



Big Data and Business Intelligence in the Public Sector: Implementation and Benefits

Charles Tandilino¹, Rizky Khaerany², Grace T. Pontoh³, Aini Indrijawati^{4*}

^{1,2}Ministry of Finance of Republic of Indonesia, Directorate General of Taxes, Jl.Gatot Subroto Kav.40-42, Jakarta, Indonesia

^{3,4}Accounting Department, Hasanuddin University, Jl Perintis Kemerdekaan Km.10, Makassar, Indonesia

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Correspondence:

*ainindri@fe.umhas.ac.id

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Abstract

Purpose: This research aims to map and summarize how the implementation and benefits of big data and business intelligence (BI) leverage the advancements of the digital transformation era applied in the public sector to achieve its objectives.

Method: The research method used in this article is Systematic Literature Review (SLR) using 56 published and indexed articles by Scopus and Google Scholar in the range of 2014-2023.

Findings: The results map several important points, namely the implementation and factors that help the effective application of big data and BI in the public sector, as well as the benefits of implementing big data and BI in the public sector. Although the use of big data and BI is very important in policy determination and the provision of public services in the public sector, the literature and guidelines for its use are still very low when compared to the private sector.

Originality/Value: The implementation of big data and BI in the public sector needs to be further developed. Some of the research topics in the future that can be developed can focus on the development of implementation frameworks, success factors, and the impact of technology on efficiency, transparency, and decision-making in the public sector, while also providing practical guidance for policymakers practitioners.

Keywords: Big Data, Business Intelligence, Public Sector, Systematic Literature Review

Paper Type: Research Paper

1. Introduction

The COVID-19 pandemic, triggered by travel restrictions and government action, has significantly impacted economies, job availability, and working methods worldwide since the pandemic began in 2020 (Pontoh et al., 2024). Recently, many countries seek growth sources to increase productivity, competitiveness, and field creation. Overcoming gaps and encouraging inclusive societies requires increased transparency, accountability, and open data analysis using big data (Mohabeer et al., 2019). Big data has changed lives and jobs in the era of the 4.0 revolution and impacted organizational operations (Okwechime et al., 2018). In addition, big data has the potential to enhance decision-making in public and private organizations, thereby encouraging academics, analysts, and entrepreneurs to explore innovative approaches to improving the performance of the public sector (Desouza & Jacob, 2017).

Big data, a huge amount of data from various sources, offers unprecedented insights into customer behaviour and internal processes. However, it also presents the challenge of its unoptimal exploitation and misuse (Kimble & Milolidakis, 2015). Initiatives to implement big data have emerged in the public sector, as did the Big Data Research and Development Initiative in the Obama administration and the open data platforms owned by the city governments in the United States. These efforts aim to increase productivity and efficiency. However, big data's actual value and benefits still need to be answered, raising questions about its potential in the public sector (Desouza & Jacob, 2017). Big data is increasingly in demand in both the business and government sectors, as evidenced by increasing Information and Communication Technology (ICT) and e-government applications that enable the collection and analysis of large amounts of digital data, thereby improving efficiency, quality of services, crime detection, and reducing bureaucracy, as well as improving transparency and citizens well-being (Okuyucu & Yavuz, 2020). Big data requires storing large amounts of data to solve complex problems, but its use in business is challenging due to a lack of analytical skills and user understanding (Kim, 2014; Manikam et al., 2019).

Big Data Analytics (BDA) is an essential aspect of Business Intelligence (BI), which provides accurate insights and decision-making for organizations. BI Technology offers historical, up-to-date, and predictive business operational insights and complex analysis, data mining, process mining, and machine learning. Data quality is crucial to adequate characterization, interpretation, visualization, and relevance of results (Manikam et al., 2019). Big data, BI, and BDA are closely related, as BI provides methodological and technological capabilities for data analysis. BI and BDA have the same decision-making tools, emphasizing valuable data, information, and knowledge (Alnoukari, 2020). BDA can potentially improve management efficiency by collecting and analyzing data to understand organizational environment variables. However, there are practical, legal, and ethical barriers to using big data. Big data visualization is vital in decision-making but is limited to data summaries and reports and does not have a causality assessment. Integrate a visualized decision model with the factual data required for evidence-based decision-making. Moreover, contemporary BDA devices are a challenge for decision-makers in the public sector (Choi et al., 2018).

In today's rapidly developing digital era, big data has emerged as a pivotal concept, capturing attention not just in IT and business discussions but also within the broader information technology sector, particularly in the context of BI. This influx of data provides organizations with unprecedented opportunities to gain insights, identify trends, and inform strategic decisions through advanced analytics. In this data-driven landscape, IT and business professionals must adapt to fully leverage the potential of Big Data, making it a cornerstone of modern decision-making especially in Public Sector. A lot of research on big data and BI is done separately. However, big data research has a relatively short period, as this research had only begun to attract significant attention around 2012 when the rapid development of ICTs led to discussions about how to collect and use the amount of data generated in unprecedented amounts. On the other hand, BI has long been the focus of researchers (Jin & Kim, 2018).

Looking at the challenges and importance of the use of big data in public sector organizations, as well as the lack of research related to big data and BI in the public sector (Chen et al., 2012; Mohabeer et al., 2019), the researchers aimed to conduct this research to map and summarize the application of big data and BI using a Systematic Literature Review (SLR). SLR is an approach to analyzing a body of scientific literature to develop insights, conduct critical reflection, determine future research directions, and formulate

research questions (Massaro et al., 2016). This study is also a development of the research carried out by Manikam et al. (2019) on how the use of big data and BI in improving the quality of services in the public sector, as well as the research conducted by Merhi and Bregu (2020) on the effectiveness and efficiency of use of big data in the public sector. The research findings provide an understanding of the use and benefits of big data and BI if applied in the public sector. It can help other researchers undertake further empirical research on using big data and BI to improve public sector performance. The following is the research question for this purpose:

RQ: How the implementation and the benefits of using big data and business intelligence in the public sector?

The manuscript is structured as follows. Section 2 outlines the theoretical framework, which includes an explanation of big data, BI, the public sector, and previous research on big data and BI. In section 3, the researchers describe the steps of the research method using the Systematic Literature Review. In section 4, the researcher presents the research results from articles and discussions on related topics. Finally, in section 5, the researchers presented conclusions, limitations, and implications of advice on potential research that could be undertaken in the future.

