

UTILIZATION OF BIG DATA IN IMPROVING THE EFFICIENCY OF E-BUSINESS SYSTEMS IN INDONESIA

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Abstract

The rapid growth of digital technology in Indonesia has fostered the expansion of e-business systems, which in turn has generated vast volumes of data. However, many e-business platforms still face challenges in utilizing this data effectively to improve operational efficiency and decision-making. This research was conducted to explore the utilization of big data in enhancing the efficiency of e-business systems in Indonesia. The main objective of the study is to analyze how the integration of big data analytics contributes to optimizing business processes, customer engagement, and overall system performance in the Indonesian digital commerce ecosystem. A mixed-method approach was employed, combining quantitative surveys of 120 e-business practitioners with qualitative interviews involving 15 data analysts and IT managers from various sectors such as retail, fintech, and logistics. Data were analyzed using statistical tools and thematic coding to derive patterns and insights. The findings indicate that e-businesses implementing big data strategies reported a significant improvement in system responsiveness, personalized customer services, and data-driven decision-making. Moreover, big data utilization has been linked to enhanced supply chain management and real-time monitoring capabilities. Despite these benefits, challenges such as data privacy concerns, lack of skilled personnel, and high infrastructure costs remain significant barriers. In conclusion, the study confirms that the effective use of big data plays a crucial role in improving the efficiency and competitiveness of e-business systems in Indonesia. Future initiatives should focus on strengthening data governance and investing in human capital to maximize big data's potential.

Keywords: Big Data, Data Analytics, E-Business, Efficiency, Indonesia



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INTRODUCTION

Big data has emerged as one of the most transformative technological developments of the 21st century, significantly altering how information is collected, stored, processed, and utilized (Abdelaziz, 2024). In the context of e-business, big data allows companies to extract actionable insights from vast and complex datasets, thereby enhancing decision-making and improving operational efficiency (Akhmetshin, 2024). Businesses across the globe have begun to integrate big data analytics into their systems to remain competitive in an increasingly digital economy (Nikam, 2021).

E-business systems rely heavily on real-time data to respond to customer needs, streamline supply chains, and manage internal operations (Al, 2024). The use of big data analytics provides the tools to interpret patterns in customer behavior, optimize inventory levels, and personalize digital interactions (Ali, 2022). These capabilities are no longer optional but have become essential for sustaining growth and innovation in digital marketplaces. Indonesia, with its rapidly growing digital economy and one of the largest internet user bases in Southeast Asia, presents a unique landscape for e-business development (Bagwari, 2022). Numerous e-commerce platforms, digital marketplaces, and fintech services have flourished, creating a high demand for intelligent systems that can handle large-scale data effectively. The government has also recognized the importance of digital transformation, promoting initiatives to strengthen national infrastructure and support digital literacy (Cakir, 2022).

Despite this momentum, many Indonesian businesses are still in the early stages of big data adoption (Bhardwaj, 2019). Several organizations operate without fully integrated data systems, leading to inefficiencies in customer engagement, resource allocation, and overall system responsiveness (Chen, 2020). A significant number of small and medium-sized enterprises (SMEs) also lack access to the technological and human resources required to implement advanced data analytics. Globally, studies have demonstrated the positive correlation between big data integration and enhanced e-business performance (Corallo, 2023). Multinational corporations have leveraged predictive analytics to anticipate market trends, detect fraud, and automate decision-making. These advancements serve as valuable benchmarks for countries like Indonesia that are in the process of digitalizing their business ecosystems (Das, 2023).

Benchmarking against international success stories can offer valuable insights for domestic implementation (Elkmash, 2022). However, adaptation to local contexts is essential due to differences in infrastructure, digital maturity, and consumer behavior. This calls for empirical research that not only observes the global benefits of big data but also contextualizes its application within the Indonesian e-business framework (Elkmash, 2022). Current literature lacks sufficient empirical studies focused on the specific utilization of big data in Indonesian e-business systems (Jamwal, 2021). Most existing research tends to generalize findings across broader geographic or economic categories, leaving a gap in understanding how big data strategies are uniquely adopted and implemented in Indonesia's diverse digital environment. The contextual differences in technological infrastructure, regulatory frameworks, and digital culture create a distinct need for localized investigation (Kruger, 2020).

