
Platform specific	✓	✓	✓
Un-necessary notifications	✓	✓	✗
Un-necessary storage permission	✓	✓	✗
Website	✗	✗	✗
Nearest hospital finding	✗	✗	✓
Traffic police collaboration	✗	✗	✗

et al., 2022c; Ghazal et al., 2022i). Therefore, Java Script ES6 could be used to only for the better development of the project with the functional performance but also for providing to the best of service (Ghazal et al., 2022d; Zitar et al., 2021). It is through these proposals that were given in most of the research papers that led to the development of the mobile app using the special JavaScript as modular language.

2.1 *Technological Overview*

The project is a mobile application that will be built with react native. React Native is a complete open-source SDK for developing hybrid mobile apps. It also enables the use of Ionic components without the use of any user interface framework. Ionic delivers tools and services for creating hybrid mobile, desktop, and Progressive Web Apps utilizing modern web development technologies and processes such as CSS, HTML5, Sass, Angular JS, and TypeScript (Alnazer et al., 2017; Ghazal et al., 2022f). is an open-source front-end web framework based on JavaScript. The MEAN stack consists of MongoDB database, Express.js web application server framework, Angular.js itself, and Node.js server runtime environment. AngularJS is the frontend element of the MEAN stack. By providing a framework for client-side model–view–controller (MVC) and model–view–view model (MVVM) architectures, as well as components typically used in rich Internet applications, it seeks to facilitate both the building and testing of such systems.

2.2 *Background*

There is no technical platform that aids in supporting and coping with emergency situations (Saleem et al., 2022). This has always been difficult for productive working and the proper use of learned technology (Ghazal et al., 2022h; Ramakrishna & Alzoubi, 2022). All of these well-known foundations, as well as their ambulance services, are still not automated. There are no applications for any efficient special use that could help in the possible regard. As a result, these automated helplines inspired us to create the Rescue Smart App. We are building this application for general rescue in comparison to the manual working of that of 900 and 901, which are now operational throughout the state and in all major cities across the UAE and even across the region (Ghazal et al., 2021a, c, 2022k). This program will greatly assist them in carrying out their responsibilities.

3 **Research Methodology**

The working process for the mobile application is using the changes in the business layer for those of the end user without using any theoretical approach but rather the practical approach that is the proper implementation of the mobile application which is suggested above to be developed for the proposed problem for this research paper. The working methodology works here with the authentication process that will be provided by the security process of the react native shielding module (see Fig. 1).

Also, Fig. 2 shows Real time data base will be used of that of the React native that are provided due to reservation at the run time. In it the Google kit plugins will

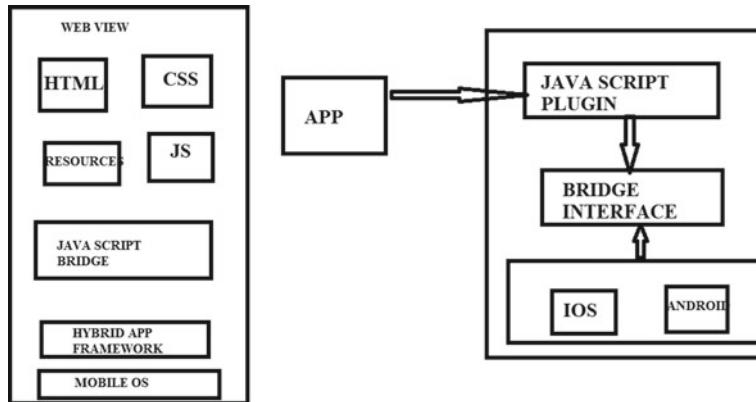


Fig. 1 The working flowchart for the application (Ghazal et al., 2022e)

also be used so as to make working of the mobile app more efficient. All of the special features that are to be provided will be provided in the app for the smooth and cohesive functional working.

It is the general working model of how the app would function in an overall way. Also, the user interfaces will be designed accordingly so as to provide the compliance to those of the mentioned core values (Hanaysha et al., 2021). The data will be reserved in the Real time data base and so as those of the Cloud computer where majorly data of the application is protected using the Google kit plug ins (Al-Naymat et al., 2021).