2. Literature Review

2.1. Big Data

The world is currently surrounded by data, with storage capacity estimated to reach almost 100 zettabytes by 2020 (Mohabeer et al., 2019). The academic definition of big data encompasses three dimensions (speed, variation, volume), four dimensions (volume, speed, variance, truth, value) and six dimensions (volume, variation, speed, value, truth, variability). However, according to practitioners, big data consists of different dimensions. There are three dimensions (speed, variation, and volume), four dimensions (speeds, variations, volumes, and truth) and seven (volume, speed, variance, validity, place, value, and vocabulary) (Mashingaidze & Backhouse, 2017).

Big data is a diverse data source used to solve problems in various aspects of business and society. The ability of organizations to access and analyze structured and unstructured data, as well as the proper infrastructure, is critical to their survival, performance, and success. City governments, for example, can use this data to improve efficiency and work more intelligently, thus requiring organizational learning (Okwechime et al., 2018). Big data is also a complex and large-volume collection of data from various categories, including structured, semi-structured and unstructured data that can provide insights and competitive advantages. Big data features include relational properties, flexibility in analysis, high correlation probability, and high detail (Madyatmadja et al., 2021). Big data is also a combination of structured and unstructured data from various sources, which is essential for management and analysis by an organization. It offers advantages such as evidence-based decision-making and can revolutionize management by influencing decision-making processes and who makes such decisions. The proper structure and tools are essential for effective data management (Khrisat et al., 2023).

From some of the definitions of big data above, big data is a combination of structured and unstructured data from various sources, which is essential for organizations to analyze and make decisions and provides significant advantages and competitive advantages. The structure and quality of big data are essential for efficient data collection

and analysis and ensure the organization's ability to make data-based decisions. It also provides valuable insights for governments and organizations to improve service efficiency and productivity.

Some researchers argue that big data is not just the size of data but also has some characteristics that are grouped into several dimensions. One is grouped in five dimensions (Alkilani & Al-Malahmeh, 2023), which are: (1) Volume refers to the amount of data taken from a source, which is an essential factor in determining the value and importance of the data. This size is measured in petabytes, exabytes, and terabytes; (2) Variety refers to the technological advances that have led to the emergence of various structured, unstructured and semi-structured data types, which require more effort to manage and process; (3) Velocity refers to the speed of delivery and data generation directly affecting an organization's competitive advantage by increasing its ability to provide practical insights; (4) Veracity refers to the validity and reliability of data obtained by an organization that has a significant impact on the company's information and outcomes; (5) Value refers to the view that data can be conceptualized as a large-scale data set or graph, which provides value to determine the relevance of individual actions or behaviours.

2.2. Business Intelligence

Organizational activities are aimed at achieving strategic goals and serving individuals effectively. Business operations generate vast amounts of data, which helps understand competitors, market share, and customer service. However, organizations need help managing this data because today's business environment is technology-based. To overcome that, BI is emerging as tools and processes that help identify traceable information from raw data, facilitate data-based decision-making, and improve organizational performance (Al-Malahmeh, 2022).

The definition of business intelligence was first formulated by Howard Dresner in 1996, an analyst from the consulting company Gartner. Dresner (2002) states that BI helps companies design a series of concepts and methods based on relevant data and information to help them make business decisions. BI is the scientific management of corporate information. BI is an information system supporting decision-making by combining and managing extensive structured and unstructured data. BI is an analytical process that turns data into knowledge for decision-makers (Tshehla, 2024).

This tool is a technology program that transforms data from everyday activities into valuable insights for decision-making. BI can process large amounts of data, provide insight into organizational performance, and identify positive factors that add to or reduce losses. BI applications have become more accessible, allowing other organizational elements to use and interact with them for faster decision-making (Alkilani & Al-Malahmeh, 2023). BI is a combination of three main parts: (1) an architecture that has four components: Business Analytics, Business Performance Management (BPM), Data Warehouse, and User Interface; (2) Databases that describe how data is collected, integrated, extracted, organized, and stored; (3) Analytical Tools that help use data comprehensively and perform quantitatively analysis is generally based on data mining and statistical analysis (Madyatmadja et al., 2021).

Some researchers mapped the BI dimension (Khrisat et al., 2023) as follows: (1) OLAP is an online analytical processing tool that allows end users to analyze business data in multidimensional cube format, providing insights for better decision-making. This tool organizes data in a cognitive model and allows users to communicate with the data warehouse via the web or a graphical interface; (2) Data mining combines information technology with statistical models to predict future variables and customer behaviour. It

plays an essential role in BI by statistically analyzing big data sets and answering questions; (3) A Data Warehouse is an object-oriented and integrated data collection for management decisions, enabling complex analysis, knowledge discovery, and decision-making. It combines historical and up-to-date data from various sources and provides long-term storage, reporting, and control over response times; (4) Client behaviour refers to the patterns customers use during research or purchase to satisfy their needs and wishes. It covers actions, procedures, and decision-making. The goal is to attract new customers and gain a competitive advantage by satisfying their needs and desires.

ICTs have enabled governmental organizations to exploit and evaluate their information assets, focusing on providing services to the public. This can be achieved through detailed multi-dimensional data analysis, allowing easy access to comprehensive information, extensive analysis of stored data, and formulation of effective strategies and policies for community facilitation (Hartley & Seymour, 2011).

2.3. Public Sector Organizations

The public sector is an integral part of the economy, providing essential infrastructure and social services to the general public. It comprises government agencies and legal bodies that aim to enforce justice, law, and social organization. The government actively shapes its environment, influenced by public vision and political projects. Public services include state defense, law enforcement, public transport, education, health services, physical infrastructure, and administrative functions (Pontoh et al., 2024). Public organizations are looking for new ways to use digital technologies to increase the efficiency of their internal processes and improve their interactions with clients, whether citizens or businesses (Scholta & Lindgren, 2023).

