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A systematic review of integration of big data analytics in performance management system: issues and insights

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Abstract: This study examines the literature related to big data analytics integration into performance management systems. The systematic literature review used the preferred reporting items for systematic reviews and meta-analyses (PRISMA) approach to select relevant studies for review. Fifty-three articles relevant to big data analytics and PMS were reviewed and analysed. The main publication trends regarding big data analytics and PMS literature, the key areas examined, and the main research opportunities were highlighted. The literature review identifies three major factors that influence the success of big data analytics integration into PMS: the organisation's data management capability to store, retrieve, and present collected data, the qualified human resource involved, and the decision-making process that may influence big data analytic integration into PMS.

Keywords: performance management system; PMS; big data analytics; BDA; strategic decision making.

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1 Introduction

The development of technology has led to the emergence of big data, which organisations can utilise to improve the effectiveness of strategic initiatives, including in forecasting, budgeting, planning and business performance analysis (Saleem et al., 2020; Nguyen et al., 2022; De Mello et al., 2015; Pugna et al., 2019). Organisations can also exploit external data derived from social media. Social media platforms serve as repositories for users' data, encompassing a wide array of information, such as individuals' preferences, shared content, visual media, and video posts, among other forms of digital expression, originating from diverse corners of the globe. These social media data can be used to analyse customer opinions, market trends, competitors' concerns, and employee behavioural issues (Nudurupati et al., 2021).

Although big data offer useful information for organisations, they are complicated and unstructured (Kokina et al., 2017). Thus, an organisation's capability to collect, display, analyse, and report the data in an understanding manner is significant for data-driven decision-making. Organisations can obtain faster real-time information regarding their performance from big data by using big data analytics (BDA), i.e., using analysis algorithms running on platforms to obtain competitive advantages (Sardi et al., 2020a). BDA enables the company to make decisions effectively based on the data provided (De Mello et al., 2015; Pugna et al., 2019). BDA can be used to evaluate those

data to manage the organisational performance as it enables the organisation's to undertake predictive and prescriptive analytics, thus enhancing their performance management system (PMS) (De Mello et al., 2015; Pugna et al., 2019). The analysis process can be integrated into business operations and PMS to improve business performance.

BDA integration in PMS still remains a significant challenge for organisations (Nudurupati et al., 2016; Ji-fan Ren et al., 2017; Maulana et al., 2019; Sardi et al., 2020b). Hence, it is imperative to gather insights from literature to determine the key issues for effective integration of big data in the PMS. As such, the focus of this paper is to review the literature on BDA utilisation in PMS to determine the publication trend, the insights from the literature and future research direction in this area.

This paper is structured as follows. Section 2 provides discussion on the rise of big data and the implication of BDA in PMS. Section 3 explained the systematic literature review approach used to analyse the literature. Section 4 discussed the review of selected articles, including publication year trend, citations, keywords distribution, and content analysis. Section 5 concludes the paper by outlining the contribution of this study to integrating BDA in PMS and providing insights for future research in this area.

2 Literature review

2.1 The rise of big data

Organisations utilise digital technologies such as social networks, IoT, internet connectivity, process automation, and BDA to enhance decision-making. For example, social networks enable organisations to monitor and analyse customer opinion, market trends, competitors' issues, or employee behavioural issues (Nudurupati et al., 2021). IoT is one of the fastest-developing technologies. IoT possesses the capacity, whether directly or indirectly, to enable objects and entities to store, process, share, and exchange data through internet connections in a more expedient manner, both within companies and among stakeholders (Nudurupati et al., 2021; Szozda, 2017). According to Davies (2015) and Fonseca (2018), there are some challenges that firms must overcome in response to technology development. First, investment in automation and ICT to support the business process. Secondly, as digital technology enables people to connect globally and increases collaboration with diverse stakeholders, organisations face the challenge of adopting new collaborative business models, which may include new potential partners. Lastly, the issue of data protection ensures data trust, confidentiality, and security.

There are several types of BDA. The first is descriptive analytics which gathers historical and current data from external sources and displays the data in an understanding manner for the manager to be analysed and then make decisions (Ajah and Nweke, 2019). Descriptive analysis is used to identify the data pattern (Kim, 2020). The second is predictive analytics to investigate what will happen. The third is diagnostics analytics to ascertain the cause of certain events in the past using the data gathered from various resources. Diagnostic analytics is being utilised in monitoring, fault detection, and maintenance (Ajah and Nweke, 2019). The fourth is prescriptive analytics which prescribes the best way to move toward specific goals or predictive patterns. Prescriptive analytics give options on how to take advantage of the predicted future or mitigate any future risk possible and the implication of each option (Pugna et al., 2019). These

analysis processes enable organisations to find the most appropriate model to describe customer demand. These processes can not be done without big data, machine learning, and artificial intelligence.

2.2 Implication of BDA in PMS

Digital technology enables managers to collect data from various resources on a real-time basis and deploy the data analysis in multiple formats. Thus, PMS that integrates BDA enables the achievement of organisational objectives and supports more effective and efficient decision-making as it enables managers to get real-time practical insights from more accurate data (Nudurupati et al., 2022), and also to identify any risk and fix it (Yin and Qin, 2019). The feed-forward information from data analytics is crucial for diagnostics control and strategy evaluation (Ferreira and Otley, 2009).

BDA in performance management (PM) has become an essential tool in managing firm performance as it enriches performance analysis in the control system (De Mello et al., 2015). Various studies have show that big data provide prompt and reliable external data that can be used in business performance analysis, forecasting, and planning (De Mello et al., 2015; Pugna et al., 2019). Thus, it enables strategic control by guiding the organisation's future direction and ensuring the strategies run in the right direction (El-Toukhy, 2021).

BDA increases the consistency and accuracy of measuring key performance indicators (KPI) and provides a faster insigths of the reasons for the achievements of these KPIs. Using BDA, companies can obtain more immediate real-time information about their performance, allowing them to make more effective and profitable decisions. For example, BDA helps a company create sales strategies for specific products and services rather than control and improve sales performance. Big data enables the predictive and prescriptive analytics in the analysis of the organisation's performance (De Mello et al., 2015; Pugna et al., 2019).