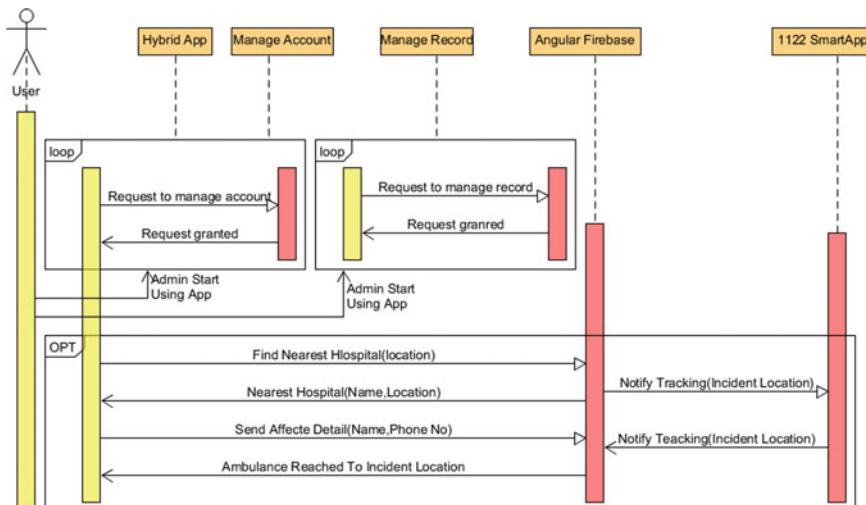


Fig. 2 The Real time data base (Ghazal et al., 2022e)

4 Discussion

This research work has enables us to develop an application that would be Cross-Platform app providing with the best possible solutions and hence providing the best User-friendly interfaces making it easy for the end users to use with the best of understanding. The Java Script used in this is the unique implementation approach that is different as compare to simple java script used in the website development. The modular machine language barrier and translation at threading and multithreading level is a different unique feature that has been implemented in this application (Alzoubi et al., 2022e). The mobile application that was always platform specific has been catered in this research paper and has provided the unique app that will function the same way in all of the mobile operating systems without making any changes in the user interfaces but the back end changes will be made to develop compatibility with that of the operating system of the mobile that is to get the services of the applications. The special and unique real time data base space formation for the app is itself unique that wasn't implemented and used in any of the mobile application shown in the tables above.

5 Conclusion

The current work's future scope includes constructing an ambulance application called 'Rescue Smart app Technical Ambulances,' which gives solutions for product stock display and builds an emergency kind and product type mapping. The future application can be connected with the existing app to create a comprehensive medicinal product that allows users to examine drugs for a certain ailment type and place orders after examining entire stock and pricing listings, this detailed sampling of medicines required for the type of reported emergency would help the ambulances to more steps ahead for the protection of the human lives cause as well as locate nearby ambulances to respond to the emergency calls or reporting. Adding to this, the special approach called as the HYBRID approach with the Reactive native and Iconic would help in developing the possible solutions for the proposed problem. The google special kit plug ins if implemented with the language Java Script ES6 would provide even best of the solutions that would help in running of the application at run time without crashing. This study uses the benefits of React-Native, a framework capable of developing hybrid mobile applications for cross platforms, to come up with a solution to the problem. React-Native, which was created by Facebook developers in 2015, provides a single place to write code in the java script ES6 programming language and construct mobile applications for both iOS and Android at the same time, using a single code base for both native platforms.

