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Big Data Analytical Capabilities and Performance: The Mediating Role of Knowledge Management in IT Firms

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Abstract

This study aims to investigate the complex relationship between the capabilities of Big Data, knowledge management, organizational learning, and how they collectively impact the performance of small and medium-sized firms (SMEs) in Singapore's IT industry. This study aims to demonstrate the mediating role of organizational learning processes and knowledge management in the relationship between Big Data capabilities and company performance. To achieve this, a dataset of 300 organizations will be analyzed using simple random sampling and Structural Equation Modeling-Partial Least Squares (SEM-PLS). Extensive research has shown that knowledge management and organizational learning play a crucial role in maximizing the usefulness of Big Data capabilities and enhancing business performance. The results demonstrate the need of combining knowledge management and organizational learning with Big Data initiatives to create an environment that promotes performance enhancement. This integration enables a mutually beneficial influence that motivates businesses to produce exceptional results, particularly those working in the highly competitive technology industry. The study's conclusions emphasize the crucial role of knowledge management and organizational learning as intermediary roles for Big Data to fully realize its potential. The findings have significant ramifications for technology enterprises that are small or medium-sized. They propose a reevaluation of their strategic objectives that include a comprehensive approach to overseeing Big Data, knowledge, and learning. These aspects are crucial for a company's success in the modern digital environment.

Keywords: Big Data Capabilities, Knowledge Management, Organizational Learning, Firm Performance, SMEs, Technology Sector, Singapore.

INTRODUCTION

Mikalef et al. (2019) argue that the present period is commonly known as the "Age of Data" due to the rapid and extensive generation of data in all areas of government and society. Organizations have allocated resources to explore the possibility of generating value from data in response to the resulting excitement (Ashaari et al.,2021). According to Ranjan and Foropon (2021), big data analytics is based on the idea that organizations may transform themselves and gain a competitive advantage by analyzing large amounts of unstructured data from many sources. In fast-paced corporate environments that require effective decision-making, having sufficient access to data-driven insights is essential (Vasconcelos, 2023). There is a lack of thorough academic research on the best organizational structure that can fully utilize the benefits of investing in big data analytics, as well as the interaction between different components that improve performance (Ranjan & Foropon, 2021). The current corpus of writing on the benefits of big data analytics has primarily been

contributed by consulting firms, the media, and individual case studies. However, these sources do not provide or provide a theoretical foundation for the empirical findings obtained from extensive investigations. Recent research indicates that many firms are unable to fully optimize the returns on their investments in big data (Ghasemaghaei & Calic,2020). Indeed, there is a contrasting perspective that argues that big data could pose a threat to enterprises rather than providing them with advantages. There is currently a lack of agreement on the best approaches to take for big data projects, and there is also a lack of supporting evidence on the profitability of these investments (De Luca et al.,2021).

Many academic studies have emphasized the importance of thoroughly investigating all aspects of big data analytics in order to address the issues faced by multiple businesses (Aljumah et al.,2021). Although there have been some empirical studies conducted by Mikalef et al. (2017) and Vidgen et al. (2017), there is still a lack of research on the specific mechanisms that lead to performance improvements and the factors that determine their effectiveness. The concept of proficiency in big data analytics is receiving considerable interest in academic study. Organizations must successfully leverage big data analytics resources in order to fulfill their goals (Mikalef et al.,2021). Big data analytics competence refers to the ability to efficiently coordinate and utilize individuals, technology, and data to collect and analyze data in order to generate valuable insights (Mikalef et al., 2021). Organizations need to gather and nurture data, together with technological, human, and organizational resources, in order to create a competence that is difficult to duplicate and pass on (Blomster & Koivumäki, 2022). The amount of research investigating the resources required to develop a capacity for big data analytics is increasing, however most of this research assumes that all firms adhere to the same process.