Organizations that are not part of the public sector are in the private sector or the voluntary sector. The private sector is profit-oriented and aims to compete effectively in the marketplace. The volunteer sector, or the third sector, comprises non-governmental and non-profit groups that seek to benefit the community. Public-sector organizations face more legal constraints, political influence, and public supervision. They need to be more flexible in recruiting, reassignment, and adjusting the level of compensation. Success in the public sector often brings only small rewards, making managers more risky than in the private sector (Roztocki et al., 2023). While both public and private organizations have the purpose of serving people, their priorities are different. Private corporations cater to individuals as consumers and strive to maximize profits, while government organizations serve individuals as constituents. Government organizations not only seek financial resources for their sustainability but also have to consider the concept of public value (Twizeyimana et al., 2019).

3. Research Method

Systematic Literature Review (SLR) is a rigorous and structured process designed to systematically identify, evaluate, and synthesize all relevant research evidence to address specific research questions. This methodology is particularly valuable for obtaining a comprehensive understanding of a particular topic, as it enables researchers to collate and analyze existing studies transparently and replicable. The primary objective of an SLR is to synthesize findings across multiple studies, highlight consistencies and discrepancies, identify gaps in the literature, and propose directions for future research. By providing a holistic view of the research landscape, SLR contributes to the advancement of knowledge

in a specific field. The research methodology used in this study uses the SLR process guidelines, which consist of five stages or phases (Denyer & Tranfield, 2009) namely;

3.1. Formulation of the research question

Researchers define research topics based on literature and research developments that can be explored and thus generate new knowledge. The search is carried out by identifying relevant keywords related to research topics, such as "big data business intelligence", "business intelligence public sector", and "big data public sector", from the Scopus database literature. After entering the keyword, researchers identify and compile research concepts based on the research's themes, titles and focus. Based on the existing literature, researchers gain a better understanding of the application of big data and BI in the public sector. Research questions serve as the guiding principle that guides research and form the basis for formulating the hypothesis or purpose of research to be tested and investigated. In this study, the focus is on how the implementation and benefits of big data and BI in the public sector.

3.2. Localizations of the articles

A selection process is carried out from various available data sources to find relevant research. For this research, a database has been selected that provides access to a wide range of literature related to research questions, such as Watase Uake and Publish or Perish (PoP). It has collected articles from several publishers such as Elsevier, Emerald, Springer, Wiley, Taylor & Francis, and others from both of these databases. The keywords used in the search string include "big data business intelligence", "business intelligence public sector", and "big data public sector". Particular search protocols are then applied when browsing the Watase Uake database, focusing on relevant research variables.

3.3. Selection and evaluation of the studies

The search resulted in 109 relevant articles. Each article was evaluated using inclusion and exclusion criteria, where the article must be published between 2014 and 2023. The evaluation process involves three phases of elimination. The first step, identification process, by removing duplicate articles, releases articles outside the year and articles without abstract. Next, in the screening phase, further elimination is carried out. After initial filtering, the remaining 87 full-text articles were evaluated for inclusion in qualitative synthesis. Decisions are based on eligibility criteria. Based on the research objectives of the researcher, the inclusion or exclusion criteria are set to identify the applications and benefits of integrating big data and BI in the public sector. There were 31 released for not dealing with relevant topics and articles not in English. At the final analysis stage, the results identified 56 articles that met the criteria and passed the elimination phase. These articles will be analyzed and synthesized to obtain answers to previously asked research questions. The elimination process will be presented in Figure 1.

3.4. Analysis and synthesis

By analyzing 56 articles and performing data extraction, the study understood the implementation and benefits of integrating big data with business intelligence in the public sector. The researchers conducted a content analysis of the relationship between the research topics of big data, BI and the public sector of the literature collected. The results of the analysis of the study are synthesized to solve problems related to the research question.

3.5. Development of report with findings

Research results are presented in tables, and a modified presentation of the research conducted by [Klievink et al. \(2017\)](#). Detailed information includes search strategies, inclusion and exclusion criteria, study selection process, quality assessment, data extraction, and data synthesis. The analysis of the findings is then submitted through a report or scientific article containing comprehensive and structured information on the implementation and benefits of big data with BI in the public sector.

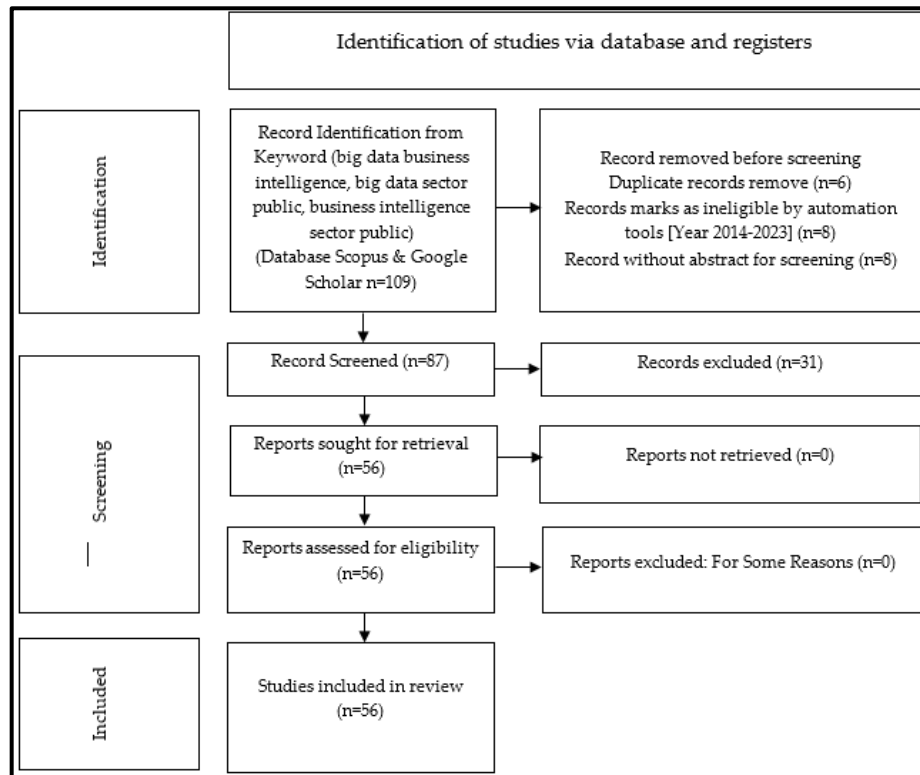


Figure 1. Preferred Reporting Items for Systematic Review

Source: Generate from Watase Uake Tools, based on PRISMA 2020 reporting

Adhering to these systematic stages ensures that the SLR conducted in this study's findings are robust and comprehensive. It offers valuable insights into the chosen topic and contributes to developing evidence-based recommendations. Systematic Literature Review investigation utilized the Preferred Reporting Items for Systematic Review and Meta-analyses (PRISMA) guidelines proposed by [Moher et al. \(2009\)](#). PRISMA is a comprehensive framework that provides clear, unbiased, and unambiguous guidelines for reporting systematic reviews. Originally developed for healthcare research, PRISMA has since seen extensive use in the fields of business and marketing ([Siddaway et al., 2019](#)).

