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Big Data Analytics Adoption in Malaysia Digital Status Companies: The Moderating Role of Training

Nur Khairiah Muhammad*, Nor Hasni Osman, Nurul Azita Salleh

School of Technology Management and Logistics, Universiti Utara Malaysia, 06010 Sintok, Kedah, Malaysia

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ABSTRACT

This study examines the factors influencing Big Data adoption and its impact on organizational performance within Malaysia Digital Status Companies, particularly in the Global Business Services (GBS) sector. Grounded in the Technology-Organization-Environment (TOE) framework and Resource-Based View (RBV) theory, the study explores the roles of data quality management, data security, ease of use, and top management support, with training acting as a moderating variable. Based on 272 survey responses analyzed using Partial Least Squares Structural Equation Modelling (PLS-SEM), the findings reveal that data quality management, ease of use, and top management support contribute significantly to organizational performance, whereas data security does not exhibit a significant effect. Furthermore, training enhances the influence of ease of use, highlighting the importance of intuitive technology and skill development. This study supports the Malaysia Digital Economy Blueprint by advancing data-driven strategies, strengthening digital infrastructure, and boosting economic competitiveness.

INTRODUCTION

In recent years, increasing adoption of digital technology has generated an unparalleled boom in data generation, influencing the modern corporate landscape (Dubey et al., 2021). This exponential rise is projected to continue as digital transformation speeds up across businesses (Paul et al., 2024). Big Data, defined by its massive volume, velocity, variety, and veracity (Kamarulzaman & Hassan, 2019; Su et al., 2022), has emerged as a critical enabler of data-driven decision-making, allowing enterprises to increase productivity, optimize operations, and gain a competitive advantage. In Malaysia, the incorporation of big data is consistent with the country's digitization ambition, with important projects led by the Malaysia Digital Economy Corporation (MDEC) and policies such as the Malaysia Digital Economy Blueprint (Economic Planning Unit, 2021). Despite these efforts, Big Data adoption is still low, with only 36% of businesses employing sophisticated data solutions. One of the most pressing challenges is the shortage of skilled data professionals, projected to reach 15,000 (Yusoff et al., 2021), combined with organizational

* Corresponding author. *E-mail address*: * nkmnur@gmail.com

resistance and data security concerns. These barriers hinder companies, particularly within the Global Business Services (GBS) sector, from fully leveraging Big Data to improve operational performance and long-term sustainability (Hashim et al., 2021). While previous studies have identified technological, organizational, and environmental challenges affecting Big Data adoption (Maroufkhani, et al., 2020), research remains limited in examining the role of training in addressing Malaysia's skills gap. This study addresses this gap by combining the Technology-Organization-Environment (TOE) framework and the Resource-Based View (RBV) theory to investigate how training modifies the impact of key adoption factors such as data quality management, data security, ease of use, and top management support on organizational performance.

Understanding this relationship is crucial because good training initiatives can boost technical skills, minimize adoption resistance, and improve data-driven decision-making. This study presents a strategic roadmap for organizations looking to manage the complexity of digital transformation by providing new insights into the relationship between training and Big Data adoption. The findings are particularly important for policymakers, industry leaders, and stakeholders seeking to improve Malaysia's position in the global digital economy.

LITERATURE REVIEW

Technology Factors

Data quality and ease of use are critical for the effective adoption of Big Data under the technology factors. High-quality data ensures reliability and accuracy, forming the backbone of actionable insights, while ease of use facilitates user accessibility and technology acceptance (Parulian et al., 2023; Shanmugam et al., 2023). Data quality, a critical technological focus, is fundamentally challenged by issues of incompleteness, inaccuracy, and inconsistency. Incomplete data, frequently resulting from the massive volume and unstructured nature of Big Data, complicates extraction, transformation, and integration processes, leading to inefficiencies and reduced compliance capabilities (Ali, 2023; Arunachalam & Kumar, 2018). Inaccuracy further hampers organizational efficiency, as poor quality of data disrupts supply chains and blow up operational costs (Onyeabor & Ta'a, 2018; Shanmugam et al., 2023). Similarly, inconsistent data weakens decision-making and strategic alignment, obstructing businesses from fully leveraging data-driven insights (Alfred, 2019; Dias et al., 2021). A study by Chuah & Thurusamry, (2021) highlighted that the primary challenges for companies in Malaysia, often lead to issues with data quality, as these companies may lack the necessary infrastructure and expertise to manage and maintain high-quality data, resulting in incomplete, inaccurate, or inconsistent datasets.

Ease of use, another factor under technology, influences the adoption and effectiveness of Big Data technologies. Complex tools, non-intuitive interfaces, and integration challenges represent significant barriers (Ajah & Nweke, 2019; Asiri et al., 2024a). Complex tools often induce user resistance, reducing adoption rates and limiting operational efficiencies (Smith, 2023). Non-intuitive interfaces frustrate users, leading to errors and underutilization, emphasizing the need for user-friendly designs (Thanabalan et al., 2024). Integration challenges disrupt workflows, creating data silos and hindering insights (Dias et al., 2021). In Malaysia, many organizations encountered difficulties in adopting big data analytics due to complexities in data management and a lack of user-friendly tools. A study by Zian et al. (2024) highlighted that technological challenges, including the complexity of Big Data tools and the absence of intuitive interfaces, are significant barriers to adoption among Malaysian organizations. These challenges often lead to user resistance and underutilization of Big Data capabilities. Addressing these technological impediments is essential for organizations to achieve the promised benefits of Big Data, including enhanced decision-making and improved performance.

