INTERNATIONAL JOURNAL OF ACADEMIC RESEARCH IN BUSINESS & SOCIAL SCIENCES

Vol 16, Issue 3, (2026) E-ISSN: 2222-6990

Big Data Analytics Adoption Conceptual Framework: A Comparative Study between Indonesian and Malaysian Retail SMEs

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DOI Link: http://dx.doi.org/10.6007/IJARBSS/v16-i3/27972

Published Date: 17 March 2026

Abstract

Purpose: A lack of widespread adoption of Big Data Analytics (BDA) in Small and Medium-Sized Enterprises (SMEs) results from implementation hurdles and difficulties. Different conditions of each country will make a difference in BDA adoption. This paper proposes a conceptual framework of BDA adoption on the Technology, Organization, and Environment (TOE) framework. The proposed model will be able to explain the differences in BDA adoption determinants between countries. **Design/methodology/approach:** The Partial Least Square (PLS) with Multi-Group Analysis (MGA) technique must be employed to test and analyze the proposed model. **Findings:** The findings are not pertinent as this is a conceptual paper. **Research limitations/implications:** Although this paper has the potential to quantitatively explain the disparities in BDA adoption among countries, which are currently lacking, it has not yet been empirically verified. **Practical implications:** This paper offers practical implications for SMEs, BDA vendors, and the government in effectively formulating strategies for BDA adoption. **Originality/value:** This paper contributes significantly to the literature on BDA adoption in SMEs by proposing a comparative study between countries and highlighting the importance of environment factors (competitive pressure and government regulation) as moderators of the TOE framework.

Keywords: BDA Adoption, TOE, Retail SMEs, Comparative Study, PLS-MGA

Introduction

Big Data Analytics (BDA) is a cutting-edge technology that became popular and widely employed in various industries during the fourth industrial revolution. BDA is also prevalent in various research themes because it has high strategic and operational potential to create value and change the business process (Fosso Wamba et al., 2015). Big Data is the primary characteristic of vast data, represented in their volume when the capacity is gained in large data centers and storage area networks. Due to the enormous amount of massive data, datasets are heterogeneous and have a wide range of dimensionalities (Rafiq et al., 2022). In

addition, conventional data management methods and systems cannot acquire, organize, and analyze them (Al-Darras & Tanova, 2022). According to Fosso Wamba et al. (2015) and Patel (2019), BDA is a comprehensive process that involves the ability, skills, and expertise to store, extract, and analyze data that has five attributes, namely volume, variety, velocity, value, and veracity to create a competitive advantage for a business (Fosso Wamba et al., 2015). Volume is related to the amount of data, variety is associated with the diversity of data sources, velocity is related to the speed of data change, value is associated with the business value of the data, and veracity is related to the uncertainty of the data (Patel, 2019).

BDA has been extensively researched to aid decision-making and enhance business performance (Fosso Wamba et al., 2015). BDA can optimize business opportunities and processes while enhancing customer service and value, which is also a competitive advantage (Shan et al., 2019). Using BDA in businesses has numerous advantages and gains. Not all businesses, however, have benefited from it. Large firms have widely used BDA, but the using BDA in SMEs is still developing (Shouhong & Hai, 2020). Moreover, researchers studying SMEs still need to be widely found (Maroufkhani et al., 2020). There are barriers and challenges to BDA adoption, such as human resources, financial expertise, capability, technology support, etc. (Maroufkhani et al., 2020; Ogbuokiri et al., 2015; Sen et al., 2016; Seseni & Mbohwa, 2018; Shah et al., 2018). This creates variations in BDA applications in firms (Maroufkhani et al., 2020).

Previous research focuses on investigating BDA adoption in various sectors of SMEs, such as the hotel industry, manufacturing, insurance, Information and Technology (IT), and healthcare (Maroufkhani et al., 2020; Olufemi, 2018; Yadegaridehkordi et al., 2020). Nonetheless, research on BDA adoption in retail sector SMEs has not been widely conducted. Data is essential in the retail sector, which has high market competition. The shift in retail trends from selling through physical stores to online channels makes the data generated even bigger (Mneney & Van Belle, 2016; Seetharaman et al., 2016). Retail sector companies intend to implement BDA in their business. However, the lack of infrastructure, funding, and skilled human resources, as well as doubts about data quality, make BDA adoption still a challenge for the sector (Ahmad, 2020; Dittert et al., 2018; Ram et al., 2016; Surabhi Verma & Bhattacharyya, 2017). Furthermore, based on a survey in the US, only 5% of retail companies are data-driven companies (Harvard Business Review, 2018). Companies should be able to extract business value from the data they generate. By utilizing a data-driven strategy, the retail sector can benefit business value in facing the threat of low margins in the retail industry, such as reducing the cost structure for winning the market competition and also providing different offerings through market segmentation (Mneney & Van Belle, 2016; Santoro et al., 2018; Verma & Bhattacharyya, 2017).