Prior research has elucidated the mechanisms through which corporations enhanced competitiveness by harnessing the power of big data (Leoni and Parker, 2019). Leoni and Parker (2019) investigated the control mechanism in Airbnb, one of the successful digital platform companies. The result shows that Airbnb implements formal bureaucratic control to foster the required behaviours of platform users. These controls use the form of BDA, which is elaborated and calculative to describe the host's activities and behaviours.

The efficacy of PMS is contingent upon an organisation's aptitude to cultivate a harmonious integration of human resources, procedural frameworks, and technological infrastructure. Multiple roles are needed to make the technology processed effectively, such as the IT group providing skills and guidance on selecting technologies and techniques to integrate business intelligence tools into the PMS. Additionally, it requires statisticians with the latest statistical techniques to analyse the data, analysts, and decision scientists knowledgeable in business measurements and data experimentation to connect statisticians and business managers (Mawed and Hajj, 2017). Accountants often play important roles in providing management with timely and reliable reports that lead to strategic decision-making. Therefore, accountants have critical roles in the BDA implementation. Accountants need analytics skills to use various data types from multiple sources (Kokina et al., 2017). Employee participation in the process and the acquisition of talent with data analytics skills are crucial to the success of BDA adoption (Daniri et al., 2023).

Another challenge for organisations in utilising big data is their capability in data management. The more complex organisation's interactions with stakeholders will generate rich data and information that might be useful for management. Unstructured data, accessed through the cloud, social networks, and websites, will require more effort to store, retrieve, and summarise in useful ways for decision-making (Jia et al., 2015). On the other hand, not all data and information needed in organisations can be accessed digitally. Manual data collection becomes another problem for organisations implementing BDA in the PMS (Abidi et al., 2020). Data collected manually (e.g., data is stored and measured using a spreadsheet) usually will raise a problem in data accuracy and data reliability, affecting managers' trust in data and commitment to data-driven decision-making (Pugna et al., 2019).

The data collected and analysed must also be aligned with the organisation's objectives (Mawed and Hajj, 2017). Big data provide information from various sources, but not all the information benefits organisations. Organisations must comprehend what data is required for decision-making, which will lead them to where the data can be collected and how it should be presented. Additionally, the accuracy and reliability of data can be enhanced when the data collected and analysed is both valuable and pertinent in assessing the organisation's objectives. The challenge lies in effectively harnessing the potential of big data to gain a competitive advantage in the market by pinpointing specific areas of focus for strategic action (Poma et al., 2020).

The manager that uses data for decision-making will drive data-driven decisions in the organisation (Spanò and Ginesti, 2021). The manager develop an analytical culture among the employees where decision-making is based on analysis of data and information (Raffoni et al., 2018). How the managers use the data to make decisions will determine where the data is collected and how it is presented. The data can be used to evaluate any problem, predict the future outcome, or provide options to take advantage of the predicted data. The analytical culture, where every decision is made based on the data and information analytics process, is important to increase the effectiveness of BDA.

3 Methodology

A systematic literature review approach was used to collect, select and analyse relevant literatures and provide insights for future research. The research objectives are to examine the literature and outline the issues related to BDA integration into PM. In this study, we adopted the method of synthesis described by Bryman (2012). The steps to synthesise the literature review include:

1 defining the goal and scope of the review

2 researching studies relevant to the goal and score of the review

3 analysing and summarising the results of each study.

3.1 Data collection

The systematic literature review used the PRISMA approach by Moher et al. (2009) is used to select relevant studies suitable for the review. The PRISMA approach entails the following steps:

1 identifying by database search

2 screening the articles

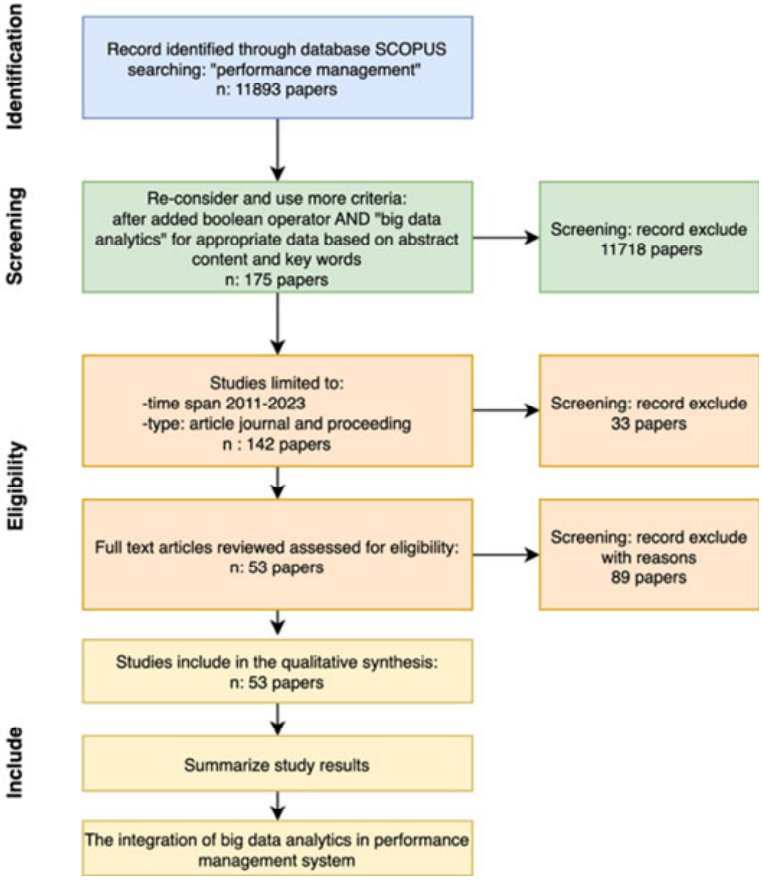
3 selecting eligible articles

4 qualitative synthesis studies

5 data selection.