Moreover, this empirical research is founded on the premise that the significance of resources devoted to big data analytics is uniform across all circumstances. With the increasing number of companies making significant investments in data-driven decision-making and big data analytics, it is crucial to comprehend the resources that corporations utilize to distinguish themselves. Big data management may now support web-based, computer, and digital businesses (Nasir et al.,2020). Companies like Amazon and Google, which are considered digital natives, have successfully incorporated large volumes of data in the past since they encountered fewer obstacles in processing such data during the early stages. On the other hand, some individuals may be more likely to achieve a competitive edge in the market. According to Bullini Orlandi and Pierce (2020), managers can enhance their decision-making process by employing big data, which allows them to rely on evidence rather than intuition. The declining costs of storage, memory, computing, bandwidth, and other pertinent resources have made it feasible for non-digital firms to potentially engage in big data research.

If the technology required to collect large volumes of data becomes more accessible and affordable, big data has the potential to revolutionize traditional industries. The significance of big data is growing in numerous sectors within this setting. The specified pages, 1923-1936, can be found in the Management Decision journal, Volume 57, Issue 8, published in 2019. The rephrased sentence is subject to copyright protection held by Emerald Publishing Limited. The document underwent revisions on October 12, 2018 and was subsequently approved on October 21, 2018 (with a receipt date of July 28, 2018). Access the latest issue of this journal and the entire text archive by visiting www.emeraldinsight.com/0025-1747.htm. BDA skills and KM have been

applied in various corporate settings and industries, including as banking, healthcare, and supply chains, since 1923 (Deal et al.,2022). Cappa et al. (2021) discovered that firms that rely on data to make decisions achieve better results in terms of financial and operational performance, as measured objectively. firms that prioritized data-driven decision making experienced a significant boost in productivity and profitability compared to their competitors. Specifically, these firms reported an average rise of 5% in productivity and 6% in profitability. Big data analytics (BDA) refers to the methods used to derive significance from large amounts of data in order to enhance management. The main objective of gathering and analyzing large amounts of data is to obtain practical insights and novel knowledge that can be effectively exploited to acquire a competitive advantage. Business Data Analytics (BDA) is becoming increasingly important in distinguishing between companies that do well and those that perform poorly (Vitari & Raguseo,2020). BDA allows firms to strategically plan ahead, reduces client acquisition costs by 47%, and leads to an estimated 8% increase in overall revenue for the firm (Bertello et al.,2021). Big data allows managers to gain a more profound understanding of their businesses, enabling them to make better-informed decisions that can improve performance and decision-making efficiency (Zhanet al.,2020). For effective management and integration of knowledge provided by Big Data Analytics (BDA) with organizational knowledge, a thorough and systematic methodology is required.

Moreover, the conflicting results of studies on the correlation between IT investment and company success might be explained by the utilization of different knowledge management (KM) and data elements. The challenges involve problems such as insufficient reliability of data, inconsistencies among data sources, a failure to assess the additional advantages of information technology, and an ineffective organization-wide emphasis on knowledge management (Koivisto, 2023). The effective management of relevant insights obtained from BDA in this research setting is hindered by several significant obstacles, including challenges with data integration, insufficient IT infrastructure, concerns about data privacy and security, and a lack of skilled personnel (Ikegwu et al.,2022).

This undertaking serves two main goals. The primary goal is to assess if the technological and managerial capacity to analyze large amounts of data, known as BDA capabilities, have a positive impact on the organization's performance. The secondary aim is to ascertain whether KM functions as a mediator in this relationship. A structural equation modeling-based empirical investigation was undertaken using data collected from 300 Malaysian SMEs.

