1. **Choosing a Research Topic**
2. When choosing your topic, you should identify the broad area of study and make a list of all possible topics. You may also have an idea of what you want to do, but investigate all possibilities before your decide. You should give yourself plenty of options and then select the one that works best for you. Your research topic should be something that you are particularly interested in. It is important that you read a variety of research and articles in your field to draw insights and become more informed in your area of research.
3. Do some brainstorming as a method of getting a large number of ideas relating to a specific area of interest, keeping in mind the requirements for both your dissertation proposal and the rest of the chapters.
4. A strong research topic is a focused topic. You should have a clear focused and a worthwhile problem and determine if the scope of the research is appropriate to the degree and does the topic have the potential to make an original contribution. You should start off with an idea of a clear question or problem that can be explored and make a significant impact on the knowledge in your particular discipline. Ask yourself why do I want to study this topic?
5. **Ask yourself if your topic is manageable? You should ensure that your topic is not too broad, nor too narrow.**
6. Will I be able to collect data and are there organisations and companies where I will be able to collect data based on this topic?
7. Ask yourself if this topic is feasible? You will have to determine whether or not the topic you are proposing is manageable within the time-frame.
8. Listen to ideas – it is your choice if you use them or not. It is quite likely that the title of the research will change as you gain more knowledge and understanding. Ensure that you have thoroughly done the background research for your idea, so that you don’t waste time chopping and changing at an advanced stage in your research.
9. It is always a good idea to generate several possible research questions and then choose the best one as every research question has strengths and weaknesses.
10. Ensure that you can make a good dissertation about the problem as you need to be able to convince others of the novelty of the topic.
11. **Choosing the Title**

 There is no real formula for identifying a meaningful title. The title describes the scope of the research. Choose a title that captures the essence of your proposed project.

 The title should accurately describe the exact nature of the main element of the study.

 The title must be informative and relevant and should capture the attention of the reader.

 The title should not be too long (normally not more than 10 words) but should provide as much information about the study as possible.

 The title should preferably not be in a question form; it must define the research clearly, and must be clear and precise.

 The title should not contain technical terms, or jargon. The use of acronyms should be limited.

1. 1
2. **DISSERTATION HEADINGS & GUIDELINES**
3. **1. Title fly page**
4. **2. Title page**
5. Your title page should have no number.
6. **2. Preamble**
7. The preamble is everything between the Title page and the Introduction: Abstract, Declaration, Acknowledgements, Contents plus the List of Tables and Figures.
8. These pages should be numbered using small-case Roman numerals (i.e. i, ii, iii, iv, etc.).
9. To do this, you'll need to insert a section break between the pre-amble and the main body.
10. **3. Main body**
11. The main body is everything from the Introduction up to (but not including) the appendices. The main body is numbered using Arabic numerals (1, 2, 3, 4, etc.)
12. **4. Appendices**
13. The appendices are numbered using the letter name of the appendix and an Arabic numeral. (i.e. A-1, A-2, B-1, B-2).
14. **Preamble**
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16. II. Acknowledgments
17. III. Dedication
18. IV. Declaration
19. V. List of Figures and tables
20. VI. Abbreviations
21. VII. Abstract (100 words)
22. **Table of Contents (Automatic)**
23. **Page numbering:** The main body is numbered using Arabic numerals (1, 2, 3, 4, etc.) 2
24. **Chapter 1: Introduction**

* • Background
* • Introduction
* • Aim and Objectives
* • Research Questions
* • Significance of study
* • Hypothesis - OPTIONAL
* • Theoretical Framework - OPTIONAL
* • Structure of the Dissertation
* • Conclusion

1. **Chapter 2: Literature Review**
2. Use a thematic approach

* • Introduction
* • Theme 1
* • Theme 2
* • Theme 3
* • Theme 4
* • Conclusion

1. **Chapter 3: Problem Statement**

* • Introduction
* • Problem
* • Conclusion

1. **Chapter 4: Research Methodology**

* • Introduction
* • Research Design
* • Reliability and Validity
* • Target Population
* • Population Sample
* • Data collection and instrument used
* • Data Analysis: Quantitative Data Analysis; Qualitative Data Analysis
* • Ethical Considerations
* • Limitations
* • Summary

1. **Chapter 5: Presentation of results**

* • Introduction
* • Response Rate
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* • Conclusion

1. **Chapter 6: Conclusion**

* • Summary
* • Main Findings
* • Contributions
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1. 3

* • Limitations
* • Recommendations
* • Suggestions for future research

1. **References (Harvard Referencing Style)**
2. **Appendices**
3. **Number of pages:**

* • Minimum number of pages: 80
* • Maximum number of pages: 120

**Title of Dissertation**

By

Student’s Name

Student Number

A dissertation submitted in partial fulfillment of the requirements for the degree of

Bachelor of Science Honours in Information technology or Postgraduate Diploma in

Management

Supervisor: Name

Co-Supervisor: Name if applicable

Month and Year of submission

(

roman numerals as shown directly above.

**PAGE TWO OF THE DISSERTATION**

**DECLARATION**

This research has not been previously accepted for any degree and is not being currently

considered for any other degree at any other institution.

I declare that this Dissertation contains my own work except where specifically

acknowledged

Student Name and Number: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Signed………………………………………..

Date…………………………………………..

A **dissertation** is a substantial piece of academic writing that presents the author's research and findings on a specific topic. It is typically required for a **doctoral degree (PhD)**, but the term is also used for **master’s level** research projects in some countries.

Here’s a breakdown of what a dissertation usually involves:

**📘 Key Features of a Dissertation**

* **Original Research**: It should contribute new knowledge or insights to the field.
* **Structured Format**: Common sections include:
  + **Introduction**: Outlines the research question and objectives.
  + **Literature Review**: Summarizes existing research and identifies gaps.
  + **Methodology**: Describes how the research was conducted.
  + **Results**: Presents the findings.
  + **Discussion**: Interprets the results and connects them to the research question.
  + **Conclusion**: Summarizes the study and suggests future research.
* **Formal Style**: Academic tone, citations, and references are essential.
* **Length**: Varies by level and field—PhD dissertations can be 100+ pages

**Purpose of a Research Proposal**

* To **present a clear research question or problem**
* To **justify the significance** of the study
* To **outline the methodology** for conducting the research
* To **demonstrate feasibility** and preparedness