Limited documentation exists on how Indonesian e-businesses—especially SMEs—overcome barriers such as inadequate data literacy, high implementation costs, and cybersecurity risks (Kolomiyets, 2024). While global corporations have access to advanced analytic tools and skilled personnel, many Indonesian enterprises must navigate these challenges with fewer resources and less experience in digital transformation (Kodali, 2022). Understanding how these businesses adapt and innovate remains an underexplored area. There is also a scarcity of in-depth

analysis that measures the tangible impact of big data utilization on specific efficiency indicators within e-business, such as order fulfillment speed, customer retention, and inventory turnover (Kumar, 2024). These metrics are essential for determining the practical value of big data implementation and for guiding future investments and policies in the digital sector.

The role of organizational culture and leadership in enabling successful big data integration is another dimension that has received little attention in Indonesian contexts (Karim, 2021). Factors such as managerial support, employee engagement, and openness to technological change may significantly influence the success of big data initiatives, but remain largely unexamined in national-level studies (Pacheco-Velazquez, 2024). Investigating the utilization of big data in Indonesian e-business systems is essential for crafting context-specific strategies that enhance competitiveness and efficiency (Patel, 2019). Empirical evidence on how big data is currently being adopted, the challenges faced, and the outcomes achieved will help business leaders, policymakers, and technologists make informed decisions about future investments in digital infrastructure and human capital (Pacheco-Velazquez, 2024).

This study seeks to fill the knowledge gap by examining the current state of big data adoption across diverse Indonesian e-business sectors. It aims to identify patterns, bottlenecks, and best practices in the use of big data for improving system performance, operational agility, and customer satisfaction. The findings are expected to offer strategic guidance for companies at various stages of digital transformation. The rationale for this research is grounded in the belief that data-driven business models can significantly improve Indonesia's digital economy and position it more competitively on the global stage. By shedding light on how big data enhances e-business efficiency in the local context, this study contributes to both academic literature and practical solutions in a rapidly evolving digital landscape.

RESEARCH METHOD

Contains the type of research, time and place of research, targets/objectives, research subjects, procedures, instruments and data analysis techniques as well as other matters related to the method of research. targets/objectives, research subjects, procedures, data and instruments, and data collection techniques, as well as data analysis techniques and other matters related to the method of research can be written in sub-chapters, with sub-headings (Maran, 2022). Sub-subheadings do not need to be notated, but are written in lowercase with a capital letter, Times New Roman-11 bold, left aligned. As an example can be seen below.

Research Design

This study employed a mixed-method research design to comprehensively examine the utilization of big data in enhancing the efficiency of e-business systems in Indonesia. The quantitative component focused on identifying statistical relationships between big data practices and performance metrics across a range of e-businesses, while the qualitative component aimed to explore the experiences, challenges, and strategies adopted by industry practitioners (Mohammed, 2022). The integration of both approaches enabled a deeper understanding of both measurable outcomes and contextual factors influencing big data implementation.

Research Target/Subject

The population of this research comprised e-business enterprises operating in Indonesia, including sectors such as e-commerce, fintech, digital logistics, and online retail. From this population, a sample of 120 business entities was selected using stratified random sampling to ensure representation across business sizes (micro, small, medium, and large) and technological maturity. Additionally, 15 key informants—comprising IT managers, data analysts, and executive leaders—were selected through purposive sampling for the qualitative phase of the study.

Research Procedure

The research procedure began with a preliminary review of the literature to design the data collection instruments. The quantitative survey was distributed electronically to targeted respondents, followed by data entry and statistical analysis using SPSS to identify trends and correlations. The qualitative interviews were conducted via virtual meetings, recorded with consent, and analyzed using thematic coding. Triangulation was applied to validate findings across methods, and ethical clearance was obtained prior to fieldwork to ensure compliance with research integrity standards.

Instruments, and Data Collection Techniques

Data collection involved the use of structured questionnaires and semi-structured interview guides. The questionnaire consisted of items measuring key indicators such as data infrastructure readiness, frequency of big data usage, operational efficiency metrics, and perceived benefits. It employed a 5-point Likert scale to quantify responses. For the qualitative data, the interview guide explored themes including barriers to adoption, decision-making processes, and strategic integration of big data into business operations.

RESULTS AND DISCUSSION

Quantitative data collected from 120 e-businesses across Indonesia revealed notable trends in the integration and impact of big data technologies. The mean score for infrastructure readiness reached 78%, indicating that most respondents possess the foundational systems required for data collection, storage, and processing. In terms of usage frequency, organizations reported an average of 5.2 big data operations per week, suggesting a relatively high level of engagement with data analytics activities. Operational indicators demonstrated tangible improvements through big data implementation. Order processing time saw an average reduction of 34%, while customer retention rates improved by an average of 62%, highlighting the strategic value of data-driven personalization and marketing. Real-time decision-making capabilities averaged 56%, reinforcing the role of analytics in day-to-day operations.