Organization Factors

Top management support is crucial for the successful adoption of Big Data Analytics solutions, playing a key role in directly influencing organizational performance and contributing to organizational factors. Resistance to change, often related to fear of disruption, unfamiliar workflows, and perceived job insecurity, remains a major barrier. Clear communication, inclusive planning, and targeted training driven by senior management can foster a culture of collaboration, ensuring employees understand and embrace the benefits of Big Data (Hafizal et al., 2023; Reyes-Veras et al., 2021). In Malaysia Digital Status companies, leadership commitment is particularly critical for addressing these challenges and achieving seamlessness (Al-Khasawneh, et al., 2022; Reza et al., 2021). In Malaysia, the significance of top management support in Big Data adoption has been highlighted in various studies. For instance, research by Wahab et al. (2021) identified that factors such as relative advantage, technological infrastructure, absorptive capability, and government support significantly influence the adoption of Big Data analytics in the Malaysian warehousing sector. Additionally, Baig et al. (2019) found that the complexity of Big Data analytics can have a negative impact on top management support. The challenges associated with the complexity of Big Data technology may cause reluctance among top management to invest in such initiatives, thereby hindering adoption efforts.

Lack of awareness about Big Data's strategic value further hinders adoption. Many organizations struggle with limited knowledge and fail to recognize the potential of big data to enhance decision-making and innovation. Proactive initiatives, such as conferences and external collaborations, led by top management, are crucial for bridging this knowledge gap and fostering organizational learning (Alsyouf, et al., 2022; Nasrollahi et al., 2021). In this context, Malaysia Digital Status companies benefit significantly from creating a culture of continuous learning to maximize Big Data's potential (El-Haddadeh et al., 2021; Falahat et al., 2023).

Shifting priorities due to market changes and internal realignments often deprioritize Big Data initiatives. Embedding big data goals into core organizational strategies ensures consistent focus and resource allocation, even amidst evolving priorities (Falahat et al., 2023; Zian et al., 2024b). In the Global Business Services (GBS) sector, senior management must align outsourcing practices with internal capability development to achieve sustainable digital transformation (Hanafizadeh & Zareravasan, 2020; Iranmanesh et al., 2023). Ultimately, Big Data Analytics should be an integral part of an organization's strategic roadmap, embraced by outsourcing partners to drive innovation and align with the headquarters' long-term objectives.

Environment Factors

The environmental factors influencing data security significantly impact organizational performance in the context of Big Data adoption. Data privacy, security threats, and data breaches are critical sub-factors that shape the security landscape. Data privacy ensures the protection of sensitive information from unauthorized access, emphasizing compliance with ethical and legal standards. According to Anwar et al. (2021) and Marr (2018), the importance of robust privacy measures in fostering trust and mitigating risks, ultimately enhancing organizational performance. Without adequate privacy safeguards, organizations risk losing stakeholder confidence, hindering their operational success.

Security threats, including cyber-attacks and malware, pose significant risks to data integrity and availability. Studies by Kim and Cho (2018) and Mangla et al. (2020) stress the need for advanced protocols, such as intrusion detection systems, to counter evolving threats. Proactive threat management ensures operational resilience and continuity, vital for organizational sustainability in a data-driven environment. For example, a study examining cybersecurity behavior among Malaysian government employees found that enhancing threat awareness and promoting protective habits through targeted training programs significantly improved employees' cybersecurity practices. The findings suggest that well-

designed training initiatives can lead to better compliance with security protocols and a reduction in security incidents, thereby positively impacting organizational performance (Sulaiman et al., 2022).

Data breaches, characterized by unauthorized access to sensitive information, can result in financial losses and reputational harm. Insights from Tao et al. (2019) and Ibrahim Ahmed et al. (2023) highlight the importance of comprehensive breach prevention strategies to minimize vulnerabilities. Organizations with effective breach responses demonstrate resilience and maintain trust, safeguarding their long-term performance.

In summary, data security that encompasses data privacy, security threats, and data breaches holds essential roles in influencing big data adoption and an organization's performance. Organizations that invest in robust data security measures are better equipped to protect their data, ensure compliance, and maintain operational resilience. As the digital landscape continues to evolve, ongoing research and adaptation of security practices will be essential for sustaining organizational performance in the face of emerging data security challenges.

Training

Training is critical to Big Data adoption because it provides employees with necessary skills and fosters an environment conducive to creativity. Structured training programs help firms manage technology obstacles, improve user competency, and optimize data-driven decision-making (Majnoor & Vinayagam, 2023; Ujang et al., 2023). Training improves technical abilities, allowing personnel to manage difficult analytics jobs, integrate new technologies with old systems, and eliminate security (Salleh & Janczewski, 2019; Ujang et al., 2023). Targeted training programs also encourage ongoing learning and flexibility, which directly contributes to improved organizational performance (Baharuden et al., 2019b). Furthermore, raising awareness through training closes knowledge gaps, promotes accountability, and encourages strategic engagement with Big Data technology. Employees that are aware of the strategic benefit of Big Data are more aligned with company goals, increasing the likelihood of adoption and success. Training also serves as a moderator, increasing the links between data quality management, data security, ease of use, and leadership support, ultimately improving organizational performance.

Ensuring excellent data quality is essential for companies that want to draw accurate and useful insights. Inconsistencies, errors, and inadequate data can lead to incorrect analysis and poor decision-making. Training programs address these difficulties by providing staff with the necessary data management abilities. The Malaysia Digital Economy Corporation (MDEC) has implemented specific big data training programs that focus on data extraction, transformation, and integration to ensure data reliability (MDEC, 2022). Empirical studies show that structured data governance training efforts reduce data processing errors and improve the accuracy of analytics-driven decision-making (Ahmed et al., 2024; Reddy Koilakonda, 2024). Similarly, training programs improve ease of use by shortening the learning curve associated with sophisticated Big Data applications. According to research, training enhances perceived ease of use, leading to increased acceptance and seamless integration of Big Data Analytics (BDA) into corporate workflows (Rob et al., 2024; Vysotskaya & Prokofieva, 2024). For example, Telekom Malaysia's workforce training project has considerably increased employees' ability to use data analytics for strategic decision-making ((Telekom Malaysia Berhad, 2022).