It is also found that most BDA adoption research was only conducted in one country, especially in a developed country. As a result, the research's findings cannot be applied to other countries. The existence of differences such as economic status, technological progress, and the lifestyle of a country will affect the decision to adopt technology, such as BDA (Baig et al., 2019). There is a need to conduct a comparative study between countries as suggested by previous researchers (Raguseo, 2018; Yadegaridehkordi et al., 2020) to provide a better understanding of BDA adoption determinants between developing countries such as Indonesia and Malaysia. Therefore, the paper will fill the research gaps and provide literature

and practice contributions by investigating BDA adoption determinants between Indonesia and Malaysia SMEs in the retail sector based on the Technology, Organization, and Environment (TOE) framework.

This paper will contribute significantly to the literature on BDA adoption in SMEs by proposing a comparative study between countries to analyze the differences in the suggested model framework and introducing environmental factors as a moderator in the TOE framework. Based on the problem statement, the aims of this paper are three folds. First, to investigate the technology and organization factors influencing BDA adoption in Indonesia and Malaysia retail sector SMEs. Second, to investigate the moderating influence of environmental factors (competitive pressure, external support, and government regulations) on the relationship between technology and organization factors on BDA adoption in Indonesia and Malaysia SMEs. Third, to compare the BDA adoption state in Indonesia and Malaysia SMEs.

Literature Review

Big Data Analytics (BDA) Concept

As one of the advanced technologies, BDA is prevalent in various research topics because it has high strategic and operational potential to create business value and can change the entire business process (Fosso Wamba et al., 2015). Using BDA, techniques and tools are needed, namely data management and analytics (Mneney & Van Belle, 2016). BDA is a comprehensive process that involves the ability, skills, and expertise to store, extract, and analyze data to create a competitive advantage for a business (Fosso Wamba et al., 2015). BDA has been widely used in various domains and countries. This can be seen from the research on BDA adoption that have been carried out in both developing and developed countries in various fields or contexts such as firms, organizations, companies, information technology, telecommunications, services, finance, supermarket, retail, government, logistic and supply chain, education, and ecology (Al-Rahmi et al., 2019; Baig et al., 2019; Fosso Wamba et al., 2015; Lai et al., 2018; Walker & Brown, 2019; Wu et al., 2017). Numerous benefits can be obtained by using BDA. Integrating various structured and unstructured data sources and historical data can create better service management and delivery (Fosso Wamba et al., 2015). BDA can tackle the problems commonly faced in government circles, namely transparency and accountability issues within and between organizations (Fosso Wamba et al., 2015). BDA has been widely studied to help decision-making and improve company performance (Fosso Wamba et al., 2015). Similarly, Tan et al. (2017) emphasize that BDA can assist decision-makers in making fact-based decisions to improve company performance or create better business strategies. BDA can help enterprises make marketing strategies that are more effective and better in facing market competition by better analyzing consumer behavior as to what they want, need, and pay attention to (Seseni & Mbohwa, 2018). Moreover, Silva et al. (2019) state that BDA provides a competitive advantage and an opportunity for fashion retailers to survive in fluctuating economic conditions.

BDA has been widely used in various sectors in Indonesia and Malaysia, such as e-commerce, finance and banking, e-health, telecommunication, public transport, consumer, creative economy, energy, and service (Bigit, 2020; Pemisindo & Mauritius, 2020; Tien et al., 2020). However, BDA adoption in Indonesia is less advanced than in other countries and still faces challenges in the future. This can be seen from the unequal distribution of Information, Communication, and Technology (ICT) infrastructure and the lack of resources needed for

BDA adoption (Kementrian Komunikasi dan Informasi, 2019; Pemisindo & Mauritsius, 2020). Based on the Global Connectivity Index (Huawei, 2019), Indonesia is in the starter category, which means that Indonesia is in the early stages of developing ICT infrastructure with a focus on expanding connectivity access to many people. Meanwhile, Malaysia is in the adopter category, meaning ICT investment produces the most significant GDP growth. Adopter countries focus on increasing demand for high-speed connectivity to foster industrial digitization development and boost economic growth. The existence of environmental differences in a country causes the factors of BDA adoption to be different from other countries (Pemisindo & Mauritsius, 2020).

SMEs Characteristics in Indonesia and Malaysia

SMEs play an essential role as economic drivers, job creators, and supporters of national economic stability in facing shocks from external factors in a country (Badan Pusat Statistik, 2019; SME Corp. Malaysia, 2020). Indonesian and Malaysian SMEs comprise micro, small, and medium-sized enterprises. In Indonesia, the number of SMEs in 2022 reached more than sixty-four million, or around 99.99% of the total business, contributing to 57.14% of the Gross Domestic Product (GDP) and 96.2% of the country's employment. Micro-sized SMEs make a significant contribution to business establishment (98.67%), GDP (30.07%), and country employment (89.04%). Meanwhile, small and medium-sized SMEs contribute only a tiny amount. In 2019, Small and medium-sized SMEs only contributed to 1.32% of business establishments and 7.16% of the country's employment. In terms of the contribution to GDP, micro-sized, and small medium-sized SMEs have a contribution that is not much different, namely 30.07% for micro-sized SMEs and 27.07% for small medium-sized SMEs (Kementrian KUKM Indonesia, 2021). In Malaysia, there were over 1.1 million SMEs in 2020 which accounted for 97.2% of the total business in the country. Micro SMEs dominate this figure, amounting to 903,174 businesses (78.4%). Meanwhile, the number of small and medium-sized SMEs was 229,876 (20%) and 18,289 (1.6%), respectively. The contribution of SMEs to business employment in 2020 slightly decreased compared to 2019, at 98.5%. The contribution of Malaysian SMEs to GDP is not as significant as Indonesian SMEs, wherein in 2020, the contribution was 38.2%, and this number decreased slightly compared to 2019, which amounted to 38.9%. Meanwhile, the contribution of SMEs to total employment in Malaysia in 2020 was 48%, which also decreased compared to 2019, which amounted to 49.4%. The COVID-19 pandemic caused a decline in 2020, but this decline was not too significant and still shows an excellent contribution to the Malaysian economy (National Entrepreneur and SME Development Council, 2021).