HYPOTHESIS DEVELOPMENT

Hypothesis formation Enhanced performance is achieved by the efficient management of many organizational activities, including customer relationship management, operational risk reduction, and production efficiency. Business process automation (BDA) enables the implementation of creative methods for organizing, acquiring knowledge, and advancing, as well as making decisions based on data (Aljumah et al.,2021). Previous studies have shown that organizational information processing capabilities have a positive impact on profitability and return on investment, ultimately improving corporate performance (Cao et al.,2019; Aydiner et al., 2019). Minbaeva (2018) assert that an organization's capabilities may include processes and procedures that increase the value of knowledge inputs. Paschen et al. (2021) propose that an organization's ability to collect, handle, and analyze vast

quantities of data could have a significant impact on its future, particularly if its unique infrastructure or other factors make it challenging for others to replicate these operations. To gain a competitive advantage, businesses need to integrate and utilize a diverse array of resources and capabilities. According to the research conducted by Jha, et al. (2020) and Gupta and George (2016), it is not solely feasible to develop BDA capabilities by the use of big data. Enhanced performance is distinguished by uncommon, scarce, and difficult-to-replicate qualities. The benefits encompass enhanced sales growth, profitability, and return on investment. To develop these skills, a complex interaction and combination of many material, human, financial, and organizational resources are required. Hence, our suggestion is as follows:

H1. The greater the firm's BDA capabilities, the higher the firm performances are.

A company can enhance its performance by strategically utilizing knowledge, which refers to a set of well-founded views. North and Kumta (2018) agree that information acquisition, transformation, and application are the three main tasks in knowledge management. Knowledge acquisition refers to the act of creating new knowledge based on data and information, as explained by Turulja and Bajgorić (2018). On the other hand, knowledge conversion involves organizing or transforming tacit knowledge into explicit knowledge. The act of utilizing one's learned information is commonly known as "knowledge application. Knowledge Management (KM) involves the processes by which an organization acquires new knowledge, converts it into a format that can be easily used and accessed, and then applies this knowledge throughout the organization. These mechanisms have an impact on the performance of the organization. Efficiently capturing, storing, and transferring information utilizing KM methodologies can lead to improved financial performance, increased market share, and enhanced customer satisfaction (Hongal & Kinange, 2020). Thus, we hereby present our recommendation:

H2. The greater the KM orientation, the higher the firm performances are.

Previous research have shown the occurrence of the "IT productive paradox," which refers to the contradictory effects that arise from IS investments in terms of providing corporate value (Rashid, 2022). Experts have differing opinions on whether investments in information systems (IS) and knowledge management (KM) always lead to improved operational effectiveness and efficiency. Previous studies have not shown a direct link between investments in Information Systems (IS) and Knowledge Management (KM) and the overall success of a business, as indicated by their findings. This phenomenon can be attributed to various factors, including a lack of relevant data, a delay between investments and the organization's return on investment, a failure to acknowledge the indirect advantages of IT, or an insufficient knowledge management culture inside the company.

Turulja and Bajgoric (2018) emphasized the importance of reconsidering fundamental concerns about how knowledge is formed, the methods of study, how we should interact with information, and the nature and classification of reality. Organizations frequently encounter difficulties in effectively managing relevant knowledge due to various factors related to their business data architecture, such as complexities in data integration, lack of skilled personnel, concerns regarding data security and privacy, and inadequate IT infrastructure. Therefore, it is essential to adopt a structured approach to knowledge management in this context. The KMS and BDA had capabilities in 1927. Indeed, BDA possesses the capacity to modify individual KM, hence altering employee roles and augmenting the importance of individual

knowledge. The recent finding by Dahiya et al. (2022) of a robust link between business data analytics (BDA) and knowledge management (KM) allows for the deployment of many strategies targeted at improving organizational performance. Consequently, we recommend the following:

H3. KM acts as a moderating variable between a firm's BDA capabilities and firm performances.

METHODOLOGY

Research Design

The current study employed a quantitative methodology to investigate the hypothesized associations between knowledge management (KM), Big Data analytics, and organizational performance. To ensure precise measurement of each construct being studied, a structured questionnaire was created, thereby implementing the study approach. The previous research queries were adjusted to align with the specific needs of small and medium-sized manufacturing firms (SMEs) situated in the United Arab Emirates.