The flow of this research's SLR-based data collection process is described in the steps below.

Figure 1 Articles screening process adapted from PRISMA statement (see online version for colours)



Source: Moher et al. (2009)

The eligibility criteria aim to sort and screen relevant studies that match the data collection purpose in the SLR. In this study, we use the following criteria:

1 Include only articles published in Scopus indexed. Scopus is the source for many reliable studies listed with various topics of interest. Scopus provides high coverage of peer-reviewed research in social studies.

2 To enhance the relevancy, the article included in the review was limited to studies published in journals and proceedings from 2011 up to 1st July 2023.

3 Include only articles that were written in English.

4 To ensure the suitability of the selected articles, the articles must include keywords related to PM and BDA. Specifically, all studies had words directly related to PM and BDA in the titles, abstracts, or the study's keywords.

5 The final screening of suitability was confirmed by reading all remaining articles for essential data collection that align with the goal and scope of the review.

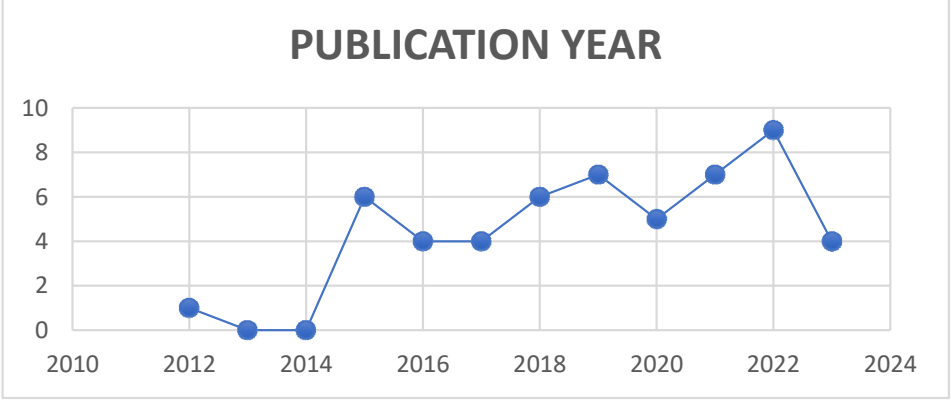
The final screening for the articles follows these criteria:

a Exclude articles not covering the issue regarding using big data and BDA.

b Exclude articles that did not cover the issue regarding PMSs.

The collected data are analysed to address the research question. First, a bibliometric analysis was conducted to provide publication year, sources, citation number, and the distribution of the keywords. This method aims to describe the relevancy of data and the research gap in this area. Second, a content analysis of the selected papers was conducted to identify the key main issues and insights gained from the papers.

Figure 2 Selected articles' publication year distribution (see online version for colours)



4 Findings and discussion

The overview of the research papers is provided in the first part of this section. The second section provides a content analysis of the reviewed article and research-based insights on the pertinent issues that must be addressed when integrating BDA into PMS.

Table 1 Selected articles' citation distribution

Authors	*Title*	*Source title*	*Cited by*
Rabl et al. (2012)	Solving big data challenges for enterprise application performance management	*Proceedings of the VLDB Endowment*	365
Calatayud et al. (2019)	The self-thinking supply chain	*Supply Chain Management*	187
Raffoni et al. (2018)	Business performance analytics: exploring the potential for performance management systems	*Production Planning and Control*	92
Attaran et al. (2018)	Opportunities and challenges for BDA in US higher education: a conceptual model for implementation	*Industry and Higher Education*	81
Kokina et al. (2017)	The role of data visualisation and analytics in performance management: guiding entrepreneurial growth decisions	*Journal of Accounting Education*	80
Nudurupati et al. (2016)	Contemporary performance measurement and management (PMM) in digital economies	*Production Planning and Control*	69
Pugna et al. (2019)	Corporate attitudes towards big data and its impact on performance management: a qualitative study	*Sustainability* (Switzerland)	54
Minatogawa et al. (2020)	Operationalising business model innovation through BDA for sustainable organisations	*Sustainability* (Switzerland)	49
Mawed and Hajj (2017)	Using big data to improve the performance management: a case study from the UAE FM industry	*Facilities*	48
Robert et al. (2022)	Implementing industry 4.0 real-time performance management systems: the case of Schneider electric	*Production Planning and Control*	45
Muntean (2018)	Business intelligence issues for sustainability projects	*Sustainability* (Switzerland)	43
Sardi et al. (2020s)	Big data and performance measurement research: trends, evolution and future opportunities	*Measuring Business Excellence*	36
Nudurupati et al. (2021)	Impact of the changing business environment on performance measurement and management practices	*International Journal of Production Economics*	32