4. Results and Discussion

4.1. Identifying the Novelty of Big Data and Business Intelligence Research Over Time

The analysis of the distribution of the articles examined shows the development of interest in the topics of Big Data and Business Intelligence (BI) over the past ten years. In Figure 2, the yearly increase in the number of articles reflects how this scientific discourse has grown alongside technological advancements and the rising need for organizations to

adopt data-driven approaches. A significant increase occurred in 2017, with the number of articles reaching 10. This period marks a global momentum in embracing technology and data processing. Many countries are starting to invest significant resources to build digital infrastructure. This development includes adopting national data platforms, high-speed internet networks, and the Internet of Things to integrate information across agencies. Public and private organizations worldwide realize that data-driven decision-making can help formulate more effective policies, especially in addressing marketing, customer satisfaction, financial reporting, urbanization, climate change, and improving public services. Attention to this topic remained stable in 2018-2021, with an average of seven articles per year. This stability indicates that Big Data and BI have become integrated themes in the cross-disciplinary research agenda.

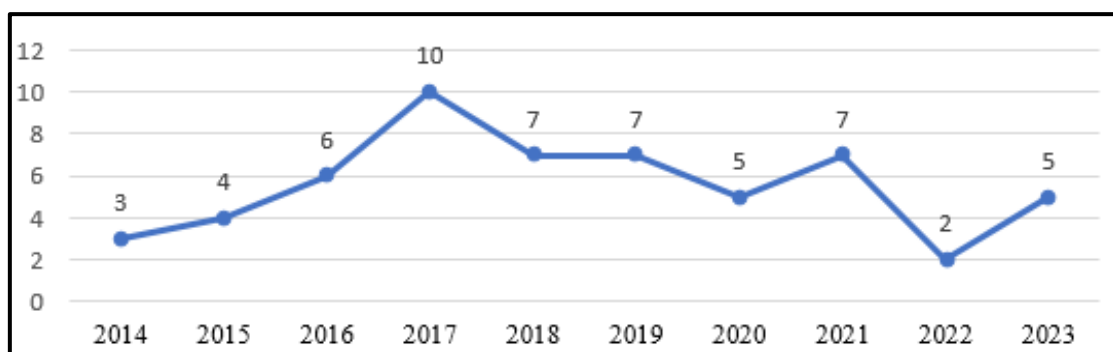


Figure 2. Big Data and BI Research Over Several Years

Although the trend had increased in previous years, the number of articles decreased to two in 2022. This decline is likely due to the COVID-19 pandemic from 2020-2022, which diverted much of the attention of academics and policymakers to more urgent topics, such as public health responses, vaccination, and economic sustainability. However, the number of articles increased again in 2023, with five articles published. This resurgence indicates that attention to big data and BI remains relevant, especially as the public sector faces new challenges, such as the accelerated digital transformation due to the pandemic. This trend also reflects the global return to focusing on the modernization of governance and data-driven decision-making.

4.2. Research Design: The Emergence of Theoretical Sophistication

In Figure 3, this study analyzes 56 articles that use various research methods, reflecting a multidisciplinary approach to exploring the implementation of big data and BI. The case-field study method used in 22 articles is the most dominant, highlighting empirical exploration of the application of this technology in real-world contexts, such as corporate governance and administration, business process automation, healthcare services, and innovative city management. As many as 15 other articles adopt conceptual analysis that focuses on developing a theoretical framework to understand the relationship between technology, policy, and its impact. The survey questionnaire method, used in 9 articles, provides quantitative insights into this technology's perceptions and adoption levels from the perspective of stakeholders such as government employees and the general public. Additionally, 6 articles use literature reviews to construct a comprehensive picture of trends, gaps, and potential future research, while 4 articles employ content analysis to identify patterns and strategic themes from documents such as government reports and policy data. This diversity shows that research on big data and BI is not only interdisciplinary but also

combines quantitative and qualitative methods to understand the complexity of its implementation. This approach reflects the importance of cross-disciplinary collaboration, methodological flexibility, and integrating theory and practice to provide relevant strategic insights for the public sector worldwide.