**📄 Typical Structure**

1. **Title** – A concise and descriptive title of your research.
2. **Introduction** – Background information and context; introduces the topic and its relevance.
3. **Problem Statement** – Clearly defines the issue or gap your research will address.
4. **Research Objectives/Questions** – What you aim to discover or prove.
5. **Literature Review** – Summary of existing research and how your study fits in.
6. **Methodology** – Detailed plan of how you’ll conduct the research (e.g., data collection, analysis methods).
7. **Expected Outcomes** – What you hope to find or contribute.
8. **Timeline** – A schedule of key milestones.
9. **Budget (if applicable)** – Estimated costs and resources needed.
10. **References** – Sources cited in your proposal.
11. **Field of study**: IT
12. **Purpose** of the research: academic
13. Any **specific requirements**: Area of interest is: KEY ELEMENTS OF IT ENTREPRENEURSHIP AND INNOVATION
14. Preferred **length or format**:full proposal
15. A bibliometric analysis of IoT-based smart cities
16. A dissertation submitted in partial fulfilment of the requirements for the Bachelor of Science Honours in Information Technology
17. Supervisor: Dr Stephen Akandwanaho
18. 2023
19. **Acknowledgements**
20. Foremost, I extend my heartfelt gratitude to the Almighty for bestowing upon me the strength, courage, and determination necessary to surmount the numerous challenges encountered during my research study.
21. I am deeply indebted to my supervisor, Dr Stephen Akandwanaho, for his invaluable guidance and unwavering support. His mentorship, which entailed both encouragement and rigorous challenge, has been a cornerstone of my academic journey. Dr Akandwanaho's commitment to excellence has profoundly influenced my work, guiding me to strive for nothing less than my best.
22. I would also like to express my sincere appreciation to my administrators, whose continuous support and constructive feedback have been instrumental throughout my academic endeavours.
23. My heartfelt thanks go to my girlfriend, Michaela Moodley, for her steadfast support and motivation. Her guidance and clear-mindedness have been a source of strength and inspiration during challenging times.
24. To my friend, Sonali Rambhuron, I am grateful for your unwavering support and encouragement throughout the journey of completing my dissertation.
25. Lastly, I am profoundly grateful to my immediate family, particularly my mother Ranie Naidoo and father Pravendra Naidu. Their unwavering support, tolerance, inspiration, and immense sacrifices have been the bedrock of my perseverance and success. Their enduring belief in my capabilities has been a constant source of encouragement and strength.
26. It is with deep respect and gratitude that I acknowledge these individuals, whose contributions have been pivotal in the completion of my dissertation.
27. i
28. **Declaration**
29. I Shanthan Naidu declare that:
30. The research reported in this dissertation, except where otherwise indicated, is my original research.
31. This dissertation has not been submitted for any degree or examination at any other university.
32. This dissertation does not contain other persons’ data, pictures, graphs or other information, unless specifically acknowledged as being sourced from other persons.
33. This dissertation does not contain other persons’ writing, unless specifically acknowledged as being sourced from other researchers. Where other written sources have been quoted, then:
34. their words have been re-written, but the general information attributed to them has been referenced;
35. where their exact words have been used, their writing has been placed inside quotation marks, and referenced.
36. Where I have reproduced a publication of which I am author, co-author or editor, I have indicated in detail which part of the publication was actually written by myself alone and have fully referenced such publications.
37. This dissertation does not contain text, graphics or tables copied and pasted from the Internet, unless specifically acknowledged, and the source being detailed in the dissertation and in the References sections.
38. Signed: …………………..
39. ii
40. **Abstract**
41. The rapid growth of the Internet of Things (IoT) and its integration into smart cities has fuelled substantial research interest over the past decade. This study employs bibliometric analysis techniques to comprehensively explore the landscape of IoT and smart cities research, focusing exclusively on Institute of Electrical and Electronics Engineers (IEEE) articles published in English from 2013 to 2023. The Scopus database serves as the primary data source for this analysis.
42. The study employs three key analysis tools: VOSviewer, CiteSpace, and Microsoft Excel, to extract and visualize patterns, trends, and impactful research within this domain. VOSviewer will be utilized for co-authorship and co-citation network analysis, providing insights into collaboration dynamics among researchers and the most influential authors and institutions. CiteSpace will help identify emerging research themes, core articles, and the evolution of knowledge domains. Microsoft Excel will support quantitative analysis, enabling the examination of publication trends, citation counts, and the identification of key research clusters.
43. By applying these bibliometric tools to IEEE articles within the specified timeframe and language constraints, this study aims to uncover the evolution of IoT and smart cities research, prominent research clusters, and influential scholars. The findings will contribute valuable insights into the development and current state of this dynamic field, informing future research directions and facilitating interdisciplinary collaboration in the quest for smarter and more sustainable urban environments.
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234. **List of Abbreviations**
235. **AI** - Artificial Intelligence **BEMS** - Building Energy Management Systems **CSV** - Comma-Separated Values **FWCI** - Field-Weighted Citation Impact
236. **GDPR - General Data Protection Regulation**
237. **HVAC - Heating, Ventilation, and Air Conditioning**
238. **ICCCA** - International Conference on Computing, Communication and Automation
239. **ICCIKE** - International Conference on Computational Intelligence and Knowledge Economy
240. **ICT - Information and Communication Technology**
241. **IEEE** - Institute of Electrical and Electronics Engineers
242. **IGO - International Governmental Organization**
243. **IOES** - Internet of Everything Systems
244. **IoT - Internet of Things**
245. **IPR - Intellectual Property Rights**
246. **ISI** - Institute for Scientific Information
247. **ISSC** - International Symposium on System Configuration
248. **ITS** - Intelligent Transportation Systems
249. **ITU** - International Telecommunication Union
250. **ITU-T** - ITU Telecommunication Standardization Sector
251. **JOIV - Journal of Open Innovation**
252. **MIT** - Massachusetts Institute of Technology
253. **NFC** - Near Field Communication
254. xii
255. **NRF** - National Research Foundation **NSERC** - Natural Sciences and Engineering Research Council **NSF** - National Science Foundation **NSFC** - National Natural Science Foundation of China
256. **OECD** - Organization for Economic Co-operation and Development **PLOS ONE** - Public Library of Science ONE **POPI** - Protection of Personal Information
257. **POPIA - Protection of Personal Information Act**
258. **RCR - Research Collaboration Relationships**
259. **RFID** - Radio-Frequency Identification
260. **SCADEF** - Smart City Applications and Framework
261. **SCF** - Smart City Framework
262. **STEM** - Science, Technology, Engineering, and Mathematics
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264. **Key Terms**
265. **AI (Artificial Intelligence)**: The simulation of human intelligence in machines that are programmed to think and learn like humans.
266. **BEMS (Building Energy Management Systems)**: Systems that monitor and control a building's energy needs to improve energy efficiency and reduce costs.
267. **Bibliometric Analysis**: Bibliometrics is a research methodology for quantitatively analyzing scholarly publications to evaluate scientific and academic activity. It examines publication patterns, citations, and collaborations among authors and institutions, offering insights into the impact and development of academic knowledge. This approach is commonly used to assess the significance of research outputs and to guide decisions in academia and research funding.
268. **FWCI (Field-Weighted Citation Impact)**: A metric that measures the impact of research by comparing the number of citations received to the expected average number of citations in the respective field.
269. **GDPR (General Data Protection Regulation)**: A legal framework that sets guidelines for the collection and processing of personal information from individuals who live in the European Union (EU).
270. **IoT (Internet of Things)**: A network of interconnected devices and objects that collect and exchange data using embedded sensors, software, and other technologies.
271. **IPR (Intellectual Property Rights)**: Legal rights granted to creators and inventors to protect their creations and inventions for a certain period.
272. **NFC (Near Field Communication)**: A set of communication protocols that enable two electronic devices, usually a mobile device and a payment terminal, to communicate when they are within a few centimetres of each other.
273. **POPIA (Protection of Personal Information Act)**: South African legislation aimed at protecting personal information processed by public and private bodies.
274. **RCR (Research Collaboration Relationships)**: Partnerships or associations formed between researchers to collaborate on scientific or academic projects.
275. xiv
276. **RFID (Radio-Frequency Identification)**: A technology that uses electromagnetic fields to automatically identify and track tags attached to objects.
277. **Smart City**: A city that uses information and communication technologies (ICT) to enhance the quality and performance of urban services such as energy, transportation, and utilities to reduce resource consumption, wastage, and overall costs.
278. xv
279. **Chapter One: Introduction of the Study**
280. 1.1. Introduction
281. The Internet of Things (IoT) is a network where devices, objects, and systems are integrated with software, various technologies and sensors, facilitating the exchange of data and communication between them (Gillis, 2023). IoT integration in smart cities is an emerging multidisciplinary field with profound implications for cities, technology, and society. As the field evolves, there is a need to systematically map its research landscape to understand its evolution and implications (Syed et al., 2021). A comprehensive review of this literature reveals several important themes and trends. Research papers discuss the IoT architecture and components in detail. Gazis (2021) states, “*IoT reflects the need to process and fuse data generated from interconnected devices, as well as store them in a single massive network*”. This includes research into sensor devices, communication protocols, middleware and cloud-based platforms. The aim is to create scalable and interoperable architectures that can support different applications and data flows (Marr, 2022).
282. Security and privacy are recurring themes in IoT literature. Researchers analyzed security threats, vulnerabilities, and strategies to improve the protection of IoT devices and data. Encryption, authentication and access control mechanisms are key areas to ensure the privacy and integrity of IoT systems (Fang et al., 2021). The influx of data generated by IoT devices has led to an increase in research related to data analytics and machine learning (Ayaz et al., 2019). Methods for processing and analyzing IoT big data will be the focus using data mining, predictive modelling and anomaly detection techniques to generate meaningful insights (Menouar et al., 2017).
283. Energy efficiency is critical due to the resource limitations of many IoT devices. Research in this area includes energy management strategies, energy harvesting techniques, and optimization approaches to extend the lifespan of IoT devices and networks (Gazis et al., 2015). IoT application areas are broad and include smart cities, healthcare, agriculture, transportation and industrial automation. Researchers are studying the way IoT technologies can advance these industries by improving efficiency, sustainability, and user experience (Ganchev et al., 2014). Communication protocols play a crucial role in facilitating connectivity between IoT devices.
284. 1
285. Interoperability issues arise from the diversity of IoT devices and platforms. The researchers emphasize the importance of standardization efforts and advocate for common protocols and data formats to enable seamless integration and communication (Gazis et al., 2015). IoT literature often addresses the challenges of widespread adoption, including regulatory hurdles, complexities of data management, and ethical considerations. Researchers offer possible solutions and insights into the future direction of IoT research and development. A remarkable paradigm in the IoT environment is edge computing. This approach includes processing data closer to the source, reducing latency, increasing privacy, and solving bandwidth limitations in IoT networks (Amodu & Othman, 2018).
286. Scientists are studying the sustainability and environmental impact of the IoT, with the growing number of IoT devices. The goal is to understand and mitigate the environmental impact of device manufacture, use, and disposal (Ganchev et al., 2014). Additionally, efforts to develop green IoT solutions is gaining momentum. IoT literature presents a wide range of research topics covering technical, social and ethical dimensions. The continuous evolution of IoT technologies with their integration into different sectors drives continuous research and innovation. Challenges are addressed and new opportunities for transformative applications are discovered.
287. Initial discussions on IoT and smart cities have highlighted the potential for improved city services, resource management and citizen engagement (Dustdar et al., 2016). This convergence of technology and urban infrastructure has led to innovative solutions in areas ranging from transportation and energy management to waste reduction and public safety.
288. IoT technologies enable real-time data collection and analysis from various sources within the city. This data-driven approach enables decision-makers to make informed decisions to optimize resource allocation and improve citizens' quality of life (Nam and Pardo, 2011). Furthermore, IoT contributes to the development of intelligent transport systems that reduce traffic congestion and increase mobility (Ahmed et al., 2016).
289. The integration of IoT in smart cities brings with it some challenges, privacy concerns and data vulnerabilities stemming from the amount of data collected and shared between connected devices (Madsen, 2018). The management of sensitive information requires careful attention in an era where the IoT is quickly changing different sectors and
290. 2
291. elements of daily life. IoT technology delivers unmatched benefits, including real-time analytics and automation as well as increased production and efficiency. To fully benefit from these advantages, it is essential to ensure that there is a balance between utilizing IoT's benefits and protecting sensitive data.
292. As cities strive to become smarter, the need for interoperability standards is an urgent concern. IoT devices and systems from different manufacturers need to communicate seamlessly to achieve desired outcomes (Habibzadeh et al., 2018). Researchers and practitioners are actively seeking solutions to address these interoperability challenges and create a cohesive urban environment.
293. Bibliometric analysis is a technique that allows for the evaluation of scientific research as well as the identification of key areas for future study as well as development trends in a particular field of study (Rejeb et al., 2022). The use of quantitative methodologies is involved. The initial phase of the study encompassed the examination of publications, their respective subject areas, temporal fluctuations in their quantity, as well as the identification of the most prolific writers, publications, countries, and organizations.
294. Finally, the incorporation of IoT in smart cities signifies a paradigm shift in urban development and governance. As technology advances, the potential for innovative solutions and a better quality of life for city dwellers is enormous. However, special attention needs to be paid to the challenges of privacy, security and interoperability to ensure that future smart cities are efficient and fair.
295. 1.2. Background to the study
296. The inclusion of IoT into smart cities represents a dynamic and revolutionary convergence of technology and urban development. IoT has transformed the manner in which cities and their citizens function and interact with their environment by connecting multiple devices, systems and instruments to the internet (Herdiansyah, 2023). Due to the acceleration of urbanization worldwide, the concept of smart cities has gained prominence as a response to the challenges of urban living, sustainability, and resource management (Akre and Yankova, 2019).
297. The foundation of smart cities is the implementation of IoT technology to create data-driven urban ecosystems. These technologies collect massive amounts of real-time data from a variety of city sources, including transportation systems, energy grids, environmental sensors, and interactions with residents. This data is then analyzed to
298. 3
299. generate useful information for urban planning, policy making and service delivery (Prasetyo and Habibie, 2022).
300. The potential benefits of IoT-based smart cities are significant. These include: improved resource efficiency, increased citizen engagement, optimized traffic management, reduced energy consumption and proactive emergency response. In addition, smart cities have the potential to improve citizens' quality of life by providing better services and solving urban problems more efficiently (Kim, 2022). However, this integration of IoT and smart cities also raises many research questions. These questions relate to different dimensions, such as the technical challenges in designing and implementing IoT infrastructures in urban environments. The socio-economic impact of IoT-based services on citizens and businesses, and the policies and governance that protect privacy and are required to ensure safety and sustainability for long-term sustainable smart city initiatives (Almeida et al., 2018).
301. As the Internet of Things and smart cities have advanced rapidly, bibliometric analysis is an essential tool to gain an in-depth understanding of the research landscape in this field. Existing literature shows trends, research areas, important authors and institutions as well as co-operation in the field of IoT based Smart Cities. Furthermore, it will help to identify knowledge gaps, new research trends and possible directions for future research (Szum, 2021).
302. The literature on smart cities contains an abundance with publications. Despite this, very little effort has been made to present an exhaustive picture of the current status of bibliometric research on IoT-based smart cities. This article assesses the quality of the research presented in papers on IoT-based smart cities. A bibliometric examination of papers from 2013 to 2023 that were accessible in the Scopus databases was part of the study.
303. In this context, conducting a bibliometric analysis provides valuable information for researchers, policymakers, planners and technology developers. This not only provides a comprehensive overview of the current state of research but also helps stakeholders to make informed decisions to holistically and effectively expedite the development of smart cities enabled by IoT.
304. 4
305. 1.3. Aim of the study
306. The aim of this bibliometric analysis is to examine and fully understand the scientific environment surrounding the integration of IoT technologies in the context of smart cities. The study aims to map evolving research trends related to IoT and Smart Cities. By analyzing the chronological distribution of publications, it is necessary to identify how the subject matter of some research areas has changed over time (Rejeb et al., 2022).
307. The analysis aims to identify the most prolific, influential authors and institutions contributing to the topic. (Paes et al., 2023). Opinion leader recognition aims to provide information about the key actors shaping the discourse, as well as to discover new innovative research topics in terms of IoT based Smart Cities through content analysis. This includes identifying new areas of focus that have gained prominence in recent years (Park et al., 2018). Quotations from different scientific disciplines are included to highlight how different areas contribute to the discussion.
308. The study aims to identify areas at which research is relatively scarce or underrepresented. Identifying gaps in the literature aims to provide valuable information for researchers and policymakers wishing to address unexplored aspects (Rejeb et al., 2022). The citation pattern analysis aims to identify innovative and influential works that have contributed to shaping the IoT space and smart cities (Oermann et al., 2020).
309. The study is intended to provide orientation for future research directions with the use of a comprehensive overview of the research landscape. The aim is to help researchers, policymakers and practitioners identify areas that need further research and development (Nowell et al., 2017). The aim of this bibliometric analysis is to provide a holistic, data-driven understanding of developments, trends, and gaps in IoT and smart city research. In order to achieve these goals, the study aims to contribute to the knowledge base on the combination of IoT technologies in the context of creating more efficient, sustainable and liveable Smart Cities.
310. 5
311. 1.4. Research Questions
312. 1.4.1. Research Objectives
313. This study aims to understand the relationships between publications associated with IoT-based smart cities. In addition it aims to explore the network of scholarly work, examining how various research outputs are interconnected:
314. To analyze citation patterns to understand the prevalence and the impact of key works in the IoT and smart city literature.
315. To identify and analyze new research areas, topics or keywords that have gained prominence in IoT based Smart Cities field in recent years.
316. To classify and analyze the dominant research topics in literature to uncover important areas of interest associated with IoT based smart cities.
317. IV.
318. To identify underrepresented or unexplored aspects in literature to highlight areas that require further research surrounding IoT based smart cities
319. To identify temporal growth patterns and key research associated with IoT based smart cities.
320. 1.4.2. Research Questions
321. The primary objective of this study is to gain a comprehensive understanding of the interconnections and associations among various publications within the domain of Internet of Things (IoT)-based smart cities. The objective of this study is to investigate the intricate web of academic literature, analyzing the interrelationships between different research outputs.:
322. How have citation patterns for significant publications in the IoT-based smart city literature developed over time?
323. What are the emerging research areas, topics, and keywords that have gained prominence in the field of IoT-based smart cities in recent years?
324. What are the dominant research topics that can be categorized to reveal the primary areas of interest and research in the IoT and smart city literature?
325. IV. Which specific aspects or subtopics in existing literature have been underrepresented within IoT and Smart Cities?
326. How have research publications associated with IoT based smart cities evolved over time?
327. 6
328. 1.5. Significance of Research
329. The proposed bibliometric analysis on the inclusion of IoT technologies in smart cities has important implications for many stakeholders, including researchers, policy makers, urban planners, industry players and the general public. Through a comprehensive review of the scientific literature, this study will provide an in-depth understanding of the current state of research, trends and gaps in the field of IoT and Smart Cities (Rejeb et al., 2022). This knowledge is essential for researchers to contextualize their work in the broader academic discourse.
330. Analysis provides insights into emerging trends, challenges and possible solutions for IoT integration in smart cities (Syed et al., 2021). Policymakers can use this information to make informed decisions about urban planning, infrastructure development and IoT deployment to improve city life. Urban planners can benefit from understanding the evolving research landscape to strategically align their initiatives with the latest trends in technology and research (Bush & Doyon, 2019). This analysis can help design more efficient and sustainable urban environments. By identifying knowledge gaps and underrepresented areas in the literature, this study may lead researchers to unexplored areas that require further research (Rejeb et al., 2022). Closing these gaps can lead to broader and more holistic research outcomes.
331. IoT integration in smart cities is an emerging multidisciplinary field with profound implications for cities, technology, and society. As the field evolves, there is a need to systematically map its research landscape to understand its evolution and implications (Syed et al., 2021). The analysis provides insights into evolving trends, focal points and emerging topics in conjunction with IoT and Smart Cities. This information is essential for researchers, policymakers, and practitioners who want to focus their efforts on the latest and most relevant research areas (Rejeb et al., 2022).
332. This study will reveal gaps in our understanding of IoT-based smart cities by identifying areas that are under-represented or overlooked in the literature. This knowledge can guide future research initiatives and contribute to a more holistic understanding of the topic (Sharifi et al., 2021). The results inform policymakers and urban planners about the latest technological advances, challenges and solutions in IoT and Smart Cities. This knowledge can assist in the formulation of policies that support sustainable urban development and improve citizens' quality of life (Javed et al., 2022). Analytics can
333. 7
334. benefit research organizations and funding agencies to allocate resources efficiently by identifying high-performing research areas, influential contributors, and emerging trends that deserve attention and investment (Rejeb et al., 2022).
335. The analysis of interdisciplinary engagement can foster collaboration between researchers across disciplines, enriching the research ecosystem and leading to innovative interdisciplinary solutions (Rejeb et al., 2022). The identification of influential authors, institutions, and cutting-edge work, a study can validate and recognize the contributions of key stakeholders to the advancement of IoT and smart city knowledge (Marrone & Hammerle, 2018). Industry professionals such as technology developers and urban solution providers can benefit from understanding the latest research trends to adapt their innovations to the changing needs of smart cities (Anthony, 2023).
336. The integration of IoT in smart cities has the potential to improve the quality of life of citizens (Alahi et al., 2023). By highlighting the advances and challenges in this area, the research contributes to the broader societal goal of creating more liveable and sustainable urban environments. Analytics can be a valuable asset for academia, allowing teachers to incorporate the latest trends and insights into their curricula so that future professionals can benefit from a comprehensive understanding of IoT and smart cities (Alahi et al., 2023). Research can foster informed discussion and collaboration among stakeholders, including researchers, policymakers, practitioners and citizens, enabling a holistic approach to smart city development (Alamoudi et al., 2022).
337. An analysis of interdisciplinary engagement will encourage researchers of all disciplines to collaborate and promote a more holistic approach to addressing the complex challenges of IoT and Smart Cities (Rejeb et al., 2022). Recognition of influential authors, institutions, and innovative papers recognizes their contributions and encourages further research on the critical issues of IoT-enabled smart cities (Marrone & Hammerle, 2018). The industry of IoT based smart cities can benefit from analyzing current and emerging research trends, this knowledge can guide the development of innovative products and services that meet the changing needs of urban environments (Rejeb et al., 2022).
338. Analytics can improve instructional programs by providing teachers with up-to-date information that can be incorporated into their programs. This enables students to become familiar with the latest developments and challenges in this field (Paes et al., 2021). For cities that want to become smarter and more sustainable, analytics provides the basis for
339. 8
340. data-driven decision-making. It enables the reconciliation of technological innovations with the needs of society and environmental aspects (Paes et al., 2021).
341. In conclusion, the rationale of the proposed study lies in its ability to provide a structured and comprehensive understanding of the IoT and smart city research landscape. By filling knowledge gaps, guiding research and informing policymakers, analytics contribute to smart urban development, technology integration and informed policymaking. This will guide urban development, inform decision-making, encourage interdisciplinary collaboration and contribute to the common goal of creating smarter and more sustainable cities.
342. 1.6. Theoretical Framework
343. Theoretical Framework: Bibliometric Analysis of IoT based Smart Cities Research
344. *Figure 1.6 - Framework Process of the Study*
345. Core Concepts: IoT and Smart Cities:
346. IoT Definition: This is an interconnected network of devices, objects and sensors equipped with data collection and communication capabilities, facilitating the exchange of information and automation.
347. 9
348. Smart Cities Definition: Smart cities are urban environments that employ advanced technologies, including IoT, to enhance city operations, services, and sustainability, with a focus on improving the quality of life for residents.
349. Bibliometric Analysis as a “lens”:
350. Bibliometrics Definition: Bibliometrics is the quantitative analysis of publications, citations, and collaborations in scientific literature. It provides insights into research trends, knowledge diffusion, and scholarly impact.
351. Research Dimensions:
352. Publication Trends: Examining the growth of publications related to IoT and smart cities over time, identifying key publication sources, and assessing the geographic distribution of research output.
353. Author Collaboration: Analyzing co-authorship networks to identify influential authors, research clusters, and interdisciplinary collaborations.
354. Citation Patterns: Investigate citation networks to identify highly cited works, influential papers, and research trends within the field.
355. Bibliometric Indicators:
356. Publication Count: The number of publications related to IoT and smart cities over different time periods, providing insights into research activity.
357. Citation Count: The number of citations received by publications, indicating their impact and influence within the scholarly community.
358. Collaboration Network Metrics: Metrics such as centrality, density, and modularity in co-authorship and collaboration networks to identify key authors and research clusters.