Data security is a critical factor for businesses employing Big Data, particularly as the volume of processed information grows. Training programs that focus on cybersecurity knowledge, encryption techniques, and regulatory compliance assist employees in recognizing and mitigating security risks. A study of cybersecurity awareness in Malaysian businesses revealed that structured training programs significantly reduced data breaches and boosted compliance with data protection rules (Sulaiman et al., 2022). Furthermore, Malaysian financial institutions have adopted cybersecurity awareness programs to protect sensitive consumer data, emphasizing the need for structured training in combating cyber risks (Krishnan et al., 2023).

Meanwhile, top management support is required for developing a data-driven culture, as leadership is key in securing resources for Big Data initiatives. The Malaysian Center of Applied Data Science (CADS), in collaboration with Harvard Commercial School, provides executive training programs that help senior leaders understand the commercial implications of data analytics (CADS, 2024). This ensures that leaders continue to aggressively support big data strategies in their organizations.

Organizations can maximize the benefits of Big Data use by tackling important post-adoption challenges with targeted training programs. Training not only enhances technical proficiency and security awareness, but it also fosters a leadership culture that prioritizes data-driven decision-making. Structured training programs improve data quality, ease of use, data security, and top management support; all of which are crucial to Big Data success. As Malaysia continues its digital transformation journey, comprehensive training activities will be critical to increasing organizational performance and ensuring long-term competitiveness in a changing technological landscape.

Organizational Performance

Organizational performance is about how well a company achieves its goals, focusing on key areas like operational efficiency, market value, and competitive advantage (Gutterman, 2023; Soebroto & Budiyanto, 2021). Operational efficiency is all about making processes smoother and reducing costs while getting the best out of available resources. Using tools like big data and advanced analytics can make a huge difference here, helping organizations forecast better and make quick decisions based on real-time information (Côrte-Real et al., 2020; Davenport, 2019). This not only saves money but also ensures that quality stays high.

Market value reflects how much a company is worth in the eyes of its stakeholders, often influenced by how innovative and customer-focused it is. Companies that use big data effectively often see an increase in their values by understanding their customers better, responding to market trends faster, and aligning their actions with strategic goals (Dias, 2021; Gutterman, 2023). This creates a positive value of higher stakeholder satisfaction and sustainable growth (Rubio-Andrés et al., 2022).

Competitive advantage comes from standing out and doing things better than competitors. For Malaysia Digital Status companies, embracing Big Data is a game-changer, helping them make smarter decisions, scale their operations, and deliver an exceptional customer experience (Akbari, 2024). The Table 1 below highlighted previous studies on Big Data adoption in Malaysia.

Table 1. Previous studies on Big Data adoption in Malaysia

Author(s)	Year	Industry	Title	Key Findings
(Aziz et al., 2024)	2024	Hotel	The impact of big data analytics on innovation capability and sustainability performance of hotels: evidence from an emerging economy	Achieving benefits involves technology infrastructure, data management capabilities, and a data-driven culture, stressing BDA's importance in innovation and competitive advantage.
(Thanabalan et al., 2024)	2024	Manufacturing	Big Data Analytics Adoption in Manufacturing Companies : The Contingent Role of Data-Driven Culture	This study examines factors influencing Big Data Analytics (BDA) adoption in Malaysian manufacturing companies and its impact on performance. Findings reveal BDA adoption enhances financial and market

				performance, with data-driven culture moderating financial performance, offering strategic insights for businesses.
(Zian et al., 2024)	2024	Education	Technological, organizational and environmental factors influencing on user intention towards big data technology adoption in Malaysian educational organization	Propose suitable technologies, intensive training programs, and managerial support to encourage data-driven decision-making, and collaborate with legislators on Big Data adoption.
(Abdullah Sani et al., 2023)	2023	Public	Technology, Organization and Environment as Strategic Factors of Big Data Analytics Readiness and Acquisition Intention to adopt Big Data Analytics in Malaysian Libraries	The study finds that legal, architectural, social, and market factors are significant challenges for SMEs in adopting big data analytics, according to Lessig's Four Modalities.
(Ibrahim Ahmed et al., 2023)	2023	Manufacturing	Rationalising Factors Influencing the Effective Utilisation of Big Data in Malaysian Fintech Companies	The report emphasizes technical preparedness, a competent workforce, and a strong infrastructure. Fintech requires strategic investments and regulatory assistance to harness Big Data for service, efficiency, and competitiveness.
(Vachkova et al., 2023)	2023	SME	Big data and predictive analytics and Malaysian micro-, small and medium businesses	The study emphasizes the challenges that SMEs face, such as limited funds, qualified labor, and technological infrastructure, but also finds them more adaptive to big data adoption. Government incentives and training can help boost their competitiveness and growth.
(Anawar et al., 2022)	2022	Telecommunication	Security and Privacy Challenges of Big Data Adoption: A Qualitative Study in Telecommunication Industry	Highlights security and privacy issues related to telecom Big Data adoption, emphasizing threats from data breaches, complex regulatory frameworks, and obsolete IT infrastructure, all of which necessitate robust and up-to-date security solutions.