References

- Ahmed, G., & Amiri, N. A. (2022). The transformational leadership of the founding leaders of the United Arab Emirates: Sheikh Zayed Bin Sultan Al Nahyan and Sheikh Rashid Bin Saeed Al Maktoum. *International Journal of Technology, Innovation and Management*, 2, 1.
- Al-Dmour, N., & Teahan, W. (2005). The blackboard resource discovery mechanism for distributed computing over P2P networks. In International, T. (Ed.), *PDCN. Conference on Parallel and Distributed Computing and Networks, Innsbruck, Austria, February* (pp. 15–17).
- Al-Dmour, N. A. (2020). Using unstructured search algorithms for data collection in iot-based WSN. *International Journal of Engineering Research & Technology*, 13, 1992–1998.
- Al-Hamadi, H., Gawanmeh, A., & Al-Qutayri, M. (2015a). Formal validation of QRS wave within ECG. In *2015 International Conference on Information and Communication Technology Research, ICTRC 2015* (Vol. 9, pp. 190–193).
- Al-Hamadi, H., Gawanmeh, A., Baek, J., & Al-Qutayri, M. (2015b). Lightweight security protocol for ECG bio-sensors'. *Wireless Personal Communications*, 95, 5097–5120.
- Al-Hamadi, H., Nasir, N., Yeun, C. Y., & Damiani, E. (2021). A verified protocol for secure autonomous and cooperative public transportation in smart cities. In June, I. (Ed.), *2021 IEEE International Conference on Communications Workshops (ICC Workshops)* (pp. 1–6).
- Al-Nashashibi M., Hadi, W., El-Khalili, N., Ghassan, I., & AlBanna, A. (2021) A new two-step ensemble Learn. Model Improv. Stress Predict. Automob. Drivers. *The International Arab Journal of Information Technology*, 6.
- Al-Naymat, G., Hussain, H., Al-Kasassbeh, M., & Al-Dmour, N. (2021). Accurate detection of network anomalies within SNMP-MIB data set using deep learning. *International Journal of Computer Applications in Technology*, 66, 74–85.
- Al-Tahat, S., & Moneim, O. A. (2020). The impact of artificial intelligence on the correct application of cyber governance in Jordanian commercial banks. *International Journal of Scientific & Technology Research*, 9, 7138–7144.
- Ali, N., Ahmed, A., Anum, L., Ghazal, T. M., Abbas, S., Khan, M. A., Alzoubi, H. M., & Ahmad, M. (2021). Modelling supply chain information collaboration empowered with machine learning technique. *Intelligent Automation & Soft Computing*, 30, 243–257.
- Alnazer, N. N., Alnuaimi, M. A., & Alzoubi, H. M. (2017). Analysing the appropriate cognitive styles and its effect on strategic innovation in Jordanian universities. *International Journal of Business Excellence*, 13, 127–140.
- Alnuaimi, M., Alzoubi, H. M., Ajelat, D., & Alzoubi, A. A. (2021). Towards intelligent organisations: An empirical investigation of learning orientation's role in technical innovation. *International Journal of Innovation and Learning*, 29, 207–221.
- Alsharari, N. (2022). The implementation of enterprise resource planning (Erp) in the United Arab Emirates: A case of Musanada corporation. *International Journal of Technology, Innovation and Management*, 2, 1.
- Alshurideh, M., Gasaymeh, A., Ahmed, G., Alzoubi, H., & Kurd, B. A. (2020). Loyalty program effectiveness: Theoretical reviews and practical proofs. *Uncertain Supply Chain Management*, 8, 599–612.
- Alshurideh, M. T., Al Kurdi, B., Alzoubi, H. M., Obeidat, B., Hamadneh, S., & Ahmad, A. (2022). The influence of supply chain partners' integrations on organizational performance: The moderating role of trust. *Uncertain Supply Chain Management*, 10, 1191–1202.
- Alzoubi, H., & Ahmed, G. (2019). Do TQM practices improve organisational success? A case study of electronics industry in the UAE. *International Journal of Economics and Business Research*, 17, 459–472.