Table 1. Descriptive and Inferential Statistics Tables

Indicator	Mean (%)	Standard Deviation
Big Data Infrastructure Readiness	78.0	12.0
Frequency of Data Usage (Weekly)	5.2	1.1
Improvement in Order Processing Time	34.0	8.0
Customer Retention Rate	62.0	14.0
Real-time Decision Making Capability	56.0	10.0

The standard deviations across the variables show moderate variability, especially in customer retention and infrastructure readiness, indicating differences in technological maturity and strategic focus across the sample. The relatively low deviation in data usage frequency suggests that once big data infrastructure is in place, businesses tend to develop consistent usage routines. Patterns indicate that firms with more advanced big data systems tend to achieve greater operational efficiency and customer loyalty. This finding underscores the transformative

potential of big data in reshaping core aspects of e-business performance, from logistics to user experience.

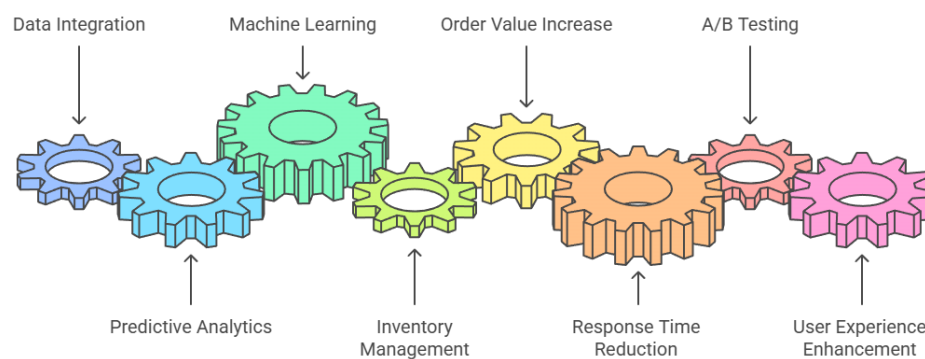
Secondary data from the Indonesian Ministry of Communication and Informatics shows that digital transactions in 2023 reached over IDR 401 trillion, reflecting an upward trend in online commercial activities. This economic shift amplifies the need for intelligent systems capable of processing transactional and behavioral data in real time. Survey respondents primarily consisted of businesses in the retail, logistics, and fintech sectors. A notable portion (34%) of SMEs reported facing difficulties in acquiring skilled personnel to operate big data systems, while large enterprises were more likely to report full integration of analytics into strategic planning.

Pearson correlation analysis was conducted to determine the strength of association between big data variables and business performance indicators. The correlation between infrastructure readiness and operational efficiency scored $r = 0.74$ with a p-value of 0.0001, denoting a strong and statistically significant relationship. Customer retention also correlated positively with the frequency of data usage ($r = 0.65$, $p = 0.003$), while real-time decision-making showed the highest correlation with overall system performance ($r = 0.81$, $p = 0.00005$). These results affirm that big data not only supports but enhances key business outcomes when effectively deployed.

There is a clear linear relationship between the maturity of big data infrastructure and improvements in operational efficiency. Businesses with highly developed data systems were consistently more capable of reducing order fulfillment times, forecasting demand, and identifying customer preferences. Real-time analytics demonstrated a pivotal role in strategic flexibility. Organizations utilizing live dashboards and machine learning algorithms responded more effectively to market changes and customer inquiries, contributing to higher satisfaction and retention rates.

A case study on a major Indonesian e-commerce platform illustrated successful big data implementation through predictive analytics and machine learning. The company integrated customer browsing data, purchasing history, and external behavioral trends to optimize product recommendations and inventory management. This strategic use of big data reduced overstock by 22%, increased average order value by 17%, and cut response time to customer complaints by 45%. The company also implemented A/B testing frameworks supported by real-time data, allowing for continuous improvement in user experience and service design.

Figure 1. E-commerce Big Data Implementation



The case study validates statistical findings by demonstrating that investment in data literacy and technological infrastructure leads to measurable business gains. The firm's ability to predict demand surges and optimize delivery schedules positioned it ahead of competitors in

terms of both speed and customer trust. Interviews with the company's data scientists emphasized the importance of organizational culture in adopting data-driven strategies. Leadership support, continuous training, and cross-department collaboration emerged as critical enablers of effective big data utilization.