There are differences in the classification of SMEs in Indonesia and Malaysia. Indonesian SMEs are classified based on the working capital criteria (capital used for establishing or registering business activities) or annual sales results (Pemerintah Republik Indonesia, 2021). Meanwhile, Malaysian SMEs are classified based on the criteria of sales turnover or the number of full-time employees. Sales turnover refers to total revenue, including other incomes. Full-time employee refers to all workers, including foreign and contract workers, who are paid to work at least 6 hours a day and 20 days a month or at least 120 hours a month. A business is classified as an SME if it can meet one or both (SME Corp. Malaysia, 2020).

In terms of the industrial sector, most SMEs in Indonesia are engaged in the wholesale and retail businesses, under wholesale and retail trade, repair of motor vehicles, and motorcycles

sector (Badan Pusat Statistik, 2019). In 2017, the number of SMEs in Indonesia engaged in this sector reached 46.40% of the total number of SMEs in Indonesia. Meanwhile, the employment of SMEs in this sector is the largest compared to other sectors, reaching 37.95% (Badan Pusat Statistik, 2019). In 2020, most Malaysian SMEs (64.3%) and SME employment (63.2%) were concentrated in the service sub-sector, namely wholesale and retail trade. This wholesale and retail sub-sector also contributed to almost two-thirds (63.9%) of the value-added of SMEs in the service sector and other sub-sectors, namely food & beverages and accommodation (National Entrepreneur and SME Development Council, 2021). Based on this data, retail sector SMEs play an essential role in the national economy of Indonesia and Malaysia.

There are differences in the use of ICT in Indonesian and Malaysian SMEs. Indonesia is a country with many islands with challenging geographical conditions. This has resulted in the development of ICT infrastructure that has yet to be evenly distributed throughout the province. Therefore, only some SMEs have used ICT in their business. This can be seen from data in 2017 showing that only about 9.76% of SMEs used the Internet to run their businesses (Badan Pusat Statistik, 2019). Meanwhile, the development of ICT in Malaysian SMEs is more advanced than in SMEs in Indonesia. In 2018, 73.3% of SMEs in Malaysia used the Internet for business purposes, and 37.9% were already doing online business (National Entrepreneur and SME Development Council, 2019). However, the productivity growth of Malaysian SME workers decreased in 2018 by 2.9% compared to the year 2017 amounted to 3.6%. Several factors can affect SMEs' productivity growth, such as a lack of scale of production, managerial skills, innovation, finance, and market access. Thus, it is necessary to improve management and use of technology to increase productivity and operational efficiency and reduce costs (National Entrepreneur and SME Development Council, 2019). Furthermore, SMEs face many challenges in the industrial revolution 4.0 era. Hence, capabilities and skills are needed, such as technology savvy, if they want to continue to develop and survive in the face of market competition. SMEs can also enter the e-commerce market and use technological innovations such as cloud computing and BDA to reach a broader market, increasing sales and business productivity (Badan Pusat Statistik, 2019).

BDA and SMEs

Large firms have widely used BDA, but the use of BDA in SMEs is still developing (Shouhong & Hai, 2020). There are barriers and challenges to Big Data adoption in SMEs, such as more human resources, financial expertise, capability, and technology support (Kiziltan, 2018; Ogbuokiri et al., 2015; Sen et al., 2016; Seseni & Mbohwa, 2018; Shah et al., 2018). This makes SMEs reluctant to use BDA in their business. However, Maroufkhani et al. (2019) argue that SMEs with a smaller organizational structure make them more flexible in finding opportunities to use innovative technology such as BDA. SMEs usually know their customers more closely and understand the sources, needs, and value of data (Shouhong & Hai, 2020). SMEs must use and take advantage of BDA because of the fast data growth and customer interactions (Schaeffer & Olson, 2014). The limited funds SMEs own that make them reluctant to use BDA can be overcome by using free BDA providers such as google analytics (Schaeffer & Olson, 2014). Park & Kim (2019) suggest that companies can manage budgets and allocate funds effectively to finance BDA investments to overcome the high cost of implementing BDA. There are several strategic reasons behind using BDA in SMEs: reducing costs, increasing profits,

improving marketing strategies and customer service, creating long-term business continuity, and effective decision-making (Shouhong & Hai, 2020).