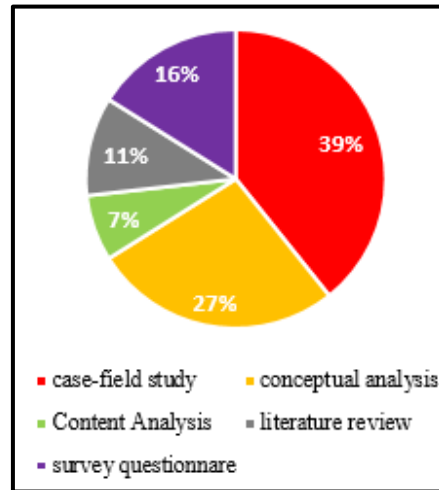


Figure 3. Distribution by Research Method

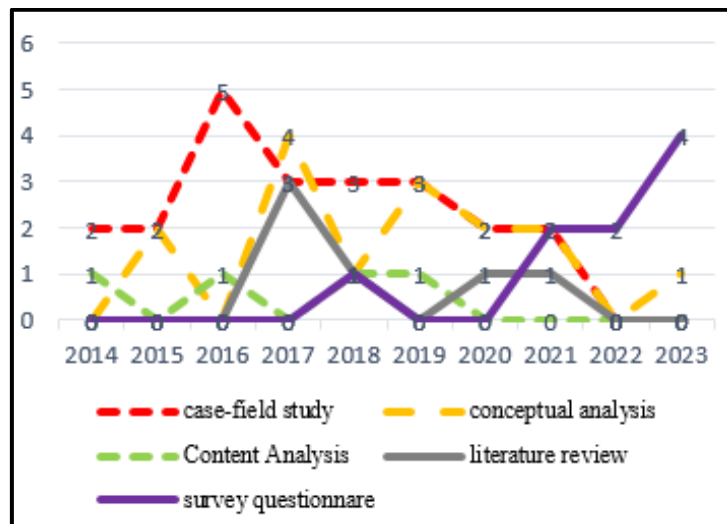


Figure 4. Distribution by Research Methods by Year

This research also reveals an interesting relationship between the publication time of articles and the research methods used by illustrating the evolution of methodological approaches in big data and BI studies over the past decade. This analysis reveals trends in the preference for specific methods and provides insights into how the needs and challenges in this field have changed over time. Overall, this analysis shows significant patterns of evolution in research on big data and BI. In the early phase (2014–2019), empirical case-based and field studies dominated research to identify this technology's implementation practices in various local contexts. The main focus during this period was to understand the initial challenges, opportunities, and success factors in implementing big data technology in the organization. The intensive growth period (2017–2019) marked the diversification of methodological approaches, with an increased use of conceptual analysis and literature

review. This approach reflects the efforts of academics to strengthen the theoretical foundation, develop a conceptual framework, and integrate various findings from previous research to create a more comprehensive and in-depth understanding of the benefits and challenges of implementing this technology. In the modern phase (2020–2023), research shows a shift in focus towards the user perspective through survey-based approaches. This trend reflects the response of academics to emerging new dynamics, such as the increasing need for data-driven decision-making amid global challenges like the pandemic and rapid digital transformation. Survey-based research helps evaluate the success of implementing this technology from the perspective of users and stakeholders. It provides insights into the barriers and perceptions that can influence further adoption.

4.3. Research context: Placing Big Data and Business Intelligence research location

Research on implementing Big Data and Business Intelligence (BI) reflects significant geographical diversity. In Figure 5, Asia has become the dominant region in Big Data and BI research, with 27 studies. Countries such as Malaysia, China, India, and Jordan stand out with various case studies. In Malaysia, research highlights the importance of integrating Business Intelligence and Big Data analytics to enhance the performance management of public organizations (Manikam et al., 2019). In China, the focus is on utilizing big data from social media to support strategic decision-making (Niu et al., 2021), while in India, multidimensional OLAP models are applied to enhance data management efficiency (Wani & Jabin, 2018). Europe has made a significant contribution with 16 studies. Countries such as Spain, the Netherlands, Germany, and Turkey demonstrate how theory-based approaches and frameworks can be applied to maximize the potential of Big Data and BI. In the UK, the focus is on organizational learning and cross-sector collaboration to effectively manage Big Data (Okwechime et al., 2018), while research in Germany introduces the SOA-based ELTA approach for Business Intelligence solutions responsive to Big Data (Dmitriyev et al., 2015). Additionally, studies in the Netherlands highlight the importance of information governance in driving innovation in the public sector (Klievink et al., 2017).

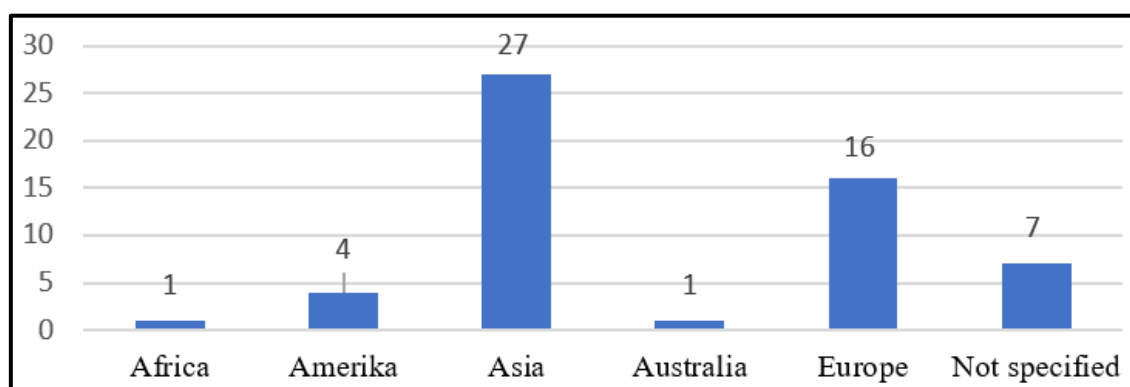


Figure 5. Distribution by Location

The American continent contributed 4 studies focusing on the efficiency and effectiveness of Big Data implementation in organization. In the United States, the research emphasizes the importance of strong data governance, security, and transparency to harness this technology's potential fully (Desouza & Jacob, 2017). Research in Cuba explores the development of better architectures and methodologies to address the challenges of Big Data in the public sector (Marín-Ortega et al., 2014). In Africa, research in Mauritius shows

the great potential of Big Data to enhance efficiency, transparency, and the quality of public services (Mohabeer et al., 2019). Although the number of studies in this region is still limited, the research results indicate significant potential for further exploration. Australia contributed one study highlighting the importance of top management roles, performance measurement, and the import of external knowledge in integrating BI in the public sector (Elbashir et al., 2022). This research reflects attention to managerial and strategic aspects of the implementation of big data and BI technology. Some studies do not specify particular geographic locations but provide relevant global insights. This research highlights the need for a critical and cautious approach in utilizing this technology and the necessity for better management development and technological structures in the future. Each region has unique challenges and priorities, such as technology adaptation, regulation, and organizational culture. These findings indicate that implementing big data and BI requires an approach tailored to the specific needs of each region, as well as cross-country collaboration to share knowledge and best practices. This makes big data and BI strategically relevant tools for supporting digital transformation across various sectors.