- Alzoubi, H. M., Ahmed, G., Al-Gasaymeh, A., & Al Kurdi, B. (2020). Empirical study on sustainable supply chain strategies and its impact on competitive priorities: The mediating role of supply chain collaboration. *Management Science Letters*, 10, 703–708.
- Alzoubi, H., Alhamad, A. Q. M., Akour, I., Alshurideh, M., Al-Hamad, A. Q., Kurdi, B. A., & Alzoubi, H. (2021a). Predicting the intention to use google glass: A comparative approach using machine learning models and PLS-SEM. *International Journal of Data and Network Science*, 5, 311–320.
- Alzoubi, H. M., Vij, M., Vij, A., & Hanaysha, J. R. (2021b). What leads guests to satisfaction and loyalty in UAE five-star hotels? AHP analysis to service quality dimensions. *Enlightening Tourism*, 11, 102–135.
- Alzoubi, H., Alhamad, A., Alshurideh, M., Alomari, K., Al Kurdi, B., Hamouche, S., & Al-Hawary, S. (2022a). The effect of electronic human resources management on organizational health of telecommunications companies in Jordan. *International Journal of Data and Network Science*, 6, 429–438.
- Alzoubi, H., Alshurideh, M., Kurdi, B. A., Akour, I., & Aziz, R. (2022b). Does BLE technology contribute towards improving marketing strategies, customers' satisfaction and loyalty? The role of open innovation. *International Journal of Data and Network Science*, 6, 449–460.
- Alzoubi, H. M., Ahmed, G., & Alshurideh, M. (2022c). An empirical investigation into the impact of product quality dimensions on improving the order-winners and customer satisfaction. *International Journal of Productivity and Quality Management*, 36, 169–186.
- Alzoubi, H. M., Ali, N., Ghazal, T. M., Ahmed, A., Abbas, S., Khan, M. A., Farooq, U., Ahmad, M., & Khan, M. A. (2022d). Fusion-based supply chain collaboration using machine learning techniques. *Intelligent Automation & Soft Computing*, 31, 1671–1687.
- Alzoubi, H. M., Alshurideh, M. T., Al Kurdi, B., Ghazal, T. M., Said, R. A., AlHamad, A. Q., Hamadneh, S., Sahawneh, N., & Al-kassem, A. H. (2022e). Fuzzy assisted human resource management for supply chain management issues. *Annals of Operations Research*, 1–19.
- Alzoubi, H. M., Alshurideh, M. T., Kurdi, B. A., Alhyasat, K. M. K., & Ghazal, T. M. (2022f). The effect of e-payment and online shopping on sales growth: Evidence from banking industry. *International Journal of Data and Network Science*, 6, 1369–1380.
- Alzoubi, H. M., & Aziz, R. (2021). Does emotional intelligence contribute to quality of strategic decisions? The mediating role of open innovation. *Journal of Open Innovation: Technology, Market, and Complexity*, 7, 130.
- Alzoubi, H. M., & Yanamandra, R. (2020). Investigating the mediating role of information sharing strategy on agile supply chain. *Uncertain Supply Chain Management*, 8, 273–284.
- Ghazal, T. M., Bibi, R., Saeed, Y., Zeb, A., Rahman, T., Said, R. A., Abbas, S., Ahmad, M., & Khan, M. A. (2021a). Edge AI-based automated detection and classification of road anomalies in VANET using deep learning. *Computational Intelligence and Neuroscience*, 2021, 1–19.
- Ghazal, T. M., Hasan, M. K., Alkhalfah, A., Abu Bakar, K. A., Omidvar, A., Nafi, N. S., & Agbinya, J. I. (2021b). *Fischer linear discrimination and quadratic discrimination analysis-based data mining technique for internet of things framework for healthcare* (p. 9). Public Heal.
- Ghazal, T. M., Siddiqui, S. Y., Haider, A., Khan, M. A., Naseer, I., Abbas, S., Rahman, M., Khan, J. A., Ahmad, M., Hasan, M. K., Mohammed, A., & Ateeq, K. (2021c). IoMT cloud-based intelligent prediction of breast cancer stages empowered with deep learning. *IEEE Access*, 9, 146478–146491.
- Ghazal, T. M., Abbas, S., Ahmad, M., & Aftab, S. (2022a). An IoMT based ensemble classification framework to predict treatment response in hepatitis C patients. In *2022 International Conference on Business Analytics for Technology and Security, ICBATS 2022* (pp. 1–4).
- Ghazal, T. M., Abbas, S., Alhwaiti, Y., Fatima, A., Khan, M. A., Khan, M. A., Kanwal, A., Ahmad, M., & Elmitwally, N. S. (2022b). Convolutional neural network based intelligent handwritten document recognition. *Computers, Materials and Continua*, 70, 4563–4581.
- Ghazal, T. M., Abbas, S., Munir, S., Khan, M. A., Ahmad, M., Issa, G. F., Zahra, S. B., Khan, M. A., & Hasan, M. K. (2022c). Alzheimer disease detection empowered with transfer learning. *Computers, Materials and Continua*, 70, 5005–5019.