Olufemi (2018) suggests that SMEs can benefit from using cloud-based BDA to store data centrally, extract business-critical insights from their BDA, create marketing strategies and disclose strategic information used by competitors, improve customer relationship management, detect fraud, quickly analyze massive security monitoring data, enables disaster recovery and business continuity through successful data backup and data recovery of cloud-based BDA and control of ideas and information. SMEs are more likely to apply cloud-based BDA if their organization's technology roles and activities are combined, and the data processing criteria match correctly (Olufemi, 2018). Therefore, SMEs should be able to take advantage of opportunities from the use of BDA for the advancement of their business and to be able to compete with their competitors.

Technology Adoption Theoretical Foundations

Several theoretical foundations of technology adoption were used in the context of BDA adoption, such as the Theory of Planned Behavior (TPB), Technology of Acceptance Model (TAM), Diffusion of Innovation (DOI), and TOE (Technology, Environment, and Organization). Using the TPB framework, Varma (2018) examines BDA adoption intention on management accountants. Al-Rahmi et al. (2019) examine the effect of Big Data adoption and knowledge management sharing on education sustainability using TAM and motivation theory. Surabhi Verma et al. (2018) discuss the influence of system characteristics on managers' attitudes toward BDA adoption intention using the extended model of TAM.

Diffusion of Innovation (DOI) is a process of delivering information to the social innovation community through a communication channel over time. Technological innovation will create uncertainty in the minds of potential users regarding the expected consequences of the technology, such as whether the technology can meet their needs. Alternatively, solve problems experienced by the individual. To reduce uncertainty, this individual will seek information about technological innovations to help decide whether the technology will be used or rejected (Rogers, 1983). The diffusion process can involve various channels, including mass media (electronic media/internet) and individual communication (Rogers et al., 2009). The diffusion of innovation concept is widely used by researchers in technological innovation (Rogers et al., 2009).

The Technology, Organizations, and Environment framework (TOE) was developed by DePietro et al. (1990) to explain the decision-making factors of a firm in using technological innovation and whether to use or reject it. DePietro et al. (1990) mention technical aspects related to technology from the internal and external of the firm, such as the availability and characteristics of modern technology. Organizational factors relate to informal or formal managerial structures, communication process, firm size, and internal slack resources amount. Meanwhile, environmental factors relate to outside the organization, such as industry and market structure characteristics, infrastructure supporting technology, and government regulation. TOE framework helps complete learning about the technology diffusion process at the firm's level from the DOI theory by adding environmental elements (Lai et al., 2018). TOE framework has been widely used in technology adoption literature such as e-commerce adoption (Rahayu & Day, 2015), government cloud adoption (Tweneboah-

Koduah et al., 2014), mobile marketing adoption intention (Maduku et al., 2016). Therefore, its validity has been proven (Lai et al., 2018).

Hypothesis Development

BDA and TOE Framework

In the technological context, BDA adoption determinants that have been studied include IT infrastructure, IT human assets, perceived benefits, relative advantage, complexity, simplicity of system usage, compatibility, trialability, data security, data quality, observability, uncertainty and insecurity, and technology assets (Lai et al., 2018; Maroufkhani et al., 2020; Park & Kim, 2019; Pemisindo & Mauritsius, 2020; Ramanathan et al., 2017; Tien et al., 2020; Walker & Brown, 2019; Yadegaridehkordi et al., 2020). In the organizational context, several BDA adoption determinants have been studied by researchers, such as top management support, financial support, financial readiness, financial investment competence, IT infrastructure/capabilities, organizational readiness, skills and experiences, human resource expertise, application domains, complementary investments, organization size, business and IT alignment, and absorptive capacity (Lai et al., 2018; Maroufkhani et al., 2020; Park & Kim, 2019; Pemisindo & Mauritsius, 2020; Ramanathan et al., 2017; Tien et al., 2020; Walker & Brown, 2019; Yadegaridehkordi et al., 2019). Meanwhile, in the environmental context, BDA adoption determinants that have been studied include IT fashion, competitive pressure, competitor adoption, competitive intensity, partner adoption, market environment, environmental uncertainty, relationship assets, business pressure, regulatory environment (support or policy), high degree of regulatory, data privacy, business type governance, buy type, and vendor support (Lai et al., 2018; Maroufkhani et al., 2020; Park & Kim, 2019; Pemisindo & Mauritsius, 2020; Ramanathan et al., 2017; Tien et al., 2020; Walker & Brown, 2019; Yadegaridehkordi et al., 2019).