4.4. Research focus: Implementation and Benefit of Big Data and Business Intelligence

Research on Big Data and Business Intelligence (BI) in the public sector highlights the importance of these technologies in the digital era. It dissects two main aspects that are the focus of the study, namely implementation and benefits. Of the 56 articles analyzed in Figure 6, there is an interesting distribution regarding the research focus on Big Data, BI, and their combination. As many as 30 articles focus on the implementation aspects of Big Data. This research describes various challenges organizations face in adopting Big Data, including the need for reliable technology infrastructure, effective data governance management, and the development of human resource competencies. These implementation aspects also include strategies for integrating data from various heterogeneous sources to support better decision-making. The implementation aspects of BI are discussed in 20 articles. This focus encompasses multiple approaches to integrating BI into organizational systems, such as developing adaptive frameworks, adopting advanced analytical technologies, and training human resources. These articles also highlight the importance of good data governance and cross-sector collaboration to ensure the successful implementation of BI in the public sector.

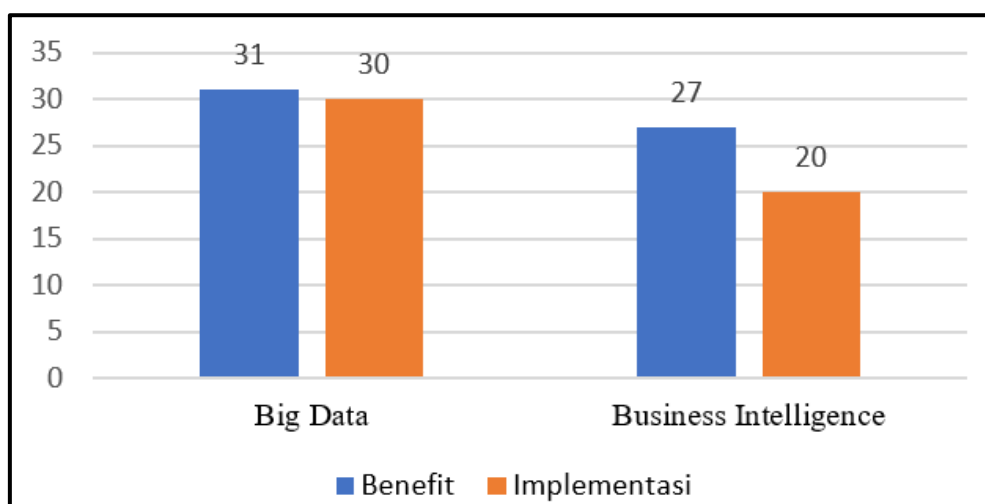


Figure 6. Distribution of Research Themes

Implementing big data and BI in the public sector is a new concept of data management and is still being continuously developed by some governments. Research related to big data in the public sector first appeared in 2014, explaining that big data has great potential for improving efficiency in the public sector (Desouza & Jacob, 2017). While related to BI, previous research on Business Intelligence Systems (BIS) mainly focused on the private sector (Chen et al., 2012). Implementing big data and BI in the public sector is a complex process that requires a thorough understanding. Success factors play an essential role in ensuring the implementation. The challenges of using big data from organizational readiness include organizational alignment, organizational maturity and organizational capabilities (Klievink et al., 2017). The importance of technological and organizational preparation in adopting big data technology, mature planning, and strong security in facing obstacles in implementing big data (Srinavin et al., 2021). Meanwhile, Nasab et al. (2017) identified four key dimensions of critical success factors for implementing BIS such as organization, process, technology, and organizational culture. In addition, there is also the concept of Critical Success Factors for the implementation of BIS, namely support, process, governance, and Technology (Abai et al., 2019; Yahaya et al., 2019). Factors such as system quality, information quality, user quality, customer satisfaction, and user performance also significantly influence system efficiency and BI success (Al-Okaily et al., 2023).

In the public sector, support from top management and staff, planning and budgeting, and understanding of the interpretation of technology needs influence organizational decisions in implementing BI. The effectiveness of the implementation of BI depends on how the transformation process is. The Kimball Lifecycle methodology for developing BI outlines the stages of the BI implementation process that can be implemented in a series of stages, namely project planning, identifying business needs, design, development, installation, and improvement (Yahaya et al., 2019). It involves efficient processes in collecting, integrating, analyzing, and presenting data for effective decision-making. The governance system in the public sector is structured to establish clear policies and regulations related to the use of big data and BI in organizations, including data security settings, privacy, regulatory compliance, and proper risk management. Collaboration between agencies, departments, and working groups can help address a big data project's complex data governance and privacy issues. Working together, the parties can support each other to ensure compliance with privacy regulations and data security (Desouza & Jacob, 2017). Financial management should focus on efficiency and effectiveness in managing financial resources to ensure that BI implementation in managing big data can reach its goal (Patel & Sharma, 2020).

Governments have great potential to leverage big data and BI to optimize services and decision-making. However, there are still obstacles to overcome to enable big data to reach its full potential. One of them is organizational culture. These requirements may challenge today's culture, so organizations must analyze whether certain cultural factors need to be considered to achieve the most appropriate alignment between technology and culture (Nasab et al., 2017). Public sector organizations that are not flexible and unprepared to adapt to new technologies tend to have difficulty managing big data effectively. A change in organizational culture is needed to encourage data-driven decision-making (Malomo & Sena, 2017). If the organizational culture supports big data initiatives and there is strong leadership support, the implementation of big data can be improved. Leadership that does not support innovation and digital transformation can be a barrier to managing big data. Meanwhile, the assimilation of BI integration into the management control system of public sector organizations can provide better visibility to the data and information needed for

better decision-making (Dmitriyev et al., 2015; Elbashir et al., 2022).

As many as 31 articles explore the benefits of Big Data in the public sector. This research highlights the potential of big data to improve operational efficiency, accelerate data-driven decision-making, and provide deeper insights for public policy managers. Big Data is viewed as a key tool to promote transparency, accountability, and responsiveness in public services. On the Business Intelligence side, 27 articles focus on the benefits of this technology. These studies highlight the role of BI in providing strategic insights through comprehensive data analysis. BI helps organizations monitor performance, evaluate programs, and design evidence-based policies. These benefits make BI an important tool in addressing the complexities of public needs in the digital era.

Application of big data and business intelligence can provide significant benefits to the public sector in improving the efficiency of business processes (Sait & Ali, 2022), improving and measuring organizational performance (Elbashir et al., 2022), enhancing the quality of public services (Manikam et al., 2019), improving financial performance and supporting better decision-making (Qaffas et al., 2023). Combining big data, BI, and public operational performance can bring benefits through increased public satisfaction (Ramos et al., 2017). Information technology-based business processes can increase efficiency in bureaucracy involving elements in government so that policy formulation (Ho et al., 2023) and public facilities can benefit society. Based on management theory, big data and BI can be powerful tools to improve the performance and competitiveness of organizations if managed and used properly (Alnoukari, 2020).