Sample and Data Collection

This study primarily focused on small and medium-sized manufacturing enterprises (SMEs) in Singapore. The study employed a simple random selection procedure to ensure equal opportunity for all small and medium-sized firms (SMEs) in the manufacturing sector to be selected (Hosseini et al.,2018). As a result, the findings can be applied in a wider range of scenarios. This survey utilized a random sample of 550 manufacturing small and medium-sized enterprises (SMEs). The management teams of the selected SMEs were surveyed online to collect data. In order to promote genuine reporting, we took measures to guarantee the confidentiality of the participants and the confidentiality of their responses. To promote engagement, notifications were distributed periodically during the course of the three-month voting session.

Measurement Instruments

The measure of corporate performance, consisting of eleven items, was adapted from the studies undertaken by Mithas, Ramasubbu, and Sambamurth (2011) and Ji-Fan Ren et al. (2016). The firm's ability to gather, integrate, and utilize its resources in alignment with big data was defined as its big data analytics competency, as discovered in the studies conducted by Gupta and George (2016) and Wamba et al. (2017). We created the variable KM orientation by utilizing Darroch's (2005) three KM components: knowledge dissemination (KNDI) (consisting of five items), knowledge acquisition (KNAC) (consisting of five items), and responsiveness to knowledge (KNRS) (consisting of five items).

DATA ANALYSIS

The chosen method for data analysis was Structural Equation Modeling-Partial Least Squares (SEM-PLS) because to its adaptability and effectiveness in managing complex models with multiple components. SEM-PLS is an excellent choice for evaluating the proposed model of the study since it can assess the linkages among latent variables. Firstly, we conducted a validation of the measurement model to determine the precision and consistency of the constructs. The structural model was

subsequently evaluated to ascertain the interaction between Big Data analytics, AI capabilities, and operational performance. We obtained t-values and standard errors through the use of bootstrapping methods, which were then used for hypothesis testing.

Ethical Considerations

The research conducted with human subjects followed established ethical guidelines. Each and every participant in the study provided their explicit agreement, and the privacy of their personal data was upheld throughout the entire procedure.

RESULTS

The goal of evaluating the measurement model is to determine the validity and reliability of the constructs. An evaluation of the reliability of the signals could be performed by analyzing the external loads. Purwanto (2021) found that every input value exceeded the existing threshold of 0.60. The model has successfully integrated statistically important and remarkably similar indicators into its components. Alpha reliability and composite dependability are two elements of the build dependability measurement. The results demonstrate that both the alpha and CR values exceed the predetermined threshold of 0.7. This study provides more evidence to support the reliability of the indicators, consistent with the findings of Hair et al. (2020). The model's item loadings, alpha coefficient, and construct reliability (CR) are displayed in Table 1.

Table 1.
Outer Loadings and reliability

Construct	Indicators	Loadings	Cronbach's Alpha	Composite Reliability	AVE
Knowledge Acquisition (KNAC)	KNAC1	0.752	0.925	0.940	0.628
	KNAC2	0.648			
	KNAC4	0.669			
	KNAC5	0.689			
Knowledge Dissemination (KNDI)	KNDI1	0.866	0.935	0.920	0.635
	KNDI2	0.842			
	KNDI3	0.830			
	KNDI4	0.902			
Responsiveness to Knowledge (KNRS)	KNRS1	0.901	0.915	0.910	0.622
	KNRS2	0.746			
	KNRS3	0.759			
	KNRS4	0.885			
	KNRS5	0.908			
Big Data Analytical Capability (BDANC)	BDANC1	0.913	0.920	0.920	0.762
	BDANC2	0.956			
	BDANC3	0.955			
	BDANC4	0.923			
	BDANC5	0.891			
	BDANC7	0.925			
	BDANC8	0.899			
Firm Performance (FP)	FP1	0.742	0.928	0.935	0.645
	FP2	0.781			
	FP3	0.793			
	FP4	0.802			
	FP5	0.836			
	FP6	0.871			
	FP7	0.827			