Factors that affect an organization's decision to adopt BDA may vary in the different industries due to the various role of BDA in other aspects (Sun et al., 2018). Similarly, Pemisindo & Mauritsius (2020) and Park & Kim (2019) mention that in specific industries, other BDA adoption factors only apply to that particular industry. Therefore, this study uses factors that influence BDA adoption based on previous research in the retail sector (Mneney & Van Belle, 2016; Santoro et al., 2018), namely: technology factors (relative advantage, complexity, data quality, and cost of adoption), organization factors (top management support, organizational readiness, entrepreneurial orientation), and environment factors (competitive pressure, external support, and government regulations). Environment factors are proposed to be used as moderating variables because the existence of differences such as economic status, technological progress, and the lifestyle of a country will affect the supporting and inhibiting variables constructed in the TOE framework to determine BDA adoption (Bremser, 2018; Maduku et al., 2016; Maroufkhani et al., 2020; Olufemi, 2018; Park & Kim, 2019; Tien et al., 2020; Walker & Brown, 2019; Yadegaridehkordi et al., 2020). Pemisindo & Mauritsius (2020) also mention that the existence of environmental differences in Indonesia causes the factors of BDA adoption to be different from other countries. Therefore, this study looks at differences in BDA adoption factors in different environments, as previously conducted by Lai et al. (2018).

Technology Factors

Relative Advantage

Based on previous systematic literature review studies, relative advantage is the most frequently used and significant factor in BDA adoption research (Baig et al., 2019; Sun et al., 2018). A relative advantage is the extent to which an innovation is considered better than what it replaces. The nature of the innovation will significantly determine the type of relative advantage for its users. However, the user's character will also affect the dimensions of what relative advantage is considered the most important (Rogers, 1983). Several studies have shown that BDA provides advantages over other traditional analytical methods. Real-time BDA can analyze structured and unstructured data to get deeper insights, whereas conventional business intelligence methods are limited. However, BDA is considered to complement existing systems and not replace them (Walker & Brown, 2019). The increasing awareness of the benefits of BDA will increase a solid desire to adopt it to help a company's business run smoothly (Yadegaridehkordi et al., 2018).

Sun et al. (2018) research shows that relative advantage is a factor in adopting BDA, which other researchers in the TOE framework most widely use. Maroufkhani et al. (2020) evidence that relative advantage does not significantly affect BDA adoption. Although the benefits of BDA are known, this does not make SMEs want to use BDA because SMEs have financial limitations, IT infrastructure, and skilled human resources. However, some researchers have proven that relative advantage positively relates to adopting BDA (Park et al., 2015; Yadegaridehkordi et al., 2018). Therefore, it is proposed that:

Hypothesis 1: Relative advantage positively influences BDA adoption in Indonesian and Malaysian SMEs.

Complexity

Innovation can be considered relatively difficult to understand and use due to its complexity (Rogers, 1983). The complexity of innovation will be negatively related to the level of use (S Verma & Bhattacharyya, 2017). The implementation of BDA in a company can be delayed because BDA is a complex technology that can process extensive amounts of data (Yadegaridehkordi et al., 2018). Adopting BDA in SMEs will experience problems because SMEs need the ability and expertise in the company, but this can be overcome by using BDA outsourcing (Maroufkhani et al., 2020). However, Walker & Brown (2019) confirm that organizations with a high tolerance for the complexity of new technology will move more quickly to using BDA. Previous studies showed that complexity negatively influences the adoption of BDA (Maroufkhani et al., 2020; Tien et al., 2020). Therefore, it is proposed that:

Hypothesis 2: Complexity negatively influences BDA adoption in Indonesian and Malaysian SMEs.

Compatibility

Compatibility is how innovation fits present values, past experiences, and future adopters' needs. Innovation may or may not be compatible with sociocultural values and beliefs, previous ideas, and the user's need for innovation (Rogers, 1983). According to Maroufkhani et al. (2020), compatibility is the degree to which technology adoption matches the company's existing systems. This includes technology consistent with the firm's business practice, fits with organizational culture, and is easy to incorporate into the firm. Shan et al. (2019) mention that compatibility which is the consistency between the use of Big Data to

support business strategies and goals, are two important aspects that companies must consider to make BDA work effectively in organizations and make decisions quickly. If the firm has a compatible information system with the BDA system, the changes due to BDA will be consistent with existing practices. Hence, the positive changes brought by BDA will encourage the adoption of BDA (Agrawal, 2015). However, Maroufkhani et al. (2020) argue that compatibility does not influence the decision to use BDA in SMEs. This is because the small firm size makes it more flexible in adjusting or changing business practices than large firms. However, the compatibility of technological innovations such as BDA has been shown extensively concerning their application (Agrawal, 2015; Park et al., 2015; Surabhi Verma & Bhattacharyya, 2017; Yadegaridehkordi et al., 2019; Yadegaridehkordi et al., 2018). Therefore, it is proposed that:
Hypothesis 3: Compatibility positively influences BDA adoption in Indonesian and Malaysian SMEs.

Uncertainty and Insecurity
Data analytics can reveal confidential information about organizations or individuals. Even checking separate datasets with seemingly benign data can disclose some private information when the datasets are combined for checking. As a result, intentional or inadvertent privacy breaches can occur (Erl et al., 2016). In the BDA world, privacy is becoming increasingly important and needs to be addressed. System privacy refers to protecting information about personal issues and identity. In addition, the system also offers a meaningful guarantee that it will not share private information (Seetharaman et al., 2016). Seetharaman et al. (2016) emphasize that customer data is one of the firm's greatest assets. Concerns about data privacy arise from both the firm and the customer. The firm is expected not to share customer personal information with other parties as scheduled by the customer. As a result, managers must ensure that personal and organizational privacy is protected in the context of BDA, which is a massive problem for businesses (Fosso Wamba et al., 2015). In the age of big data, protecting personal information involves much more than just passing legislation. The critical difficulty is structuring the relationships between the legal needs and the inherent motivations of information owners through scientific law and system design, making personal information security an internal necessity of information owners (Zhu & Song, 2022).