Big data can be used to design more effective and responsive public services to society's needs (Okwechime et al., 2018). With a good understanding of the relationship between big data, BI, and operational performance, organizations can optimize using big data to improve their operations. Governments can use big data analysis technology in data-based decision-making related to public service procurement (Choi et al., 2018). The public sector can leverage valuable information, support more efficient and effective decision-making, and improve the quality of decision-making with more accurate and up-to-date information. BI mediates the relationship between big data and organizational performance through the ability of BI to process, analyze, and present information from big data to facilitate decision-making processes (Chang, 2018; Alkilani & Al-Malahmeh, 2023).

In the private sector, the knowledge-based perspective explains how big data and BI can be seen as sources of competitive advantage, thereby improving company performance (Alnoukari, 2020; Ratia et al., 2018). Integrating big data and BI can be key to the digital transformation of companies in the hospital and tourism sectors, enabling them to create competitive advantages and increase their business efficiency (Madyatmadja et al., 2021). Big data and BI can predict the needs and wishes of customers (Khrisat et al., 2023) telecommunications companies. BDA capabilities positively impact BI infrastructure, directing corporate financial performance achievement (Chongwatpol, 2016; Ratia et al., 2018) and gaining business insights for better decision-making (Fan et al., 2015; Sun et al., 2018; Niu et al., 2021; Ahmad et al., 2023). The public sector can also implement big data and BI and the benefits the private sector has obtained. The public sector can use this technology to examine the needs of both the government and the public as users of public services.

4.5. Public sector: Big data and Business Intelligence

Out of the total 56 articles reviewed, research on Big Data, BI, and their combination shows significant differences in attention towards the public and private sectors. In Figure 7, research on Big Data is more dominant in the public sector, with 15 articles (88%) discussing its implementation and benefits in government organizations and public institutions, focusing on improving public service efficiency, transparency, and data-driven decision-making. In carrying out its functions, data is used by the public sector to formulate policies so that it can provide services and provision of public facilities to the public. Increasing data growth from year to year has brought about the definition of big data, demanding that the public sector formulate strategies in its management. The core of the big data paradigm is not an increasing amount of data but its analysis for intelligent decision-making that can result in cost reductions in public organizations while improving service delivery to the public (Mohabeer et al., 2019). Big data applications in the public sector can potentially improve operational efficiency between core government bodies, institutions, and public companies.

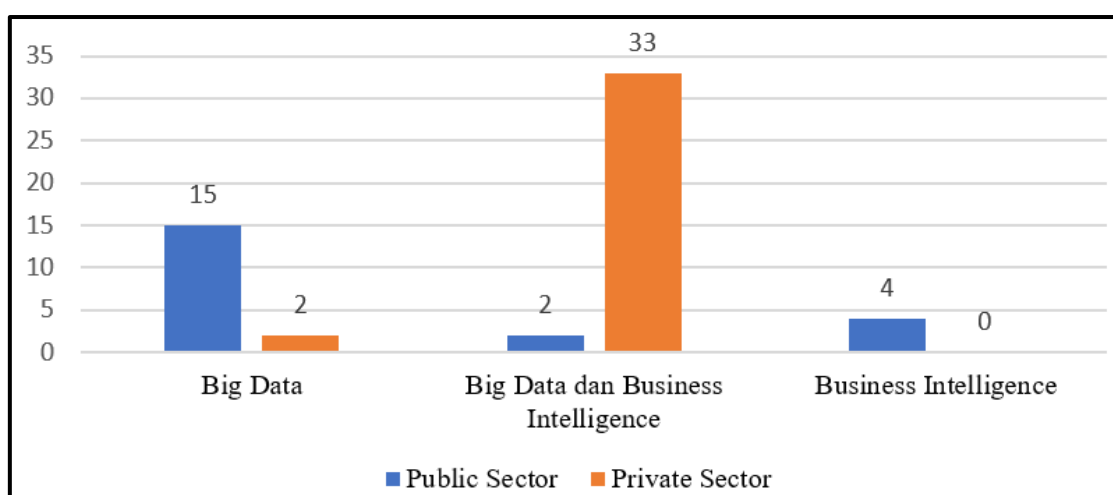


Figure 7. Distribution of Research Themes by Sector

In the public sector, research focuses on 4 articles that explore how BI is used to improve service quality, monitor performance, and formulate evidence-based strategies. Big data analytics in the public sector will promote transparency and cooperation among key stakeholders by sharing huge and varied amounts of data from various sources within government agencies, enabling decision-making processes to be more effective in the long term (Sait & Ali, 2022). Business Intelligence is a systematic technology framework that can manage and organize data into information for decision-making. Many organizations today face increasing challenges related to big data. Even though they have acquired abundant information, they are very unfortunate for not being able to use it fully (Manikam et al., 2019). Meanwhile, there are only 2 articles that discuss both big data and BI, focusing on cross-departmental data management to improve decision-making and enhance operational efficiency. Research conducted by Jamaludin et al. (2021) found that using Microsoft Power BI can be integrated with big data to improve maintenance management in the government sector. This process includes data collection, processing, analysis, and visualization that support better decision-making. Data collection is often a tedious and time-consuming task that is frequently overlooked in many courses. However, the research only explores one BI tool (Microsoft Power BI), which may limit insights into the potential use of other tools

more suitable for specific needs. Additionally, the biggest challenge affecting this is the technology users, where many government staff still lack sufficient knowledge about visualization tools and new interaction techniques, hindering the effective implementation of BI. Although research on applying the relationship between big data and BI is still scarce, this modern information technology system offers great benefits and potential in managing public sector administration data.