359. Keyword Frequency Analysis: Identifying frequently occurring keywords to understand prevalent research themes.
360. Citation Analysis: Examining citation patterns to identify seminal works and research trends.
361. 10
362. Drivers and Motivations:
363. Urbanization Challenges: The need to address urbanization challenges, including resource management, sustainability, and quality of life improvements, drives research in IoT and smart cities.
364. Technological Advancements: The availability of advanced IoT technologies and data analytics tools motivates researchers to explore their applications in urban contexts.
365. Interdisciplinary Collaboration: The interdisciplinary nature of IoT and smart cities research fosters collaboration among experts from various fields.
366. Research Impact:
367. Policy Influence: Assessing the impact of IoT and smart cities research on urban policies, planning, and governance.
368. Technological Advancements: Investigating how research findings have contributed to the development of new technologies and solutions for smart cities.
369. Quality of Life Improvements: Evaluating the extent to which research has influenced improvements in urban services and residents' quality of life.
370. The proposed theoretical framework for bibliometric analysis with regard to IoT-based smart cities provides a structured and thorough approach to understanding research trends, knowledge transfer, and the overall academic landscape in this interdisciplinary field. By utilizing bibliometric techniques, this study seeks to clarify the development and significance of research, pinpoint new research themes, identify knowledge gaps, and support well-informed policy and future research decision-making.
371. The framework includes crucial steps such as the gathering of data from reputable academic databases; careful data pre-processing and cleaning to ensure data accuracy and relevance; and the use of bibliometric indicators like citation counts; co-citation analysis; and bibliographic coupling to analyze citation patterns and research collaborations. The interpretation and understandable presentation of complicated bibliometric data are captured by the incorporation of visualization tools.
372. Finally, this theoretical framework offers the groundwork for future research, empirical investigations, and practical applications in addition to offering a systematic method for
373. 11
374. bibliometric analysis within the context of IoT-based smart cities. Utilizing bibliometric analysis, it aims to improve our comprehension of the developing IoT-based smart city landscape, opening the way for developments that help create more intelligent, efficient, and sustainable urban environments.
375. 1.7. Overview of the Study
376. In this comprehensive study, we delve into the dynamic and evolving field of IoT as it intersects with the development of Smart Cities. The manuscript is meticulously structured into six chapters, each serving a distinct yet interconnected purpose.
377. **Chapter Two: Literature Review** - This chapter forms the foundation of the research, offering an exhaustive review of existing literature on IoT and Smart Cities. It not only elucidates key concepts and trends but also identifies crucial gaps in current knowledge. This exploration into theoretical and conceptual frameworks lays the groundwork for understanding the intricacies of IoT-enabled Smart Cities. Additionally, the significance of bibliometric analysis in grasping the research landscape is discussed, setting the stage for the methodology adopted in this study.
378. **Chapter Three: Research Problem** – This chapter articulates the central research problem, drawing from the insights gleaned in the literature review. This chapter is pivotal in shaping the research direction and framing the subsequent analytical methods.
379. **Chapter Four: Methodology** - In this chapter, the research design and methodological approach, particularly the use of bibliometric analysis, are detailed. It describes the methods of data collection, including the selection of databases, keywords, and search criteria. The processes of data mining, cleansing, and the rationale behind choosing specific publications are also discussed, providing clarity on the research process.
380. **Chapter Five: Data Analysis and Presentation** - This chapter presents the core analytical work of the study. It demonstrates the quantitative techniques employed in data mining and analyzes trends over time. The chapter explores research themes, emerging topics, and conducts a keyword analysis. It also emphasizes interdisciplinary collaboration, profiling prominent authors and institutions, and examines their contributions and areas of expertise. Furthermore, the analysis extends to the network of co-authorship and institutional collaboration, offering insightful observations.
381. **Chapter Six: Summary and Future Research** - The final chapter synthesizes the findings in terms of IoT based smart cities and offers concrete recommendations for
382. 12
383. researchers, policymakers, and practitioners. It discusses how the results can serve as a guide for future research and decision-making, highlighting the practical implications of the study and suggesting avenues for future exploration.
384. Each chapter builds upon the preceding one, weaving a narrative that is both analytically rigorous and practically relevant, offering a comprehensive overview of the current state and future potential of IoT in the development of Smart Cities.
385. 13
386. **Chapter Two: Literature Review**
387. 2.1. Introduction
388. The term "Internet of Things" (IoT) describes how commonplace items and objects are connected to the Internet so they may exchange and collect data (Gillis, 2023). The integration of IoT technology in urban environments has garnered significant attention, mostly due to its promise to transform cities into smart, efficient, and sustainable entities.. This survey of the literature attempts to offer an overview of the IoT, its implications for urban environments, and perspectives from diverse authors on this game-changing technology.
389. In order to implement IoT in urban settings, various infrastructures must be equipped with sensors and communication devices that allow for data gathering and processing (Rai, 2023). Cities may increase sustainability, public services, resource allocation, and economic growth with IoT.
390. IoT has the potential to enable smart cities by giving city planners access to real-time data, according to Alahi et al. (2023). They talk about how IoT may improve healthcare, waste management, energy use, and traffic management, which will ultimately result in better resource management and a higher standard of living. Park (2018) provides a thorough summary of IoT technologies, uses, and difficulties. The primary objectives of their efforts revolve around enhancing urban sustainability, reducing energy consumption, and fostering a cleaner environment by employing intelligent resource management strategies, hence underscoring the need of smart cities based on the IoT.
391. Hassebo & Tealab (2023) have examined IoT's contributions to the urban environment, particularly around the area of smart cities. They go over the many IoT applications, such as smart grid systems, smart transportation, and smart healthcare, highlighting the importance of effective data management and security to fully reap the rewards. IoT-enabled smart cities are thoroughly examined by Syed et al. (2021), who also highlight the many parties and components involved. In order to produce sustainable, liveable urban places, they emphasize the significance of a holistic strategy that incorporates technologies, policies, and public interaction.
392. Although all experts agree that IoT has the ability to transform urban areas into "smart cities," their viewpoints differ in terms of depth and emphasis. Hassebo & Tealab (2023)
393. 14
394. highlight a variety of applications, while Alahi et al. (2023) primarily concentrate on practical applications and real-time data utilization. Syed et al. (2021) emphasize the significance of a holistic approach involving multiple stakeholders for successful implementation.
395. The potential for creating smart cities through IoT integration in urban settings is enormous. The ability of IoT to revolutionize how resources are managed, advance sustainability, and enhance quality of life is widely acknowledged by authors. For the IoT to be deployed effectively in the urban environment, it is necessary to take into account a multidimensional strategy that includes technology, policy, and citizen involvement. For IoT to fully contribute to the construction of smarter, more sustainable cities, additional research and practical applications are required.
396. 2.1.1. Key Components and Technologies:
397. In his complete proposal, Gillis (2023) identifies four essential building pieces for IoT systems: sensing, communication, data processing, and action. They emphasize the significance of sensors for gathering data, communication networks for transmitting data, data analytics for drawing conclusions, and actuators for implementing changes in response to the conclusions drawn. According to Douzis et al. (2018), integrating cloud computing and IoT is a crucial step in creating smart cities. They talk about how cloud computing makes it possible to store and handle massive volumes of data produced by IoT devices in a scalable manner, enabling resource optimization and real-time decision-making in urban environments.
398. Fog computing is emphasized by Zahmatkesh and Al-Turjman (2020) as a key technology in IoT-based smart cities. They explain how extending cloud capabilities to the network's edge with fog computing which enables quicker data processing and lowers latency. This is especially important for applications that require quick responses in smart city settings. The communication standards and protocols required for IoT deployment in smart cities are discussed by Mansour et al. (2023). The need for established protocols to promote smooth communication and interoperability among IoT devices is emphasized as they explore several communication methods, including Radio-Frequency Identification (RFID), Near-Field Communication (NFC), and Internet Protocol Version 6 (IPv6).
399. 15
400. While the basic elements like sensing, connectivity, and data processing are shared by all writers, their emphasis on integrating cloud and fog computing varies. Gillis gives a thorough description of the fundamental elements, whereas Douzis et al. (2018) concentrates on integrating cloud computing, Zahmatkesh & Al-Turjman (2020) emphasizes the value of fog computing, and Mansour et al. (2023) emphasizes the significance of standardized communication protocols.
401. The creation of smart cities depends critically on the integration of IoT components and technology. Although authors have different opinions on the function of cloud and fog computing, they all agree on the importance of the sensing, communication, and data processing components. For the IoT to be fully utilized in the construction of smart and sustainable cities, it is essential to comprehend and utilize these elements and technologies in concert. In order to maximize the integration and interoperability of these components for maximum impact, additional research and practical applications are essential.
402. 2.2. Historical Evolution and Conceptual Framework:
403. Smart cities have undergone a transformation as a result of the IoT historical evolution and how it interacts with the creation of smart cities. This analysis of the literature attempts to provide an overview of the development of IoT historically and its incorporation into the idea of smart cities, pulling from the opinions of many authors and contrasting them.
404. 2.2.1. Historical Development of IoT:
405. In their work on ubiquitous computing, Kumar et al. (2019) introduced the idea of effortlessly integrating computing into daily life, which served as the foundation for IoT. In his vision, computers would become a natural part of society and enable interactions between people and technology that would later become known as the Internet of Things. The term "Internet of Things," which captures the idea of a network of networked objects sharing information and conversing autonomously, was introduced in an influential piece by Gubbi et al. (2013). By enabling items to gather and transmit data over the internet, he stressed how RFID and sensor technologies have the potential to revolutionize a number of industries.
406. 16
407. 2.2.2. Historical Development of Smart Cities:
408. An early, thorough definition of smart cities was offered by Zhao et al. (2021), along with a timeline of their development. They followed the transition from conventional urban planning to a more comprehensive strategy that included Information and Communication Technology (ICT) to improve urban sustainability and effectiveness. The historical growth of smart cities and its direct connection to the development of urban informatics and digital technologies were noted by Shin et al. (2021). He talked about the way the paradigm for urban development and governance is shifting in favour of using data, ICT, and collaborative methods.
409. The writers present contrasting viewpoints on the IoT's historical evolution. The conceptual framework was established by the visionary concepts of Kumar et al. (2019), and the word "IoT" was popularized and defined by Gubbi et al. (2013). Shin et al. (2021) highlighted the connection between digital technology and the advancement of smart cities, whereas Zhao et al. (2021) focused on the integration of ICT into urban planning in the area of smart cities.
410. From theoretical foundations to worldwide standardization and actual implementations, the historical development of IoT and its integration into smart city concepts constitutes a dynamic growth. The revolutionary potential of IoT and ICT in creating smarter, more sustainable urban landscapes is acknowledged by authors. To fully appreciate the entire nature of IoT and smart cities and to guide future research and development in this quickly developing field, it is essential to understand this historical trajectory. The development and improvement of IoT and smart city projects will continue to be fuelled by additional research and practical applications.
411. 2.2.3. Conceptual Frameworks for Understanding IoT in Smart Cities:
412. A complete framework for smart cities was proposed by Sucupira Furtado et al. (2023), focused on six dimensions: the smart economy, the smart mobility, the smart environment, the smart people, the smart living, and the smart government. Despite not addressing IoT specifically, their paradigm offers a solid framework for comprehending how IoT is integrated across different dimensions in the context of smart cities. In their proposed layered model for IoT in smart cities, Tekinerdogan et al. (2023) included layers for perception, network, data processing, and application. Their paradigm offers perceptions into how IoT devices and sensors take in their surroundings, communicate
413. 17
414. data via networks, analyse data, and produce useful applications, ultimately aiding in the creation of smart city solutions. A conceptual model for IoT in smart cities was put forth by Syed et al. (2021), with an emphasis on data management, analytics, and applications. In order to attain the goals of the smart city, they underlined the significance of data-driven decision-making and the necessity for efficient data management, analysis, and application development. A model that highlights the function of IoT in allowing smart services inside a city was provided by Rejeb et al. (2022). The framework was divided into three layers: perception, network, and service. Their model demonstrates how IoT helps provide services and improves quality of life in smart cities.
415. Although experts agree on the significance of IoT in smart cities, their frameworks vary in terms of emphasis and level of detail. While Tekinerdogan et al. (2023) and Syed et al. (2021) provide extensive models concentrating on IoT's technological components and data management, Sucupira Furtado et al. (2023) propose a broader perspective on smart cities without directly addressing IoT. Rejeb et al. (2022), on the other hand, focus on offering intelligent services made possible by IoT.
416. A multi-dimensional strategy is necessary to fully comprehend the integration of IoT in smart city efforts, taking into account a number of different factors like data management, technology layers, and service provisioning. With varying degrees of specificity and intensity, each proposed conceptual framework offers a distinctive lens through which to understand this integration. To fully realize the potential of IoT in creating smarter, more sustainable cities, greater study and practical use of these frameworks are absolutely necessary. Future efforts in the IoT-driven transformation of urban environments will be guided by the iterative improvement and consolidation of these frameworks.
417. 2.3. Key IoT Applications in Smart Cities:
418. 2.3.1. IoT Applications in Transportation:
419. IoT applications in ITS that improve traffic flow, lessen congestion, and increase road safety are covered by Oladimeji et al. (2023). In real-time traffic monitoring, adaptive traffic signal regulation, and vehicle-to-vehicle (V2V) communication, they highlight the importance of IoT-enabled sensors and data analytics. In order to effectively manage parking spaces within cities, Fahim et al. (2021) concentrate on IoT applications in smart parking systems. They emphasize the use of sensors to determine parking space
420. 18
421. availability, providing vehicles with real-time information and maximizing the use of parking resources.
422. 2.3.2. IoT Applications in Energy Management:
423. IoT applications for smart energy grids are described by Madhuri et al. (2022), with a focus on real-time monitoring and management of energy distribution. They go over how the IoT enables demand-side management, the integration of renewable energy sources, and efficient energy use via smart meters and gadgets. Al-Obaidi et al. (2022) explore IoT applications for Building Energy Management Systems (BEMS), demonstrating how IoT-enabled gadgets optimize energy use in buildings. They draw attention to energy-saving Heating, Ventilation, and Air Conditioning (HVAC) systems, lighting controls, and occupancy sensors that support sustainable construction techniques.
424. 2.3.3. IoT Applications in Healthcare:
425. For remote patient monitoring and healthcare administration, Rejeb et al. (2022) investigate IoT possibilities in healthcare. In order to demonstrate how IoT improves healthcare accessibility, efficiency, and patient outcomes, they place a strong emphasis on wearable technology, smart healthcare devices, and telemedicine. IoT applications in healthcare for geriatric care and health monitoring are covered by Perez et al. (2023). They emphasize how the IoT is enabling the development of smart houses with health sensors and aids that improve the quality of life for senior citizens.
426. The writers agree that IoT has the potential to change a number of industries within smart cities. IoT applications in the field of transportation are discussed by Oladimeji et al. (2023) and Fahim et al. (2021), respectively, with an emphasis on traffic management and smart parking systems. IoT applications in energy management, particularly in energy grids and building energy systems, are highlighted by Madhuri et al. (2022) and Al-Obaidi et al. (2022). IoT applications in healthcare are covered by Rejeb et al. (2022) and Perez et al. (2023), with a focus on patient monitoring and senior care.
427. Smart city IoT applications offer a substantial paradigm shift in urban management, improving productivity, sustainability, and quality of life. The opinions of the authors highlight the variety of IoT applications across the transportation, energy, and healthcare sectors. For informed decision-making and the successful implementation of IoT to create smarter, more resilient cities, an understanding of these applications is essential. These applications will be improved by additional study and real-world application, allowing
428. 19
429. cities to reach their full potential in influencing a sustainable and technologically advanced future.
430. 2.3.4. Impact and Benefits of IoT Adoption in Healthcare:
431. IoT's influence on healthcare is discussed by Rejeb et al. (2022), with a focus on remote patient monitoring and individualized care. They underline how IoT technologies, like wearables and health sensors, offer real-time patient monitoring, increasing patient outcomes and healthcare delivery. The advantages of IoT in healthcare are emphasized by Kelly et al. (2020). These advantages include better patient care, more effective resource allocation, and lower healthcare expenditures. They talk about how IoT innovations, such as telemedicine and connected medical equipment, improve the efficiency and accessibility of healthcare.
432. 2.3.5. Impact and Benefits of IoT Adoption in Agriculture:
433. The authors analysis of the Internet of Things' effects on precision farming, Akhter and Sofi (2022) emphasizes the advantages of smart farming. They emphasize how IoT-enabled agricultural sensors and data analytics maximize pest management, fertilization, and irrigation, resulting in higher crop yields and more environmentally friendly farming methods. In their discussion of the advantages of IoT in smart farming, Dhanaraju et al. (2022) place a focus on resource conservation and environmental sustainability. They explain how IoT apps help farmers make data-driven decisions that save resources and promote sustainable farming practices.
434. 2.3.6. Impact and Benefits of IoT Adoption in Manufacturing:
435. The impact of IoT in manufacturing is discussed by Javaid et al. (2022), with an emphasis on the advantages of Industry 4.0 (IR4.0). They underline how enhancing supply chain management, production efficiency, and quality control using IoT-enabled smart factories will increase manufacturing competitiveness. Verma (2022) examines the advantages of IoT in manufacturing, emphasizing more flexibility, cost reductions, and better production. They go over how IoT technologies, such real-time monitoring and predictive maintenance, improve manufacturing operations and cut downtime.
436. 2 .3.7. Impact and Benefits of IoT Adoption in Transportation:
437. Oladimeji et al. (2023) focus on linked and smart vehicles as they discuss the effects of IoT in transportation. They place a strong emphasis on how IoT technologies improve traffic management, ease congestion, and increase road safety, all of which contribute to
438. 20
439. the development of more effective and sustainable transportation systems. Dzuiba (2021) emphasizes the advantages of IoT in the transportation sector, focusing on increased mobility, lower emissions, and better urban planning. They talk about how IoT technologies, like intelligent traffic lights and vehicle-to-infrastructure connectivity, improve transportation networks and support sustainable urban development.
440. The benefits and positive effects of IoT adoption in several sectors are agreed upon by the authors. The focus of Kelly et al. (2020) and Rejeb et al. (2022) is on cost-effectiveness and healthcare outcomes. Sustainable agricultural approaches are highlighted by Akhter & Sofi (2022) and Dhanaraju et al. (2022). Verma (2022) and Javaid et al. (2022) concentrate on increasing productivity and efficiency in the industrial sector. Oladimeji et al. (2023), as well as Dzuiba (2021), stress the importance of better traffic management and transportation sustainability.
441. IoT adoption has demonstrated significant benefits in a variety of industries, including manufacturing, transportation, agriculture, and healthcare. The revolutionary advantages of IoT adoption are emphasized by authors, who emphasize increased effectiveness, sustainability, cost savings, and service quality. Making educated decisions and integrating IoT technology successfully depend on an understanding of these advantages, which will eventually spur innovation and advancement across a variety of industries. The study will gain a deeper knowledge and realize the full potential of IoT across these sectors through additional study and real-world applications.
442. 2.4. Bibliometric Analysis Methodology:
443. 2.4.1. Data Sources for Bibliometric Analysis:
444. Web of Science (WoS) is well known for its thorough coverage of academic journals, conference proceedings, and other publications. It is a popular option for bibliometric studies because of its structured data and precise citation information, which guarantees complete and trustworthy data. A reputable multidisciplinary database with extensive coverage of academic literature is called Scopus. It is a thorough source for bibliometric analysis because it includes journals, conference papers, and patents. In addition to WoS, researchers frequently use Scopus to support their analyses. Google Scholar is freely accessible and indexes a large range of scholarly information, despite being less controlled and structured than WoS and Scopus. Researchers frequently utilize it to broaden their search and find more papers, particularly in the area of grey literature and unconventional academic sources.
445. 21
446. 2.4.2. Search Strategies for Bibliometric Analysis:
447. Prudent keyword selection and the use of Boolean operators (AND, OR, NOT) to create accurate and thorough search queries are essential components of effective search techniques. To ensure thorough coverage, authors stress the value of employing regulated vocabulary and synonyms. Truncation and wildcards increase the number of search results by incorporating different search phrases. This method makes sure that every pertinent item is included, regardless of spelling or word changes.
448. 2.4.3. Inclusion and Exclusion Criteria:
449. Inclusion criteria are developed by researchers to specify the standards for choosing pertinent publications. Common requirements include peer-reviewed papers, articles published within a certain time frame, and publications that were published. Exclusion criteria specify the conditions under which specific items are excluded from the analysis. Non-peer-reviewed articles, duplicates, extraneous material, and studies that are not relevant to the research are typical exclusions.
450. Google Scholar is important for bibliometric analysis, according to Rejeb et al. (2022). They highlight this by pointing out its broad coverage and capacity to find citations in a variety of publications. They emphasize its value despite possible biases and indexing difficulties. Ellegaard & Wallin (2015) promote a complete strategy for bibliometric analysis and advise combining WoS, Scopus, and Google Scholar to achieve thorough data gathering. They emphasize how crucial it is to be aware of each source's advantages and disadvantages. To increase precision and memory, they emphasize the need for a well-rounded strategy. In their comprehensive examination of search tactics, Ho et al. (2016) highlight the benefits of using Boolean operators, truncation, and wildcards to create powerful queries.
451. It is important to carefully analyze data sources, search tactics, and inclusion and exclusion criteria before conducting a bibliometric analysis. The well-known data sources WoS, Scopus, and Google Scholar each have their own advantages. The use of keywords, Boolean operators, and truncation in effective search strategies is essential. The scope of the analysis is determined by the inclusion and exclusion criteria. The benefits and drawbacks of diverse procedures are highlighted by contrasting the approaches of writers, underscoring the significance of a considered and flexible approach to bibliometric research. Conducting thorough bibliometric analyses that significantly enhance
452. 22
453. knowledge in academia and in the field of research requires an awareness of these approaches.
454. 2.5. Bibliometric Analysis Findings:
455. 2.5.1. Quantitative Analysis of Publications Over Time:
456. A thorough bibliometric analysis was carried out by Ghani et al. (2022) to evaluate the features and growth trends of the world's scientific output. Their study, which used data from Scopus and WoS, highlighted the impact of research globalization by revealing a considerable increase in the number of publications over time. VOSviewer, a software program for creating and viewing bibliometric maps, was presented by Li & Hasnah Hassan. (2023). It enables the quantitative analysis of publication patterns, co-authorship networks, and research subjects. Their method makes it easier to detect research hotspots and new trends in a certain sector.
457. 2.5.2. Publication Types in Quantitative Analysis:
458. An approach for classifying scientific materials into four basic categories—articles, reviews, conference papers, and editorials was given by Chen & Xiao (2016). For effective bibliometric analysis, their study stressed the significance of precisely categorizing publication types because each type offers unique insights into research output. The rise of various document kinds, such as articles, reviews, and conference papers, in a variety of scientific topics was examined by Jun et al. (2018). Their research exposed disparate growth rates and patterns of publishing formats, illuminating scholarly communication inequalities between disciplines.
459. 2.5.3. Geographical Analysis of Publications:
460. A bibliometric analysis was carried out by Mohadab et al. (2020) to examine the production of research in library and information science in various nations. Their study shed light on worldwide research distribution by offering insights into publication trends and contributions from various nations. When examining how geographic location affects the output of research, Dwivedi et al. (2023) concentrated on the publication patterns of writers from various locations. Their research revealed regional differences in writers' publication rates and patterns, as well as the influence of institutional and cultural factors.
461. While all writers agree that quantitative analysis is important for comprehending publication trends, growth patterns, publication kinds, and geographic variances, their methods are different. Bibliometric methods and databases are used by Ghani et al. (2022)
462. 23
463. and Li & Hasnah Hassan (2023) to examine growth patterns and depict research landscapes. In order to identify subtle trends, Chen & Xiao (2016), Jun et al. (2018), and others emphasize accurate classification of publishing categories. Geographical analysis is the main emphasis of Mohadab et al. (2020) and Dwivedi et al. (2023), who provide insights into regional differences in research output.
464. Understanding the dynamics of academic research requires the use of quantitative analysis of publications across time. The studies, under examination, show the variety of methodology and strategies used to examine growth trends, publication kinds, and geographic variances. By combining these methodologies, one can gain a thorough grasp of the rapidly changing research scene and make well-informed decisions about future academic endeavours. The accuracy and breadth of quantitative analyses in academic research will continue to be improved through additional study and developments in bibliometric tools and methodology.
465. 2.5.4. Identifying the Most Cited Articles:
466. “Internet of Things (IoT): A Vision, Architectural Elements, and Future Directions” is a seminal work written by Madakam et al. (2015). This book offers a thorough analysis of IoT architecture, components, and prospective applications; as such, it will serve as a fundamental reference for the IoT industry. Zymbler, Kumar, and Tiwari (2019). The article “Internet of Things is a revolutionary approach for future technology enhancement: a review” offers a thorough examination of IoT innovations and how they fit into the idea of smart cities. The study emphasizes how IoT has the ability to revolutionize urban landscapes and has received numerous citations in related studies.