The security of BDA is another concern related to adoption (Albert et al., 2019; Rafiq et al., 2022). More than traditional data privacy and security mechanisms are required to deal with BDA use cases (Surbakti et al., 2020). Before implementing BDA, organizations should consider privacy and security concerns (Rafiq et al., 2022). To secure BDA, it must be ensured that authentication and authorization mechanisms can adequately secure data networks and repositories (Erl et al., 2016). In addition, several security challenges have also been identified in the context of data platform use. There may be an interest in outsourcing cloud-based infrastructure to host critical data or perform data analysis for third parties (Surbakti et al., 2020). The lack of proper BDA security and encryption will lead to severe threats from BDA (Bolonne & Wijewardene, 2020).

Ensuring data privacy and security are proven to have a positive impact on BDA adoption (Bolonne & Wijewardene, 2020; Schüll & Maslan, 2018; Seetharaman et al., 2016). Conversely, despite the many benefits of using BDA in improving company performance, security, and privacy concerns hinder BDA adoption. Yadegaridehkordi et al. (2019) proved

that security and privacy concerns negatively influence BDA. Similarly, Maroufkhani et al. (2020) also confirmed that the uncertainty and insecurity of the BDA system will have a negative effect on BDA adoption. This research uses the same terminology as Maroufkhani et al. (2020): uncertainty and insecurity. Uncertainty and insecurity refer to the need to use BDA, creates concerns about data security and privacy, creates vulnerability in access control of an organization's information asset, and complicates the process of implementing corporate policy in protecting individual privacy and data security (Maroufkhani et al., 2020). Therefore, it is proposed that:
Hypothesis 4: Uncertainty and insecurity negatively influence BDA adoption in Indonesian and Malaysian SMEs.

Organization Factors

Top Management Support

The support and active involvement of top management are strongly related to the successful implementation of BDA in an organization (Fosso Wamba et al., 2015; S Verma & Bhattacharyya, 2017). Without strong top management support, there would be resistance from employees which would slow down BDA adoption, although it would be helpful for the organization (Olufemi, 2018; Yadegaridehkordi et al., 2018). Therefore, top management must create a supportive environment and provide what it needs for BDA implementation (Yadegaridehkordi et al., 2018). Previous studies evidenced that top management support positively influences BDA adoption (Park & Kim, 2019; Yadegaridehkordi et al., 2018). In the case of management support, large companies/middle-standing companies showed that the active interest and support of the CEO influenced Big Data's introduction and did not affect small companies (Jang et al., 2019). Therefore, it is proposed that:
Hypothesis 5: Top management support positively influences BDA adoption in Indonesian and Malaysian SMEs.

Organizational Readiness

Top management needs to build organizational readiness to face all kinds of changes and prepare the company to be able to implement BDA properly such as capable human resources, adequate technology, and appropriate finance (Maroufkhani et al., 2020; Yadegaridehkordi et al., 2018). The use of technology in an organization can help analyze the extent to which the organization's readiness is related to Big Data adoption (Baig et al., 2019). Previous studies evidenced that organizational readiness positively influences BDA adoption (Maroufkhani et al., 2020; Yadegaridehkordi et al., 2018). Therefore, it is proposed that:
Hypothesis 6: Organizational readiness positively influences BDA adoption in Indonesian and Malaysian SMEs.

Entrepreneurial Orientation

In small businesses, strategic decision-making can be influenced by individual entrepreneurial approaches from the owner or top management, which will then become the organizational culture. Entrepreneurial orientation is related to decision-making activities that lead to new entries that tend to act independently, are willing to innovate and take risks, proactive in looking for market opportunities, and aggressive towards competitors (Lumpkin & Dess, 1996; Rank & Strenge, 2018). This entrepreneurial orientation is discussed in the literature as an organizing element in the TOE framework. However, Sedkaoui (2018) mentions that entrepreneurial orientation can be used by small businesses to consider when using BDA. BDA

is a source of information for companies in making decisions about the company's external environment. Companies that are proactive, innovative, and willing to take risks are more likely to invest in new technology to discover and take advantage of new opportunities. Therefore, it is proposed that:
Hypothesis 7: Entrepreneurial orientation positively influences BDA adoption in Indonesian and Malaysian SMEs.

The Moderating Roles of Environment Factors
Environment factors are not widely used as a moderator in the context of BDA adoption using the TOE framework. Lai et al. (2018) researched BDA adoption by using environmental factors as a moderator in the TOE framework in the logistics and supply chain sector. The results showed that environmental factors, i.e., government policy and regulation and BDA adoption of competitors, can strengthen the relationship between organizational factors, namely top management support and BDA adoption.