4.1 Overview of the research papers

4.1.1 Publication year

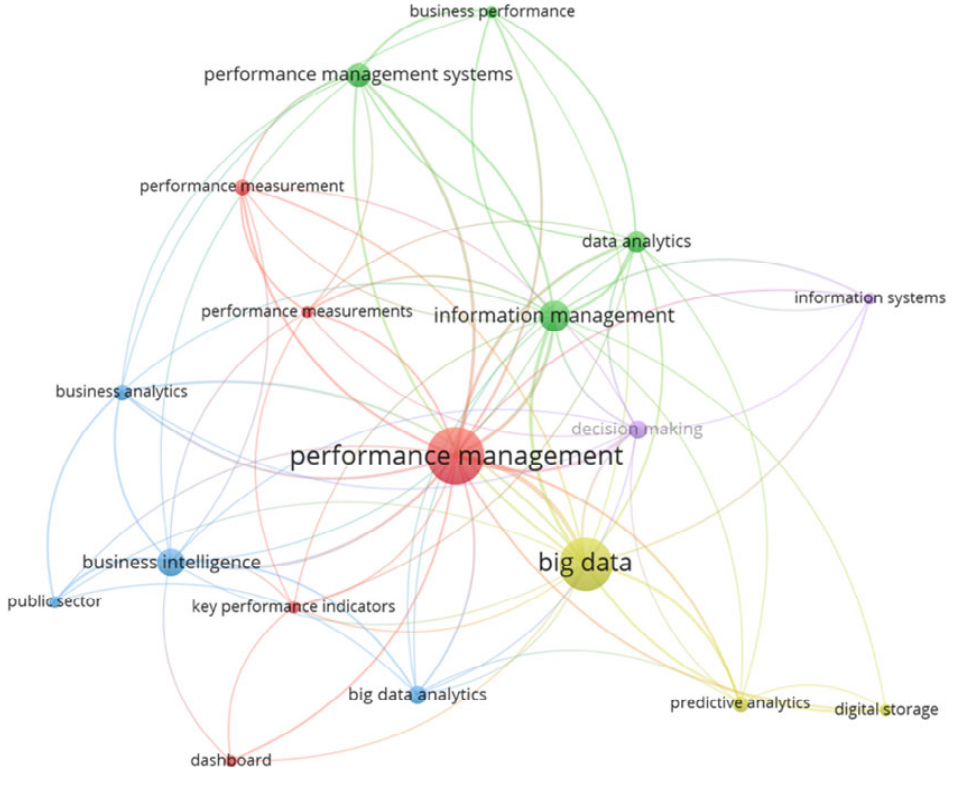
Figure 2 shows that research related to the implications of big data on PM is increasing from year to year. Of 53 studies relevant to BDA and PMS, only one was conducted in 2012. From 2015 to 2022, there has been an increase in publications in this area. However, the number of existing studies is still insufficient. It shows that BDA and PMS studies are still rarely explored, even though studies in this area have begun to increase over the last five years.

4.1.2 Citations

There are 1,490 citations from 53 selected articles in this study. However, only 13 articles have more than 30 citations.

Table 1 shows that the article with the most citation in the last ten years is a study from Rabl et al. (2012) with 365 citations. The other 12 articles with more than 30 citations were published in 2016–2022. This indicates a growing interest in big data and PM research during the aforementioned time frame (2016–2022).

Figure 3 Selected articles' keywords distribution using VOSviewer application (see online version for colours)



4.1.3 Keywords distribution

The keywords were submitted to the VOSviewer application to map the correlations between keywords. Figure 3 shows that the authors used only 18 keywords in the selected articles that appear simultaneously more often in the defined keywords. PMS keywords are linked to big data, information management, business intelligence, data analytics, and PMS. This demonstrates that research in PMS has solid associations with these specific keywords. Figure 3 shows there are 5 cluster areas divided into five colours. The first, cluster red, shows that research relates to PM elements such as dashboard, KPI, and performance measurements. This cluster explored the use of BDA in presenting the data for performance measurement, one of the elements in PM. However, the PM study rarely explores research related to dashboards for visualising the data.

Second, the green cluster which indicates that PM research focuses primarily on data analytics, business performance, information management, and PMS. This cluster showed the connection between information management, which can produce data analytics for PMS, and the relation to the improvement in business performance. However, from Figure 3, the focus on business performance is still rarely discussed. Thus, it might be interesting to explore the implementation of information management and data analytics and its connection to business performance.

The third cluster, blue, indicates that BDA research focuses primarily on the business intelligence and business analytics dimension. It is also interesting to explore business intelligence when investigating BDA. This cluster primarily focuses on the function of BDA. The fourth cluster, yellow, also focuses on the function of BDA, which covers big data, digital storage, and predictive analytics. The last purple cluster focuses on the information system (IS) and decision-making, which connect to PM.

When investigating the relationship between BDA and PMS, it is necessary to take into account these clusters of research keywords. The vital area to be explored are information/data management (such as business intelligence, data analytics, digital storage, dashboard, and IS), PMS, and performance measurement.

4.2 Content analysis

Table 2 shows the highlights of 53 studies from the selected articles. The findings from the review of selected articles showed three significant issues that are explored in PMS studies:

1 Data management

2 Qualified human resources

3 Strategic decision making.

4.2.1 Data management

The organisation's operations and interactions with the stakeholders generate rich data and information useful for reporting and decision-making. However, large amounts of data and their sources have become a significant obstacle for organisations seeking to make data-driven decisions. Unstructured data, such as email data, website traffic data, customer comments, and reviews in social media, require more effort to store, retrieve, and summarise in valuable ways for decision-making. Data management capability

includes data collection, integration, quality (accuracy and reliability), and data accessibility. Data collection is the ability of an organisation to gather relevant data from different sources. Data integration relates to an organisation's ability to aggregate data from other sources in a different format. Data quality refers to managing data quality via data cleansing, standardisation, and access security (Jia et al., 2015). The data management capability to store, retrieve, and present all data for PM is a complex issue for organisations (Kokina et al., 2017). Various researchers have suggested the importance of data storing and data management in utilising big data (Manikam et al., 2019; Abai et al., 2019; Kokina et al., 2017; Abai et al., 2015) in the decision-making process.

Several concerns raised in previous case studies regarding the implementation of big data management in organisations impacted their use of PMS systems. The first issue is that the organisation wishing to use BDA in PMS encountered difficulties storing and gaining access to the data because data sources are not readily available. Some performance indicators and measurement data are stored manually on paper or in spreadsheet documents (Abidi et al., 2020). Therefore, manual data collection and the possibility of conflicting data become an issue in implementing BDA. In the context of BDA, the problem may arise due to a lack of organisational understanding and commitment to technology use. Organisational work culture is related to analytical and digitalisation culture, which can influence an organisation's commitment to advancing technology within their business. Employees who work in an environment where organisations pay less attention to digitalisation and data analytics will not be concerned with the accuracy of data used for performance measurement (Abidi et al., 2020).

