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Analyzing the Impact of Digital Technology Challenges on the Sustainability Performance of MSMEs

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Abstract

The survival of businesses depends on adapting to changes. Many businesses tend to fail and close down within a short period. One of the main causes is technological change. Currently, the world has entered the era of the digital economy where businesses are driven and dependent on digital technology. Digital technology plays a crucial role and impacts traditional business operations. If businesses do not recognize the importance and try to adapt, they will not be able to survive amidst business competition. Therefore, this study aims to analyze the digital technology challenges that influence the sustainability performance of small, medium, and micro enterprises (MSMEs). We used primary data obtained from an online questionnaire survey from a sample of 385 MSMEs within Thailand and analyzed the results using a multiple regression model. The results showed that digital technology challenges including artificial intelligence (AI), cloud computing and internet of things (IoT) have a positive influence on the sustainability performance of MSMEs. This research can be used as a guideline for improving and developing strategies, as well as assisting Thai entrepreneurs in deciding on the adoption of digital technology, leading to sustainability performance of MSMEs.

Keywords: Challenge; Digital technology; MSMEs; Sustainability; Performance

1. Introduction

From statistical data, it is found that Thailand gets an average of 70,000 new businesses established each year. However, more than 50% of these businesses close within their first year, and over 40% close within three years, leaving only about 10% remaining sustainable [1]. The adoption of digital technology within business units has been shown to enhance competitiveness, enabling businesses to survive and sustain operations amid high competition today [2]. Digital technology refers to electronic tools, systems, and devices that process, store, and transmit data in digital formats, encompassing a wide range of technologies [3], especially artificial intelligence (AI), cloud computing, the Internet of things (IoT), and big data. Nevertheless, applying digital technology faces significant challenges and constraints, particularly concerns about initiating change and the required investment for each enterprise [4].

Reviewing previous research on the challenges of digital technology adoption affecting the sustainability performance of medium, small, and micro-sized enterprises (MSMEs) in Thailand reveals insufficient coverage and exploration of contemporary digital technologies. Therefore, this research aims to investigate digital technology challenges influencing the sustainability performance of MSMEs in Thailand. The findings aim to provide insights for improving and developing strategies and serve as a decision-making tool for entrepreneurs

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in selecting digital technologies for sustainable business outcomes.

2. Literature review

2.1. AI

AI technology refers to artificial intelligence created by humans, capable of reasoning, logic, planning, and learning, similar to human abilities, using programs or software for various training purposes as specified and written by humans. Currently, it is used to assist humans in various aspects [5]. AI technology is becoming increasingly popular and playing a role in assisting humans in problem-solving and supporting various work tasks to create competitive advantages and growth opportunities for large organizations or even medium-sized and small businesses [6]. Therefore, the fundamental goal of applying AI technology is primarily to improve operational processes efficiently, such as increasing sales, reducing management costs related to consumer systems, and enhancing data analysis accuracy, as well as increasing organizational flexibility. The use of AI technology aids in solving management problems [7].

2.2. Cloud computing

Cloud computing has emerged from the continuous development of information technology on the Internet network [8]. Cloud computing refers to service technologies that encompass processing units, data storage units, and various online systems provided by service providers to reduce complexity in installation and system maintenance, save time, and reduce costs in building computer systems and networks. These services are available in both free with limitations and paid models [9]. Currently, organizations or businesses can rent cloud computing from service providers to use in operations without needing to invest in purchasing their own hardware and software, as well as not needing to establish their own network infrastructure. This reduces responsibility for maintenance because the service provider manages it. Furthermore, system updates are easier, and users can access systems and data over the Internet, manage system resources through the network, and share resources collaboratively [10].

2.3. Internet of things

IoT refers to devices or objects that can connect and exchange data with each other through the Internet or other wireless networks, without human intervention [11]. According to surveys, over 90% of experts in MSMEs believe that IoT is a key enabler that can enhance operational performance [12]. This aligns with previous research indicating that in MSMEs, IoT technology is predominantly used in conjunction with cloud technology in manufacturing processes to increase speed and agility. IoT helps improve efficiency and streamline production processes [7, 13-14].