Underpinning Theories

The integration of the Technology-Organization-Environment (TOE) framework and the Resource-Based View (RBV) theory provides a robust foundation for understanding the factors influencing Big Data adoption and its subsequent impact on organizational performance. The TOE framework, initially developed by Tornatzky and Fleischer (1990), categorizes key drivers into three dimensions: technology (data quality management, ease of use), organizational (top management support), and environmental (data security). This approach highlights how external pressures, such as regulatory requirements and competition, interact with internal organizational readiness to shape adoption outcomes (Hashim et al., 2022; Salleh & Janczewski, 2019; Zian et al., 2024). The RBV theory complements this by emphasizing the strategic importance of internal resources, such as human capital and training, which are critical for leveraging Big Data technologies effectively (Barney, 1991; Garavan, 2020). Training, in particular, serves as a key moderating variable, transforming technical complexity into strategic opportunities by enhancing workforce competencies and ensuring seamless technology integration (Al-Khasawneh et al., 2022; Wahab et al., 2021). Recent studies validate this integrated approach, demonstrating how organizations can strategically align external and internal factors to overcome barriers and achieve competitive advantages (Ibrahim Ahmed et al., 2023; Maroufkhani, Tseng, et al., 2020). This dual-framework approach is particularly relevant for Malaysian Global Business Services (GBS) companies, addressing their unique challenges in navigating global operational complexities and local regulatory demands.

Hypothesis Development

The development of hypotheses in this study is grounded in a robust theoretical foundation through the integration of Technology-Organization-Environment (TOE) framework and the Resource-Based View (RBV) theory to explore the determinants influencing Big Data adoption and its impact on organizational performance. The combination of these two theories is in accordance with current research. For example, (Al-Khasawneh, et al., 2022) underline the importance of taking a holistic approach to understanding both internal (RBV) and external (TOE) factors that influence Big Data adoption and performance. These studies emphasize the need for a comprehensive approach that encompasses both external technological aspects and internal resources in boosting organizational performance during digital transformation.

Data Quality Management and Organizational Performance

High-quality data is essential for reliable analysis and decision-making, encompassing key attributes such as accuracy, relevance, completeness, timeliness, and accessibility. Without these characteristics, organizations risk making erroneous decisions that lead to operational inefficiencies and poor strategic outcomes (Ghasemaghaei & Calic, 2019; Nilashi et al., 2023; Wook et al., 2021). Studies have highlighted the detrimental effects of poor data quality on organizational performance. Incomplete data can create information gaps, increasing risks in decision-making and reducing transparency (Solana-González et al., 2021). Inaccurate data disrupts efficiency, raising operational costs as companies work to correct errors (Onyeabor & Ta'a, 2018; Shanmugam et al., 2023). Inconsistent data further complicates decision-making by hindering integration efforts, leading to misaligned strategies (Dias et al., 2021; Nilashi et al., 2023).

From the Technology-Organization-Environment (TOE) framework perspective, data quality is a key technological factor that significantly influences organizational performance. High-quality data ensures more accurate, relevant, and timely decision-making, thereby enhancing operational efficiency and strategic effectiveness (Ghasemaghaei & Calic, 2019; Nilashi et al., 2023). The TOE framework positions technological readiness, including data quality, as a crucial driver of performance improvements through Big Data adoption (Tornatzky and Fletscher, (1990). Effective data quality management strengthens data integrity, completeness, and accuracy, which are essential for high-performing organizations Dias, (2021).

Based on the above discussion, the study proposes the below hypothesis:

H1: There is a significant positive relationship between data quality management and organizational performance.

Data Security and Organizational Performance

The increasing reliance on data-driven decision-making has raised concerns about data security, particularly regarding the protection of sensitive information (Amalina et al., 2019; Anwar et al., 2021; Asif & Hassan, 2023; Falahat et al., 2023). Ensuring data integrity, confidentiality, and availability is crucial for maintaining corporate trust, regulatory compliance, and operational reliability. Sweeney (1997) and other early discussions on data security highlighted its significance in public health, emphasizing the need to balance technological innovation with regulatory frameworks. This perspective is further supported by Dias et al. (2021) and Fatt & Ramadas, (2018).

Data privacy plays a vital role in building stakeholder confidence and ensuring adherence to legal and ethical standards (Anwar et al., 2021; Marr, 2018; Salleh & Janczewski, 2019). Cyber threats, including malware and unauthorized access, pose significant risks to data integrity and operational continuity (H. Y. Kim & Cho, 2018; Salleh & Janczewski, 2019). Effective security threat management not only mitigates these risks but also enhances organizational performance, as evidenced by studies from (Asiri et al., 2024a; Ibrahim Ahmed et al., 2023; Tao et al., 2019).

Data security is classified as an environmental factor within the Technology-Organization-Environment (TOE) framework, as it aligns with regulatory compliance, data protection laws, and cyber risk management (Anawar et al., 2022). As organizations adopt Big Data technologies, preventing breaches remains critical to sustaining operational resilience and stakeholder trust.

Based on the above discussion, this study proposes the following hypothesis:

H2: Positive relationship between data security and organizational performance.

Ease of Use and Organizational Performance

Davis (1989) proposed that perceived ease of use is essential in technology adoption as it influences user acceptance and engagement with digital systems. Contemporary studies (Ghaleb et al., 2021; Haddad et al., 2019; Loh & Teoh, 2021; Thanabalan et al., 2024) have refined this concept, emphasizing minimal cognitive effort and efficient task execution as key determinants of user satisfaction. Ease of use directly enhances organizational effectiveness by simplifying adoption processes and reducing training costs (Mohamad et al., 2020). A user-friendly system promotes widespread adoption, maximizing its intended benefits (Smith, 2023). Furthermore, it increases employee productivity by reducing cognitive burden and facilitating faster decision-making (Asiri et al., 2024a).