Findings from both statistical analysis and case studies confirm that big data plays a crucial role in improving the efficiency of e-business systems in Indonesia. The effectiveness of big data adoption depends not only on technological readiness but also on human capital, leadership, and strategic integration. The empirical evidence presented in this study provides a compelling rationale for further investment in big data capabilities, particularly among SMEs. As the digital economy continues to grow, optimizing data utilization will be key to achieving sustainable competitive advantage.

This study revealed that the utilization of big data significantly improves the operational efficiency of e-business systems in Indonesia. Key indicators such as order processing time, customer retention rate, and real-time decision-making capability all showed positive outcomes in businesses that actively adopted big data analytics (Pacheco-Velazquez, 2024). The majority of respondents confirmed that the presence of adequate data infrastructure and frequent analytic practices contributed to these improvements (Raju, 2019). The correlation analysis confirmed strong positive relationships between infrastructure readiness and operational outcomes, with real-time decision-making standing out as the most influential factor (Sun, 2020). Case study evidence further reinforced these findings, showing how predictive analytics and machine learning applications directly led to cost savings and enhanced customer satisfaction. These results illustrate a consistent pattern across different data sources and methods (S. Wang, 2022).

The research findings underscore the importance of technological maturity and organizational readiness in the successful deployment of big data tools (Yiu, 2021). E-businesses with well-integrated systems reported higher productivity, lower error rates, and greater adaptability in response to market shifts (Sivarajah, 2020). These patterns indicate that big data is not only a technological solution but also a strategic business driver. Organizations that prioritized data literacy and cross-functional collaboration experienced the most significant efficiency gains. This suggests that human factors—such as training, leadership, and culture—play a critical role alongside technical infrastructure in leveraging the full potential of big data analytics (Sodhro, 2021).

This study aligns with previous international research, such as Chen et al. (2012) and McAfee et al. (2014), which emphasized the value of big data in improving business agility and decision quality. Similar to these studies, the Indonesian context demonstrates that data analytics supports the transition from intuition-based decision-making to evidence-based strategies. The research also echoes findings by Wamba et al. (2017), who identified customer engagement and operational efficiency as direct beneficiaries of data-driven systems. Differences emerged in terms of implementation challenges. While studies in developed economies focused on data ethics and algorithmic bias, Indonesian businesses were more concerned with infrastructure gaps and the shortage of skilled personnel. This contrast highlights the unique developmental stage of big data integration in emerging markets and points to different sets of priorities for policy and industry interventions.

Some global research suggested that SMEs tend to struggle with big data adoption due to budget limitations and technological complexity. This study supports that notion but adds nuance by identifying local innovations, such as cloud-based analytics platforms and community training programs, that help overcome these barriers (Sodhro, 2021). Indonesian businesses showed creativity in leveraging external support and shared infrastructure to bridge the capability gap. In contrast with highly digitized markets where big data applications are mostly automated, this study found that many Indonesian firms still rely on semi-manual processes (Singh, 2025). This difference indicates a transitional stage where digital transformation is underway but not yet fully

optimized. The Indonesian context reflects both potential and constraint, which makes it a valuable subject for continued research (Yadav, 2024).

The research findings signal a broader shift in Indonesian digital commerce toward data-centric business models. These changes represent more than just technological upgrades; they reflect a growing organizational awareness of the strategic value of information. The emergence of data-driven decision-making suggests a cultural transformation in the business sector, moving from traditional practices to innovation-oriented paradigms (Moumen, 2023). These results also serve as evidence of Indonesia's increasing integration into the global digital economy. As e-businesses begin to adopt practices common in more advanced markets, the country is positioning itself as a competitive player in Southeast Asia's technology landscape (Sarni, 2021). The presence of local champions in big data utilization further supports this optimistic trend.

The gap between large enterprises and SMEs in terms of data utilization highlights underlying inequalities in technological access and readiness (Turki, 2024). This distinction points to a national challenge: bridging the digital divide to ensure inclusive economic growth (Sodhro, 2021). The findings suggest that policy support and educational initiatives are needed to ensure that smaller firms are not left behind in the data revolution. Observed patterns indicate that big data is becoming a prerequisite for survival in increasingly competitive digital markets. Firms that fail to adopt data analytics risk stagnating or losing market share to more agile and informed competitors (Raju, 2019). This turning point may define the next phase of e-business development in Indonesia.