2.4. Big data

Big data, as defined by the National Institute of Standards and Technology (NIST) of the United States, is a source of large-scale data obtained from aggregating all data within an organization [15]. Fundamentally, it encompasses at least three main characteristics: 1. Large volume (Volume), 2. Continuous change over time (Velocity), and 3. Diversity in data structures (Variety) [16]. This technology represents a new paradigm that helps improve business processes for MSMEs in various aspects such as supply chain management, logistics systems, and customer insights [17-18]. Businesses can leverage data from big data for various analyses to aid in planning and decision-making, thereby enhancing business opportunities and supporting sustainable innovation within organizations [18].

2.5. Sustainability performance

Sustainable operational outcomes for a business unit denote its ability to achieve long-term goals and generate organizational value consistently, ensuring continual success and enhancing operational efficiency amidst evolving business landscapes [19]. This sustainability framework comprises three core dimensions: economic performance, focusing on resource and capital efficiency and strategic investments; social performance, emphasizing ethical business practices, community engagement, and stakeholder support; and environmental performance, prioritizing sustainable resource management and environmental responsibility to foster genuine long-term sustainability [20-21].

2.6. MSMEs

MSMEs refer to medium, small, and micro enterprises. These enterprises encompass all business sectors, including manufacturing, trade, and services [22]. The classification criteria in Thailand, according to the Office of Small and Medium Enterprises Promotion, define MSMEs as follows: Micro enterprises in both the manufacturing and trade/services sectors employ no more than 5 people or have an annual income not exceeding 1.8 million baht. Small enterprises in the manufacturing sector employ no more than 50 people or have an annual income not exceeding 100 million baht, while those in the trade/services sector employ no more than 30 people or have an annual income not exceeding 50 million baht. Medium enterprises in the manufacturing sector employ 50 to 200 people or have an annual income of 100 to 500 million baht, and those in the trade/services sector employ 30 to 100 people or have an annual income of 50 to 300 million baht. If employment and income fall into different categories, income is the primary criterion for classification [1].

2.7. Related research

Recent studies highlight the transformative impact of AI, cloud computing, IoT, and big data on MSMEs. AI enhances customer engagement and satisfaction by analyzing buying behaviors and recommending personalized offerings, thereby

boosting sales and operational performance [24-28]. Cloud computing reduces costs associated with digital infrastructure and enhances data sharing and workflow coordination across MSMEs, leading to improved productivity and reduced operational waste [29-32]. IoT technologies optimize production processes, improve resource efficiency, and support social sustainability initiatives like workplace safety and environmental impact monitoring [33-35]. Big data further enhances MSMEs' competitiveness by enabling agile responses to market demands and operational challenges [36-37].

Therefore, we included the four digital technologies—AI technology, cloud computing, IoT, and big data —as independent variables in this study. The dependent variable of the study is sustainability performance, which is measured across three dimensions: economic, social, and environmental. The hypotheses of this research are proposed as follows:

H1: AI influences sustainability performance of MSMEs.

H2: Cloud computing influences sustainability performance of MSMEs.

H3: IoT influences sustainability performance of MSMEs.

H4: Big data influences sustainability performance of MSMEs.

Based on these hypotheses, the conceptual framework of this research is presented in Fig. 1.

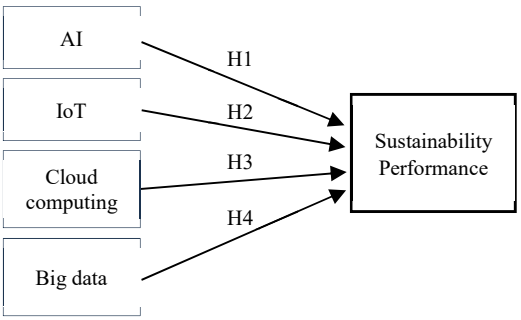

Fig. 1. conceptual framework

3. Methodology

The population for this study consists of MSMEs within Thailand's social enterprise sector. Convenience sampling was used to gather data from a sample of 385 enterprises, calculated according to formula [38]. Data collection was conducted via an online questionnaire, validated for reliability using Cronbach's Alpha coefficient (>0.7). The survey questions were developed based on theoretical frameworks, academic literature, and related research [39-40], employing closed-ended questions where respondents used a Likert Scale to indicate their responses on a scale from 1 to 5.