The second issue is how organisations handle the massive amounts of information that must be presented to management for decision-making purposes. The problem is that stored, collected, and analysed data do not fully match organisations' objectives (Abidi et al., 2020). The alignment of business objectives and technological support is necessary (Mawed and Hajj, 2017). The unmatched data with the objective could lead to misleading information used in decision-making. Therefore, organisations must link the objectives and performance measurements before designing the data management system. A clear set of key indicators focusing on strategic objectives and priorities is important in constructing BDA for PM (Raffoni et al., 2018).

The last issue concerns the quality of the database system used to manage big data. The system's configuration that supports data management activities faces several challenges, such as technology complexity, data accuracy, the rights of data usage, security and privacy, and system design and manufacturing (Mawed and Hajj, 2017). Investing in the right technology in the system is one of the efforts organisations need to make when utilising BDA in PM (Pugna et al., 2019). The problems arise from the lack of data configuration capabilities, such as data security (Kumar et al., 2022), data accuracy, and data misuse, possibly caused by the lack of organisational focus on system support development and investment. The study by De Mello et al. (2015) suggested that investment in data and system infrastructure is essential in developing data management for PMS. Technology compatibility is important as it hinders the successful adoption of Industry 4.0 (Obermayer et al., 2022). An organisation focusing on data-driven management will commit to developing the IS.

Table 2 Selected articles' content analysis

No	*Authors*	*Study highlights*	*Area*
1	Rabl et al. (2012)	Evaluate six open-source database management systems in storing and monitoring big data	*Data Management*
2	Vera-Baquero et al. (2015)	Provide an analytical framework for business activity monitoring using cloud computing and a solution for the entire supply chain in querying the big data to deliver business insight	*Data Management*
3	Jia et al. (2015)	Develop a five-dimension framework of data-driven decision-making capabilities	*Strategic Decision Making*
4	Hani et al. (2015)	Specify issues in the implementation of business intelligence and analytics:	*Data Management; Qualified Human Resources*
5	Abai et al. (2015)	Develop a four layers framework in the implementation of integrated business intelligence and analytics in PMS: human resource, governance, process (strategic planning), and application and tool	*Data Management; Qualified Human Resources; Strategic Decision Making*
6	Bertei et al. (2015)	Proposed a theoretical framework of big data technology's roles in the exploration of unstructured and unusual data sources for decision making	*Strategic Decision Making*
7	De Mello et al. (2015)	Investigated the use of BDA in performance measurement systems to make decision using predictive and prescriptive analysis	*Strategic Decision Making*
8	Eze et al. (2016)	Develop a cloud-based big data framework for systematic performance management across the entire healthcare system using cloud computing	*Data Management*
9	Yahaya et al. (2016)	Developed an integrated framework of business intelligence and BDA	*Strategic Decision Making*
10	Nudurupati et al. (2016)	Investigate the benefits of new technological advancements such as big data and IoT and how it is integrated through strategy. The finding finds that technology can enhanced decision-making, including IoT and social media. Some issues revealed that when dealing with big data, they need to be able to capture, process and communicate the data to the decision-makers with more understandable tools and techniques. This	*Strategic Decision Making; Data Storage And Management*
11	Zibitsker et al. (2017)	Reviewed case studies in BDA applications for performance assurance	*Strategic Decision Making*
12	Kokina et al. (2017)	Investigate the role of an accountant in designing a PMS that aligns with the organisation's objectives	*Qualified Human Resources; Strategic Decision Making*
13	Mawed and Hajj (2017)	Describe challenge faced by the organisation in the data collection which is the area of human resources	*Qualified Human Resources*
14	Al Rashdi and Nair (2017)	Developed a framework to implement the business intelligence and analytics capabilities in performance management	*Qualified Human Resources; Strategic Decision Making; Data Management*
15	Zibitsker et al. (2017)	The study provides several examples of dynamic performance management of big data clusters application and describes the challenges of data collection	*Data Management*
16	Raffoni et al. (2018)	Develop a framework for business performance analytics development in PMS and suggest important issues: development of analytical culture and the availability of analytical skills	*Qualified Human Resources; Strategic Decision Making*
17	Attaran et al. (2018)	Identified the potential of data analytics to address challenges faced by the university	*Strategic Decision Making*

Table 2 Selected articles' content analysis (continued)

No	*Authors*	*Study highlights*	*Area*
18	Muntean (2018)	Identified the issue of how business intelligence and the tools can improve the collecting, analysing, and reporting of business data	*Data Management; Strategic Decision Making*
19	Jayakrishnan et al. (2018)	Proposed framework that emphasises more on human behaviour and socio-technical perspective paradigm in performing strategic performance diagnostics by utilising business intelligence	*Strategic Decision Making*
20	Syed Thajudeen (2018)	Described a case study of organisation journey towards data-driven organisation	*Data management; Strategic Decision Making*
21	Jantarada and Grilo (2018)	Proposed a new approach to operational PMS tools by combining Design Thinking (DT) and Data Analytics (DA)	*Strategic Decision Making*
22	Calatayud et al. (2019)	Propose a new supply chain model using ICT advantages to address key supply chain challenges in a complex and uncertain environment	*Strategic Decision Making*
23	Pugna et al. (2019)	Investigates big data's impact on performance management	*Qualified Human Resources; Strategic Decision Making*
24	Manikam et al. (2019)	Exploring the BDA framework and the impact on performance measurement	*Data Management*
25	Abai et al. (2019)	Suggested four integrated factors of business intelligence and analytics and organisational performance management implementation: skill, documentation, visualisation, work culture	*Data Management; Qualified Human Resources*
26	Cavalcante Siebert et al. (2019)	Investigated application of technology in predictive analytics using machine learning techniques	*Strategic Decision Making*
27	Viswanandhne et al., (2019)	Explored the role of prescriptive analytics and how prescriptive analytics using AI and Machine learning improved systems that handle predicted outcomes	*Strategic Decision Making*
28	Okasha et al. (2019)	Developed a novel approach to performance management	*Strategic Decision Making*
29	Sardi et al. (2020)	Suggest new research themes in developing the system of big data usage in PMS	*Data Management*
30	Sanchez-Marquez et al. (2020)	Develop a method to evaluate quality management systems by analysing the balanced scorecard KPI using data analytics	*Qualified Human Resources; Strategic Decision Making*
31	Minatogawa et al. (2020)	Provides an artefact model for supporting decision-making in the business model innovation process using BDA	*Strategic Decision Making*
32	Robert et al. (2020)	Suggest several characteristics of PMS in Industry 4.0 and identified two main management principles: adherence of all actors and solidarity between actors	*Qualified Human Resources; Data Management*