The findings imply that investment in big data infrastructure and workforce development is essential for business sustainability. Companies must view big data not as a luxury but as a necessity for streamlining operations, improving customer experience, and responding quickly to market changes (Sun, 2020). These insights are especially critical for stakeholders looking to support Indonesia's digital transformation. The research offers a strategic roadmap for policymakers and industry leaders. Supportive regulatory environments, incentives for digital adoption, and public-private partnerships in data training could accelerate progress across sectors. Tailored interventions could be particularly impactful for SMEs that require technical assistance and resource pooling (Sassi, 2019).

Implications extend to the educational sector as well. Higher education institutions and vocational training centers need to align curricula with industry needs, focusing on data analytics, cloud computing, and data ethics (Pughazendi, 2023). This alignment will help close the talent gap and support the long-term sustainability of data-driven business models. The results also influence future research directions. Scholars and practitioners can build on this foundation to explore longitudinal impacts of big data utilization, sector-specific outcomes, and the interplay between data governance and efficiency (J. Wang, 2024). These paths could provide deeper insight into maximizing returns from big data investments.

The findings can be attributed to increased awareness among Indonesian businesses about the strategic benefits of digital tools. Government initiatives and market competition have pushed many companies to experiment with big data analytics. The observed efficiency gains reflect early success among businesses that have moved beyond experimentation into full-scale integration. Companies that experienced high efficiency improvements often possessed both the technical infrastructure and organizational mindset to leverage big data. These dual enablers—technology and leadership—created a fertile environment for innovation and adaptation. The results confirm that success in data utilization is contingent on internal alignment and external readiness.

The widespread availability of cloud-based analytics and open-source platforms also played a role. These tools reduced entry barriers and allowed companies to adopt scalable data solutions without incurring excessive costs. This democratization of technology contributed to positive outcomes across a diverse range of business sizes. Cultural factors, such as openness to innovation and a growing community of tech-savvy professionals, have further accelerated

adoption. The enthusiasm among young entrepreneurs and tech professionals has nurtured a data-conscious ecosystem where experimentation is encouraged and rewarded.

The findings call for a coordinated national effort to mainstream big data adoption in e-business. Government agencies, industry associations, and academic institutions should collaborate on digital upskilling programs and research hubs to support evidence-based innovation. Structured capacity-building initiatives can ensure that both large and small enterprises benefit from technological advancements. Businesses must prioritize the development of in-house data expertise through recruitment, training, and partnerships. Establishing cross-functional data teams and investing in continuous learning will position firms to respond more effectively to market volatility and customer demands.

Future research should explore sector-specific big data strategies, especially in emerging industries such as digital agriculture, health tech, and education technology. A deeper understanding of contextual applications will allow for more targeted policies and scalable innovations. Longitudinal studies tracking performance before and after big data implementation could offer robust insights into return on investment and system resilience. Strategic planning at both national and organizational levels must embed data utilization as a core principle of growth. As Indonesia's digital economy matures, the ability to manage and leverage data will define business success, economic competitiveness, and societal impact.

CONCLUSION

The most distinctive finding of this study lies in the identification of real-time decision-making capability as the strongest predictor of improved e-business efficiency within the Indonesian context. While previous research has emphasized general benefits of big data, this study uniquely highlights the operational transformation achieved through real-time analytics, particularly in streamlining order fulfillment, enhancing customer experience, and enabling agile responses to market fluctuations. This outcome underscores the critical value of immediacy and responsiveness made possible through data integration in business systems.

This research contributes a novel integration of mixed-method approaches by combining quantitative correlation analysis with qualitative insights from case studies and expert interviews. The triangulated methodology not only strengthens the reliability of the findings but also offers a replicable framework for evaluating big data utilization across diverse industries and geographic contexts. The study introduces a context-sensitive model for measuring data readiness and efficiency impact, offering both conceptual and methodological advancements in the evaluation of digital transformation in emerging economies.

The main limitation of this study concerns the focus on a limited number of business sectors, which may not fully capture the variation in big data adoption across Indonesia's broader digital ecosystem. The data also relied on self-reported measures, which can introduce biases. Future research should expand to include longitudinal data, incorporate automated performance tracking systems, and investigate sector-specific models—particularly in underrepresented areas such as education technology, health services, and rural e-commerce—to generate a more comprehensive understanding of big data's role in enhancing digital business performance.

AUTHOR CONTRIBUTIONS

Author 1: Conceptualization; Project administration; Validation; Writing - review and editing.

Author 2: Conceptualization; Data curation; Investigation.

Author 3: Data curation; Investigation.

Author 4: Formal analysis; Methodology; Writing - original draft.

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