4. Result

4.1. Descriptive statistics

From the survey data in this research sample, there were 170 business owners, accounting for 44.16%, and 215 middle management employees, accounting for 55.84%. This indicates that a majority of respondents representing businesses are from middle management, rather than business owners. Regarding the number of employees, the data shows that most businesses in the sample employ between 6-30 staff, predominantly in the retail sector. In terms of revenue, a significant portion of businesses (35.32%) earn less than 1.8 million baht per year. Considering the size of the businesses, the majority are small enterprises, followed by micro-enterprises, and medium-sized enterprises. In addition, this is followed by a statistical analysis of digital technology challenges, including AI, cloud computing, IoT, and big data as described in Table 1.

Table 1. Descriptive statistics of MSMEs' digital technology challenges.

Digital technology challenges	Mean	Standard deviation	Level
AI	3.61	1.05	High
Medium enterprises	4.08	0.73	High
Small enterprises	3.83	0.84	High
Micro enterprises	3.04	1.19	Moderate
Cloud computing	3.59	1.06	High
Medium enterprises	4.00	0.76	High
Small enterprises	3.80	0.84	High
Micro enterprises	3.05	1.25	Moderate
IoT	3.59	1.12	High
Medium enterprises	4.04	0.81	High
Small enterprises	3.84	0.93	High
Micro enterprises	3.00	1.24	Moderate
Big data	3.56	1.13	High
Medium enterprises	4.09	0.81	High
Small enterprises	3.80	0.88	High
Micro enterprises	2.92	1.27	Moderate
Total	3.59	1.04	High

From Table 1, it is found that the overall digital technology challenge level within the research sample is high, with an average score of 3.59. When broken down by types of digital technology, the sample exhibits the highest average usage level in AI, with a score of 3.61 (high). Following this are IoT and cloud computing, both scoring an average of 3.59 (high). Meanwhile, the use of big data technology shows the lowest average score of 3.56 (high).

When considering business size, medium-sized enterprises show the highest level of digital technology usage, followed by small and micro-enterprises in descending order. It is evident that micro-enterprises have only a moderate average level of digital technology usage, which is notably lower compared to other business sizes.

For the descriptive statistics of sustainability performance in the three aspects—economic, social, and environmental—of MSMEs, details can be found in Table 2. It was found that the sample had an average level of sustainability performance across the three aspects equal to 3.73 (high level). The economic aspect had the highest average score of 3.79 (high level), followed by the social aspect with an average score of 3.70 (high level), and the environmental aspect with the lowest average score of 3.68 (high level).

It can be observed that the average sustainability performance scores for all three aspects are quite similar. However, when considering the size of the enterprises, it was found that micro enterprises had relatively lower average scores in all aspects, which were at a moderate level. Meanwhile, medium-sized and small enterprises had average scores at a high level, with medium-sized enterprises having

the highest average scores. From this data, it can be concluded that currently, medium-sized enterprises are able to achieve the best sustainability performance, followed by small enterprises and micro enterprises, respectively.

Table 2. Descriptive statistics of MSMEs' sustainability performance.

Sustainability performance	Mean	Standard deviation	Level
Economic dimension	3.79	1.01	High
Medium enterprises	4.30	0.40	Very high
Small enterprises	3.96	0.87	High
Micro enterprises	3.24	1.20	Moderate
Social dimension	3.70	1.01	High
Medium enterprises	4.13	0.57	High
Small enterprises	3.81	0.86	High
Micro enterprises	3.27	1.23	Moderate
Environmental dimension	3.68	1.06	High
Medium enterprises	4.15	0.65	High
Small enterprises	3.84	0.92	High
Micro enterprises	3.17	1.22	Moderate
Total	3.73	0.99	High

4.2. Statistical analysis

The statistical results of the multiple regression analysis on digital technology challenges influencing sustainability performance, covering three aspects: economic, social, and environmental. From Table 3, the results in the digital technology challenges on economic sustainability performance show that the IoT and AI have p-values less than 0.05, respectively. Therefore, IoT and AI have a significant influence on the economic sustainability performance of MSMEs. Additionally, the data indicate that IoT has the most positive influence on economic performance (β = 0.339), followed by AI (β = 0.274).