Other researchers also use environmental factors as moderators in the TOE framework. Abdulkarem & Hou (2021) studied Cross-Border E-Commerce (CBEC) adoption in SMEs in China using the environmental context as a moderator. The results showed that the environmental context strengthened the relationship between organizational factors and levels 3 & 4 of CEBC adoption. Environmental context includes competition pressure, customers pressure, suppliers' pressure, regulatory and legal environment, and country readiness. Level 3 includes static websites; communication with customers, vendors, and suppliers; online transactions; and payment facilities. Level 4 consists of all elements in Level 3 plus integrating business operations with supply chain partners and suppliers (online collaboration) (Abdulkarem & Hou, 2021). Lastly, Oliveira et al. (2019) studied Software-as-a-service (SaaS) using environmental context (coercive pressures, normative pressures, and mimetic pressures) as moderators. Coercive force includes the intention from governments, industry associations, and the competitive environment that suppress the firm to adopt SaaS. Normative pressures include suppliers, customers, and governments influencing the firm to use SaaS as their use of SaaS increases. The mimetic force consists of adopting SaaS positively perceived by competitors, suppliers, and customers. In addition, the adoption of SaaS has dramatically benefited the firm. The results showed that the environmental context strengthens the relationship between the technology factor (technology competence) and SaaS adoption. However, this study also showed no moderating effect of environmental context on the organizational factor (top management support). It is still unclear why there is no such moderating effect, and it requires, even though there is only a little literature examining the moderating role of environmental factors on the TOE framework; more literature is needed to determine whether those factors can strengthen or weaken the BDA adoption. This becomes relevant since the surrounding environment influences firms. Thus, it is legitimate to investigate the influence of these environmental factors on other factors in the TOE framework (Oliveira et al., 2019).

Competitive Pressure
External pressure is one of the factors that motivate companies to use BDA. Companies, especially SMEs, will worry and fear losing competitiveness if their competitors or suppliers use new technology such as BDA (Yadegaridehkordi et al., 2018). External pressure would also come from customers, making the companies want to improve customer service (Olufemi,

2018). BDA use requires other networks' assistance, so companies can consult BDA providers to help them solve this external pressure problem before they adopt BDA (Yadegaridehkordi et al., 2018). Maroufkhani et al. (2020) evidence that external pressure has no significant effect on the use of BDA due to low levels of local competition and a lack of multinational companies investing in a country. However, previous studies have proven that external pressure positively influences BDA adoption (Yadegaridehkordi et al., 2018). Nevertheless, competitive pressure is proposed to be used as a moderator on the TOE framework in this study. This is because businesses will attempt to apply similar technologies to rivals to keep up with them in the face of fierce rivalry (Pemisindo & Mauritsius, 2020). This has also been proven by Lai et al. (2018) that BDA adoption of competitors can strengthen the relationship between organization factor (i.e., top management support) and intention to adopt BDA. Besides that, BDA adoption of competitors as a moderator also influences technology factor (i.e., technology complexity) despite the non-significant effect. This shows that even though BDA technology is perceived as challenging and complex, managers are motivated to implement BDA because their rivals have already done so. Therefore, it is proposed that:

Hypothesis 8a: Competitive pressure moderates the negative relationship between complexity and BDA adoption in Indonesian and Malaysian SMEs.

Hypothesis 8b: Competitive pressure moderates the positive relationship between top management support and BDA adoption in Indonesian and Malaysian SMEs.

Government Regulation

The role of government is vital in helping SMEs businesses by encouraging technology transfer from large companies to SMEs by offering free ICT and e-commerce training. Governments can also work with IT companies to provide easy-to-use software in local languages to reduce perceived IT complexity (Candra & Nasution, 2014). Government policies such as open data, data utilization, and promotion procedures that can secure external data and collaborate in data analysis are essential in providing BDA adoption's institutional foundation and value (Park & Kim, 2019). Government policies and support, such as supplying BDA experts, consulting, and financial assistance, are needed for SMEs to reduce the cost of introducing and implementing BDA (Park & Kim, 2019). However, government regulations and their compliance may impede the use of BDA (Olufemi, 2018). Maroufkhani et al. (2020) found that government support has no significant effect on BDA adoption because the investment spent on BDA adoption is higher than the incentives provided by the government. Similarly, Pemisindo & Mauritsius (2020) also state that government support has no significant effect on the desire to adopt BDA because the government still needs to provide direct support for the implementation of BDA. In addition, government regulation that is rapidly changing makes managers uneasy in making decisions related to these regulations, such as in implementing BDA (Maroufkhani et al., 2020). However, previous studies have evidence that government support positively influences BDA adoption (Park & Kim, 2019). In this study, government regulation is proposed as a moderator, evidenced by Lai et al. (2018) that government policy and regulation can strengthen the relationship between organizational factors, i.e., top management support in adopting BDA. This may be because managers are likelier to comply with government policy and regulation in implementing BDA. Therefore, it is proposed that:

Hypothesis 9: Government regulation moderates the positive relationship between top management support and BDA adoption in Indonesian and Malaysian SMEs.