Within the Technology-Organization-Environment (TOE) framework, ease of use is a critical technological factor for effective Big Data implementation. Ensuring system accessibility and alignment with user needs contributes to improved organizational performance and competitive advantage (Asiri et al., 2024b; Ujang et al., 2023). In summary, ease of use serves as a key enabler of Big Data adoption. It not only optimizes resource utilization but also enhances organizational adaptability in an increasingly data-driven business landscape.

Given these findings, this study proposes the following hypothesis

H3: Positive relationship between ease of use and organizational performance.

Top Management Support and Organizational Performance

Top management support is critical in promoting organizational performance, particularly the adoption of cutting-edge technologies like Big Data. Onyekwere et al. (2023) emphasized that effective organizational change requires strong leadership. In line with this perspective, successful leaders must establish a clear vision, develop strategic objectives, communicate effectively, and foster commitment to change initiatives to achieve sustainable performance improvements.

Leadership engagement entails establishing a clear goal, assigning appropriate resources, and building a culture that promotes risk-taking and continual learning. Without this support, companies frequently experience issues such as insufficient training, low employee engagement, strategic misalignment, and reluctance to change (El-Haddadeh et al., 2021; Schroeck et al., 2012).

Furthermore, Mikalef & Gupta (2021) argued that senior management must address leadership, human resource management, technology capabilities, and decision-making to fully realize Big Data's potential. This is consistent with the Technology-Organization-Environment (TOE) framework, which identifies top management support as a critical organizational element that supports resource allocation, strategic alignment, and opposition mitigation, hence promoting Big Data adoption.

Based on this discussion, the study proposes the following hypothesis:

H4: Positive relationship between top management support and organizational performance.

Training as a Moderator in Data Quality Management and Organizational Performance

Training is critical to accelerate Big Data adoption and improving organizational performance. It provides personnel with the skills and information required to effectively use Big Data technology, resulting in better decision-making and operational efficiency (Christopher & Nelson, 2024). While training is frequently viewed as a direct influencer of technology adoption, its role as a moderating factor between Big Data adoption and organizational performance is underexplored, particularly in Malaysian organizations (Al-Rahmi et al., 2019; Baharuden et al., 2019b). Chui et al. (2021) argued that companies that invest in training can improve data literacy and analytical skills, resulting in better performance outcomes. Training enhances technical abilities (Baharuden et al., 2019b), assists in navigating the difficulties of system integration (Salleh & Janczewski, 2019), and raises awareness to promote responsibility and informed decision-making (Maroufkhani et al., 2020). However, it should be highlighted that training may not always produce beneficial results due to challenges such as outdated content and a lack of ongoing assistance (Thanabalan et al., 2024). The study investigates how insufficient training in large corporations affects the outcome of Big Data adoption.

From the discussion, the study proposes the following hypothesis:

H5(a): Training significantly moderates the relationship between data quality management and organizational performance.

Training as a Moderator in Data Security and Organizational Performance

Ensuring robust data security is paramount for organizations adopting big data, as security breaches can lead to financial losses, reputational damage, and regulatory non-compliance (Tao et al., 2019). Effective data security management involves implementing encryption protocols, access controls, and intrusion detection systems to safeguard sensitive information (Ntizikira et al., 2023). However, the effectiveness of these security measures is heavily dependent on employees' ability to understand, implement, and adhere to data security policies. Training plays a crucial moderating role by equipping employees with the necessary skills to mitigate cybersecurity threats, identify vulnerabilities, and comply with security frameworks (Tolossa, 2023). Without adequate training, employees may inadvertently expose the organization to data breaches through human errors, phishing attacks, or weak password management, thereby undermining the overall effectiveness of data security initiatives (Amoresano & Yankson, 2023).

From the discussion, the study proposes the following hypothesis:

H5(b): Training significantly moderates the relationship between data security and organizational performance.

Training as a Moderator in Ease of Use and Organizational Performance

The ease of use of Big Data technologies significantly influences their adoption and subsequent impact on organizational performance. When employees find data systems intuitive and user-friendly, they are more likely to engage with them effectively, leading to improved decision-making and operational efficiency (Davis, 1989; Wamba et al., 2017). However, despite advancements in user-friendly interfaces, many organizations still encounter challenges related to complex tools, non-intuitive designs, and integration difficulties (Mlekus et al., 2020). Training serves as a crucial moderating factor in this relationship by equipping employees with the necessary skills to navigate Big Data systems efficiently, reducing the learning curve, and enhancing system usability (Maroufkhani et al., 2019). Without adequate training, even highly sophisticated yet user-friendly platforms may fail to deliver optimal outcomes due to a lack of user competence and confidence in handling data-driven processes (Thanabalan et al., 2024).

From the discussion, the study proposes the following hypothesis:

H5(c): Training significantly moderates the relationship between ease of use and organizational performance.

Training as a Moderator in Top Management Support and Organizational Performance

Top management support plays a crucial role in facilitating Big Data adoption by providing strategic direction, allocating necessary resources, and fostering a data-driven culture within organizations (Shafique et al., 2024). When leadership actively champions Big Data initiatives, employees are more likely to perceive the value of such technologies and align their efforts accordingly, leading to improved organizational performance (Prakash, 2024). However, despite strong managerial commitment, challenges related to skill gaps and technological complexity may hinder the effective implementation of Big Data strategies (Maroufkhani et al., 2019). Training serves as a key moderating factor in this relationship by ensuring that employees develop the necessary competencies to execute top management's strategic vision effectively (Baharuden et al., 2019). Without structured training programs, even well-supported Big Data initiatives may face resistance, operational inefficiencies, and suboptimal performance outcomes (Thanabalan et al., 2024).