467. 2.5.5. Identifying the Most Cited Authors:
468. Significant contributions have been made by Madakam et al. (2015), a well-known researcher in IoT and smart cities, including ground-breaking publications like “Internet of Things for Smart Cities”. His large citation count reflects his prominence in the field and the breadth and depth of his knowledge and research output.
469. 2.5.6. Identifying the Most Cited Journals:
470. The Institute of Electrical and Electronics Engineers (IEEE) “Internet of Things” Journal is a top source for academic IoT research. Articles published in this journal typically receive high citations due to its broad readership and strict review procedure, solidifying its place as a leading journal in the industry. The open-access journal “Sensors” covers a
471. 24
472. wide range of subjects pertaining to sensor technologies and applications, including IoT. This magazine is a noteworthy venue for the distribution and citation of research in the area of IoT-based smart cities because of its accessibility and rich content.
473. There is general agreement regarding the significance of the ground-breaking research by Madakam et al. (2015) and Kumar, Tiwari & Zymbler (2019), however different writers bring different viewpoints to the IoT-based smart cities field. Journals like the IEEE Internet of Things Journal and Sensors, which reflect the multidimensionality of IoT in smart cities, similarly support the various research demands of the subject.
474. IoT-based smart cities' most frequently referenced articles, authors, and journals can be used to gain important insights into the field's leading scholars and prominent research. The discussion of IoT applications in urban settings has been greatly influenced by Madakam et al. (2015) and Kumar, Tiwari & Zymbler (2019). The IEEE “Internet of Things” Journal and “Sensors” are important venues for the publication and citation of research, highlighting how IoT-based smart cities are interdisciplinary in nature. Future studies and ongoing analysis of citations will shed more light on developing patterns and important works in this dynamic and developing subject.
475. 2.6. Research Themes and Trends:
476. Understanding the various applications and effects of the IoT inside smart cities requires categorizing the literature based on study themes.
477. 2.6.1. IoT-Enabled Transportation:
478. A basic study on IoT applications in Intelligent Transportation Systems (ITS) is offered by Oladimeji et al. (2023). They explain how combining real-time data from sensors and linked vehicles might help IoT technology optimize traffic flow, increase road safety, and lessen congestion. The IoT applications for managing urban traffic are the main topic of Sarrab et al. (2020). They give a thorough analysis of how intelligent traffic lights and IoT-enabled traffic monitoring systems can dramatically improve traffic management, resulting in more effective transportation in smart cities.
479. 2.6.2. IoT for Sustainable Energy:
480. IoT applications in smart grids and energy management are highlighted by Madhuri et al. (2022). They discuss about how IoT provides real-time monitoring and control of energy distribution, encouraging sustainable behaviours and efficient energy use in smart cities.
481. 25
482. A thorough analysis of IoT applications in renewable energy systems is provided by Al-Obaidi et al. (2022). They emphasize how IoT technology can facilitate the integration of renewable energy sources, resulting in a more environmentally friendly and long-lasting energy infrastructure.
483. 2.6.3. IoT in Healthcare within Smart Cities:
484. The focus of Javaid et al. (2022) is on the use of IoT in healthcare, particularly in remote patient monitoring, inside smart cities. They talk about how IoT-enabled medical equipment and telemedicine programs improve access to and the standard of care, which benefits patients. In their assessment of IoT applications in healthcare, Rejeb et al. (2022) place a focus on healthcare data analytics and security. In order to enable informed decision-making and improve healthcare services in smart cities, they investigate how IoT technology can handle and analyze healthcare data.
485. IoT is important across a range of smart city disciplines. Using IoT-enabled technologies, Oladimeji et al. (2023) and Sarrab et al. (2020) concentrate on improving transportation networks. The potential of IoT in reaching sustainable energy targets is highlighted by Madhuri et al. (2022) and Al-Obaidi et al. (2022) IoT has a revolutionary impact on healthcare in smart cities, notably in patient monitoring and data analytics, as highlighted by Javaid et al. (2022) and Rejeb et al. (2022).
486. A structured understanding of IoT applications and their effects is provided by categorizing IoT literature based on research themes such as transportation, renewable energy, and healthcare within smart cities. Collectively, the authors' numerous perspectives demonstrate the IoT's varied possibilities for influencing programs for smart cities. This category makes it easier to conduct focused study and implement solutions, advancing the development of technologically sophisticated, sustainable, and efficient smart cities. Our grasp of these study subjects will be strengthened by additional multidisciplinary cooperation and research, which will also open the door for upcoming developments in IoT-driven smart cities.
487. Understanding how a given area develops, adapts, and reacts to shifting settings and technology depends on analyzing emerging patterns and shifts in study focus across time.
488. 2.6.4. Emerging Trends and Shifts in Research Focus Over Time:
489. Rejeb et al. (2022) used bibliometric methods to spot trends and changes in the direction of research over time. Their study focused on the move from print-based to electronic
490. 26
491. publication and the rise of open access publishing, examining the shift from traditional research themes to emergent and transdisciplinary domains. Network analysis and topic modelling were used by Heller et al. (2023) to map the scientific landscape and pinpoint new trends in research. They highlighted the fusion of diverse fields as they spoke about the rise of interdisciplinary research and the impact of funding and collaborations on research focus. Lungeanu et al. (2014) used co-word analysis and network visualization, to comprehend new research trends and interdisciplinarity. By analyzing the body of scientific literature, they pinpointed emergent research themes and stressed the value of multidisciplinary research in solving complex societal concerns.
492. In order to examine new trends and changes in the research focus throughout time, authors use a variety of approaches. While Heller et al. used network analysis and subject modelling to analyze multidisciplinary trends, Rejeb et al. (2022) largely used bibliometrics to track changes in publication patterns and formats. Co-word analysis was used by Lungeanu et al. (2014) to highlight the value of multidisciplinary research in tackling societal problems.
493. Understanding the changing research landscape requires an analysis of new trends and shifts in research concentration across time. Whether using bibliometrics, network analysis, or co-word analysis, each method offers distinct insights into the changing nature of research across a range of disciplines. The observed patterns and changes in research priorities show the interdisciplinary character of current research and the value of collaboration and social requirements adaption. We will continue to get a deeper grasp of changing research trends through more research and the application of cutting-edge analytical methodologies, which will support discipline-specific innovation and well-informed decision-making.
494. 2.7. Methodologies and Data Analysis in IoT-based Smart City Research:
495. Numerous approaches are used in the IoT research conducted in smart cities to comprehend its uses, effects, and difficulties.
496. 2.7.1. Methodologies in IoT Research for Smart Cities:
497. In their study on IoT research for smart cities, Syed et al. (2021) emphasized the importance of case studies since they offer in-depth insights into practical implementations. Case studies give academics the chance to look into particular implementations, difficulties, and successes while providing insightful qualitative and
498. 27
499. contextual knowledge. Zahmatkesh & Al-Turjman (2020) talked on the usage of surveys to gather information on IoT applications in smart cities. Surveys give researchers a controlled way to collect data from a large sample, allowing for quantitative analysis and the discovery of trends, preferences, and problems.
500. To assess the influence of IoT on smart cities, Alahi et al. (2023) underlined the value of simulations and models. Through the use of simulations, researchers may test different hypotheses, forecast results, and optimize IoT deployments without actually implementing them. This gives them insights into effectiveness and scalability. In order to evaluate the effectiveness and viability of IoT technology in smart cities, Rejeb et al. (2022) argued for experimental investigations. Using empirical data from experiments, researchers can assess the technological merits, dependability, and efficacy of IoT systems.
501. All authors appreciate case studies, surveys, simulations, and experimental investigations, they all place different emphasis on these types of studies. Syed et al. highlight the detailed contextual knowledge gained from case studies that reveal actual IoT applications. The importance of surveys in gathering data at scale and generating quantitative insights is emphasized by Zahmatkesh & Al-Turjman (2020). Prior to real deployment, Alahi et al. (2023) emphasize the use of simulations for scenario testing and optimization. Experimental research is encouraged by Rejeb et al. (2022) to confirm the technical efficacy and applicability of IoT technology.
502. In IoT-related research for smart cities, a range of approaches are used to meet a range of research goals and data collection requirements. Case studies provide contextual information; surveys collect a wide range of data; simulations provide scenario testing; and experimental research substantiates results. To expand the knowledge and use of IoT in smart cities, researchers should carefully select and combine these approaches based on their unique research goals. The depth and breadth of study in this dynamic topic will be significantly improved by future developments in these approaches. Any scholarly investigation must include research procedures since they influence the data collecting, analysis, and interpretation processes.
503. 2.7.2. Quantitative Research:
504. The collecting of numerical data is a component of quantitative research, which is praised for its objectivity, generalizability, and capacity to identify patterns and linkages. Ishtiaq
505. 28
506. (2019) places a strong emphasis on its capacity to deliver exact, quantifiable results and enable statistical analysis for a more organized and accurate understanding of study phenomena.
507. Rahman (2016) points out the possible flaw in quantitative research's tendency to oversimplify complex social issues while admitting its advantages in providing numerical data and statistical analysis. He says it might be shallow and fall short of capturing the complexity and variety of human experiences.
508. 2.7.3. Qualitative Research:
509. For its breadth, depth, and comprehensive understanding of human feelings and behaviour, qualitative research is praised. Collins and Stockton (2018) draw attention to the adaptability of the approach, which enables the dynamic examination of intricate social circumstances, attitudes, and cultural influences. It provides a deeper comprehension of skewed reality. Rahman (2016) emphasizes how effective qualitative research is at capturing the subtleties of human behaviour and circumstance, facilitating the development of theories, and offering in-depth insights. They do point out that it can be labour- and time-intensive and that subjectivity and interpretation issues could arise.
510. 2.7.4. Mixed Methods Research:
511. This involves utilizing the advantages of each, mixed methods research combines quantitative and qualitative methodologies. Schoonenboom & Johnson (2017) highlight their capacity to offer a thorough understanding by combining data from many sources and approaching research problems from a variety of angles, resulting in a more thorough and nuanced study. In using the advantages of both quantitative and qualitative research procedures, Fetters et al. (2013) highlight the adaptability of mixed methods research. To retain the rigor and credibility of the study, they do warn that it takes competence in both methodologies and careful integration.
512. The strengths of each study methodology quantitative for its objectivity, qualitative for its depth, and mixed techniques for their complimentary nature are recognized by the authors in agreement. They differ, nevertheless, in how much emphasis they place on flaws such the difficulty of integrating methodologies in mixed methods research and the contrast between the potential subjectivity of qualitative versus quantitative approaches.
513. For researchers to choose an appropriate methodology, they must be aware of the advantages and disadvantages of various approaches. Though it can oversimplify things,
514. 29
515. quantitative research gives impartiality and generalizability. While qualitative research offers richness and depth, it may lack objectivity. While integrating strengths, mixed methods research necessitates integration expertise. In order to choose the approach that is best in line with their study objectives and open-ended research questions, researchers must take these factors into account.
516. 2.8. Challenges and Future Directions:
517. The use of IoT in smart cities can significantly improve sustainability. As noted by Bibri (2020), IoT technologies enable better resource management, reducing waste and energy consumption. This contributes to more sustainable urban environments. However, any transformational effort has its own set of difficulties and restrictions.
518. 2.8.1. Challenges and Limitations in IoT Adoption in Smart Cities:
519. The implementation of IoT for smart cities still faces considerable obstacles in interoperability and standards by Allioui & Mourdi (2023). The promise of a unified IoT ecosystem is constrained by heterogeneity in devices, protocols, and platforms, which prevents smooth communication and integration. The deployment of IoT in smart cities is surrounded by serious privacy and security concerns by Fabrègue & Bogoni (2023). Strong security measures are required because to the enormous volume of data collected and transmitted, which creates privacy concerns and puts key infrastructure at danger from cyberattacks. Scalability of IoT infrastructure is a problem, especially in metropolitan regions that are developing quickly by Alabdulatif & Thilakarathne (2023). The management of the increasing quantity of IoT devices and the associated data they generate, while considering energy and resource consumption, remains an ongoing concern.
520. One significant restriction is the high cost of adopting IoT technology and infrastructure. For urban planners and legislators, funding smart city initiatives and assuring a return on investment while providing citizens with accessible services presents considerable problems by Park et al. (2018). It can be difficult to involve individuals and ensure inclusivity in IoT adoption by Shin et al. (2021). For cities to be genuinely smart and inclusive, the digital divide must be closed and equal access to IoT-enabled services must be guaranteed.
521. On important issues including interoperability, security, and scalability, the writers are in agreement. Both Fabrègue & Bogoni (2023) and Allioui & Mourdi (2023) place a strong
522. 30
523. emphasis on the technological elements, particularly interoperability and security. Financial and sustainability issues are raised by Alabdulatif & Thilakarathne (2023) and Park et al. (2018), who also stresses the practical and financial difficulties. Shin et al. (2021), who represents a socio-cultural perspective and emphasizes the value of citizen interaction.
524. The barriers to IoT adoption for smart cities have been identified, and they span a variety of technical, economical, sociological, and environmental issues. For the IoT to be successfully integrated in urban settings, issues related to interoperability, security, scalability, cost, and public participation must be addressed. Realizing the full promise of the IoT in building smarter, more sustainable, and citizen-centric cities will require an understanding of and ability to address these difficulties. IoT will be more easily and effectively adopted in smart cities as a result of future research and practical application that will improve techniques for overcoming these obstacles. It is crucial to identify future research directions and prospective areas for advancement as the IoT integration in smart cities continues to develop.
525. 2.8.2. Future Research Directions:
526. Kumar et al. (2019), enhancing the scalability and optimization of IoT technologies in smart cities should be the main emphasis of future research. As the IoT ecosystem expands, addressing issues linked to the growing volume of data and the effective management of devices will be essential to ensuring smooth operations. Songhorabadi et al. (2023), a significant research area is examining the possibilities of edge computing and fog computing in IoT-enabled smart cities. It will be crucial for improving IoT deployments to investigate how these paradigms might decrease latency, improve data processing, and increase energy economy. Alahi et al. (2023), future studies should examine how IoT and machine learning may be combined with Artificial Intelligence (AI) to create smart cities. A crucial area for development is comprehending how AI algorithms may extract useful insights from data produced by the IoT to enhance decision-making and services.
527. 2.8.3. Potential Areas for Improvement:
528. Deebak et al. (2022), the advancement of privacy-preserving technologies is a crucial issue. Research should concentrate on creating strong protections for people's privacy and sensitive information while enabling the smooth use of IoT gadgets and services in
529. 31
530. smart cities. Allioui & Mourdi (2023), it is essential to raise standards and guarantee interoperability between various IoT platforms and devices. A more unified and effective IoT ecosystem should be supported by future research that aims to create standards and protocols that enable seamless communication and integration. Aditya et al. (2023), a potential area for improvement is enhancing community involvement and including citizens in the co-creation of smart city solutions. In order to ensure that the creation of IoT-enabled services is in line with people' needs, preferences, and social values, research should focus on strategies to empower citizens.
531. Scalability, optimization, and AI integration are consistently emphasized by authors as important future research objectives. Songhorabadi et al. (2023) place more emphasis on edge and fog computing while Kumar et al. (2019) concentrate on scaling issues. Alahi et al. (2023) stress the importance of integrating AI. Deebak et al. (2022) emphasize privacy-preserving technology, Allioui & Mourdi (2023) promote standards and interoperability, and Aditya et al. (2023) emphasize community interaction when discussing potential areas for improvement.
532. In order to ensure the successful and long-lasting integration of IoT in smart cities, it is essential to identify future research topics and potential development areas. Further research and development must focus on issues including scalability, utilizing new computing paradigms, integrating AI, strengthening privacy, ensuring interoperability, and involving communities. Addressing the scalability of IoT systems is crucial for smart cities. As per Zanella et al. (2014), scalable solutions are needed to manage the massive amount of data generated by numerous IoT devices across a city. As these sectors advance, smart cities will become more effective, inclusive, and citizen-centric, maximizing the potential of IoT technology and promoting sustainable urban growth. The incorporation of AI in IoT systems can lead to smarter decision-making and automation. As highlighted by Al-Fuqaha et al. (2015), AI techniques can enhance data analysis and decision-making in smart cities.
533. Future developments in IoT-enabled smart cities will be shaped by ongoing research and innovation in these areas.
534. 2.9. Policy and Regulatory Landscape:
535. Due to its potential to transform urban development and enhance quality of life, the Internet of Things' (IoT) integration in smart cities has attracted a lot of interest. However,
536. 32
537. a strong regulatory structure and laws are required to oversee the widespread application of IoT in smart cities. A comprehensive legal framework is needed to govern IoT deployments in smart cities. As Townsend (2013) asserts, such a framework should address liability, standards compliance, and the management of public-private partnerships involved in smart city projects.
538. 2.9.1. Frameworks for National IoT Policy in Smart Cities:
539. The United States has taken the initiative to create a regulatory framework for the deployment of IoT. In order to make IoT adoption easier, the U.S. Department of Commerce's "National Strategy for IoT" (2016) placed a strong emphasis on stimulating innovation, improving cybersecurity, and advancing global standards. Creating IoT policy frameworks has been a top priority for the European Union's European Commission. Examples of significant initiatives that prioritize data privacy, security, and interoperability include the "Digital Agenda for Europe" and the "IoT European Large-Scale Pilots Programme" (European Commission, 2021). In processing IoT data, the comprehensive data protection regulation known as General Data Protection Regulation (GDPR) plays a key role. The "National Digital Communications Policy 2018" of India promotes the creation of a complete IoT policy framework and provides a vision for IoT adoption. With an emphasis on using technology for sustainable development, it seeks to connect rural and urban areas using IoT (Government of India, 2018).
540. 2.9.2. International Policy Initiatives for IoT in Smart Cities:
541. The International Telecommunication Union (ITU) has played a key role in advancing global standards for the IoT. To achieve universal interoperability and smooth integration, the ITU-T SG20 (IoT and its applications, including smart cities and communities) focuses on standardization in the field of IoT (ITU-T, 2021). To help its member nations with their IoT policies, the Organisation for Economic Co-operation and Development (OECD) has produced a set of IoT policy principles. Encouragement of free markets, encouragement of investment and innovation, and maintenance of security and privacy are among the guiding ideals (OECD, 2018).
542. 2.9.3. Challenges and Considerations:
543. IoT adoption faces significant obstacles in the areas of privacy and security. To safeguard user data and IoT devices from potential cyber risks, regulatory frameworks must address data privacy, consent methods, and security protocols by Voigt et al. (2017). It might be
544. 33
545. difficult to achieve compatibility between various IoT systems and devices. To encourage smooth communication and collaboration, it is crucial to harmonize international standards and ensure adherence to them, Gubbi et al. (2013). To guarantee that IoT serves all facets of society, policy frameworks should address challenges of socioeconomic inclusion. IoT-enabled services and solutions must be accessible, affordable, and distributed fairly, Jennings et al. (2016).
546. The effective and responsible use of IoT in smart cities is greatly influenced by policy frameworks and laws. The significance of adopting comprehensive policies to handle many issues, like as privacy, security, interoperability, and inclusion, is being recognized by nations and international organizations. In order to support the sustainable development of IoT-enabled smart cities, future efforts should continue to expand these frameworks by combining international standards and best practices.
547. A key factor in determining how the IoT is implemented and developed in smart cities is the policy frameworks that are in place. These policies provide rules, specifications, and recommendations that direct IoT deployments and guarantee their sustainable, responsible, and secure integration.
548. 2.9.4. Impact on IoT Implementation and Growth:
549. Implementing the IoT requires policies that establish regulatory compliance and standards. Interoperability and smooth communication between various IoT devices and platforms are guaranteed through standards, such as those established by the International Telecommunication Union (ITU) and other organizations (ITU-T, 2021). By providing a single IoT ecosystem within smart cities, compliance with these standards accelerates integration efforts and promotes growth. For the IoT to thrive, strict regulations addressing data security and privacy are essential. Data gathered by IoT devices must be managed safely and responsibly according to legislation like the General Data Protection Regulation (GDPR) in the European Union and comparable data protection rules around the world by Voigt et al. (2017). Such laws increase public confidence and promote wider use of IoT technologies in smart cities.
550. IoT growth is accelerated by policies that encourage cooperation and partnerships between public and commercial institutions. Public-Private Partnerships (PPPs) frequently encourage private sector investment and innovation in projects for smart cities. Private companies are encouraged to invest in IoT infrastructure by government
551. 34
552. incentives and grants, which increases the adoption and growth of IoT solutions in smart cities, (Song et al., 2023). To guarantee that the advantages of IoT are available to all facets of society, policies emphasizing digital inclusion and equity are essential. Equitable growth is promoted through reducing the cost of IoT-enabled services and raising digital literacy (Jennings et al., 2016). The expansion of IoT in smart cities is fuelled by inclusive policies that promote broad adoption and engagement.
553. Growth in the IoT is largely influenced by policies that support environmental responsibility and sustainability. The direction of IoT implementation will be greatly influenced by regulations that promote energy-efficient IoT devices, waste reduction, and sustainable urban design (Ehsanifar et al., 2023). Sustainable IoT solutions support global initiatives for smarter, greener cities.
554. 2.9.5. Challenges and Considerations:
555. Aligning policy across diverse industries and domains is a significant problem. IoT has an impact on many industries, thus policies must be coordinated to guarantee effective deployment and expansion (Almalki et al., 2023). To achieve a unified and integrated approach, policymakers and stakeholders must effectively coordinate. Rapid technological change necessitates the need for quickly adaptable and evolving policy. To stay up with the changing IoT world, which includes new technologies and shifting threat landscapes, policies must be flexible (Allioui & Mourdi, 2023). Promoting ongoing and sustained growth of IoT in smart cities requires adaptation.
556. The development of IoT in smart cities and its implementation are heavily impacted by policy frameworks. The adoption of IoT is influenced by policies that are focused on sustainability, public-private partnerships, regulatory compliance and standardization, data privacy and security, and digital inclusion. The development of smart cities is ultimately fuelled by these regulations, which create an atmosphere that is suitable to responsible and effective IoT integration. The necessity for dynamic, coordinated, and agile policy frameworks that can keep up with technological improvements and social needs is highlighted by challenges connected to policy alignment and adaptability. To maintain a successful IoT ecosystem within smart cities, future research and policy activities should concentrate on tackling these issues.
557. 35
558. 2.10. Integration of IoT with Emerging Technologies:
559. An essential technology for the creation of smart cities is the IoT. But when combined with other cutting-edge technologies like edge computing, blockchain, artificial intelligence (AI), and more, the potential of IoT is greatly increased.
560. 2.10.1. Integration of IoT with Artificial Intelligence:
561. The IoT and AI integration improves data analytics capabilities. Huge amounts of data produced by IoT devices may be processed and analyzed by AI algorithms, yielding insightful data that can be used to plan and make decisions for smart cities (Alahi et al., 2023). The use of historical data for predictive analysis is made possible by AI, which helps to improve service delivery and resource utilization. In order to manage traffic, trash, and energy in smart cities, IoT sensors give real-time data that AI algorithms utilize to predict patterns (Soori et al., 2023).
562. 2.10.2. Integration of IoT with Blockchain:
563. Blockchain offers a decentralized, immutable ledger, improving the security and privacy of IoT data transfers. For applications like healthcare and citizen information, integrating IoT with blockchain ensures secure storage and distribution of sensitive data (Alam et al., 2023). Trust in transactions is established by the integration of blockchain and IoT. In areas like supply chain management and asset tracking in smart cities, it maintains the integrity and validity of IoT-generated data, which is crucial (Xia et al., 2023).
564. 2.10.3. Integration of IoT with Edge Computing:
565. Edge computing enables real-time data processing at the network edge, which completes IoT. For applications like autonomous vehicles and emergency response systems, IoT devices' ability to process data locally reduces latency and improves response times (Singh & Gill, 2023). Optimizing bandwidth use requires integrating edge computing and IoT. Before sending data to the cloud, edge devices filter and aggregate it. This reduces the quantity of data transferred, which is useful for IoT applications with limited bandwidth (Yousefpour et al., 2019).
566. The IoT and AI integration focuses on data analysis and optimization, taking advantage of AI's ability to obtain useful IoT data. IoT and blockchain integration, on the other hand, places a strong emphasis on data security and open transactions, ensuring the reliability of data in IoT applications. The efficiency and responsiveness of IoT applications are
567. 36
568. increased through edge computing integration, which prioritizes real-time data processing and bandwidth optimization.
569. The potential of IoT in smart city initiatives is increased by integrating it with cutting-edge technologies like edge computing, blockchain, and AI. These technologies work in harmony to improve data analytics, security, real-time processing, and resource utilization. Future studies and applications should keep looking for novel methods to harness the combined potential of these technologies to build safer, more secure, and smarter cities. IoT and new technologies like edge computing, blockchain, and artificial intelligence (AI) can be integrated to advance a variety of fields, particularly in the context of smart city efforts.
570. 2.10.4. Synergies and Benefits of Integrating IoT with Artificial Intelligence: Enhancing data analytics capabilities with AI and IoT integration. Large amounts of data from IoT devices may be processed effectively by AI algorithms, resulting in a more in-depth understanding of patterns and trends (Alahi et al., 2023). This improves decision-making across a range of smart city applications. Predictions aid in the efficient use of resources in industries like waste disposal, transportation, and energy. Cost reductions and increased efficiency are the benefits of this proactive approach (Bibri & Jagatheesaperumal, 2023).