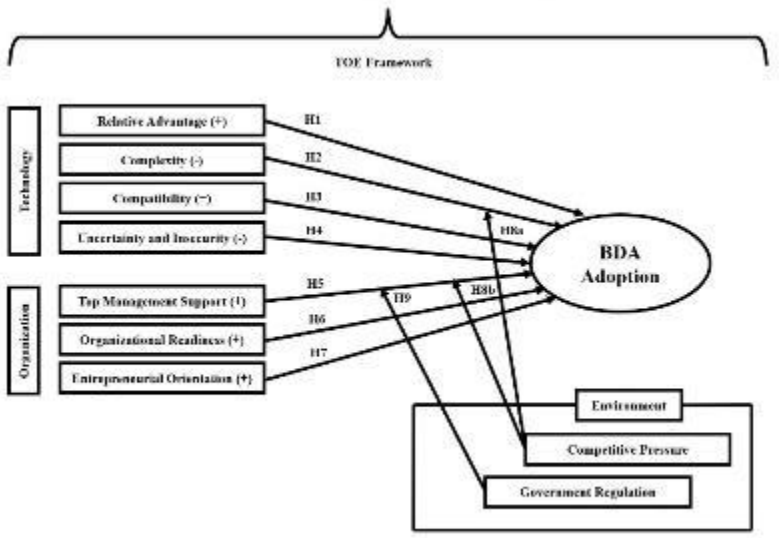

Figure 1. Proposed research framework

Drawing on the TOE framework, the proposed research model (Figure 1) shows the driving and inhibiting factors for BDA adoption in the retail sector. The inhibiting factors are in the technological element, namely complexity, uncertainty, and insecurity. Meanwhile, the driving factors are included in technology (relative advantage and compatibility) and organization (top management support, organizational readiness, and entrepreneurial orientation) factors. Environment factors (namely competitive pressure and government regulations), usually used as independent variables, are used as moderators in this research in strengthening the relationship between technology (complexity) and organization factors (top management support) on BDA adoption.

Methods

The proposed model must be tested and analyzed using Partial Least Square (PLS) with Multi-Group Analysis (MGA) technique.

Discussion and Conclusion

BDA provides many strategic benefits for companies. However, its use has yet to be widely applied to SMEs due to several factors. Previous research on BDA mostly used large firms in developed countries. Thus, studying BDA on SMEs in developing countries will be interesting. This paper proposes a research framework to analyze the adoption of BDA on retail sector SMEs in Indonesia and Malaysia using the Technology, Organization, and Environment (TOE) framework. The proposed model describes the factors that influence the adoption of BDA specific to the retail sector. Factors that influence BDA adoption will vary in different environments. Thus, environmental factors are used as moderators to strengthen the influence of technological and organizational factors on BDA adoption. This becomes relevant in this comparative study since the two countries' environments will differ.

Theoretical Implications

This paper provides several contributions to the literature. First, this paper focuses on retail sector SMEs. Second, this proposed model is intended to examine the comparison of BDA adoption in two countries, i.e., Indonesia and Malaysia. Third, the proposed model utilizes

environmental factors in the TOE framework as moderators. All of them should be discussed more in previous research. Therefore, this paper will better understand BDA adoption determinants between two countries, i.e., Indonesia and Malaysia SMEs in the retail sector.

Practical and Social Implications

This paper will positively contribute to scholars and retail practitioners in identifying the challenges related to BDA, how they should be able to utilize BDA in their business and finding the right strategy for adopting BDA. The retail sector certainly gets vital benefits from using BDA, such as getting customer insights on purchasing behavior, developing innovative marketing strategies, making innovative and creative products based on consumer needs, improving services, reducing costs, making business decisions, and increasing other business values. SMEs can survive or even outcompete their competitors if they implement this BDA into their operations. Finally, the differences in the proposed model framework results of the two countries will be obtained by doing a comparative study. Thus, it will provide input to owners, managers, BDA vendors, and governments of both countries regarding strategic matters that must be implemented in implementing BDA to compete and sustain in the international market in this industrial revolution 4.0 era.

Limitations and Suggestions for Future Research

Several contributions to literature as well as practical implications have been described in this paper. However, this paper has limitations. First, the proposed conceptual model is limited to retail sector SMEs in Indonesia and Malaysia. Second, not all TOE elements are included in this research. Only elements specific to the retail sector and proven to be significant based on previous research are included in the model. Third, the proposed framework model has yet to be empirically tested. Hence, future research is suggested to use other sectors to conduct a comparative study between countries and test this research model by adding additional variables. In addition, further research is also recommended to utilize other IT adoption frameworks such as DOI (Diffusion of Innovation), UTAUT (The Theory of Acceptance and Use of Technology), and TAM (Technology Acceptance Model) to provide insight into the various determinants of BDA adoption. The proposed model can also be extended by adding other variables to explain how BDA adoption can benefit the company's performance. Even though this study can explain quantitatively the differences in BDA adoption between countries, it would also be interesting if further research could examine this topic using qualitative methods. Thus, a more comprehensive understanding will be obtained. Overall, the suggested model can provide new insights into comparing BDA adoption between countries which is presently still limited.

Acknowledgement

We would like to thank the Research and Community Service Institute of Universitas Internasional Batam for the funding support provided in preparing this paper.

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