From the discussion, the study proposes the following hypothesis:

H5(d): Training significantly moderates the relationship between top management support and organizational performance.

METHODOLOGY

Framework of the Study

Based on Figure 1, the theoretical framework of the study integrates the Technology-Organization-Environment (T-O-E) framework with the Resource-Based View (RBV) to investigate the relationship between key determinants and organizational performance in the context of Big Data adoption. The T-O-E framework is particularly suitable for exploring how technological, organizational, and environmental factors influence the adoption of Big Data technologies, offering a structured approach to analyze external and internal determinants (Tornatzky & Fletscher, 1990). The factors selected are Data Quality Management, Data Security, Ease of Use, and Top Management Support.

In parallel, the RBV theory emphasizes the strategic role of internal resources, particularly training, in enhancing organizational capabilities and supporting technology adoption (Barney, 1991). Training in big data analytics, as introduced in this study, is conceptualized as a moderating variable that strengthens the relationship between organizational determinants and performance. According to (Al-Khasawneh, et al., 2022), recent research has validated the synergistic application of the T-O-E and RBV frameworks, highlighting the importance of training interventions in addressing complex adoption scenarios and enhancing organizational performance. This integrated framework provides a comprehensive lens for understanding Big Data adoption and its organizational impact, particularly in the context of Malaysia's Digital Status companies.

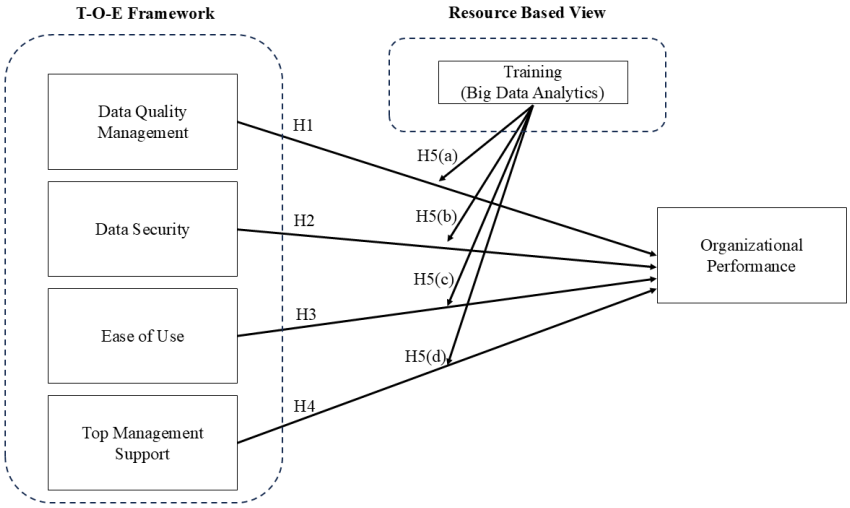

Figure 1. Research Framework

Sample Size

The data was collected from 428 Global Business Services (GBS) companies registered with the Malaysia Digital Economy Corporation (MDEC), targeting data professionals and management board members. Krejcie and Morgan's (1970) table determined a minimum sample size of 201 respondents, while G*Power (2013) confirmed 129 as sufficient for a 95% confidence level. The study began with simple random sampling, a strategy generally renowned for its ability to reduce selection bias and improve generalizability. However, due to poor response rates, a common issue in organizational survey the approach was changed to convenience sampling during the COVID-19 pandemic. This change was required to maintain data integrity, ensuring that the study included qualified responders with technical competence and strategic supervision of Big Data technology.

The decision to employ dual sampling techniques was carefully made to balance methodological rigor with practical constraints. Research on survey-based methodologies highlights the importance of flexibility in survey methodologies to ensure valid outcomes, especially during unforeseen circumstances like the COVID-19 pandemic (K.S. Kim, 2021).

Data Collection Procedure

For this study, a self-administered online questionnaire hosted on Google Forms was used for data collection. The survey link was shared via email, WhatsApp, LinkedIn, and social media for cost-effective, confidential participation (Noor, 2020). To address low response rates, follow-up reminders were sent (Shiyab et al., 2023). The questionnaire employed a five-point Likert scale ("strongly disagree" to "strongly agree") to effectively capture respondents' perceptions, enhancing data validity and reliability (Coombes et al., 2021). This method ensured ease of administration and robust engagement despite challenges associated with online surveys.

DATA ANALYSIS AND RESULT

Data Analysis

This study employed SmartPLS version 4.0 to perform Partial Least Squares Structural Equation Modeling (PLS-SEM), evaluating measurement and structural models. As illustrated in Table 2, structural model results revealed significant positive relationships between data quality management ($t=2.19$, $p=0.029$), ease of use ($t=6.391$, $p<0.001$), and top management support ($t=2.483$, $p=0.013$) with organizational performance, while data security showed no significant effect ($t=1.066$, $p=0.286$). Moderation analysis indicated that training significantly enhanced the relationship between ease of use and organizational performance ($t=1.854$, $p=0.032$) but not for other variables.

The findings suggest that to achieve significant improvements in organizational performance, the implementation of big data solutions should prioritize the adoption of user-friendly and intuitive systems. Furthermore, focused training programs are essential to maximize the skill capability of data professionals in the organizations.