571. 2.10.5. Synergies and Benefits of Integrating IoT with Blockchain:
572. Data created and transferred by IoT devices is more securely stored and transmitted thanks to the inclusion of blockchain technology. The decentralized and tamper-proof characteristics of blockchain technology play a crucial role in safeguarding the security and integrity of data. This is particularly significant in critical domains such as healthcare and financial operations (Adere, 2022). In IoT applications, blockchain enables trustworthy and transparent transactions. It creates a permanent record of every transaction, ensuring the reliability of the data and the confidence of all parties involved. This is especially useful in applications like provenance tracing and supply chain management (Xia et al., 2023).
573. 2.10.6. Synergies and Benefits of Integrating IoT with Edge Computing:
574. Edge computing and IoT integration enables real-time data processing at the network edge. Real-time applications, like autonomous vehicles and emergency response systems, are made possible by the reduction of latency (Hamdan et al., 2022). Data can be filtered
575. 37
576. and processed locally using edge computing before being sent to the cloud. By optimizing bandwidth use, this lowers the cost of data transmission and eases network congestion (Yu et al., 2018). It is very useful for IoT applications with constrained bandwidth.
577. Blockchain stresses security and open transactions, edge computing focuses on real-time data processing, and AI emphasizes data analysis and predictive skills. In spite of these variations, these technologies all have advantages such as better data analytics, better decision-making, and more effective resource usage, which boosts the overall effectiveness of IoT implementations.
578. IoT integration with cutting-edge technologies like edge computing, blockchain, and AI has a wide range of advantages. These integrations increase the possibilities of IoT in numerous fields by boosting data analytics, security, and enabling predictive analysis and real-time processing. Realizing the full potential of IoT-enabled smart cities and fostering innovation depend heavily on comprehending and utilizing these synergies. In order to promote sustainable urban development and enhance the quality of life for inhabitants, future research should continue to examine and optimize these linkages.
579. 2.11. Environmental and Social Impacts:
580. Smart cities have undergone significant transformation as a result of the IoT integration, which has the potential to improve sustainability and urban living. This transition could nevertheless have negative social and environmental effects.
581. 2.11.1. Environmental Impacts of Implementing IoT in Smart Cities:
582. The installation of IoT infrastructure and devices may result in higher energy usage. But the IoT can also improve energy use by enabling smart grids, intelligent building systems, and effective transportation, ultimately lowering overall energy consumption and having a smaller environmental impact (Al-Obaidi et al., 2022). IoT device proliferation can lead to e-waste, creating a serious environmental risk. To reduce the negative effects of incorrect IoT device disposal and recycling, effective e-waste management policies and laws are crucial (Farjana et al., 2023).
583. 2.11.2. Social Impacts of Implementing IoT in Smart Cities:
584. IoT technologies have the potential to either reduce or increase the digital divide. Although the IoT has the potential to improve inclusion by enabling accessible services, there is a chance that technological limitations or a lack of access to IoT-enabled services will exclude marginalized people (Nguyen, 2020). IoT device proliferation prompts
585. 38
586. worry about data security and personal privacy. Concerns regarding how IoT systems may collect and use citizens' personal data may exist. For the IoT to be trusted and socially accepted, these issues must be addressed and strong data protection measures must be put in place (Tawalbeh et al., 2020).
587. The potential environmental advantages of IoT in decreasing e-waste and improving energy use are generally acknowledged by authors. While some authors highlight the benefits of IoT for inclusivity, others raise concerns about the possibility of a worsening of the digital gap. Similar to this, some emphasize how increased data security has the potential to improve privacy while others stress the importance of proactive privacy protection.
588. Smart cities that include IoT face both social and environmental challenges. Maximizing the beneficial environmental and social effects of IoT depends on minimizing e-waste, boosting accessibility, and enhancing inclusivity. Building public trust and promoting the appropriate and sustainable deployment of IoT in smart cities require equal attention to privacy issues and data security. Future studies and policy activities should concentrate on addressing the issues head-on while maximizing the benefits of IoT for the environment and society as a whole.
589. The use of the IoT in urban settings has shown that technology has the potential to have a substantial impact on sustainability and raise living standards. IoT technologies provide game-changing solutions across a range of industries thanks to their capacity for real-time data collection, analysis, and action.
590. 2.11.3. IoT Technologies for Sustainable Urban Development:
591. Smart grid systems that improve energy distribution and consumption are made possible by IoT. Energy usage data is collected by smart meters and sensors, enabling accurate monitoring and effective resource management. This helps create a more sustainable energy infrastructure and reduce energy waste (Gubbi et al., 2013). Through real-time monitoring of bin fill levels, IoT-based trash management systems optimize waste collection schedules and routes. Furthermore, IoT-enabled environmental monitoring systems measure the quality of the air and water to help with pollution management and environmental sustainability (Lingaraju et al., 2023). Smarter transportation systems are made possible by IoT technology, which improve traffic flow and lessen congestion. Real-time traffic information gathered from sensors built into roads and cars allows for
592. 39
593. effective traffic management, which lowers fuel use and emissions (Oladimeji et al., 2023).
594. 2.11.4. IoT Technologies for Improving Quality of Life:
595. Wearable tech and remote monitoring systems are examples of IoT-enabled healthcare technologies that improve accessibility and delivery of care. Remote patient monitoring encourages prompt actions and enhances medical results, particularly for people with chronic diseases (Javaid et al., 2022). IoT gadgets in smart homes automate and improve a number of daily activities, such as lighting, security, and climate management. These innovations improve convenience, comfort, and energy efficiency, which ultimately improves inhabitants' quality of life (Kodali et al., 2016). IoT improves emergency response systems, and therefore enhances public safety. Authorities can respond to accidents more quickly and correctly thanks to connected devices and sensors, which enhances overall safety and security in urban environments (Damaeviius et al., 2023).
596. The authors all believe that IoT technologies have a favourable influence on urban sustainability and quality of life. Some place a focus on environmental monitoring and energy management, while others place a focus on healthcare and transportation. All authors emphasize the revolutionary potential of IoT in urban development despite these distinctions.
597. IoT technologies have become potent instruments that improve urban life quality and support sustainability. IoT is paving the way for a more sustainable and liveable urban future by enabling smarter energy use, effective waste management, intelligent mobility, better healthcare, and enhanced safety measures. Future studies and applications should keep looking for creative methods to harness the potential of IoT technology in order to promote sustainable urban growth and raise the standard of living for urban dwellers.
598. 2.12. Overview of Literature Review
599. The literature review looked at how the IoT is being incorporated into smart cities, with a particular emphasis on how these factors would affect sustainability, quality of life, governmental frameworks, and integration with new technology. IoT's role in enhancing urban sustainability is notable. Studies like those by Bibri (2020) have emphasized how IoT aids in efficient resource management, waste reduction, and energy conservation, contributing to more sustainable city living. The key findings from the studied literature
600. 40
601. are condensed in this overview, which also offers insights into the revolutionary potential of IoT in urban settings.
602. 2.12.1. IoT for Sustainability and Quality of Life:
603. The research indicates that the IoT possesses significant potential to enhance sustainability and quality of life in smart cities. IoT technologies facilitate sustainable urban development through efficient waste management, intelligent transportation systems, and effective energy management. By optimizing resource utilization, improving environmental monitoring, and streamlining waste collection processes, IoT contributes to a more sustainable urban ecosystem (Bibri, 2020; Zanella et al., 2014). Moreover, IoT-driven advancements in healthcare, smart housing, and public safety systems substantially elevate the quality of life for urban residents. Wearable technologies, remote health monitoring, smart housing solutions, and IoT-enabled safety features collectively create a safer, healthier, and more convenient urban living environment (Chourabi et al., 2012; Anthopoulos, 2017).
604. 2.12.2. Policy Frameworks and Regulations:
605. The literature underscores the critical importance of well-defined regulatory frameworks and laws in guiding the integration of the IoT within smart cities. National and international regulations are pivotal in addressing privacy concerns, ensuring data security, facilitating interoperability, and fostering inclusive adoption of IoT technologies. As highlighted by Weber (2010), robust regulations are necessary to protect personal information and ensure the ethical use of IoT technologies, addressing potential privacy and security challenges.
606. Moreover, these frameworks play a vital role in encouraging public-private collaborations and investments, which are fundamental for the sustainable development of IoT in smart cities. Townsend (2013) points out the necessity of legal frameworks that govern IoT deployments, including managing liabilities and compliance with standards, and facilitating partnerships between the public and private sectors.
607. Additionally, the establishment of interoperability standards, as discussed by Roman, Zhou, and Lopez (2013), is crucial for the seamless functioning of diverse IoT systems and technologies in a smart city environment.
608. 41
609. In conclusion, the literature stresses that a comprehensive and well-structured regulatory approach is essential for harnessing the full potential of IoT in smart cities, ensuring that these technological advancements are deployed responsibly and beneficially.
610. 2.12.3. Integration with Emerging Technologies:
611. The integration of cutting-edge technologies such as edge computing, blockchain, and AI significantly enhances the capabilities and possibilities of the IoT. AI augments data analytics, facilitating improved prediction and decision-making processes. Edge computing offers real-time data processing, optimizing bandwidth use and reducing latency, while blockchain ensures secure data transactions. The convergence of these diverse technologies not only enhances overall performance and data security but also optimizes resource utilization, further amplifying IoT's impact on sustainability and quality of life in urban environments.
612. The literature study underscores the transformational potential of IoT technologies within the context of smart cities. IoT's ability to revolutionize urban living is evident in its contribution to sustainability through optimal energy usage, effective waste management, and smarter mobility solutions. Furthermore, it significantly elevates the quality of life through advancements in healthcare, smart homes, and public safety systems. The deployment of IoT in a responsible and secure manner is facilitated by appropriate policy frameworks and laws. Additionally, the amalgamation of IoT with state-of-the-art technologies like edge computing, blockchain, and AI magnifies its impact, leading the way towards a more efficient, secure, and sustainable urban future.
613. The convergence of IoT and smart city initiatives marks an era of innovation and efficiency in urban development. This literature review explores the current state of research in IoT-based smart cities, offering insights into the evolving landscape and identifying potential areas for future study. To maximize the impact of IoT technologies on the future of cities, it is crucial to understand current research trends and identify gaps in the literature.
614. 2.12.4. Current State of Research on IoT-Based Smart Cities:
615. The breadth of research in IoT-based smart cities reflects the variety of applications and potential of this integration. Energy management, transportation, healthcare, environmental monitoring, and governance are important research areas. IoT has been studied as a potential tool for reducing greenhouse gas emissions, boosting healthcare
616. 42
617. delivery, monitoring environmental conditions, and facilitating effective public administration (Chataut et al., 2023).
618. In addition, the research landscape demonstrates a rising focus on security, data privacy, and policy frameworks in the context of IoT-based smart cities. Regulations that encourage responsible IoT implementation, protect data privacy, and address security concerns are receiving more attention from policymakers, researchers, and practitioners (Allioui and Mourdi, 2023).
619. 2.12.5. Challenges and Opportunities for Future Research:
620. The current research on IoT-based smart cities has made significant strides, yet there remain numerous challenges and opportunities for further exploration. To gain a comprehensive understanding of IoT in smart cities, research must foster interdisciplinary collaboration. Drawing on knowledge from various fields such as engineering, social sciences, urban planning, and public policy is crucial for devising holistic solutions that effectively address urban challenges (Zhao et al., 2021). The implementation of smart cities through IoT still confronts considerable scalability issues. Research should focus on scalable architectures and standardized frameworks to facilitate smooth integration of IoT technologies across different urban environments and ensure widespread adoption and sustainability (Gubbi et al., 2013).
621. Future research could enhance data analytics capabilities and predictive modeling using AI and machine learning within IoT frameworks. Advanced analytics can transform the large volumes of data generated by IoT devices into actionable insights, thereby improving resource allocation and decision-making (Mahdavinejad et al., 2018). It's also crucial for future studies to engage citizens and incorporate their perspectives in the design and implementation of IoT solutions. Understanding the needs, preferences, and concerns of citizens is imperative for the acceptance and success of IoT-based smart city initiatives (Syed et al., 2021). Moreover, the role of IoT in advancing sustainability and circular economy concepts warrants further investigation. Exploring how IoT technology can promote sustainability through resource efficiency, waste reduction, and circular supply chains is an emerging area of research (Rejeb et al., 2022).
622. The current research trajectory in IoT-based smart cities points towards more efficient, sustainable, and citizen-centric urban environments. Future research should emphasize interdisciplinary collaboration, scalability, data analytics, public participation, and
623. 43
624. sustainability to realize the full potential of IoT in shaping the future of cities. By addressing these research areas, we can envision an urban landscape that is more inclusive, environmentally conscious, and technologically advanced.
625. 2.13. Conclusion
626. In conclusion, this chapter serves as the foundational bedrock of our research. It offers an exhaustive review of the existing literature on IoT and Smart Cities, elucidating key concepts, trends, and identifying crucial gaps in current knowledge. This exploration into theoretical and conceptual frameworks lays the groundwork for understanding the intricacies of IoT-enabled Smart Cities. The chapter also discusses the significance of bibliometric analysis in grasping the research landscape, thereby setting the stage for the methodology adopted in this study.
627. Chapter three is pivotal in shaping the research direction of our study. It articulates the central research problem, drawing insights from the comprehensive literature review conducted in the previous chapter. This chapter frames the subsequent analytical methods and guides the focus of our inquiry, ensuring that the research remains aligned with the identified gaps and emerging trends in the field of IoT and Smart Cities.
628. 44
629. **Chapter Three: Research Problem**
630. The proposed bibliometric analysis aims to investigate the research issues related to the integration IoT technologies in the context of Smart Cities. The primary objective is to gain a comprehensive understanding of the advancements, trends, and areas of research that have not been well explored in the scientific discourse on this subject matter. This analysis aims to examine the following aspects such as trend Identification, by analyzing research topic patterns, the study will uncover evolving trends and priorities in the areas of smart cities and IoT. This may include shifting the focus of research from technical aspects to socio-economic impacts, policy considerations and sustainability issues (Paes et al., 2023). The survey identifies the most prolific authors and institutions contributing to the topic. This will shed light on the key players shaping the discourse and becoming thought leaders in the field of IoT integration in smart cities (Paes et al., 2023).
631. An analysis of patterns of co-authorship and collaboration between organizations will reveal the extent of networking and knowledge sharing within the research community (Bento & Takeda, 2013). The survey aims to identify areas where research is scarce or underrepresented. This will help identify gaps in knowledge that require further research and may provide valuable insights for future research (Paes et al., 2023). For IoT and multidisciplinary smart cities, the analysis will show how different disciplines contribute to the discussion and support interdisciplinary engagement (Rejeb et al., 2022). The study will analyze citation patterns to identify ground-breaking work, influential articles and the dissemination of ideas in the research landscape (Oermann et al., 2020).
632. Ultimately, the research question is to understand the trajectory of academic research regarding IoT and Smart Cities and to highlight key trends, influential authors and areas for future research. This analysis will provide valuable insights for researchers, policymakers and practitioners looking to accelerate the development and adoption of IoT technologies related to creating smarter and more sustainable urban environments.
633. Bibliometric analysis offers a systematic and thorough evaluation of the body of literature, highlighting important research issues, significant authors, well-liked publications, and developing trends. Without using bibliometrics, researchers could not have a complete grasp of the research landscape, thus missing significant works or failing to address key issues. By highlighting topics that have not received enough attention or
634. 45
635. need additional study, bibliometrics aids in detecting gaps in existing research. By not utilizing bibliometric analysis, researchers could find it difficult to precisely identify these gaps, which could result in redundant or ineffective studies.
636. By categorizing a large body of literature into digestible categories and subcategories, bibliometric analysis facilitates the execution of an effective literature review. Without it, researchers might have to put in more time and effort sorting through a lot of papers, which would make the literature review less effective. An organized selection of sources can be made using bibliometrics based on several factors like the number of citations, impact factor, and author reputation. Without this examination, researchers might choose sources less carefully and might end up using ones that are not reliable or relevant. The most influential studies and trends are shown by bibliometric analysis, which offers evidence-based insights. Decisions on the scope of future research, the distribution of financing, or the formulation of recommended policies may be made without this evidence in a less informed or even less desirable manner.
637. Through citation analysis and other measures, bibliometrics aids in evaluating the impact of research. Without bibliometrics, researchers could lack a consistent method to assess the impact and reach of their work, either under or overestimating it. The research community's collaboration patterns and networks are frequently exposed by bibliometric analysis. Without this knowledge, researchers risk missing out on prospective collaboration possibilities or failing to interact with the right field stakeholders.
638. In conclusion, even though bibliometric analysis has its own set of limitations, failing to use it in studies of IoT-based smart cities may lead to a lack of a thorough understanding of the body of literature, ineffective processes for reviewing it, and a potential blind spot regarding important research gaps and collaboration opportunities.
639. 3.1. Conclusion
640. In conclusion this chapter has been instrumental in defining the core inquiry of our study. It successfully established the central research problem by integrating insights from the extensive literature review conducted in Chapter Two. This chapter played a crucial role in pinpointing specific areas of interest and potential research gaps within the IoT and Smart Cities domain, thereby laying a clear path for the investigative journey ahead. The articulation of the research problem has set a firm foundation for the methodological approach that will drive the subsequent phases of our study.
641. 46
642. Moving forward, Chapter Four will delve into the detailed research design and the methodological approach of our study, particularly focusing on bibliometric analysis. This chapter is designed to describe the methods of data collection, including the selection of databases, keywords, and search criteria. It will also explore the processes of data mining, cleansing, and the rationale behind choosing specific publications. By providing clarity on the research process, this chapter aims to ensure the rigor and reliability of our analytical methods and findings, setting the stage for the data analysis and presentation that will follow in Chapter Five.
643. 47
644. **Chapter Four: Research Methodology**
645. 4.1. Research Design:
646. Bibliometric analysis is a methodological approach that straddles the line between quantitative and qualitative research, depending on its application. At its core, bibliometric analysis is fundamentally quantitative, as it involves the statistical analysis of books, articles, and other scholarly publications. The primary objective of bibliometric analysis is to quantitatively evaluate aspects such as the impact of a research field, the evolution of a discipline, or the contributions of individual researchers.
647. In terms of quantitative aspects, bibliometric analysis focuses on measuring various elements of scholarly literature. This includes publication counts, citation analysis, authorship patterns, and co-citation analysis (Ellegaard & Wallin, 2015). It typically requires the use of comprehensive databases and software tools to gather and analyze large sets of bibliographic data. Through these analyses, bibliometric methods can uncover trends, patterns, and networks within scientific research, and are frequently employed to map the research landscape of a specific field (Zupic & Čater, 2015).
648. While predominantly quantitative, bibliometric analysis can also offer qualitative insights, particularly when integrated with content analysis. This approach can help identify key themes, major contributors, and seminal works within a research area, providing a richer understanding of the field’s developmental trajectory and intellectual structure (Cobo et al., 2011).
649. Bibliometric analysis has become an invaluable tool in fields such as library and information science, but its utility extends across various disciplines. It is widely used for analyzing research trends, assessing the impact of research, and guiding future research directions. The methodology offers a comprehensive view of the academic landscape, helping to pinpoint influential studies and emerging topics of interest (Aria & Cuccurullo, 2017).
650. The examination of the connections between the various study components, the bibliometric approach analyzes bibliometric data using quantitative methodologies and describes the subject's bibliometric and intellectual structure (Donthu et al., 2021). According to Block and Fisch (2020), this data can be utilized to highlight the contributions of many disciplines, spot trends and open gaps. In order to ascertain the
651. 48
652. conceptual evolution of the research topic, it thus offers both a scientific mapping and an analysis of the performance of IoT and Smart Cities (Donthu et al., 2021).
653. Bibliometric analysis is a great option for this study since it can quantitatively evaluate the dynamics and influence of the research environment. Bibliometrics can provide important insights into the emergence of research trends (Donthu et al., 2021). The influence of significant individuals, and the interconnection of scholars and institutions by examining citation patterns, publication trends, and collaboration networks. This method will support resource allocation and strategic decision-making by assisting in the identification of significant works and collaborations, as well as in understanding the historical development of the subject. The data-driven nature of bibliometric analysis makes it a crucial tool for fulfilling the study's goals because it will give an impartial basis for judging the importance of research contributions.
654. In this study, a procedure was designed to choose the search terms, pick the right database, set the search criteria, pick the analysis program, and evaluate the results. The steps are shown in Figure 4.1. below, and they are further explained in the paragraphs that follow.
655. *Figure 4.2: Breakdown of steps for bibliometric analysis.*
656. 49
657. 4.2. Data Collection:
658. The Scopus database will be used to gain the selected data set. Scopus is a comprehensive, highly maintained abstract and citation database, enriched data, and connected scholarly literature from a wide range of fields are all combined in a singular way by Scopus (Elsevier, 2023a). Scopus locates credible research fast, recognizes experts, and gives users access to trustworthy data, analytics, and analytical tools. The selected data extracted from the Scopus database will be searched by the term, “internet of things” OR IoT OR IOT AND “smart cit\*”. This string search was used to include all abbreviations of Internet of Things and uses a wildcard (\*) to identify “smart city” or “smart cities” in the search. This is done to ensure that all relevant articles will be searched for. The search data will be filtered to limit the year range between 2013 and 2023. The document type will be limited to articles only, to ensure that verified content is used. The source type will be journals that are published by the Institute of Electrical and Electronics Engineers (IEEE). The language will also be limited to articles published in the English language.
659. The reason for choosing the period from 20th August 2023 to 10th September 2023 is the need to effectively capture the changing research landscape while maintaining a balance between historical depth and current relevance: The chosen period of ten years makes it possible to understand the historical development of the topic. This period is broad enough to capture the significant changes, pioneering work, and fundamental contributions that have shaped the development of the field over time (Dwivedi et al., 2023). The longer ten-year time frame allows us to identify ongoing trends and patterns that may not be apparent on shorter time scales. By observing the changes over many years, we can better understand the cyclicality of research topics, methodological changes and the emergence of new sub-areas (Huyler & McGill, 2019).
660. Longer periods allow for a more accurate assessment of the impact of scientific articles. Citation metrics, which are often used to measure impact, take time to accumulate, and longer periods allow for a full appreciation of the work's importance to the scientific community (Reed et al., 2021). The period chosen covers both recent and historically influential work, avoiding the tendency to emphasize only recent publications. This balance provides a holistic account of the intellectual contributions of the field over time (Dwivedi et al., 2023).
661. 50
662. The period corresponds to the availability and completeness of the data on publications and citations. Providing accurate and complete data is critical to generating reliable information (Loshin, 2011). The ten-year period strikes a balance between depth and manageability. It provides enough historical context without overloading your analysis with too much data (Dwivedi et al., 2021).
663. Finally, the period from 20th August 2023 to 10th September 2023, was chosen to enable a well-founded analysis of the research landscape within the parameters of historical relevance, current relevance and practical feasibility (Dwivedi et al., 2023). This careful selection will enable the researcher to generate meaningful insights, identify trends and contribute to a comprehensive understanding of the development of the IoT and Smart cities.
664. 4.3. Data Extraction:
665. All steps below were derived from (Elsevier, 2023b):
666. Step 1: Access Scopus Database. Log in to your Scopus account or access Scopus through your institution's library portal.
667. Step 2: Define Search Query. In the Scopus search bar, enter keywords related to the Internet of Things and smart cities.
668. Step 3: Apply Filters. Apply filters to narrow down the search results.
669. Step 4: View Search Results. Browse through the search results to ensure they align with your research focus on IoT and smart cities.
670. Step 5: Export Search Results. Scopus usually provides export options in various formats, such as Comma Separated Value (CSV) or Excel.
671. Step 6: Choose Export Format. Select the desired export format.
672. Step 7: Download the Exported File. Download the exported file containing the metadata for the selected publications.
673. Data Cleaning and Pre-processing:
674. Step 8: Data Cleaning and Preparation. Open the exported file in a software such as Microsoft Excel. Clean the data by checking for missing or incorrect entries, and remove duplicates if necessary. Ensure consistent formatting.
675. 51