Table 3. Digital technology challenges on economic sustainability performance.

Model	Unstandardized Coefficients		Standardized Coefficients	t	p-value
	B	Std. Error	β		
Constant value	1.152	.132		8.759	.000*
AI	.266	.098	.274	2.723	.007*
Cloud computing	.140	.101	.145	1.389	.166
IoT	.328	.113	.339	2.898	.004*
Big data	-.004	.087	-.005	-.049	.961
$R = 0.732$ $R^2 = 0.536$ Adjusted R Square = 0.531					

* p-value < .05

The results of the digital technology challenges, relating to social sustainability performance in Table 4. show that cloud computing and AI technology have p-values less than 0.05. Therefore, cloud computing and AI technology significantly influence the social performance of MSMEs. Additionally, the data indicate that cloud computing has the most positive influence on social performance (β = 0.400), followed by AI technology (β = 0.263).

Table 4. Digital technology challenges on social sustainability performance.

Model	Unstandardized Coefficients		Standardized Coefficients	t	p-value
	B	Std. Error	β		
Constant value	.933	.118		7.891	.000*
AI	.253	.088	.263	2.878	.004*
Cloud computing	.381	.090	.400	4.207	.000*
IoT	.147	.102	.153	1.442	.150
Big data	-.008	.078	-.009	-.105	.917
$R = 0.785$ $R^2 = 0.616$ Adjusted R Square = 0.611					

* p-value < .05

From Table 5, the results show that the digital technological challenges influencing the environmental performance of MSMEs include AI and cloud computing, both of which have p-values less than 0.05. Therefore, AI and cloud computing significantly influence the environmental performance of MSMEs. Additionally, the data indicate that AI technology has the most positive influence on environmental performance (β = 0.330), followed by cloud computing (β = 0.212).

Table 5. Digital technology challenges on environmental sustainability performance

Model	Unstandardized Coefficients		Standardized Coefficients	t	p-value
	B	Std. Error	β		
Constant value	.936	.124		7.524	.000*
AI	.327	.092	.330	3.544	.000*
Cloud computing	.209	.095	.212	2.192	.029*
IoT	.139	.107	.140	1.295	.196
Big data	.113	.082	.122	1.379	.169
$R = 0.776$ $R^2 = 0.603$ Adjusted R Square = 0.598					

* p-value < .05

Considering the overall sustainability performance in all three dimensions, the statistical results can be shown in Table 6. The findings indicate that AI, cloud computing, and IoT have p-values of 0.002, 0.005, and 0.044, respectively. Therefore, hypotheses H1, H2, and H3, which state that AI, cloud computing, and IoT influence the sustainable performance of MSMEs, are accepted. Additionally, the data indicate that AI has the most significant influence on sustainability performance (β = 0.290), followed by cloud computing (β = 0.274) and IoT (β = 0.217), respectively.

Table 6. Digital technology challenges on sustainability performance.

Model	Unstandardized Coefficients		Standardized Coefficients	t	p-value
	B	Std. Error	β		
Constant value	1.00	.118		8.544	.000*
AI	.276	.087	.290	3.152	.002*
Cloud computing	.257	.090	.274	2.854	.005*
IoT	.205	.101	.217	2.023	.044*
Big data	.023	.078	.027	.302	.763
$R = 0.781$ $R^2 = 0.610$ Adjusted R Square = 0.606					

* p-value < .05

5. Conclusions

The statistical analysis of the sample group, based on demographic data such as position, business type, number of employees, and annual revenue, reveals that the majority are small-sized enterprises predominantly engaged in retail trade. Respondents mostly represent managerial staff. Regarding digital technology challenges, medium-sized enterprises exhibit the highest average technology adoption, followed by small-sized enterprises, with micro enterprises ranking lowest. Larger enterprises prioritize technology adoption and digital economic trends more significantly. The inferential analysis concerning sustainable operational outcomes across economic, social, and environmental dimensions yields the following insights:

Economic Dimension

Digital technologies like IoT and AI significantly influence sustainable economic outcomes for MSMEs. IoT technology shows the most positive impact, followed by AI, aligning with prior research indicating IoT's positive influence on financial performance and AI's cost-reduction benefits [14, 41]. However, cloud and big data technologies show no sustainable economic impact, contrary to findings suggesting their revenue-enhancing potential [42-43].