Table 2: Result Path Analysis (t- value, p-value, f^2)

Relationship	t-value (β/σ)	p-value (α=0.05)	f^2	Effect Size	Supported
H1: DM → OP	2.19	0.029	0.035	SMALL	YES
H2: DS → OP	1.066	0.286	0.008	NO EFFECT	NO
H3: EOU → OP	6.391	0.000	0.217	MODERATE	YES
H4: TM → OP	2.483	0.013	0.028	SMALL	YES
TNG × DM → OP	1.379	0.084	0.035	SMALL	NO
TNG × DS → OP	1.221	0.111	0.012	NO EFFECT	NO
TNG × EOU → OP	1.854	0.032	0.210	MODERATE	YES
TNG × TM → OP	0.587	0.279	0.032	SMALL	NO

Data Quality Mgt (DM), Data Security (DS), Ease of Use (EOU), Top Management (TM), Org Performance (OP), Training (TNG)

Measurement Model Assessment

Convergent validity was established in this study by evaluating factor loadings, Composite Reliability (CR), and Average Variance Extracted (AVE), as recommended by Hair (2009). Table 3 illustrates the factor

loadings were retained for all 39 items, ranging between 0.569 and 0.888, meeting the acceptable threshold of 0.4 and exceeding 0.7 for most items. Cronbach's alpha values ranged from 0.811 to 0.938, and CR values ranged from 0.869 to 0.950, both surpassing the recommended minimum of 0.7 (Fornell & Larcker, 1981; F. J. Hair et al., 2014). The AVE values, ranging from 0.548 to 0.731, also exceeded the recommended threshold of 0.5, further confirming convergent validity. Specifically, AVE values were 0.621 for data quality management, 0.646 for data security, 0.548 for ease of use, 0.731 for top management support, 0.655 for organizational performance, and 0.570 for training. These results validate the outer model, confirming its reliability and internal consistency for subsequent structural analysis.

Table 3: Convergent Validity Analysis

Factor	Item	Cronbach's alpha	Composite reliability	Average Variance Extracted (AVE)
Data Quality Mgt (DM)	7	0.896	0.919	0.621
Data Security (DS)	7	0.907	0.927	0.646
Ease of Use (EOU)	6	0.830	0.878	0.548
Top Management (TM)	7	0.938	0.950	0.731
Org Performance (OP)	7	0.912	0.930	0.655
Training (TNG)	5	0.811	0.869	0.570

Discussion of study findings

This study presents empirical information on the factors influencing Big Data adoption and its influence on organizational performance in Malaysia Digital Status (MDS) organizations. The study uses the Technology-Organization-Environment (TOE) framework and the Resource-Based View (RBV) paradigm to investigate how data quality management, ease of use, data security, and top management support affect performance, with training acting as a moderator. Four of the eight hypotheses evaluated were supported, whereas the direct effect of data security on organizational performance and the moderating effects of training on data quality management, data security, and top management support were not statistically significant. This section explains the outcomes in light of the existing literature, emphasizing comparative analyses and explaining why certain relationships persist while others do not.

Data Quality Management and Organizational Performance (H1 supported)

The study confirms a significant positive relationship between data quality management and organizational performance (H1 supported), which is consistent with previous research (Al-madhrahi et al., 2022; Dias et al., 2021; Shanmugam et al., 2023; Wook et al., 2021). High-quality data improves decision-making capabilities, operational efficiency, and strategic insights, making it a key driver of performance. This study confirms the arguments of Peltier et al. (2013) and Kalra (2020), who underlined that organizations' willingness to invest in Big Data technology is heavily influenced by their data quality management capabilities.

While this relationship is well-established, the study also emphasizes challenges associated with incomplete, inaccurate, and inconsistent data, echoing concerns raised by Onyeabor and Ta'a (2018) about the complexities of managing Big Data quality in real-world applications. Poor data quality can impair analytical accuracy, weaken predictive capacities, and erode trust in data-driven decision-making (Khong et al., 2023; Parker & Parker, 2023). These findings imply that ongoing expenditures in data governance frameworks and standardized quality assurance processes are critical to maintaining the benefits of Big Data adoption.

Data Security and Organizational Performance (H2 not supported)

The study concludes that data security has no significant relationship with organizational performance (H2, not supported), which is consistent with prior findings by Ghasemaghaei (2020), Yadegaridehkordi et al. (2018) and Nilashi et al. (2023). While data security is an important issue in compliance and risk management, it does not always convert into obvious performance gains. A possible explanation is that companies operating under strict regulatory frameworks (e.g., financial services, healthcare) have baseline security measures in place, making security a non-differentiating factor in generating performance gains (Al-Khasawneh et al., 2022). Furthermore, Dias et al. (2021) and Ghaleb et al. (2023) propose that companies prioritize benefits such as innovation and operational efficiency over security threats when implementing Big Data technology. This study calls into question long-held beliefs that data security is a critical facilitator of performance. Instead, it suggests that other elements, such as strategy alignment and a data-driven culture, may have a stronger impact on Big Data adoption success.

Ease of Use and Organizational Performance (H3 supported)

The findings show that ease of use has a significant positive effect on organizational performance (H3), which is consistent with studies by Asiri et al. (2024), El-Haddadeh et al. (2021), and Loh & Teoh (2021). User-friendly Big Data technologies improve adoption rates by reducing technological complexity, lowering training expenses, and improving employee engagement. Furthermore, Grover et al. (2018) and Fosso Wamba et al. (2019) show that enterprises that deploy highly sophisticated big data solutions without taking usability into account frequently face adoption resistance and inefficiencies. These data support the claim that ease of use is a critical factor in converting technical investments into measurable performance outcomes.

Top management support and Organizational Performance (H4 supported)

The study also finds a substantial positive effect between top management support and organizational performance (H4 supported), which is similar to previous research by Al-Rahmi et al. (2019), Falahat et al. (2023), and Asiri et al. (2024). Senior leadership is critical in aligning Big Data efforts with strategic goals, providing resources, and cultivating a data-driven culture (Ghaleb et al., 2021; Haddad et al., 2019). However, the efficacy of top management support is determined by execution. According to Tabesh et al. (2019) and Huynh et al. (2023), leadership commitment is insufficient unless it is supported by operational capabilities, staff engagement, and aligned incentives. The findings demonstrate the importance of active managerial involvement beyond initial support in ensuring that big data methods lead to persistent performance improvements.