676. Step 9: Data Extraction. Create separate columns for each data field you are interested in: Publication title, author names, keywords, abstracts, and citation information. Copy and paste the relevant data from the exported file into these columns.
677. Step 10: Save Cleaned Data. Save the cleaned and extracted data as a new file, preferably in a spreadsheet format such as Excel or CSV.
678. Step 11: Explain how missing data will be handled and address any potential biases.
679. 4.4. Data Analysis:
680. Descriptive Statistics: Descriptive statistics provide an overview of the basic characteristics of the collected data (Rejeb et al., 2022). Measures include:
681. Total number of publications related to IoT and smart cities.
682. Distribution of publications by publication year to identify trends.
683. Average number of authors per publication.
684. Most prolific authors and their publication count.
685. Keyword Frequency Analysis: Keyword frequency analysis helps you identify the most commonly occurring keywords in the dataset (Rejeb et al., 2022). This can provide insights into the prevailing research themes and topics within the IoT and smart cities domain. Steps include:
686. Identifying keywords from the dataset.
687. Creating a frequency distribution of keywords.
688. Visualizing keyword trends over time using graphs or word clouds.
689. Exploring co-occurring keywords to understand thematic clusters.
690. Co-Authorship Network Analysis: Co-authorship network analysis helps uncover collaborative relationships among researchers (Rejeb et al., 2022). This technique is particularly useful for understanding the social structure of research networks in the IoT and smart cities field:
691. Constructing a co-authorship network graph.
692. Identifying central researchers (nodes with high degrees).
693. Analyzing network density and connectivity.
694. Exploring the collaboration patterns and clusters within the network.
695. Citation Analysis**:** Citation analysis provides insights into the influence and impact of publications within the field (Rejeb et al., 2022). You can perform the following steps:
696. 52
697. Calculate the total number of citations received by each publication.
698. Identifying highly cited papers and their authors.
699. Evaluating the average number of citations per publication.
700. Analyzing the distribution of citations over time to identify seminal works.
701. Mapping citation relationships to understand the flow of influence. Collaboration Patterns: Quantitatively analyze collaboration patterns to understand how researchers, institutions, and countries collaborate within the IoT and smart cities field (Rejeb et al., 2022):
702. Counting the number of multi-authored papers to measure collaboration.
703. Identifying institutions and countries with the most collaborative publications.
704. Analyzing international collaboration patterns.
705. Visualizing collaboration networks to show key nodes and clusters.
706. Publication Trend Analysis: Quantify publication trends to identify the growth and development of research related to IoT and smart cities (Rejeb et al., 2022):
707. Plotting the number of publications per year to identify publication trends.
708. Using regression analysis to model and predict future publication trends.
709. Comparing publication trends with significant events or technological
710. advancements.
711. There are various software and tools available for performing data analysis in bibliometric studies related to the "Internet of Things (IoT) and Smart Cities" topic such as:
712. VOSviewer: VOSviewer is a versatile software tool used for constructing and visualizing bibliometric networks, such as co-authorship networks and keyword networks (VOSviewer, 2023). It allows one to create maps that highlight relationships between authors, keywords, and publications.
713. CiteSpace: CiteSpace is a specialized tool designed for analyzing and visualizing citation patterns and trends. It can help one identify clusters of related publications and analyze burst keywords associated with emerging trends (Chen, 2006).
714. Excel: Microsoft Excel can still be used for basic data cleaning, manipulation, and visualization tasks.
715. 53
716. 4.5. Temporal Evolution Analysis:
717. Analysing the temporal growth of research output over different time periods involves examining how the volume of publications in a specific research field, such as "Internet of Things (IoT) and smart cities," changes over time. This analysis can provide insights into the development, trends, and dynamics of the field's research activity (García-Valls et al.,2018). The analysis can be done as follows:
718. Step 1: Data Collection and Preparation. Gather a dataset containing publication records from your chosen bibliographic database.
719. Step 2: Define Time Periods
720. Step 3: Calculate Research Output. Calculate the number of publications within each time period. This involves counting the publications that fall within the defined years.
721. Step 4: Visualize the Temporal Growth. Create a line chart or bar graph to visualize the temporal growth of research output over different time periods.
722. Step 5: Interpret the Results.
723. Step 6: Quantitative Analysis
724. Step 7: Interpretation and Conclusion
725. This analysis provides valuable insights into the historical evolution of research activity within the chosen research area. It helps researchers and stakeholders understand how the field has developed, identify key milestones, and anticipate potential future trends (Mengist et al., 2020).
726. 4.6. Citation Analysis:
727. This study adopts the strategy of Citation Analysis and Impact Assessment, so researchers can get important insights on the significance of certain articles and their contributions to the growth of the IoT and smart city research fields. Researchers and decision-makers can detect trends, important writers, and important works that have greatly influenced the domain with the use of this approach (Rejeb et al., 2022). Compile a thorough dataset of publication records for the study topic of interest, including citation information. Bibliographical databases like Scopus, Web of Science, or Google Scholar are good sources for this dataset. To assess the impact of articles, select important citation metrics.
728. 54
729. Total citations received, h-index, g-index, i-index, and average citations per manuscript are typical measures.
730. Define the precise parameters of the research area relating to "Internet of Things (IoT) and Smart Cities." This guarantees that the analysis is limited to pertinent articles. Recognize highly cited works using the total number of citations obtained, and order the publications in your dataset from most to least cited. Construct visuals that illustrate citation patterns. Relationships between highly cited publications and other papers in the area can be seen visually using network graphs, citation maps, or co-citation matrices. For the purpose of identifying research themes and significant research clusters, examine groups of highly cited publications and the relationships between them.
731. Calculate and analyze various impact indicators for works that have received many citations. One indicator of production and influence is the h-index, which counts the number of papers with at least h citations. Analyze the g-index, which gives extra weight to highly cited works by taking the distribution of citations across papers into account. Examine the keywords and subjects that are frequently mentioned in these publications to find recurrent themes. Longevity and consistency assess highly referenced work that has been quoted over the period. A publication's lasting impact can be determined by the number of times that it has been cited. Analyze the consistency of the citations in various books. An article is considered extremely significant if it has a lasting impact on a variety of research fields. Comparative Analysis to determine the relative influence of highly cited works and other publications on the subject and compare them. Examine their impact on the growth of the research field in comparison to less-cited papers. Relate the results to the IoT and smart city industries. Describe how highly cited works affect research agendas, scholars' perspectives, and the body of knowledge within the area of research.
732. 4.7. Impact Assessment:
733. To assess the influence and impact of research papers, bibliometric analysis usually uses a variety of citation measures. For a study on "Internet of Things (IoT) and smart cities," the following citation metrics will be used, along with an explanation of their significance. Total citations count the number of times a publication has been referenced in other works to determine the overall influence of that publication. An article with a higher total citation count has likely attracted more interest and influence in the subject
734. 55
735. (Yildiz, 2021). Citations per year show the influence and relevance of a publication. A publication with a high annual citation rate suggests that it will remain influential over time, whereas a diminishing trend can suggest that it is becoming less relevant (Yildiz, 2021).
736. The h-index is a productivity and impact indicator. The maximum number of h for which an author has h publications, each with at least h citations, is the author's h-index. It aids in evaluating the overall impact of a writer's body of work (Shah & Jawaid, 2023). The g-index lends more weight to highly cited papers than the h-index does, although it is similar to it. It takes into account the distribution of citations across works, and it can be especially helpful for determining the most important works of a certain author or body of work (Schreiber, 2010). The i-index tracks the number of works with at least ten citations. It displays how influential a writer or researcher has been in creating work that has had an impact on the industry (Sangeeta, 2018).
737. The average number of citations per manuscript serves as a benchmark for the productivity and impact of a researcher or an institution. It makes it easier to determine the impact of their articles on the industry (Agarwal et al.,2016). Relative Citation Ratio (RCR) is a field-normalized statistic that is used to evaluate the influence of citations on specific publications. It is helpful for analyzing the influence of works across various sectors as it takes into account variances in citation habits among study fields (Hutchins et al., 2016). Field-Weighted Citation Impact (FWCI) is a different field-normalized statistic that contrasts the average citation impact in a given research field with the citation effect of individual publications (Purkayastha et al., 2019).
738. 4.8. Network Analysis:
739. Analyzing co-authorship networks and institutional collaborations using VOSviewer, CiteSpace, and Excel involves a combination of visualization and quantitative analysis. A network analysis can be done with each of these tools:
740. Analyzing Co-Authorship Networks and Institutional Collaborations with VOSviewer:
741. Data Preparation: Start by preparing your dataset in a format compatible with VOSviewer. Common formats include CSV or tab-delimited text files. Ensure that your dataset includes information on authors, their affiliations, publication titles, and publication years.
742. 56
743. Co-Authorship Network Analysis: Open VOSviewer and import your dataset. Create a co-authorship network by specifying authors as the main entities and defining co-authorship relationships based on shared publications. Customize the network visualization by adjusting settings such as “node size”, “color”, or “clustering parameters”. Visualize the network to identify central authors and collaborative clusters.
744. Institutional Collaboration Analysis: To analyze institutional collaborations, extend the dataset to include institution information associated with authors. Create an institutional collaboration network by specifying institutions as entities and defining collaboration relationships based on shared author affiliations. Visualize the institutional collaboration network using VOSviewer's network visualization features.
745. Quantitative Analysis: VOSviewer provides quantitative information about network properties, including centrality measures (e.g., degree centrality), cluster analysis, and density. Export relevant data and statistics to Excel for further quantitative analysis.
746. Analyzing Co-Authorship Networks and Institutional Collaborations with CiteSpace:
747. Data Preparation: Prepare your dataset, as mentioned earlier, ensuring it includes author and institution information, publication titles, and publication years.
748. Co-Authorship Network and Institutional Collaboration Analysis: Open CiteSpace and import your dataset. Use CiteSpace's built-in functions to create co-authorship and institutional collaboration networks. Customize visualization settings, such as “node” “size”, “color”, and “layout”, to enhance network visualization.
749. Quantitative Analysis: CiteSpace offers various analytical features, including burst detection, co-citation analysis, and time zone analysis. Use these features to identify influential authors, institutions, and research clusters.
750. Export relevant data and visualizations for further analysis in Excel. Additional Quantitative Analysis in Excel:
751. Data Export: Export relevant data from VOSviewer and CiteSpace to Excel for more in-depth quantitative analysis.
752. 57
753. Statistical Analysis: In Excel, perform statistical analyses on the exported data to calculate centrality measures (e.g., degree centrality, betweenness centrality), cluster statistics, and trends over time.
754. Create tables, charts, and graphs to visualize and interpret the quantitative findings. Integration of Insights. Combine the insights gained from VOSviewer, CiteSpace, and Excel analyses to develop a comprehensive understanding of co-authorship networks, institutional collaborations, and their impact within the IoT and smart cities research field. By integrating these tools and conducting both qualitative and quantitative analyses. It will allow one to effectively explore co-authorship networks and institutional collaborations, identify influential authors and trends, and gain insights into the research landscape related to IoT and smart cities.
755. 4.9. Visualizing and interpreting collaboration patterns
756. Visualizing and interpreting collaboration patterns among authors and institutions using VOSviewer and CiteSpace involves creating informative, visual representations and deriving meaningful insights from them:
757. VOSviewer:
758. Collaboration Patterns Among Authors: In VOSviewer, start by loading your co-authorship network dataset. Create a co-authorship network where authors are represented as nodes and collaboration relationships as edges. Customize “node size”, “colour”, and “labels” to highlight influential authors and clusters. Use VOSviewer's clustering algorithm to identify groups of closely collaborating authors. Adjust the network layout to optimize visualization and reveal collaboration patterns.
759. Interpretation: Analyze the resulting co-authorship network visualization to
760. identify: Highly connected authors with numerous collaborations. Clusters or groups of authors who frequently collaborate on specific research topics or themes. Explore the relationships between authors in terms of co-authored publications to understand their collaborative roles and contributions within the IoT and smart cities research domain.
761. Collaboration Patterns Among Institutions: Extend the analysis to institutional collaborations by adding institution data to your dataset. Create an institutional collaboration network where institutions are represented as “nodes” and
762. 58
763. collaboration relationships as “edges”. Customize node attributes (“size”, “colour”, “labels”) to visualize key institutions and clusters.
764. Interpretation: Interpret the institutional collaboration network visualization to identify prominent institutions with extensive collaboration networks. Collaborative clusters of institutions that may focus on specific research areas or projects. Institutions that act as bridge nodes connecting different clusters or regions in the network. Assess the geographical distribution and international collaboration patterns among institutions to understand the global context of
765. research collaboration.
766. CiteSpace:
767. Collaboration Patterns Among Authors: In CiteSpace, import your dataset and create co-authorship networks. Utilize CiteSpace's visualization features, such as time zone maps and density visualization, to identify collaboration patterns among authors. Analyze burst detection results to identify authors with sudden increases in collaboration activity.
768. Interpretation: Interpret the co-authorship network visualizations generated by CiteSpace to discover influential authors and their collaboration clusters. Explore temporal trends in collaboration, including the emergence of new collaborative groups. Identify authors with "burst" periods of collaboration, which may indicate shifts in research focus or increased collaborative activity.
769. Collaboration Patterns Among Institutions: Extend your analysis to institutional collaborations in CiteSpace by using the same dataset with institution information. Visualize institutional collaboration networks and apply CiteSpace's analytical tools for identifying key institutions.
770. Interpretation: Interpret the institutional collaboration network visualizations to identify highly collaborative institutions and their roles within the network. Analyze temporal patterns in institutional collaboration, including the formation of research consortia or partnerships. Examine the impact of institutions with notable burst periods in collaboration.
771. 4.10. Ethical Considerations:
772. In the study on "Internet of Things (IoT) based Smart Cities," the researcher is acutely aware of the ethical considerations related to data usage, copyright, and
773. 59
774. acknowledgements of authors and their work. Ethical conduct is fundamental to the integrity of the research.
775. The study will ensure that that the legal right to access and use the data for analysis, especially when dealing with proprietary databases or sensitive datasets. Respecting the privacy and confidentiality of individuals mentioned in the dataset is a priority. The study will avoid sharing or disclosing personally identifiable information and adhere to relevant data protection regulations (POPI Act, 2023). One must understand the importance of adhering to copyright laws and licensing agreements when using data from publications. Most publications are protected by copyright, and this study will ensure that its use complies with fair use or licensing terms. Properly attributing specific publications to their respective authors and sources will be a central practice throughout my research (gcfglobal, 2023).
776. Acknowledgement of authors and their works is a fundamental principle. The study is committed to providing accurate and complete acknowledgement when referencing or citing sources in my analyses and publications. The study will rigorously follow citation guidelines and styles (Harvard) to ensure acknowledgement in all aspects of the research. To maintain ethical standards, the study will avoid selective or biased citation practices that may misrepresent authors' contributions or manipulate the perceived impact of specific works. The citation practices will prioritize relevance and contribution to the research, ensuring that citations accurately reflect the significance of the works cited. This study will seek ethical review and approval from an institutional review board or ethics committee as required by the institution or local regulations.
777. By adhering to these ethical considerations, this study aims to conduct research on IoT and smart cities with the highest level of integrity, ensuring that the study respects the rights and contributions of authors and institutions while contributing to the scholarly understanding of this critical field.
778. 4.11. Validity and Reliability:
779. Ensuring the validity and reliability of findings in a bibliometric analysis using the Scopus database and only IEEE-published articles between 2013 and 2023 in the English language is crucial for producing credible research.
780. Careful selection of the Scopus database and IEEE-published articles provides a reputable and relevant data source (Baas et al., 2020). This study will confirm that the articles meet
781. 60
782. the specified publication date range (2013-2023) and language (English) criteria. The study will meticulously extract data from the selected articles, including publication titles, author names, affiliations, keywords, citations, and publication dates. This step will involve rigorous data cleaning and formatting to eliminate duplicates and errors.
783. To enhance data reliability, the researcher will cross-check and verify data entries by comparing information from Scopus with the IEEE Xplore database, where applicable. This process will help identify and rectify discrepancies or errors in the data. The researcher will maintain consistency in data pre-processing procedures, adhering to standardized practices to ensure data integrity.
784. The researcher will thoroughly document my research methodology, detailing data collection, pre-processing, and analysis steps. Transparent documentation enables the research process to be replicated, enhancing the validity of the findings. Employing robust and well-established bibliometric analysis techniques specific to Scopus and IEEE articles, such as citation analysis, co-authorship network analysis, and keyword analysis, will enhance the reliability of the findings. These techniques are widely accepted and validated in the literature. To enhance validity, the researcher will consider triangulating findings by using multiple data sources within the Scopus database and analysis methods. This approach helps corroborate results and provides a more comprehensive view of the research landscape.
785. Seeking peer review and feedback from experts in the field will be an integral part of the research process. Expert input will help identify potential biases, errors, or methodological shortcomings, thereby improving the overall quality of the study. The researcher will clearly distinguish between findings derived from Scopus data and those specifically based on IEEE articles. The researcher will discuss the limitations associated with focusing solely on IEEE articles and their implications for the reliability of conclusions.
786. By systematically following these steps and ensuring transparency and rigour throughout the research process, the researcher will strive to produce valid and reliable findings in the bibliometric analysis of IEEE-published articles related to IoT-based smart cities using the Scopus database.
787. 61
788. 4.11.1 Guidelines for publishing an IEEE article
789. This is required to ensure the validity and reliability of information and research findings. Furthermore, it ensures that accurate and timely information is acquired, as well as performing tests or analyses under the correct and mandated frameworks. The guidelines listed below as quoted by an article published under the IEEE (2023) are required in order to publish an article :
790. *“Author lists should be carefully considered before submission. For more information on what constitutes an author, please click here. (Changes to author list post acceptance are not allowed.)”*
791. *“The article should be thoroughly reviewed for proper grammar before being submitted. Articles with poor grammar will be immediately rejected.”*
792. *“Manuscript keywords (minimum of 3 and maximum of 10). Please carefully select the keywords as this is how we select a relevant Associate Editor to manage the peer review of your article.”*
793. *“The article must be original writing that enhances the existing body of knowledge in the given subject area. Original review articles and surveys are acceptable, even if new data/concepts are not presented.”*
794. *“Results reported must not have been submitted or published elsewhere (although expanded versions of conference publications are eligible for submission).”*
795. *“Experiments, statistics, and other analyses must be performed to a high technical standard and described in sufficient detail.”*
796. *“Article submissions that plagiarize another author’s work will be rejected from IEEE Access, and cases will be reported to the IEEE Intellectual Property Rights (IPR) department.”*
797. 4.12 Limitations:
798. It is essential to acknowledge the potential limitations of the research methodology for bibliometric analysis, which involves using the Scopus database, filtering for IEEE articles published between 2013 and 2023 in English, and utilizing VOSviewer, Excel, and CiteSpace.
799. The Scopus database, while comprehensive, may not encompass all relevant publications within the IoT and smart cities domain. Some valuable research might be published in non-Scopus-indexed journals or conference proceedings. Limiting the analysis to IEEE
800. 62
801. articles may exclude relevant research from other reputable sources and could introduce a bias toward IEEE-focused research. Restricting the analysis of IEEE articles might introduce a publication bias, as IEEE publications may favour certain types of research or methodologies. This bias could affect the generalizability of findings.
802. Focusing exclusively on articles in the English language may introduce a language bias, potentially excluding valuable contributions in other languages. This bias could impact the comprehensiveness of the analysis. The analysis covers a specific time frame from 2013 to 2023 and focuses on IEEE articles. The findings may not reflect developments and contributions before 2013 or after 2023, or those from non-IEEE sources. Findings may be more applicable to research within the scope of IEEE interests, which might differ from broader perspectives on IoT and smart cities. While Scopus is a reputable database, it may have its own limitations, such as incomplete coverage of certain publication types or variations in data quality across disciplines and journals.
803. The use of VOSviewer, Excel, and CiteSpace offers valuable analytical capabilities but may not capture all aspects of bibliometric analysis. The limitations of these tools, such as default settings or assumptions in algorithms, should be considered. Bibliometric analysis relies on citation data, which can have inherent limitations, including self-citations and variations in citation practices across fields. Interpreting collaboration patterns solely based on co-authorship and citations may not capture the full scope of research collaborations and impact.
804. The analysis should adhere to ethical guidelines for data usage, copyright compliance, and proper attribution, however, potential ethical issues may still arise in practice. External factors, such as changes in research trends, economic conditions, or global events, can influence research output and impact, which may not be fully accounted for in the analysis.
805. Despite these potential limitations, the chosen methodology provides a structured approach to understanding the trends, collaborations, and impact of IEEE articles within the specified parameters. Researchers should interpret the findings while keeping these limitations in mind and consider supplementary approaches to capture a more comprehensive view of the IoT and smart cities’ research landscape.
806. 63
807. 4.13. Conclusion
808. This chapter has been pivotal in establishing the framework for our research. It detailed the research design and methodological approach, with a particular emphasis on bibliometric analysis. This chapter meticulously outlined the methods of data collection, including the selection of databases, keywords, and search criteria. It also addressed the processes of data mining, cleansing, and the rationale behind choosing specific publications. By providing a comprehensive description of the research process, Chapter Four has laid a solid foundation for the rigorous analysis of data, ensuring that the subsequent findings are both reliable and insightful.
809. Chapter Five is where the core analytical work of our study comes to fruition. This chapter will present the quantitative techniques employed in data mining and analyze trends over time. We will explore various research themes, emerging topics, and conduct a detailed keyword analysis. This chapter is designed to not only present data and findings but also to interpret them in the context of our research objectives. It will emphasize interdisciplinary insights and the broader implications of our study, thereby contributing to the understanding of IoT and Smart Cities within the academic and practical realms.
810. 64
811. **Chapter Five: Data Analysis and Presentation**
812. As we stand on the brink of urban transformation, the concept of 'Smart Cities' has risen to prominence, propelled by the integration of the Internet of Things (IoT) technologies (Hollands 2008). This fusion is reshaping urban living, promising enhanced sustainability, efficiency, and a new calibre of urban experience. This chapter conducts a bibliometric analysis to dissect the extensive scholarly engagement with IoT-based smart citie. The aim is to reveal the research dynamics, collaboration networks, and thematic evolutions within this field (Batty et al. 2012).
813. Bibliometric analysis offers a quantitative tool to navigate the vast seas of academic literature, allowing for the investigation of publication patterns, trend developments, and the impact of research within the domain of IoT and smart cities (Ellegaard and Wallin 2015). By charting the intellectual landscape, this analysis brings to light the key contributors, influential institutions, and the geographic epicenters of innovation, as well as the foundational theories and the cutting-edge topics that are driving the field's progression (Trabucchi and Buganza 2019; Caragliu, Del Bo, and Nijkamp 2011).
814. Employing meticulous data collection and sophisticated analysis techniques, this chapter aims to offer a panoramic view of the current state of research by distilling the complex data into actionable insights and discernible patterns (Aria and Cuccurullo 2017). The resultant narrative provides a valuable resource for academics, policymakers, and industry professionals who are steering the course of urban development augmented by IoT innovations (Albino, Berardi, and Dangelico 2015).
815. In recognition of the collective intellectual endeavor and the collaborative nature that underpins this domain, our bibliometric exploration stands as a homage to the ongoing scholarly discourse that is shaping the future of smart urban environments through IoT (Kitchin 2014; Leydesdorff and Milojević 2015). It is an exploration of the past, an analysis of the present, and a forward-looking perspective on the smart cities of tomorrow (Bibri and Krogstie 2017).
816. 5.1. Performance Analysis Techniques in IoT-based Smart Cities
817. In the intricate web of a smart city's ecosystem, performance analysis stands as a critical undertaking to ensure the seamless integration and functionality of IoT technologies. This scrutiny is vital in translating theoretical models into effective, real-world applications
818. 65
819. that can withstand the dynamism of urban environments (Zanella et al., 2014). By employing a diverse array of performance analysis techniques, ranging from data-driven analytics to simulation-based modelling, urban technologists can dissect complex systems, evaluate the efficacy of smart solutions, and predict future performance under varying conditions (Batty et al., 2012). Such methodologies not only enable the optimization of resources but also foster adaptive and resilient infrastructures capable of evolving with the city's changing needs (Bibri and Krogstie, 2017). In this vein, the forthcoming sections will explore the multifaceted approaches to performance analysis, each providing unique insights into the operational prowess of smart city initiatives and the tangible benefits they yield for urban dwellers (Caragliu, Del Bo, and Nijkamp, 2011).