Table 2 Selected articles' content analysis (continued)

No	*Authors*	*Study highlights*	*Area*
33	Abidi et al. (2020)	Suggest organisation in case study to connect performance management to an IT project for implementing performance measurement successfully	*Strategic Decision Making; Data Management*
34	Nudurupati et al. (2021)	Explored how business trend are impacting performance management and measurement. The finding proposed a framework that can guide future research into how emerging business trends affect PMM which enable the development of collaborative networks and the creation of opportunities to co-create value, all the while promoting innovation	*Strategic Decision Making*
35	Barletta et al. (2021)	Developed an organisational sustainability readiness model based on primary and secondary data. The model helps in motivating decision-makers and supporting decision-making for sustainability improvements	*Qualified Human Resources; Strategic Decision Making; Data Management*
36	Arnaboldi et al. (2021)	Developed and implemented a dynamic performance measurement tool in the university.	*Data Management*
37	Spanò and Ginesti (2021)	Investigated how Big Data is used to raise the attention of management on the relevance and usefulness of PMS	*Data Management*
38	Yan et al. (2021)	Developed an integrated knowledge visualisation and digital twin system for supporting strategic management decision-making	*Strategic Decision Making*
39	Fu (2021)	Developed multidimensional big data matrix model was used to analyse and conduct a systematic construction of a performance evaluation system	*Data Management*
40	Nica et al. (2021)	Identified the main methods and techniques of performance analysis and proper data management focusing on key performance indicators (KPI) and identifying problems	*Data Management*
41	Spanò and Ginesti (2021)	Investigated transformational process referred to as 'reorientation through boundary management.' Medical professionals actively embraced and implemented performance management system (PMS) concepts, indicating the potential for future evolutionary changes once existing constraints are addressed	*Strategic Decision Making*
42	Kumar et al. (2022)	Investigated the implementation of Industry internet of Things technologies in the manufacturing processes. The study revealed that the dominance challenges in the implementation are the security of data and reliability of technologies which can be mitigated by enabling blockchain technologies	*Data Management*
43	Obermayer et al. (2022)	Developed new definition of Industry 4.0 which emphasises the role of human factors. The research uncovered key factors driving the implementation of Industry 4.0, such as increased efficiency, accelerated information flow, and enhanced precision. Additionally, it identified obstacles, including issues of technology compatibility, human apprehensions, and a shortage of digital skills, which hinder the successful adoption of Industry 4.0 practices	*Qualified Human Resources; Data Management*

Table 2 Selected articles' content analysis (continued)

No	*Authors*	*Study highlights*	*Area*
44	Mohamad et al. (2022)	Developed a framework that will mash up some characteristics in designing an organisational strategic performance framework. The output is a conceptual performance measure framework for a typical decision-making application for organisational strategic performance management dashboarding by leveraging BI and BDA	*Strategic Decision Making*
45	Hannila et al. (2022)	Investigated the strategic role of product portfolio management (PPM) process and related targets and key performance indicators must be internalised before adjusting business IT to utilise data assets for data-driven, fact-based PPM. Factor that hindering the implementation of data driven PMM are insufficient understanding of the products nature, lack of holistic data governance, and inadequate IT support for a data-driven approach	*Qualified Human Resources; Data Management*
46	Nudurupati et al. (2022)	Explored the importance of organisational structure and cross-functional communication in fostering senior management commitment and motivation to enhance data capturing and analytical capabilities, thus facilitating effective decision-making	*Strategic Decision Making; Qualified Human Resources*
47	Sebbar et al. (2022)	Developed a Cloud manufacturing-based architecture that facilitates BDA (BDA) adoption, aiming to identify digital opportunities and significant benefits in performance management, production control, and maintenance processes	*Data Management*
48	Xiao (2022)	Explored the application of big data-driven technology in guiding decision-making processes within human resource performance management. It comprehensively demonstrates the viability of utilising big data-driven technology in intelligent human resource performance management, highlighting its key advantages and internal motivations	*Strategic Decision Making*
49	Nielsen (2022)	Developing conceptual framework by combining a holistic model which are balanced scorecard with the time-driven activity-based costing model while leveraging business analytics and performance management	*Strategic Decision Making*
50	Godavarthi et al. (2023)	Explained how to enhance leadership effectiveness and positively influence employee performance, managers in the industry should focus on key human resource management indicators such as collaboration, involvement, actualisation, perception, and teamwork. This recommendation stems from the inherent limitations of IoT devices and the decentralised nature of blockchain technology's ledger architecture	*Qualified Human Resources; Data Management*
51	Alsibhawi et al. (2023)	Developed a conceptual framework that incorporates multiple elements, including change management, knowledge sharing, information quality, IT project management, the perceived usefulness of a business intelligence system (BIS), and the perceived ease of adopting a BIS	*Strategic Decision Making*
52	Yang (2023)	Explained the application of the internet of Things and its BDA technology in the enterprise performance management system (PMS) and the sustainability of this application	*Data Management*
53	Daniri et al. (2023)	Investigated the significant role of data-driven performance management as a consequential factor. The results highlight the significance of employee engagement and talent acquisition professionals in driving the increased adoption of BDA	*Qualified Human Resources*

4.2.2 Qualified human resources

The people involved in integrating BDA into the PMS play a significant role in the success of the implementation. According to the literature reviewed in this paper, qualified human resources are needed to integrate BDA into PMS. The first topic discussed in the reviewed papers is the organisation's understanding of the advantages of BDA. A study by Raffoni et al. (2018) revealed that the controllers, project leaders, and managers had limited knowledge of the statistical and econometric language from the data provided by the system. Despite the availability of data and analytical methods, the constraint is whether the data users can effectively adopt and mobilise the data to extract valuable insight for organisations (Raffoni et al., 2018). As the system user, the organisation's management needs to understand the value of big data and develop analytical competencies to integrate BDA in PMS effectively.