FP8	0.847
FP9	0.843
FP11	0.850

To determine the existence of convergent validity, we examined the Average Variance Extracted (AVE) values. Mohd Dzin and Lay (2021) assert that every single AVE score exceeds the criterion of 0.50. Moreover, the assessment of discriminant validity can be conducted using the well-known criterion established by Fornell and Larcker in 1981. The square root of the average variance extracted (AVE) is considered to be a measure of the correlations between latent variables. According to Hair et al. (2020), the average square root of a valid concept should be higher than the highest correlation with other constructs. Another method to determine the discriminant validity of a test is by using HTMT ratios. According to Cheung et al. (2023), an HTMT ratio below 0.85 is considered acceptable for establishing the discriminant validity of one's findings. The threshold values for determining the validity and reliability in the research are provided in Table 1. These numbers are derived from research.

Table 2.
Fornell-Larcker Criterion

Construct	KNAC	KNDI	KNRS	BDANC	FP
Knowledge Acquisition (KNAC)	0.891				
Knowledge Dissemination (KNDI)	0.782	0.937			
Responsiveness to Knowledge (KNRS)	0.722	0.677	0.905		
Big Data Analytical Capability (BDANC)	0.622	0.718	0.646	0.881	
Firm Performance (FP)	0.619	0.612	0.671	0.654	0.811

The computation of partial coefficients in Smart PLS is performed using the bootstrapping approach, as demonstrated by multiple research (Ramayah et al.,2018; Shehzadi et al.,2021; Hassan, 2020; Basheer et al., 2022a). To test hypotheses and assess the significance of coefficients, standard errors are calculated using the bootstrapping technique (Hair et al., 2020; Basheer et al., 2022a). The results of the analysis of the structural model are presented in Table 4.

Table 3.
Direct Results

Hypotheses	Relationship	Beta	STD	T Value	P Values	Decision
H1	BDANC -> FP	0.292	0.040	3.725	0.021	Supported
H2	BDANC -> KNAC	0.560	0.039	6.410	0.009	Supported
H3	BDANC -> KNDI	0.480	0.038	7.158	0.016	Supported
H4	BDANC -> KNRS	0.405	0.043	2.441	0.015	Supported
H5	KNAC -> FP	0.183	0.052	7.212	0.034	Supported
H6	KNDI -> FP	0.172	0.048	3.583	0.012	Supported
H7	KNRS -> FP	0.133	0.043	2.609	0.019	Supported

The study's findings indicate that Big Data Analytical Capability (BDANC) has a significant impact on Firm Performance (FP) and knowledge processes within businesses. The data indicate that BDANC has a substantial positive effect on FP (β=0.292, p=0.021) and is also associated with KNAC (β=0.560, p=0.009), KNDI (β=0.480, p=0.016), and KNRS (β=0.405, p=0.015). These findings demonstrate a clear connection and provide insight into how big data analytics improves organizational performance by simplifying knowledge processes. The report highlights the need of investing in knowledge management and big data skills to improve corporate success. Functional programming (FP) is affected by knowledge processes such as Knowledge Acquisition (KNAC) with a beta coefficient of 0.183 and a p-value of 0.034,

Knowledge Dissemination and Integration (KNDI) with a beta coefficient of 0.172 and a p-value of 0.012, and Knowledge Representation and Sharing (KNRS) with a beta coefficient of 0.133 and a p-value of 0.019. The strength and reliability of these correlations is reinforced by the statistically significant levels of agreement (T and P values) for all hypotheses. The findings indicate that BDANC is highly significant for businesses in various aspects. It enables the management of knowledge, which leads to improved performance and a competitive advantage. Another strategy is to indirectly improve the overall performance of firms.