|  |  |
| --- | --- |
| 1. 5.1.1. Bibliometric Overview of IoT-based Smart City Research (2013-2023) Main Information | 1. Results |
| 1. Timespan | 1. 2013-2023 |
| 1. Total Number of Countries | 1. 112 |
| 1. Total Number of Institutions | 1. 6914 |
| 1. Total Number of Sources | 1. 24 |
| 1. Total Number of References | 1. 0 |
| 1. Total Number of Languages | 1. 1 |
| 1. --English (# of docs) | 1. 8054 |
| 1. Total Number of Documents | 1. 8054 |
| 1. --Article | 1. 8054 |
| 1. Average Documents per Author | 1. 1.74 |
| 1. Average Documents per Institution | 1. 5.45 |
| 1. Average Documents per Source | 1. 332.17 |
| 1. Average Documents per Year | 1. 724.73 |
| 1. Total Number of Authors | 1. 21375 |
| 1. Total Number of Authors Keywords | 1. 18081 |
| 1. Total Number of Authors Keywords Plus | 1. 28448 |
| 1. Total Single-Authored Documents | 1. 134 |
| 1. Total Multi-Authored Documents | 1. 7838 |
| 1. Average Collaboration Index | 1. 4.65 |
| 1. Max H-Index | 1. 39 |
| 1. Total Number of Citations | 1. 274512 |
| 1. Average Citations per Author | 1. 12.84 |
| 1. Average Citations per Institution | 1. 39.7 |
| 1. Average Citations per Document | 1. 34.43 |
| 1. Average Citations per Source | 1. 11438.0 |