Problems might arise when there is a lack of staff training and skill development relating to the BDA and statistics, as well as due to the unavailability of qualified human resources in the organisations. Obermayer et al. (2022) identified a lack of digital skills as one of the obstacles to adopting technology. Another case study by Pugna et al. (2019) revealed that the executives realise that the most significant constraint to creating data-driven organisations and building a data culture is not the technology capacities; but the people involved and their commitment to change. Pugna et al. (2019) also revealed that a traditional company that does not generate digital data believes big data has no value in its business process. This self-assessment of the value of big data on the company shows their lack of awareness and understanding of BDA's advantages. If the management does not commit to changing to a data-driven organisation, their ability to understand big data's potential will never be realised. The same issue was also addressed by Spanò and Ginesti (2021). Employee engagement in adopting technology and talent acquisition professionals can significantly drive the adoption of BDA in data-driven PM (Daniri et al., 2023).

The second issue is the lack of analytical culture where decision-making is based on rationality and comprehensive analysis of data and information. A controller and manager with an accounting and auditing background have a traditional view of control function, thus facing a significant challenge with ideas generated using BDA (Raffoni et al., 2018), affecting the effectiveness of BDA utilisation in PM. Work culture has become one of the issues in BDA implementation (Abai et al., 2019). Acceptance is important because the work environment consists of people with different cultures, competencies, and visions. According to Abidi et al. (2020), employees pay little attention to performance measurement, resulting in inaccurate input. This problem arises because of the unawareness of accepting changes toward data-driven organisations. Accepting the data-driven culture will increase the understanding that there is still more work to be done on the measurement matters, including the digitalisation data entry and teaming up with multidiscipline experts and managers to facilitate the decision-making process. The study by Spanò and Ginesti (2021) also revealed the same problem in the data-driven culture that affects the effectiveness of BDA integration in PM.

The third issue is the combination of skilled people involved in data management. A study by Abidi et al. (2020) revealed that one factor that causes data availability and data accessibility issue is the availability of experts involved in data management. IT experts need to be involved in the PM project to provide opportunities and explain the limitations regarding data entry to align with the design performance indicators measurement.

However, the lack of skills in BDA is one factor that causes data management issues. Human resources with expert skills in BDA are expensive (Pugna et al., 2019). Furthermore, besides technical competence, data scientists need to be sufficiently familiar with and understand the nature of the business, the objectives, and other specific features of the organisation to deliver maximum value to the organisation. A study by Syed Thajudeen (2018) showed that integrating BDA into PMS was complex due to a lack of digital fluency and skills among the management and working team; consequently, getting critical information and message across the company was challenging. A study by Spanò and Ginesti (2021) revealed that the collaboration of multidisciplinary teams results in effective data management. However, a study by Pugna et al. (2019) showed that organisations do not always respond to the necessity of hiring data translators or creating data officer functions in the company. This shows that the organisation is either less committed to addressing BDA challenges or lacks understanding and awareness.

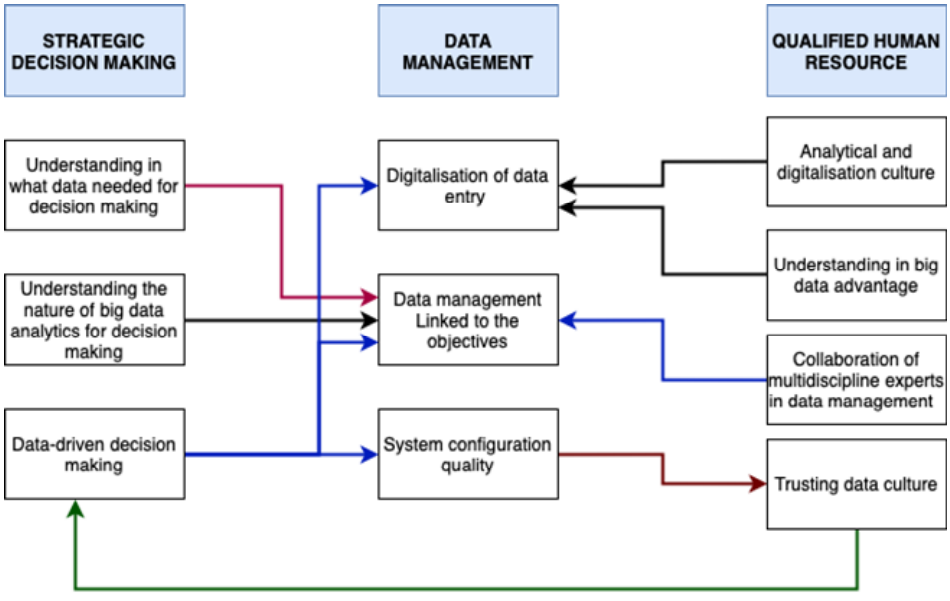
The last issue is the trust of data. Syed Thajudeen (2018) argues that organisations should drive a trusting data culture. Data need to be opened and accessible across all functions and departments within the organisation. Management should provide clear directions on the ownership of data within the organisation. Lack of data-sharing practice impacts the development of a trust-based data culture. A work environment built on trust promotes data transparency and a culture of sharing. However, Pugna et al. (2019) revealed that executives' confidence in the numerical data provided by the system is lower than expected, given their commitment to a data-driven organisational culture. The executives believe that using data and analytics can expose the organisation's reputation to risk. This issue arises because the organisation does not feel confident in the IS's data security and data accuracy. Therefore, data management also plays a vital role in increasing an organisation's trust in data.