- Ghazal, T. M., Ahmed, Z. E., Hasan, M. K., Hashim, A. A., Saeed, R. A., Mokhtar, R. A., & Singh, S. P. (2022d). Optimization procedure for intelligent internet of things applications. In *2022 International Conference on Business Analytics for Technology and Security, ICBATS 2022* (pp. 1–6).
- Ghazal, T. M., Bukhari, M. M., Abbas, S., Khan, M. A., Farooq, U., Wahbah, H., Ahmad, M., Adnan, K. M. (2022e). An intelligent proposed model for task offloading in fog-cloud collaboration using logistics regression. *Computational Intelligence and Neuroscience*.
- Ghazal, T. M., Hasan, M. K., Abdullah, S. N. H., Abubakkar, K. A., & Afifi, M. A. M. (2022f). IoMT-enabled fusion-based model to predict posture for smart healthcare systems. *Computers, Materials and Continua*, 71, 2579–2597.
- Ghazal, T. M., Hasan, M. K., Saeed, R. A., Pandey, B., Goher, H., Eshmawi, A. A., Abdel-Khalek, S., & Alkhassawneh, H. M. (2022g). A review on security threats, vulnerabilities, and counter measures of 5G enabled Internet-of-Medical-Things. *IET Communications*, 16, 421–432.
- Ghazal, T. M., Khan, M. A., Lee, S. W., & Rehman, A. (2022h). Data fusion-based machine learning architecture for intrusion detection. *Computers, Materials and Continua*, 70, 3399–3413.
- Ghazal, T. M., Mehmood, S., Khan, M. A., Zubair, M., Naseem, M. T., Faiz, T., & Ahmad, M. (2022i). Malignancy detection in lung and colon histopathology images using transfer learning with class selective image processing. *IEEE Access*, 10, 25657–25668.
- Ghazal, T. M., Noreen, S., Said, R. A., Khan, M. A., Siddiqui, S. Y., Abbas, S., Aftab, S., & Ahmad, M. (2022j). Energy demand forecasting using fused machine learning approaches. *Intelligent Automation and Soft Computing*.
- Ghazal, T. M., Rehman, A. U., Saleem, M., Ahmad, M., Ahmad, S., & Mehmood, F. (2022k). Intelligent model to predict early liver disease using machine learning technique. In: *2022 International Conference on Business Analytics for Technology and Security, ICBATS 2022* (pp. 1–5).
- Ghazal, T. M., & Taleb, N. (2022). Feature optimization and identification of ovarian cancer using internet of medical things. *Expert Systems*.
- Ghazal, T. M., Zafar, S., Asif, M., Ahmad, M. B., Faiz, T., Ahmad, M., & Khan, M. A. (2022l). Assistive devices analysis for visually impaired persons: A review on taxonomy. *IEEE Access*, 10, 13354–13366.
- Guergov, S., & Radwan, N. (2021). Blockchain convergence: Analysis of issues affecting IoT, AI and blockchain. *International Journal of Computations, Information and Manufacturing*, 1, 1–17.
- Hamadneh, S., Pedersen, O., Alshurideh, M., Kurdi, B. A., & Alzoubi, H. M. (2021). An investigation of the role of supply chain visibility into the scottish blood supply chain. *The Journal of Legal, Ethical and Regulatory Issues*, 24, 1–12.
- Hanaysha, J., Al-Shaikh, M., & Alzoubi, M. H. (2021). Importance of marketing mix elements in determining consumer purchase decision in the retail market. *The International Journal of Service Science, Management, Engineering, and Technology*, 12, 56–72.
- Hanaysha, J. R., Al-Shaikh, M. E., Joghee, S., & Alzoubi, H. M. (2022). Impact of innovation capabilities on business sustainability in small and medium enterprises. *FIIB Business Review*, 11, 67–78.
- Hasan, M. K., Islam, S., Sulaiman, R., Khan, S., Hashim, A. H. A., Habib, S., Islam, M., Alyahya, S., Ahmed, M. M., Kamil, S., & Hassan, M. A. (2021a). Lightweight encryption technique to enhance medical image security on internet of medical things applications. *IEEE Access*, 9, 47731–47742.
- Hasan, M. K., Musse, M. A., Sherfriz, S. M., Shayla, I., Huda, S. N. A. S., Eklas, H., Nazmus S. N., & Nguyen, V. (2021b). An improved dynamic thermal current rating model for pmu-based wide area measurement framework for reliability analysis utilizing sensor cloud system. *IEEE Access*, 9, 14446–14458.
- Hujran, O., Alikaj, A., Durrani, U. K., Al-Dmour, N. (2020). Big data and its effect on the music industry. In *ACM International Conference Proceeding Series* (pp. 5–9).