Social Dimension

Cloud and AI technologies significantly impact social sustainability for MSMEs, with cloud computing leading in positive social impact, followed by AI. This aligns with research suggesting cloud's support for business social sustainability [31] and AI's promotion of social sustainability [27]. However, IoT and big data technologies show no sustainable social impact, conflicting with research suggesting IoT supports social sustainability [31] and enhances business social outcomes [44], potentially due to widespread internet use and concerns over data privacy and security [46].

Environmental Dimension

AI and cloud computing significantly impact environmental sustainability for MSMEs, with AI showing the highest positive influence, followed by cloud computing. This supports research indicating AI's efficiency gains and resource savings within organizational processes [25, 27]. However, big data and IoT technologies show no sustainable environmental impact, contradicting research suggesting their application can support environmental sustainability [34, 47-49]. This discrepancy may arise from limited awareness of these technologies' potential environmental benefits within the sample group, focusing more on resource monitoring and management systems for efficiency.

This research also found that MSMEs in Thailand have significant potential to further develop their use of AI, cloud computing, and IoT, especially among micro-unit businesses where the average level of technology adoption remains moderate. Additionally, the study revealed that big data technology does not significantly influence the sustainable operational performance of MSMEs, based on the analysed data across all three dimensions of sustainability performance. This may be due to concerns about the collection of personal data, as well as data security systems. This aligns with the research by Khanan (2019), which stated that safety and privacy are major obstacles to the use of big data technology.

Regarding practical implications, this research indicates that MSMEs should increase the adoption of digital technologies that positively influence sustainable performance, namely AI, cloud computing, and IoT. This can be achieved by increasing the proportion of investment or adjusting business strategies to better accommodate these technologies. For example, encouraging employees to use technology more in their work processes and providing training to enhance their skills and expertise in using digital technologies. The level of digital technology adoption mentioned will help MSMEs improve their sustainability performance. Furthermore, entrepreneurs should continuously monitor changes and adapt to various business environments to ensure that their operations keep pace with the modern world and can withstand the digital disruption caused by technological changes in the future.

For limitation under this study, the research solely utilized quantitative analysis. Therefore, future research should consider employing alternative methodologies such as qualitative research through interviews to gain profound insights from diverse dimensions or perspectives. Additionally, it is recommended to gather data from additional sample groups, such as operational-level employees, alongside using robust performance metrics or statistical data sets to ensure comprehensive and accurate assessments of sustainability performance. Moreover, given the potential unfamiliarity among respondents regarding digital technology terms and concepts in this study's questionnaire, researchers should enhance respondents' understanding of various digital technologies used in the study for more comprehensive future research.

References

[1] Office of Small and Medium Enterprises Promotion. Annual Report on the Situation of Medium and Small Enterprises; 2020.
[2] Caylar PL, Noterdaeme O, Naik K. Digital in industry: From buzzword to value creation. Mckinsey Company. Digit Mckinsey; 2016. 2(1).
[3] Giones F, Brem A. Digital technology entrepreneurship: A definition and research agenda. Technology Innovation Management Review; 2017. 7(5).
[4] Fitzgerald M, Kruschwitz N, Bonnet D, Welch M. Embracing digital technology: A new strategic imperative. MIT Sloan Management Review; 2014. 55(2). p. 1.
[5] Hamet P, Tremblay J. Artificial intelligence in medicine. Metabolism; 2017. 69. p. 36-40.
[6] Pathak P, Pal PR, Shrivastava M, Ora P. Fifth revolution: Applied AI & human intelligence with cyber physical systems. International Journal of Engineering and Advanced Technology; 2019. 8(3). p. 23-27.
[7] Imran M, Aziz A, Hamid SNBA, Shabbir M, Salman R, Jian Z. Retracted: The mediating role of total quality management between entrepreneurial orientation and SMEs export performance. Management Science Letters; 2018. 8(6). p. 519-532.
[8] Oliveira RS, Eller CB, Bittencourt PR, Mulligan M. The hydroclimatic and ecophysiological basis of cloud forest distributions under current and projected climates. Annals of Botany; 2014. 113(6). p. 909-920.
[9] Qian L, Luo Z, Du Y, Guo L. Cloud computing: An overview. In Cloud Computing: First International Conference. Springer Berlin Heidelberg; 2009. p. 626-631.
[10] Hsu PF, Ray S, Li-Hsieh YY. Examining cloud computing adoption intention, pricing mechanism, and deployment model. International Journal of Information Management; 2014. 34(4). p. 474-488.
[11] Biswas AR, Giaffreda R. IoT and cloud convergence: Opportunities and challenges. In 2014 IEEE World Forum on Internet of Things; 2014. p. 375-376.