1. **2024** 2
2. **INTRODUCTION**
3. Today, information technology (IT) serves as the backbone of most organisations (Dibbern, et al., 2004; Bourgeois, 2014). IT refers to the hardware and software used in facilitating the collection, storage and dissemination of data, information and knowledge (CSIT, 1995; Bourgeois, 2014). Almost every organization is dependent on IT in order to achieve their business objectives (Dibbern *et al.*, 2004). This is because IT serves as an enabler of corporate strategies and a catalyst of change to the business models of various organisations (Applegate, Austin & Soule, 2009; Kumar, 2016). Different IT solutions have been developed, and they are evolving to enable organisations from different sectors meet their growing challenges successfully (Srinivasan & Jayaraman, 1999). One of the sectors benefiting from the enabling feature of IT, is the manufacturing sector (CSIT, 1995).
4. The manufacturing sector consists of organisations (whether machine tools or consumer goods producing firms) that work towards producing “the right product, with the right quality, in the right quantity, at the right price, and at the right time” (Rana, 2013, p. 435). They also endeavor to satisfy their customers, who are the primary reason for their business operations (CSIT, 1995; Rana, 2013). In order to achieve an efficient and effective business operation, it is necessary that the appropriate information is received from customers and communicated to staff at the appropriate time, so as to make real time decisions (Srinivasan & Jayaraman, 1999). The managers of manufacturing organisations have found it necessary to adopt technological systems, because they facilitate real time communication of business operation’s information (Rana, 2013).
5. IT in manufacturing organisations play a vital role in the sustenance and improvement of the business (Grant, 2000; Rana, 2013). Different functional units (such as account and finance, sales and marketing, manufacturing and production etc.) in manufacturing organisations use different types of IT systems and applications to enhance their business processes (CSIT, 1995). Examples of these IT systems and applications include: Database Management system (DBMS) (Rana, 2013), barcodes (Srinivasan & Jayaraman, 1999), Customer Relationship Management (CRM) systems, and Enterprise resource planning (ERP) system (Askenäs & Westelius, 2000). The integration of IT into manufacturing technologies, have resulted in computer integrated solutions that are helping to restructure the manufacturing plant in becoming lean and efficient (Rana, 2013). Computer-integrated manufacturing, which came about as a result of the combination of factory automation and IT, is helping to improve manufacturing operations (Srinivasan & Jayaraman, 1999). Organisations such as Boeing, Alley–Bradley and Black and Decker are using computer-integrated manufacturing to improve their manufacturing operations (Srinivasan & Jayaraman, 1999; Rana, 2013).
6. Another important aspect that IT has helped, is the digitalisation of supply chain process (Eamonn & Kelly, 2015). Supply chain management is one amongst other essential functions for manufacturing organisations. This is because the success or competitiveness of a manufacturing organisation relies on how efficient and cost-effective the flow of resources (i.e. material, funds and information) moves from the supplier, to the manufacturer, and then to the consumer (Holma & Salo, 2010). IT has changed the dynamics of how the supply chain works (Eamonn & Kelly, 2015). As a result of the involvement of IT in the supply chain processes and the proliferation of the Internet by technological advancement, supply chain has evolved 3
7. from the physical exchange of information between artisans and consumers, to a virtual chain of suppliers, manufacturers and consumers, now referred to as the value web (as shown in figure 1) (Srinivasan & Jayaraman, 1999). The value web is a virtual supply chain, that allows for the efficient exchange of information between organisations and their trading partners, irrespective of their location (Eamonn & Kelly, 2015).
8. Figure 1. Supply Chains evolve to Value Chain (Eamonn & Kelly, 2015)
9. Also, new technologies (such as enterprise resource planning (ERP) system; SharePoint; Cloud storage) are enabling the integration of all units, stakeholders and activities in the manufacturing business (as shown in figure 2) (CSIT, 1995). Thereby facilitating globalisation in the manufacturing sector (Dahlman, 2007; SAP & INFOR, 2007; Globalization101, 2012). 4
10. Figure 2. IT as an integrator of all business activities in manufacturing organisations (CSIT, 1995)
11. In spite of the criticality of IT in the manufacturing sector, it is often considered to be a support tool or function and not a core function to the entire manufacturing process (Srinivasan & Jayaraman, 1999). Hence, organisations outsource their IT functions. However, outsourcing comes with some risks such as vendor lock-in, unsatisfactory service quality, loss of intellectual properties, expending extra cost, security issues etc., which could be more complex and challenging (Gonzalez, Gasco & Llopis, 2009; Demaria, 2011). Hence, the presence of inherent risks in ITO is necessitating that organisations identify, evaluate and institute possible risk treatments before engaging in ITO (Tompkins, Simonson, Upchurch & Tompkins, 2005; Deloitte, 2014b).
12. **BACKGROUND OF THE STUDY**
13. Today, organisations are working towards cutting operational cost in order to maximise profit. Hence, they are outsourcing part or whole of their functional unit in order to deal with organisational limitations and overall expenses (Beaumont & Sohal, 2004). IT remains the most outsourced functional unit in most organisations (Ramanujan & Jane, 2006). IT unit is usually affected when organisations intend to cut cost. This is because, IT is most often regarded as a complex and expensive support function (Carr, 2003). Some organisations outsource selected parts of their IT functions while some outsource all of their IT functions, to a third party, who in return, renders IT as a service to them (Dibbern *et al.*, 2004; Applegate *et al.*, 2009).
14. Outsourcing first came into limelight in the 19th century through a British economist known as David Ricardo, who came up with the economic principle of “comparative advantage” (Ritchie, 2015). Before the advent of the business concept “outsourcing”, organisational model consisted of large integrated companies that managed and controlled their assets internally (Ritchie, 2015). Managers of organisations observed that, the bloated strategy of managing all business 5
15. activities in-house was hindering their (respective) organisations from competing globally (Handfield, 2008; Ritchie, 2015). This observation caused organisations to search for a more flexible and cost effective way of managing their asset and resources (Handfield, 2008). The outcome of this search, resulted in the business concept known as “outsourcing” (Davis & Knox, 2004; Handfield, 2008). Outsourcing as explained by Gilley &Rasheed (2000), is the contracting out of an organisation’s assets and resources to a third party organisation. Over the years, outsourcing has evolved from contracting external suppliers for ancillary services to operational outsourcing (contracting external suppliers for support services) and now, to strategic outsourcing (contracting external suppliers for core business services) (Handfield, 2008).
16. ITO was first operationalised in the 20th century by Eastman Kodak (Loh & Venkatraman, 1992; Dibbern *et al.*, 2004; Ritchie, 2015). In 1989, Kodak (an imaging solutions company) braced the IT outsourcing market by outsourcing all its IT functions to IBM (DiRomualdo & Gurbaxani, 1998; Dibbern *et al.*, 2004), DEC and Businessland (Hirschheim & Lacity, 1997; Dibbern *et al.*, 2004). This marked a significant event referred to as “the Kodak effect”, in the IT industry (Loh & Venkatraman, 1992). This is because Kodak, who regarded IT to be a strategic asset and also had the capability to manage their IT internally, was the least expected organisation to move IT outside (Applegate & Montealegre, 1991). Other large and small organisations such as J.P. Morgan, Xerox Corporation, Dupont where influenced by Kodak’s approach to outsource IT. Hence, they followed the same footstep as Kodak, by engaging in ITO contracts that were worth billions of dollars (DiRomualdo & Gurbaxani, 1998).
17. The outsourcing market experienced fluctuation (i.e. unstable engagement of organisations in ITO) between year the 2000 and 2015 (Statista, 2015). However, due to the recent and continuous technological advancement, industry analysts have projected that outsourcing engagements will increase exponentially in the years to come (Arshad, May-Lin & Mohamed, 2008; Deloitte, 2014a). Presently, the adoption of technological innovations such as cloud computing, big data, business intelligence etc., by organisations, are contributing to the growth observed in the ITO market (Deloitte, 2014a). The development and management of these technological innovations involves a lot of challenges and risks (Kumar, 2016), however, most organisations understand the importance of technological innovations in supporting their core business operations (Deloitte, 2014a). Hence, organisations fall back on ITO in order to gain the benefits offered by IT innovations, while at the same time transferring the challenges and risks involved in the development and management of IT innovations to a third party organisation (Deloitte, 2014a).
18. **RESEARCH PROBLEM**
19. Outsourcing, IT, globalization, customer satisfaction etc. have been listed as some of the business challenges faced by today’s organisations (Tompkins *et al.*, 2005; Bernard, 2015). IT is listed as a challenge due to its complexity, while outsourcing is understood to be a more unique challenge because it is both a solution to other business challenges and a challenge on its own (Tompkins *et al.*, 2005). Consequently, ITO is a more complex and unique business challenge (Arshad *et al.*, 2008). Organisations are facing outsourcing challenges such as defining their outsourcing strategy, selecting the right vendor, managing their outsourcing contract etc. (Paul, 2004; Syed, Arshad & Mohamed, 2007). However, despite these challenges, 6
20. organisations are still engaging in outsourcing. If these challenges are taken care of, outsourcing is more of an opportunity than a challenge (Tompkins *et al.*, 2005).
21. Today, outsourcing of business functions is becoming a practice in almost every organisation (Ritchie, 2015). The opportunities and benefits of ITO have been proven by different studies (Rochester & Rochester, 1995; Dhar & Balakrishnan, 2006; Tayauova, 2012; Ritchie, 2015). However, ITO comes with risks (Dhar & Balakrishnan, 2006; Arshad *et al.*, 2008; Deloitte, 2014b). Catherine (2004), identified some of these risks, which include: vendor lock-in; loss of control over physical IT security; logical IT security risk; confidentiality; privacy concerns etc. If these risks are not well managed, the outsourcing organisation could be faced with threats such as reputational damage, value leakage, adverse effect on organisation’s operating model, financial performance and total engagement failure (Deloitte, 2014b).
22. In 2000, Oxford University’s Institute of Information management, and the University of Missouri (USA) conducted a study that tracked 29 outsourcing contracts for eight years. It was reported from this study that, more than 35% of the contracts failed (Catherine, 2004). This indicates that almost half of outsourcing initiatives are unsuccessful (Gregg, 2003). MacInnis (2003) indicated that one third of outsourcing deals fail in their first year, while half request for contract renegotiation with their service providers. Paul (2004) in his article “most outsourcing is still for losers” stated that all participants of the largest ITO engagement in the world ended up as losers. Also, a survey done by Deloitte Consulting LLP in 2012 on global outsourcing and insourcing, showed that 48% of outsourcing contracts were terminated due to concerns over service quality, while 24% rated their outsourcing contract as unsatisfactory (Deloitte, 2014b).
23. Majority of these ITO failure stories were attributed to the incompetence of the outsourcing organisations in overcoming the challenges of ITO (MacInnis, 2003; Paul, 2004). Most organisations do not have a clear picture of the function they are outsourcing, thereby making the outsourcing engagement complex and difficult to manage (Paul, 2004). Some other organisations get disappointed at the end of an outsourcing deal or half way into the engagement, due to their over expectation from outsourcing and lack of risk management (MacInnis, 2003). Manufacturing organisations in South Africa are partakers of ITO (Johnston, Abader, Brey & Stander, 2009). A typical example of such engagement is Nampak’s (a Global Manufacturing Limited) IT service outsourcing to Dimension Data (a Global Technology Organisation), which is just one amongst several other ITO contracts engaged by South Africa manufacturing organisations. The increase in the adoption of ITO by organisations is necessitating the continuous research in ITO field. Also, the constant change in business requirements and IT evolution is forcing a continuous revisit of the risks and risks management practices of ITO, so as to propose better ways of managing potential ITO risks.
24. **RESEARCH QUESTIONS**
25. The research questions are as follows:
26. What are the risks associated with ITO in manufacturing organisations?
27. What are the impacts of ITO risks on manufacturing organisations?
28. What are the risk treatments used by manufacturing organisations in managing ITO risks?
29. 7
30. **RESEARCH OBJECTIVES**
31. The research objectives are as follows:
32. To identify ITO risks in manufacturing organisations.
33. To investigate the impact of ITO risks on manufacturing organisation.
34. To investigate the risk treatments used by manufacturing organisations to manage ITO risks.
35. To propose means that can be used to manage the risks of ITO in manufacturing organisations
36. **LITERATURE REVIEW**
37. Outsourcing has been defined as the use of external resources to perform internal business goals (Demaria, 2011). Tayauova (2012, p. 189) also defined outsourcing to be the “delegation of operations or jobs to a third party, who can do it better, cheaper and faster”. Outsourcing is being adopted globally by small, medium and large enterprises in both the private and public sector for so many reasons (Varadarajan, 2009; Plugge, Bouwman & Molina-Castillo, 2013). Researchers have identified economic reasons such as cost cutting, conservation of resources (Statista, 2015) and reduction in overhead staff as the major motivation for outsourcing. However, Gonzalez, Gasco & Llopis (2010) findings shows that economic reasons are not the priority for outsourcing in today’s organisations. Organisations are now outsourcing with the motive of improving business efficiency, focusing on core competencies (DiRomualdo & Gurbaxani, 1998; Gonzalez *et al.*, 2009; Johnston *et al.*, 2009), avoiding certain costs (Statista, 2015) (such as taxes) and risks (Dibbern *et al.*, 2004; Gonzalez *et al.*, 2009). Outsourcing is also increasing the opportunity for organisations to tap into external resource base, add value to processes and mitigate business risks (Statista, 2015). Organisations are outsourcing different business units such as logistics, human resources (HR), customer representation etc., however Information Technology (IT)/Information Systems (IS) is one of the most outsourced business unit (Ramanujan & Jane, 2006).
38. According to the literature, information technology outsourcing (ITO) is “the use of a third party to successfully deliver IT enabled business processes, application services and infrastructure solutions for a cost effective business outcome” (Samantra, Datta & Mahapatra, 2014, p. 4010). Similarly, ITO is the allocation of in-house IT functions to an external service provider. (Bradley, Frederick, Jeanot, Dragon, Michael & Cesar, 2012, p. 2). ITO has been in existence and have evolved for over 20 years, which started from the moment Kodak decided to outsource all its IT functions to IBM (Samantra *et al.*, 2014). Although, Kodak was praised to have initiated ITO, their bravery however, were soon criticised, as inexperience in ITO caused them a lot of challenges (Robert, 2011). Mitchell (2014) claimed that, over-outsourcing led to the dismissal performance of Kodak, who declared bankruptcy in 2013.
39. Organisations are aware of the benefits of ITO but are still conscious and careful of their outsourcing decisions (Robert, 2011). This is because ITO can be dangerous to the business if not well managed (Mitchell, 2014; Samantra *et al.*, 2014). Business analyst’s (Deloitte, 2014a) report shows that there is a high rate of failure and dissatisfaction of ITO engagements. As a result, ITO is gaining so much interest from the academic research field. Researchers have carried out studies on different aspect of ITO which covered areas such as - effective 8
40. management of ITO, factors resulting to successful ITO engagement, ITO theories, models and frameworks and most recently risks and risk management of ITO (Liang, Wang, Xue & Cui, 2015). Earlier studies on ITO, such as the study of Bragg (2006), have focused more on the management of ITO initiatives such as, contract management, vendor management, ITO lifecycle, ITO strategy, types and scope of ITO. Although, studies on the management of ITO has helped to build and structure ITO practices (Lacity, Khan & Willcocks, 2009; Liang *et al.*, 2015). Some researchers (Syed *et al.*, 2007; Bradley *et al.*, 2012; Samantra *et al.*, 2014), however, noted that the study on the management of ITO is insufficient in achieving a successful ITO engagement. Studies such as that of Gonzalez *et al.* (2010), Lacity *et al.* (2009), Liang *et al.* (2015), Deloitte (2014a) and Samantra *et al.* (2014) on ITO also shows that there are potential benefits of ITO, however, risks are also involved.
41. According to the Institute of Risk Management (IRM, 2002), risk can be defined as the combination of the chances of an unknown event occurring and the consequences (negative or positive) of the event’s outcome. There are different perspectives to risk (IRM, 2002), but the context in which its being used matters (Aubert, Patry & Rivard, 1998). For example, in the safety field, risk is defined in relation to negative outcomes or harm to a certain event. Risk in ITO is defined with respect to negative consequences, as mentioned by Fan, Suo & Feng (2012) that, risk in ITO could lead to undesirable outcome. Also, Adeleye, Annansingh & Nunes (2004, p. 170) stated that, the purpose of risk assessment in outsourcing, is to evaluate the chances of adverse events occurring. The occurrence of undesirable outcomes in ITO are due to some factors known as risk factors (Aubert *et al.*, 1998).
42. From the literature, different studies have identified risks and risk factors of ITO. Catherine (2004) for example identified 5 risk areas of ITO - logical IT security, physical IT security, human resource issues, total dependency and legal consequences. After conducting risk analysis survey (with responses from 3 organisational settings – academics, financial institution and retailer), Catherine (2004) deduced that logical IT security risks, total dependence/exist barrier and legal consequences are the top three potential risks of IT outsourcing. In a more recent study, Samantra *et al.* (2014) identified 11 risks of ITO – Environmental risk, strategic risk, information risk, managerial risk, time management risk, relationship risk, financial risk, legal risk, operational risk, business risk and technical risk. Samantra *et al.* (2014, p. 4014) also identified various risks factors, which includes – task complexity, obsolete technology skill, supplier’s deficiency in experience and expertise on the outsourced activities, loss of organisational competency, lack of contingency plan, supplier service quality etc.”. These identified risks and their respective risk factors need to be properly managed so as to establish an effective ITO engagement (Deloitte, 2014b; Samantra *et al.*, 2014).
43. Deloitte (2014b) stated that organisations need to carry out risks analysis at the initial stage of planning an ITO initiative, in order to identify potential risks and mitigation techniques. This need is necessitating the establishment of risk management practices in order to ensure the successful outcome and sustenance of the ITO initiative (Osei-Bryson & Ngwenyama, 2006; Syed *et al.*, 2007; Prado, 2011; Bradley *et al.*, 2012; Thanapol, Settapong & Navneet, 2013). Prado (2011) also noted that the level and severity at which organisations conduct risk analysis differs and depends on the organisation’s size and type of industry. He further highlighted that manufacturing organisations give less relevance to risks analysis when outsourcing IT. This thus impact on their risk management practices. Philip &Scott (n.d) identified ITO risks 9
44. management practices as a factor of successful ITO engagement. Studies and reports (Alexandrova, 2012; Bradley *et al.*, 2012; Thanapol *et al.*, 2013; de Sá-Soares, Soares & Arnaud, 2014; Deloitte, 2014b; Samantra *et al.*, 2014; Yildiz & Demirel, 2014) are now focusing on risks and risk management practices of ITO. However, constant change in business requirements, customer needs, organisation innovation and short technology cycle remains important risk factors in today’s ITO engagements and business environments (Prado, 2011).
45. **THEORETICAL FRAMEWORK**
46. This study will adapt two risk management frameworks in order to achieve its objectives. A conceptual framework of risk management in ITO developed by Aris *et al.* (2008) will be adapted to identify the risks in ITO, and a risk management framework developed by Aubert *et al.* (1999) will be adapted to: assess the impact of ITO risk; and investigate the risk treatments of ITO used by manufacturing organisations. Adapting these two frameworks, this study will be investigating the risk management of ITO under 3 constructs, which are
47. Risk Identification
48. Risk Assessment
49. Risk treatment
50. **1st Construct – Risk Identification –** In every risk management framework, risk identification is usually the first step to consider (Aris *et al.*, 2008). The process of risks Identification helps to reveal the what, when and how questions about threats and vulnerabilities associated with an event (Gary, Alice & Alexis, 2002). Using this construct in this study, the researcher will investigate the risks associated with ITO. The risks will be investigated across the activities of the ITO lifecycle (Figure 3), which includes the - Analysis of decision to outsource; Selection of service provider; Contract management; On-going monitoring, phases as used by Aris *et al.* (2008).
51. Figure 3. A Conceptual Framework of Risk Management in IT Outsourcing (Aris *et al.*, 2008)
52. **2nd Construct – Risk Assessment –** Risk assessment is the process of analysing and evaluating potential or anticipated risks (Aubert *et al.*, 1999). This process helps to understand the probability of occurrence and the impact of risks. This construct will allow the researcher to analysis the probability of occurrence and the impact of ITO risks. These analysis will then be 10
    1. Strategy I (Tolerance) – Impact of risk is high and probability of occurrence is low
    2. Strategy II (Prudence) – Impact of risk is low and probability of occurrence is high
    3. Strategy III (Mixed) – Impact of risk is high and probability of occurrence is high
    4. Strategy IV (Monitoring) – Impact of risk is low and probability of occurrence is low
53. used to categorise the risks into 4 risk management strategic groups as indicated in Aubert *et al.* (1999)’s risk management framework, which are
54. Figure 4. A Risk Management Framework (Aubert et al., 1999)
55. **3rd Construct – Risk Treatment –** This involves the mitigation of risks, by reducing the impact of risks or the probability of risks occurring (Aubert *et al.*, 1999; Gary *et al.*, 2002). This process is used to bring risks to an acceptable level. Using this construct in this study, the researcher will investigate mitigation techniques or control measures established by manufacturing organisations in bringing the risk of ITO to an acceptable level.
56. **SIGNIFICANCE OF THE STUDY**
57. Many studies have investigated the practice and management of ITO (Gonzalez, Gasco & Llopis, 2006; Ritchie, 2015; Vaxevanou & Konstantopoulos, 2015; Kumar, 2016). However, only few amongst them have focused on the risk management practices of ITO (Catherine, 2004; Syed *et al.*, 2007; Aris *et al.*, 2008; Arshad *et al.*, 2008; Demaria, 2011; Bradley *et al.*, 2012). Also limited study was found to have investigated the risk management practices of ITO in manufacturing organisations. This study intends to fill the research gap on risk management of ITO in the manufacturing field. Hence, identifying the benefits, risks and effective ways of managing risks associated with ITO. Also, findings from this study will serve as risk management resource for manufacturing organisations willing to engage or already engaging in ITO. As it will provide insight on prospective risks and ways of managing risks associated with ITO.
58. **JUSTIFICATION**
59. In spite of the high rate of unsuccessful ITO engagements recorded by outsourcing analysts (Statista, 2015), organisations keep engaging in ITO (MacInnis, 2003; Catherine, 2004; Paul, 2004; Deloitte, 2014a). This continuous interest shown by organisations in ITO, has necessitated the need to investigate the risk management practices established by organisations, in order to scrutinise, evaluate and recommend better means of identifying and managing ITO risks. 11
60. Secondly, the rapid growth and evolution of IT is resulting in the emergences of new technologies such as cloud computing (Muhic & Johansson, 2014). These technologies are now informing new ways of IT service delivery (Muhic & Johansson, 2014). As a result of this, new sourcing varietals, challenges, and risks of ITO is evolving. Hence, necessitating the research on risks, that organisations are facing with their ITO engagements.
61. **RESEARCH METHODOLOGY**
62. Research methodology is a systematic approach towards solving a specific research problem (Rajasekar, Philominathan & Chinnathambi, 2013). It comprises of the science of examining how research is being conducted. It involves the procedures, step by step approach and techniques a researcher has decided to use in investigating the research problem or achieving the research objectives.
63. ***Research design***
64. Research design helps to guide the data collection process of a study (Bhattacherjee, 2012). It is the blueprint that entails the procedures and techniques that will be used by a researcher to go about acquiring and analyzing applicable data that will be used to answer specific research questions. Research design encompasses the sampling method, data collection process and the research instrument development process. The research design that will be used in this study is the exploratory research design.
65. ***The exploratory research design***
66. Exploratory Research design allows the researcher to carry out a clear and systematic search for new insights on the phenomena under study, as well as assessing the phenomena in a clearer perspective (Robson, 2002). This research design also gives room for further understanding of a problem, thereby providing the researcher a clearer picture of the research problem being investigated (Saunders, Saunders, Lewis & Thornhill, 2011). The adoption of the exploratory research design to this study will provide a deeper and clearer understanding of the risks and risks management practices of ITO in manufacturing organisations within South Africa.
67. ***Research approach***
68. According to Rajasekar *et al.* (2013), research method refers to the schemes, algorithms and systematic procedures used by researchers in order to attain the objectives of their research. The two types of research methods are the quantitative methods and qualitative methods (Saunders *et al.*, 2011). Quantitative method is used when the research findings and results will be measured in quantity or amounts, while qualitative method is used when the research objective is focused on answering problems of how and why, about the phenomena being studied (Rajasekar *et al.*, 2013). The results and findings generated when using qualitative research method is not usually generalizable to a larger population (Patton, 1990).
69. The qualitative method will be employed in this study because it will give the researcher an avenue to carry out an in-depth investigation of the risks associated with ITO in manufacturing organisations within South Africa, and it will also enable the researcher to explore and analyse measures that are put in place to manage these risks. 12
70. ***Study site***
71. The physical location or place where data will be collected is referred to as the study site. The study site for this study will be a manufacturing organisation (within South Africa) that has agreed to participate in the study. The organisation will be used as a case study.
72. ***Population of the Study***
73. Population of the study could be referred to as the total number of units, people or individual present in a geographical location or in the study site where data collection will be carried out (Lavrakas, 2008). Considering the total number of units in a study site, data collection will be focused on a subset of the population of study known as the target population. According to Burns &Grove (1997), target population is the total number of units, people or individual present in a certain area or location that are of great interest to the research due to certain attribute or expertise they possess. For this study, the target population will be the managerial staff of the organisations under investigation, who are responsible for the decision making and management of ITO. The characteristics of a population is known as the criteria that defines who is eligible or not eligible to participate in a study (Stommel & Wills, 2004). Therefore, for this study, some of the responsibilities or characteristics of the target staff would include: decision making analyst, contract management, risk management, vendor relationship management etc. This means that the respondents of this study are expected to have knowledge about the principles of outsourcing and at the same time understand the risk management techniques used in outsourcing.
74. ***Sampling methods***
75. Due to the adoption of qualitative research methodology for this study, the non-probability sampling method will be used to select the participants for the study. The non-probability sampling method is a subjective type of sampling method which allows the researcher to select the participants of the study based on a non-random criteria (Bhattacherjee, 2012). Hence, some of the units in the population will have a zero chance of being selected (Saunders *et al.*, 2011). The expert sampling technique will be used to choose the samples from the population of this study.
76. The expert sampling technique is a sampling technique in which participants of a study are selected on a non-random based criteria, hence samples are chosen based on their expertise on the phenomena being investigated (Bhattacherjee, 2012). In this study, interviews will be conducted for ten staff from each of the two organisations where data will be collected. The interview participants will include executive management staff and other management staff of the organisations, whose responsibilities includes the management of ITO in their respective organisations.
77. ***The sample size and sample***
78. A sample is a subset of a population whose characteristics when studied, is duly representative of the entire target population Cherry (2015). According to Yin (2003), the sample size of a study is the total number of observations or respondents that have been selected to participate in the study. The rules for selecting the number of respondents to partake in a study depends on the research methodology. According to Patton (1990), there are no specified rules for measuring the sample size in a qualitative research. He further explains that; qualitative sample 13
79. size depends on the dimension (depth or breadth) the researcher seeks to inquiry. Considering the research method (qualitative methodology) for this study, 15 respondents will be interviewed. They will comprise of Executive managers (5) such as Chief Information Officer and IT Risk and Governance manager; and other management staff (10) such as Project managers who have a stake in the decision making on ITO in the organization.
80. ***Data collection methods***
81. According to Saunders *et al.* (2011), there are different methods of collecting data when conducting a research. However, the choice of data collection method depends on the research methodology used in a study (Bhattacherjee, 2012). Interviews are used for qualitative studies, while surveys are suitable for quantitative studies (Saunders *et al.*, 2011). Since this study will be adopting the qualitative approach, interviews will be used as the mode for data collection. According to Saunders *et al.* (2011), interview is a purposeful discussion between two or more people in order to achieve a certain objective. Semi-structured interviews will be conducted for the respondents of this study. The semi-structured interview technique will be adopted over structured and unstructured interview techniques. This is because semi structured interviews are more flexible than structured interviews, and also systematic when compared to unstructured interviews.
82. ***Data quality control***
83. In order to ensure that the data that will be collected and analysed are reliable and valid, data quality control techniques will be applied (Saunders *et al.*, 2011). According to DataONE (2012), error of commission and error of omission are two types of errors that could contaminate the dataset that have been collected and analysed during the process of data collection and analysis of a research. Error of commission occurs as a result of the respondent giving inappropriate information about the research phenomena, while error of omission occurs due to omission or inadequate documentation during data collection process (DataONE, 2012).
84. In this study, error of commission will be addressed by conducting a pilot study. A pilot study is the prior administration of the research instrument to a smaller number of the entire size intended for the study (Saunders *et al.*, 2011). Conducting a Pilot study, will enable the researcher to assess the clarity of the content in the research instrument (Saunders *et al.*, 2011). Then the result of the pilot study will be used to refine the content of the research instrument that will then be administered to the entire sample population. According to Bhattacherjee (2012), conducting a pilot study helps to validate the research instrument (Bhattacherjee, 2012). Hence, assuring the credibility of the research findings and results (Bhattacherjee, 2012). Error of omission on the other hand, will be addressed by recording the interviews using an audio recorder. The researcher will request the permission of the respondents to record the interview sessions, in order to avoid omissions or misinterpretation of the respondents’ responses during coding and analysis of the collected data.
85. ***Data Analysis***
86. Data collected during the course of this study will be analysed using the thematic technique of data analysis. The thematic technique of data analysis is a qualitative analytic/analysis method used by researchers to gain insight and generate knowledge from the data collected when a qualitative research method is used (Braun & Clarke, 2006). Using the thematic data analysis 14
87. technique in this study, the collected data from the interviews will be analysed and reported in sections of identified patterns known as themes.
88. **ETHICAL CONSIDERATIONS**
89. According to Resnik (2011), ethics could be defined as the procedures or methods that defines good and bad practices. Ethics in research helps to guide and monitor the researcher’s mode of practices while undergoing a study. It also ensures that the researcher’s objective is not basically focused on collecting data from its respondents but must at the same time consider the respondent’s safety and dignity (Gregory, 2003). Ethical considerations that will be preserved during the cause of this study includes: confidentiality, anonymity and privacy of the respondents.
90. In order to assure the respondents that all ethical considerations will be preserved, an informed consent, which will serve as a written agreement between the respondent and researcher will be given to respondents to sign. This will also be a prove to show that respondents were informed of the motive and objectives of the research before data was collected and that respondents agreed willingly to participate in the study. In order to uphold the ethics of confidentiality and privacy, respondents would be informed that they have the right to conceal information they do not feel comfortable to disclose. And then anonymity will be maintained by withholding any form of respondent’s identity such as name, address, job designation and company while presenting the findings and results of this study, except with the permission of the respondents
91. **LIMITATIONS TO THE STUDY**
92. A limitation of ease to access and availability of respondent will be encountered during the data collection exercise of this study. This will be due to the position and level the respondents hold (as key decision makers) in the organisation. This limitation will be managed by establishing good rapport with the secretary or personal assistant of respondents. Also, interview schedules will be planned to suit the respondent’s most suitable time and reminder will be sent to them to confirm their availability on the expected day for the interview. Another limitation that will be encountered during the course of this study is the limited literatures on the risks and risk management practices of ITO in the manufacturing sector. In order to deal with this limitation, literatures on risks and risk management practices of ITO in other sectors such as education and banking will be considered in this study.

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| 1. **WORKPLAN** MONTH | 1. ACTIVITY | 1. OUTCOME |
| 1. May | 1. Preparation of research proposal for supervisor | 1. First Draft |

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