Training and Data Quality Management (H5a not supported)

The outcomes show that training has no significant effect on the relationship between data quality management and organizational performance (H5a is not supported). While training helps individuals improve their technical abilities, it does not directly improve the essential characteristics of data quality, such as correctness, completeness, and consistency. This is consistent with the views of Mahmood et al. (2023) and Akter et al. (2016), who argue that data quality improvements are mostly driven by systematic governance, strong data management frameworks, and technical investments rather than single training efforts. These findings indicate that businesses should prioritize automated data validation processes, stringent data governance regulations and real-time data monitoring systems to assure high-quality data, rather than relying exclusively on training programs to handle data quality issues.

Training and Data Security (H5b not supported)

Training has no significant effect on the relationship between data security and organizational performance (H5b is not supported). This finding is similar to previous studies by Maroufkhani et al. (2019) and Nasrollahi et al. (2021), which found that regulatory compliance, organizational risk appetite, and technology security measures had a greater influence on security performance than staff training alone. The success of security training is heavily influenced by an organization's overall cybersecurity strategy, as well as its capacity to incorporate security protocols into operational workflows (Anawar et al., 2022). This suggests that, while security awareness campaigns are vital, they may not immediately improve organizational performance unless combined with complete security policies, advanced encryption technology, and proactive threat detection techniques.

Training and Ease of Use (H5c supported)

The study finds that training significantly enhances the relationship between ease of use and organizational performance (H5c supported), corroborating findings by Fosso Wamba et al. (2019) and Hadidi & Power, (2020). This suggests that training acts as a facilitator, helping employees leverage user-friendly tools more effectively. According to Alzahrani and Seth (2021) and Grover et al. (2018), training bridges knowledge gaps, enhances digital literacy, and reduces resistance to technology adoption, all of which contribute to higher performance outcomes. These findings indicate that even the most intuitive big data tools require structured training programs to maximize their potential.

Training and Top Management Support (H5d not supported)

Training has no substantial effect on the relationship between top management support and organizational performance (H5d is not supported). While top management support is critical in creating a data-driven culture and pushing Big Data adoption, training does not always increase its influence on performance results. This supports the findings of Ijab et al. (2019) and Hashim et al. (2021), who contend that strategic decision-making at the leadership level frequently occurs independently of employee training initiatives. Effective top management assistance is primarily demonstrated by budget allocation, long-term strategic vision, and the promotion of a data-driven culture, rather than through direct training interventions. These findings underline the importance of companies aligning training programs with strategic leadership initiatives to ensure that staff development efforts result in demonstrable performance benefits.

LIMITATIONS AND RECOMMENDATIONS

This study offers valuable insights into the relationship between Big Data adoption and organizational performance within Malaysia Digital Status (MDS) companies. However, some limitations must be acknowledged. First, the study employed a one-dimensional sampling method, focusing on managers and data specialists. Future research should adopt a multidimensional sampling approach, incorporating respondents across organizational levels and utilizing both quantitative and qualitative methods, such as surveys and in-depth interviews, to gain a more comprehensive understanding of organizational dynamics.

Second, the study focused exclusively on MDS companies within the Global Business Services (GBS) sector, limiting the generalizability of findings to other industries. Expanding future research to sectors like manufacturing, agriculture, and healthcare would provide actionable insights into sector-specific big data challenges and opportunities, contributing to Malaysia's digital transformation.

Lastly, the use of a cross-sectional study design limits the ability to observe the evolving impacts of Big Data adoption. A longitudinal design would allow researchers to track changes over time, particularly the long-term effects of training on organizational performance. This approach would provide deeper insights into how organizations adapt to technological advancements and workforce development.

For recommendations, expanding incentives for skill certification and fostering collaboration between academia, industry, and government would significantly help bridge the talent gap and build a robust pipeline of skilled professionals. Furthermore, organizations, particularly those in the GBS sector, should

prioritize investments in training programs tailored to their specific needs. Structured and continuous training focusing on data governance, analytics, cybersecurity, and ethical data practices would strengthen internal capabilities and reduce reliance on external providers.

CONCLUSION

This study explored the underexplored role of training as a moderating factor, emphasizing its critical influence on improving Big Data adoption outcomes in Malaysia Digital Status Companies. Using the Technology-Organization-Environment (TOE) framework integrated with the Resource-Based View (RBV) theory, the study provides a comprehensive perspective on how organizational and environmental factors interact to impact performance.

The findings address Malaysia's challenges in digital transformation, including low adoption rates and a shortage of skilled data professionals. This study offers practical contributions by presenting actionable recommendations for policymakers, government agencies, and businesses to improve Big Data strategies and develop training programs aligned with national initiatives like the Malaysia Digital Economy Blueprint. These recommendations aim to enhance organizational competitiveness and economic growth through effective data management practices.

The study further emphasizes the ethical dimension, advocating for data integrity based on Islamic principles, such as the Quranic injunction to uphold truthfulness and transparency (Quran 2:42). This perspective highlights the importance of maintaining data accuracy and trust, which are critical to strategic decision-making and accountability in Big Data adoption. From a theoretical perspective, this study advances existing frameworks by incorporating training, offering a novel lens to analyze Big Data adoption dynamics. Its findings provide a roadmap for improving organizational performance, with broader implications for replicability across sectors and regions, fostering innovation and sustainable practices globally.

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