[12] Moeuf A, Lamouri S, Pellerin R, Eburdy R, Tamayo S. Industry 4.0 and the SME: a technology-focused review of the empirical literature. In 7th International Conference on Industrial Engineering and Systems Management IESM; 2017.
[13] Ren S, He K, Girshick R, Sun J. Faster r-cnn: Towards real-time object detection with region proposal networks. Advances in Neural Information Processing Systems; 2015. 28.
[14] Huang X, Zeng Z, Zhang H. Metal dichalcogenide nanosheets: preparation, properties and applications. Chemical Society Reviews; 2013. 42(5). p. 1934-1946.
[15] Brown B, Bughin J, Dobbs R, Roxburgh C, Hung Byers A. Big data: The next frontier for innovation, competition, and productivity; 2011.
[16] Aliahmadi A, Nozari H, Ghahremani-Nahr J. Big Data IoT-based agile-lean logistic in pharmaceutical industries. International Journal of Innovation in Management, Economics and Social Sciences; 2022. 2(3). p. 70-81.
[17] Ahmed KA, Sharif N, Ahmad N. Factors influencing students' career choices: empirical evidence from business students. Journal of Southeast Asian Research; 2017. p. 1-15.
[18] Haider M, Gandomi A. Beyond the hype: big data concepts, methods, and analytics. International journal of information management; 2015. 35(2). p. 137-144.
[19] Haseeb M, Hussain HI, Slusarczyk B, Jermsittiparsert K. Industry 4.0: A solution towards technology challenges of sustainable business performance. Social Sciences; 2019. 8(5). p. 154.
[20] Vachon S, Klassen RD. Extending green practices across the supply chain: the impact of upstream and downstream integration. International journal of operations & Production Management; 2006. 26(7). p. 795-821.
[21] Yadegaridehkordi E, Hourmand M, Nilashi M, Shuib L, Ahani A, Ibrahim O. Influence of big data adoption on manufacturing companies' performance: An integrated DEMATEL-ANFIS approach. Technological forecasting and social change; 2018. p. 199-210.
[22] Cueto LJ, Frisnedi AFD, Collera RB, Batac KIT, Agaton CB. Digital innovations in MSMEs during economic disruptions: experiences and challenges of young entrepreneurs. Administrative Sciences; 2022. 12(1). p. 8.
[24] Bhalerao K, Kumar A, Kumar A, Pujari P. A study of barriers and benefits of artificial intelligence adoption in small and medium enterprise. Academy of Marketing Studies Journal; 2022. 26. p. 1-6.
[25] Pandya D, Kumar G. Industry 4.0 technologies for sustainable performance in Indian manufacturing MSMEs. In International Conference on Industrial Engineering and Operations Management Istanbul. Turkey; 2022. p. 3532-3542.
[26] Kumar V, Rajan B, Venkatesan R, Lecinski J. Understanding the role of artificial intelligence in personalized engagement marketing. California Management Review; 2019. 61(4). p. 135-155.
[27] Paul P, Bhimali A, Aithal PS, Kalishankar T, Saavedra MR. Artificial intelligence & cloud computing in environmental systems-towards healthy & sustainable development. International Journal of Inclusive Development; 2020. 6(1). p. 01-08.
[28] Lee K. A systematic review on social sustainability of artificial intelligence in product design. Sustainability; 2021. 13(5). p. 2668.
[29] Chang V. Towards data analysis for weather cloud computing. Knowledge-Based Systems; 2017. 127. p. 29-45.
[30] Zhou J, Leppanen T, Harjula E, Ylianttila M, Ojala T, Yu C, Yang LT. Cloudthings: A common architecture for integrating the internet of things with cloud computing. In Proceedings of the 2013 IEEE 17th International Conference on Computer Supported Cooperative Work in Design; 2013. p. 651-657.