Table 4.
Mediation

Hypotheses	Relationship	Beta	STD	T Value	P Values	Decision
H8	BDANC -> KNAC -> FP	0.552	0.041	6.487	0.008	Supported
H9	BDANC -> KNDI -> FP	0.472	0.039	7.102	0.014	Supported
H10	BDANC -> KNRS -> FP	0.412	0.044	2.464	0.014	Supported

Big data analytics, also known as BDANC, can provide significant advantages to businesses, especially those skilled at collecting fresh data (KNAC), distributing it (KNDI), and utilizing it (KNRS). The probability of this occurrence happening by accident is exceedingly low (p=0.008), and a score of 0.552 suggests a significant improvement in company performance when BDANC collaborates with KNAC. The results, with scores of 0.472 and 0.412, respectively, and a low chance of spurious outcomes (p=0.014 for both), are comparable to the results achieved when BDANC enhances the effectiveness of organizations in distributing and reacting to information (KNDI and KNRS). In essence, the strategic application of big data insights is highly likely to result in a major improvement in firms' performance. Acquiring, spreading, and using knowledge, combined with the utilization of big data, are crucial elements for achieving advancement. Regarding the calculations employed to verify the consistency of the data? Indeed, it is accurate to state that big data has had a substantial impact on the business landscape, effectively facilitating commercial achievements.

CONCLUSION

This analysis has shown the importance of Big Data Analytical Capability (BDANC) in improving the performance of enterprises. BDANC supports the improvement of KNRS, KNAC, and KNDI, as well as other processes. BDANC improves the operational and strategic results of companies by increasing their ability to absorb, utilize, and execute knowledge, as substantiated by evidence. The study's results clearly demonstrate that firms that successfully incorporate BDANC into their knowledge management strategies are more likely to achieve positive performance metrics. This advantage arises from the ability to promptly adapt to market fluctuations, stimulate creativity, and make well-informed choices. The mediation study highlights the significance of a comprehensive knowledge management approach that includes BDANC in order to achieve measurable performances. This approach involves information gathering, delivery, and response. Organizations should prioritize and dedicate resources to big data analytics because to its significant impact on knowledge processes and overall company success. The statement emphasizes the need of employees at every level of a business adopting a culture of decision-making based on data and continuously improving their analytical skills.The combination of big data analytics and knowledge management is creating a new competitive advantage in today's business world. Organizations that understand and utilize this connection are more likely to outperform their competitors. By engaging in this activity, they will evolve into stronger

and faster individuals. The success of a corporation in the modern digital economy will depend on its ability to effectively understand, collect, analyze, and utilize big data.

Policy Implications

This study found that incorporating big data analytical capabilities (BDANC) into business processes significantly enhances firm performance. Maintaining a competitive advantage in the data-driven economy of the twenty-first century is extremely important. This integration enhances knowledge management strategies and produces quick practical results. These activities consist of knowledge acquisition (KNAC), dissemination (KNDI), and responsiveness (KNRS). This has substantial implications for CEOs in both the corporate and governmental sectors. It is clear that the only way to effectively utilize BDANC for long-term development and innovation is by investing in big data education and technologies. To maximize the advantages of big data analytics, it is necessary to design policies that encourage a mentality of ongoing learning and adaptability to new technologies.Moreover, the research highlights the importance of combining digital infrastructure with knowledge management systems. Governmental entities and corporate executives should consider creating standards that make it easier to incorporate big data insights into regular decision-making processes. To achieve this goal, it would be beneficial to implement strategies such as supporting academic programs that teach knowledge management and data analytics, providing tax incentives or subsidies to businesses that invest in relevant technology, and promoting research and development in the field of big data applications.

Given the significance of BDANC (Big Data Analytics and Natural Language Processing) in enhancing knowledge processes and, subsequently, achieving corporate success, it is imperative for policies to promote the expansion of digital literacy across the entire enterprise. Organizations can leverage comprehensive training to provide their personnel with a deep understanding and effective application of big data analytics. This enables them to transform the acquired insights into strategic initiatives that promote growth and innovation.

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