The public sector has yet to receive direct feedback from such technology investments, so it is sometimes more focused on real and direct programs for the public. Unlike the private sector, which has simpler business processes because its primary focus is making profits, the public sector has long bureaucratic processes. Governments have a major problem of inefficiency, which is the involvement of bureaucracy throughout the organization in bringing about change. For example, in the United Kingdom in 2016, most local governments did not make the most of their big data due to the presence of structural data siloes and other contextual factors such as data access, ethics, and organizational capabilities (Malomo & Sena, 2017). The public sector's obstacles to transforming big data technology to implementing change management by eliminating old ways of working and using new ways of doing work are the core dilemmas of a manager (Kuoppakangas et al., 2019). Moreover, decision-making in the public sector is sometimes influenced by political dynamic processes rather than the use of data, thus ignoring techno-optimist assumptions (Vydra & Klievink, 2019). Overall, the public sector tends to be more interested in Big Data for public service reform and data-driven policies, while the private sector focuses more on the integration of Big Data and BI to gain a competitive advantage in the market.

Research that combines Big Data and BI is more commonly found in the private sector with 33 articles (94%), exploring how the combination of these two technologies can create competitive advantages and optimize management strategies. In the private sector, big data and BI offer great potential to provide in-depth insight into customer needs and competitor strategies and transform the way they run with strong data-based decisions. With the help of BI and Analytics, they can reduce uncertainty and create potentially revolutionary technologies (Kim, 2014). Trieu (2017) points out the lack of a common framework in BI that allows the business world to integrate results, use them systematically, and discuss issues that need further research (Jin & Kim, 2018). Many aspects of integration and implementation into the economic analysis process in the big data and BI field still need to be perfectly developed. One of the main problems is finding algorithms, methodological principles, factors, and conditions that enable modern companies to conduct economic analysis of BI capabilities on big data (Mitrovic, 2017). Hyle (2012) stated BI as a platform that consolidates and integrates data so that data can be analyzed to support business operational decisions. Although analytics and BI are linked, extracting BI from big data is not as easy as it seems (Kimble & Milolidakis, 2015). Efficient big data processing can be one effective way to identify business opportunities, but to gain a competitive advantage, companies certainly need to address issues such as transferring all business data to a new platform, which can be very costly and time-consuming (Wani & Jabin, 2018). Furthermore, implementing the big data and BI model framework has become one of the concerns in technological development. There is research that tries to build an integration framework of a Map Reduce strategy by performing OLAP queries through heterogeneous data sources. With this approach, users can access and analyze big data from various sources more efficiently and effectively while the integrity and integrated data structure (Maté et al., 2015). Integrating big data, BI, and BDA can be done by treating them as part of one integrated decision support system (Jin & Kim, 2018). BI information management processes can collect and analyze big data and turn it into useful information,

covering the entire information value chain from data collection to management decision-making.

Klievink et al. (2017) argues that the government lags behind the private sector in terms of capturing the potential value that exists in the use of big data (Merhi & Bregu, 2020). The public and private sectors are increasingly interested in using big data collected from their systems. Using big data and BI can improve organizational operational performance in the service sector (Alkilani & Al-Malahmeh, 2023) and improve public service (Manikam et al., 2019). Big data and BI can help organizations sustain development and improvement, ultimately enhancing their capabilities to reduce risks and obstacles (Al-Malahmeh, 2022).

These risks and obstacles can slow the organization's performance and hinder achieving desired goals. As more and more governments invest in big data analysis, there is a need to evaluate whether they are ready to run big data projects, how well they perform in their implementation, and how they should continue further development in this field (Okuyucu & Yavuz, 2020). The potential development of big data and BI integration that the private sector has developed may be applied by the public sector to support business processes and service efficiency. More research is needed to explain the policy of exploiting and managing technology, especially big data and BI, to governments and make a road map for its development.

Research on the implementation and benefits of using Big Data and BI in the public sector is still relatively limited. This indicates a significant opportunity to explore how these technologies can be effectively applied in the public sector and provide substantial benefits. Future research could focus on developing a more comprehensive implementation framework, identifying success factors, and measuring the impact of these technologies on efficiency, transparency, and decision-making in the public sector. Thus, further exploration in this field will expand academic insights and provide practical guidance for policymakers in optimizing Big Data and Business Intelligence technologies.

5. Conclusion

The development of Big Data and Business Intelligence research is very diverse worldwide. However, studies discussing the public and government sectors are still very few compared to the private sector. Utilizing this technology to enhance data-driven decision-making and efficient public services remains a significant challenge for the public sector today. Although there has been progress in applying this technology, there is still much room for further exploration of how Big Data and Business Intelligence can be optimized to create more effective policies and more transparent and responsive public services. Despite facing unique challenges, the public sector has great potential to optimize data-driven decision-making through the application of Big Data and BI. By utilizing existing data, the government can design more targeted policies, improve the quality of public services, and accelerate a more transparent and responsive decision-making process to meet society's needs. However, to achieve this, the public sector must confront various obstacles, ranging from inadequate infrastructure and limited trained human resources to resistance to change within the government's organizational culture. Management of big data and business intelligence has become one of the topics in technological development in achieving organizational goals. This application can be adopted by organizations, specifically in the public sector, in policymaking and the provision of general services to the public. Management in big data and BI technologies has huge potential and is a challenge for the public sector to implement. Implementation of big data and BI in the

public sector must be in line with the policy of governance, resources, and technological development of the organization. The public sector has complexity in implementing plans and programs because binding provisions have governed the processes and implementation. The policy determination of the planning process and stakeholder elements' integration and involvement requires a fairly long bureaucratic journey. Policy based on the dynamics of political processes is still very thick and strong in the government sector. The plethora of public sector policy priorities makes the application of technology less fully the focus of budget use. However, given the potential for huge benefits in the use of big data and BI, which has been perceived considerably by the private sector, it is not possible for the public sector to maximize the implementation of big data and BI.

This research has several limitations, such as data limitations and the research sample due to some articles that cannot be accessed directly. The scarcity of articles discussing big data and business intelligence in the public sector has drawn particular attention from researchers to develop this study. The researchers hopes this research can serve as a useful study and literature review for learners and policymakers in the public sector to leverage digital technology transformation in the current era. Another limitation of this study is the scope of the case study and the time frame, which means that the research results cannot be generalized. Future research is expected to expand the sample size and research methods use. Furthermore, Some of the research topics in the future that can be developed can focus on the development of implementation frameworks, success factors, and the impact of technology on efficiency, transparency, and decision-making in the public sector, while also providing practical guidance for policymakers practitioners. The development of this research is expected to help build a knowledge framework for implementing big data and BI in the public sector.

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