[31] Hicks Jr M. Strategies for Small Business Owners to Sustain Their Businesses in a Competitive Market. Doctoral dissertation. Walden University; 2021.
[32] Abaee M. A systematic review of how cloud computing (CC) and the Internet of Things (IoT) can contribute towards achieving the sustainable development goals (SDGs); 2023.
[33] Cong LW, Li B, Zhang QT. Internet of Things: Business Economics and Applications. Review of Business; 2021. 41(1).
[34] Muhammad K, Hamza R, Ahmad J, Lloret J, Wang H, Baik SW. Secure surveillance framework for IoT systems using probabilistic image encryption. IEEE Transactions on Industrial Informatics; 2018. 14(8). p. 3679-3689.
[35] Bibri SE. The IoT for smart sustainable cities of the future: An analytical framework for sensor-based big data applications for environmental sustainability. Sustainable Cities and Society; 2018. 38. p. 230-253.
[36] Bharadiya JP. Machine learning and AI in business intelligence: Trends and opportunities. International Journal of Computer; 2023. 48(1). p. 123-134.
[37] Dubey R, Gunasekaran A, Childe SJ, Papadopoulos T, Luo Z, Wamba SF, Roubaud D. Can big data and predictive analytics improve social and environmental sustainability?. Technological Forecasting and Social Change; 2019. 144. p. 534-545.
[38] Krejcie RV, Morgan DW. Determining sample size for research activities. Educational and Psychological Measurement; 1970. 30. p. 607-610.
[39] Sundaram, S., Schwarz, A., Jones, E., Chin, WW. Technology use on the front line: how information technology enhances individual performance. Journal of the Academy of Marketing Science; 2007. 35, p. 101-112.
[40] Khaula, Alkaabi, Bhatacharyya, P., Aldhaheri, H. Sustainable Development Goals from Theory to Practice Using Spatial Data Infrastructure: A Case Study of UAEU Undergraduate Students. Sustainability; 2023. 15(16), p. 12394.
[41] Dirican C. The impacts of robotics, artificial intelligence on business and economics. Procedia-Social and Behavioral Sciences; 2015. 195. p. 564-573.
[42] Islam M, Reza S. The rise of big data and cloud computing. Internet Things Cloud Comput; 2019. 7(2). p. 45.
[43] Latifian A. How does cloud computing help businesses to manage big data issues. Kybernetes; 2022. 51(6). p. 1917-1948.
[44] Sen D, Ozturk M, Vayvay O. An overview of big data for growth in SMEs. Procedia-Social and Behavioral Sciences; 2016. 235. p. 159-167.
[45] Datareportal. Digital 2023 Global Overview Report; 2023. https://datareportal.com/reports/digital-2023-global-overview-report.
[46] Khanan A, Abdullah S, Mohamed AHH, Mehmood A, Ariffin KAZ. Big data security and privacy concerns: a review. In Smart Technologies and Innovation for a Sustainable Future: Proceedings of the 1st American University in the Emirates International Research Conference. Springer International Publishing; 2019. p. 55-61.
[47] Al Sharif R, Pokharel S. Smart city dimensions and associated risks: Review of literature. Sustainable Cities and Society; 2022.
[48] Ceyhun GÇ. Recent developments of artificial intelligence in business logistics: A maritime industry case. Digital Business Strategies in Blockchain Ecosystems: Transformational Design and Future of Global Business; 2020. p. 343-353.
[49] Shehabi A. Data Clouds and the Environment. In Routledge Handbook of Sustainable Design. Routledge. International Journal of Operations and Production Management; 2017. 26(7). p. 795-821.