4.2.3 Strategic decision making

Data analytics can be used to evaluate organisational problems that arise, predict future outcomes, or provide options to take advantage of the predicted data. The type of decisions managers make from the data will be determined by the data sources and the data presentation that provide relevant information for the manager. Previous studies revealed several issues concerning organisations' strategic decision-making capabilities, which might affect the BDA integration into PM.

The first issue is the organisation's understanding of the relevant data needed for decision-making. Identifying what data is necessary to support decision-making has become critical in designing BDA for PM (Raffoni et al., 2018). Organisations faced a challenge as they gathered data from various resources without understanding the means and benefits of the data (Mawed and Hajj, 2017). This led to a lack of data accuracy and reliability. Massive data provides much information to be analysed; therefore, it is crucial to understand the data being analysed fully. Otherwise, the analysis result might lead to the wrong decision (Pugna et al., 2019). As highlighted in a study conducted by Jantarada and Grilo (2018), it is crucial to have deep insights into the specific operational environment and its connection with the organizational strategy. These insights are crucial in understanding the information that needs to be communicated to the managers to enhance the data-driven decision-making processes.

Figure 4 The cause-and-effect relationship between issues in the integration of BDA into PMS (see online version for colours)



The second issue is the lack of understanding of the nature of BDA. A study by Pugna et al. (2019) showed that managers did not consider historical data to be important in predicting future outcomes in the decision-making process. They believe history is not the best way to predict the future and do not trust evidence in decision-making. This shows a weakness in understanding the nature of BDA, thus affecting the implication of BDA on PM. Nudurupati et al. (2022) also revealed that senior management commitment to the technology adoption, for instance, enhancing data capturing and analytical capabilities, can increase the effectiveness of the decision-making process.

The last issue is managers' data-driven decision-making. A study by Pugna et al. (2019) found that managers generally relied too much on their experience and intuition when making decisions. They did not use enough data in decision-making. This issue is possibly caused by the data-driven decision-making acceptance among the employees (Hani et al., 2015). Employee acceptance may depend on the work culture and employees' trust in the data provided by the system.

Figure 4 illustrates how human resource issues and strategic decision-making behaviour can affect the organisation's data management quality. Data management is an essential part of BDA integration into PMS. Data management activities configure and manage the use of BDA in the PMS. Data management issues can be caused by unqualified human management and organisational behaviour toward strategic decision-making. For example, the data management issue occurs when the data stored, collected, and analysed do not match the objective (Abidi et al., 2020). The lack of understanding of business and the objective of the organisations can cause this data management issue. Therefore, the participation of experts with multidisciplinary skills, such as IT, business, finance, etc., is required in data management development. The business experts have the skills to devise a strategy to achieve the organisation's objectives. While, IT experts have the technical skills to configure the system infrastructure and implement the strategy.

Hence, multidisciplinary experts in data management can ensure the correlation between data management and the objective. Thus, to analyse the integration of BDA into PMS in an organisation, it is important first to investigate the issue in the human resource and decision-making process. Next, explore and identify the effect of those issues in the data management activities that represent the technical aspects of the integration process of BDA into PMS.

5 Conclusions

This study offers several contributions by illustrating the main publication trends regarding BDA and PMS literature and highlighting the main research opportunities in the PMS area. The result of keywords distribution analysis shows how Big Data and PMS-related research has strong relationships with some specific keywords such as big data, information management, business intelligence, data analytics, and PMS. In addition, the content analysis shows that 49% of the articles explored the issue of data management, 30% qualified human research, and 60% strategic decision-making. Most of the articles focused on developing a conceptual model or framework (Vera-Baquero et al., 2015; Jia et al., 2015; Abai et al., 2015; Eze et al., 2016; Al Rashdi and Nair, 2017; Raffoni et al., 2018; Jayakrishnan et al., 2018; Manikam et al., 2019) and investigating the issue in the BDA implementation. However, empirical research remains rare in this area of study.

To implement good strategic decision-making, the effective integration of BDA into PMS has to include qualified human resources (i.e., collaboration of multidiscipline experts, trusting data culture, analytical and digitalisation culture, and understanding of big data advantage) and good data management (i.e., digitalisation data entry, data management that linked to the objectives, and system configuration quality). Strategic decision-making needs to address some issues, such as the manager's understanding of what data is needed for decision-making and the nature of BDA for decision-making, thus enhancing data-driven decision-making.

This study gives implications to managers by suggesting three major issues to consider while exploring the integration of BDA into PMS. The issues are the organisation's data management capability to store, retrieve, and present all collected data, the qualified human resource involved, and the decision-making process that might affect the BDA integration into PMS. Thus, this paper provides insights into the practical issues that the manager may consider when integrating BDA into the organisation's PMS.

This study also suggests future research directions related to certain themes in the PMS field. The first theme is the issue of data management. Several research has discussed the conceptual model for data management; however, more empirical research is required to investigate the use of BDA in data management to improve the PMS effectively. Future research might focus on how data management is linked to the objectives and the PMS system configuration that leveraged on BDA. Second is the issue of human resources. Future research should address the role change in accounting and management and the new skills needed for adopting BDA in the business process and PMS. The change in an organisation can affect the change in the company's data culture; thus, research in this area that explores the change in the organisation, development of data culture, and qualified human resources is also needed. Third is the issue of the decision-making process. Recent literature discusses the use of BDA in the decision-

making process (eg., Jia et al. (2015), Yan et al. (2021), Mohamad et al. (2022), Xiao (2022)), however, the level of analytics in the decision-making process has not fully investigated. Future research should address how BDA can provide capabilities in descriptive, diagnostic, predictive, and prescriptive analytics to help managers make strategic decisions.

This study has some limitations. First, we did not fully explore BDA IS infrastructures. The IS infrastructures include the application and configuration of hardware and software, communication, and data architecture in the organisation's IS. Further studies are needed to explore the IS infrastructure required to support the integration of BDA into the PMS. Second, in terms of methodology, only English-language publications were reviewed. Therefore, studies related to BDA and PM in other countries published in a language other than English were not included in this study.

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