- Islam, S., Khalifa, O. O., Hashim, A. H. A., Hasan, M. K., Razzaque, M. A., & Pandey, B. (2020). Design and evaluation of a multihoming-based mobility management scheme to support inter technology handoff in PNEMO. *Wireless Personal Communications*, 114, 1133–1153.
- Joghee, S., Alzoubi, H. M., & Dubey, A. R. (2020). Decisions effectiveness of FDI investment biases at real estate industry: Empirical evidence from Dubai smart city projects. *International Journal of Scientific & Technology Research*, 9, 3499–3503.
- Kim, S.-K., Yeun, C. Y., Damiani, E., & Lo, N.-W. (2019). A machine learning framework for biometric authentication using electrocardiogram. *IEEE Access*, 7, 94858–94868.
- Kurdi, B. A., Alshurideh, M., Akour, I., Tariq, E., Alhamad, A., & Alzoubi, H. M. (2022a). The effect of social media influencers' characteristics on consumer intention and attitude toward Keto products purchase intention. *International Journal of Data and Network Science*, 6, 1135–1146.
- Kurdi, B. A., Alzoubi, H. M., Akour, I., & Alshurideh, M. T. (2022b). The effect of blockchain and smart inventory system on supply chain performance: Empirical evidence from retail industry. *Uncertain Supply Chain Management*, 10, 1111–1116.
- Lee, C., & Ahmed, G. (2021). Improving IoT privacy, data protection and security concerns. *International Journal of Technology, Innovation and Management*, 1, 18–33.
- Lee, K. L., Azmi, N. A. N., Hanaysha, J. R., Alzoubi, H. M., & Alshurideh, M. T. (2022a). The effect of digital supply chain on organizational performance: An empirical study in Malaysia manufacturing industry. *Uncertain Supply Chain Management*, 10, 495–510.
- Lee, K. L., Romzi, P. N., Hanaysha, J. R., Alzoubi, H. M., & Alshurideh, M. (2022b). Investigating the impact of benefits and challenges of IOT adoption on supply chain performance and organizational performance: An empirical study in Malaysia. *Uncertain Supply Chain Management*, 10, 537–550.
- Mehmood, T., Alzoubi, H. M., Alshurideh, M., Al-Gasaymeh, A., & Ahmed, G. (2019). Schumpeterian entrepreneurship theory: Evolution and relevance. *Academic Entrepreneur Journal*, 25, 1–10.
- Mejia, C., Ciarlante, K., & Chheda, K. (2019). A wearable technology solution and research agenda for housekeeper safety and health. *International Journal of Contemporary Hospitality Management*, 1–3.
- Radwan, N. (2022). The internet's role in undermining the credibility of the healthcare industry. *International Journal of Computations, Information and Manufacturing*, 2, 1.
- Oyelami, L. O., Adebiyi, S. O., Adekunle, B. S. (n.d.). Electronic payment adoption and consumers' spending growth: empirical evidence from Nigeria.
- Radwan, N., & Farouk, M. (2021). The growth of internet of things (IoT) in the management of healthcare issues and healthcare policy development. *International Journal of Technology, Innovation and Management*, 1, 69–84.
- Ramakrishna, Y., & Alzoubi, H. M. (2022). Empirical investigation of mediating role of six sigma approach in rationalizing the COQ in service organizations. *Operations and Supply Chain Management*, 15, 122–135.
- Rehman, A. U., Saleem, R. M., Shafi, Z., Imran, M., Pradhan, M., & Alzoubi, H. M. (2022). Analysis of income on the basis of occupation using data mining. In *2022 International Conference on Business Analytics for Technology and Security, ICBATS 2022* (pp. 1–4).
- Saleem, M., Abbas, S., Ghazal, T. M., Adnan Khan, M., Sahawneh, N., & Ahmad, M. (2022). Smart cities: Fusion-based intelligent traffic congestion control system for vehicular networks using machine learning techniques. *Egyptian Informatics Journal*.
- Shamout, M., Ben-Abdallah, R., Alshurideh, M., Alzoubi, H., Al Kurdi, B., & Hamadneh, S. (2022). A conceptual model for the adoption of autonomous robots in supply chain and logistics industry. *Uncertain Supply Chain Management*, 10, 577–592.
- Shehada, D., Yeun, C. Y., Zemerly, M. J., Al-Qutayri, M., Al-Hammadi, Y., & Hu, J. (2018). A new adaptive trust and reputation model for Mobile Agent Systems. *Journal of Network and Computer Application*, 124, 33–43.

- Shehada, D., Yeun, C. Y., Zemerly, M. J., Al Qutayri, M., Al Hammadi, Y., Damiani, E., & Hu, J. (2017). BROSMAP: A novel broadcast based secure mobile agent protocol for distributed service applications. In *Security and communication networks* (Vol. 2017). Wiley.
- Teahan, W. J., Al-Dmour, N. A., & Tuff, P. G. (2012). Knowledge distribution in multi agent systems. *Asian Journal of Information Technology*, 11, 300–311.
- Vo, D. L., Lee, H., Yeun, C. Y., & Kim, K. (2010). Enhancements of authenticated multiple key exchange protocol based on bilinear pairings. *Computers & Electrical Engineering*, 36, 155–159.
- Zitar, R. A., Al-Dmour, N., Nachouki, M., Hussain, H., & Alzboun, F. (2021). Hashing generation using recurrent neural networks for text documents. *ICIC Express Letters, Part B: Application*, 12, 231–241.