

Determinants of Big Data Analytics (BDA) Adoption among Small and Medium Enterprises (SMEs)

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Abstract

Businesses must be innovative in the current "knowledge-based economy" if they intend to create and maintain a competitive advantage over rivals. The adoption of big data analytics (BDA) is thus revolutionary for precise decision-making and top performance in the present industrial environment. BDA application has attracted interest particularly due to the prospects and benefits that may be realized from its utilization in both academic and practical circles. Nevertheless, its adoption in small and medium-sized (SME) businesses is unknown thus far, prompting this study. To determine the determinants influencing SME preparedness to adopt BDA, the current study used the Technology Organization Environment (TOE) framework. The results supported the positive effects of BDA adoption on organizational marketing and financial performance in SMEs. Hence, understanding the factors influencing BDA acceptance enables managers to undertake the right initiatives, which are essential for its successful implementation. The outcomes also render it possible for BDA service providers to draw in and spread its prevalence among SME businesses.

Keywords: determinants, big data analytics (BDA), small and medium enterprises (SMEs), technology organization environment (TOE), organization

1. Introduction

Small and Medium-sized Enterprises (SMEs) employ disruptive technologies to grow their companies and advance their operational processes in the modern digital era (Akpan, Udoh, & Adebisi, 2020). Previous knowledge may become redundant and obsolete as technology and innovation develop at an incredibly rapid rate. With limited financial and non-financial resources, businesses display a strong desire to adopt innovative technology in order to grow faster and maintain their competitiveness (El-Haddadeh, O., Hindi, & Fadlalla, 2021; Pappas, C., Pellegrini, M., & Michopoulou, 2021). Emerging technologies, particularly Big Data Analytics (BDA), are paving the way for SMEs under the Industry 4.0 phenomenon by enabling these businesses to be more optimized (Liu, S., Han, J., & Tang, 2020; Mangla, R., Narwane, Z., & Priyadarshinee, 2021; Sun, Z., & Sun, 2020).

BDA is a new technology that has evolved to improve total management effectiveness through productivity, performance, and faster real-time decision-making for businesses. According to Müller, Fay, and Vom Brocke (2018), it has changed how businesses compete; it offers innovative methods for uncovering hidden patterns in data sets to help with decision-making, productivity gains, knowledge creation, and innovation advancement. The International Data Corporation (IDC) has reported the valuation of BDA global market at around US\$66 billion in 2020 and it is expected to expand at an average annual rate of US\$157 billion by 2026 (IDC, 2020). The aforementioned statistics demonstrate why organizations have deemed BDA adoption as significant, particularly due to its promising potential (Staegemann et al., 2021). Chen (2015) have further noted the dubious belief present, in that 80% of organizations would not succeed in tapping into BDA if they advance without well-defined strategic goals.

2. Determinants of Big Data Analytics (BDA) Adoption Among Small and Medium Enterprises (SMEs)

The term “big data” refers to massive datasets that are difficult to exchange, search, visualize, and analyze. In this context, traditional data processing methods and the biggest data warehouses are overshadowed by big data. Maroufkhani, T., Iranmanesh, I., & Khalid (2020) have found that SME market and financial performance would increase with the use of BDA in such businesses. The work of Coleman, S., Gob, R., Manco, G., Pievatolo, A., Tort-Martorell, X., & Reis, M. S. (2016) has highlighted that it improves SMEs' knowledge capabilities, business strategies, data management, and data governance. The following elements denote those that influence SMEs' decision to make use of BDA accordingly.

2.1 Innovation

The word "innovation" comes from the Latin verb *Innovare*, which means to refresh. In essence, the term has continued to imply what it originally did. By definition, innovation is the act of enhancing or replacing something, such as a procedure, an item, or a service. Emami and Dimov (2017) have claimed that entrepreneurs frequently take the initiative and use creativity to provide value to their customers, and consequently, to the economy. Calls have been made for these entrepreneurs to search for ways for improving their competitive advantage in the market by becoming more innovative, thus changing the status quo and introducing new values to the marketplace (Emami, 2017; Emami & Khajeheian, 2019). Accordingly, Iqbal, M., Kazmi, S. A., Manzoor, A., Soomrani, A. R., Butt, S. H., & Shaikh, K. A. (2018) have underlined the adopted of new technologies such as BDA as one of the key tactics for SMEs to improve their position in the market and become more creative and productive. It has evolved into becoming a crucial tool for making changes in strategy, innovation, and decision-making as a result of the massive advancements in technology across the globe (McAfee & Brynjolfsson, 2012). This is driven by the fact policymakers and data scientists can obtain useful information on the basis of data analytics, implementing them to gain a competitive edge and improve firm performance.

Furthermore, the focus of modern academics on SMEs has expanded in order to support these businesses' ability to be innovative and take advantage of new technologies, such as in the fields of mobile marketing acceptance, cloud computing adoption, and mobile commerce (Asiaei & Ab. Rahim, 2019). Gupta and George (2016), as well as several earlier research efforts, have looked at how BDA and its managerial, technological, and human skills affect corporate productivity. A company can implement technological innovation in its operations and management system to boost productivity with the aid of BDA, which is predictive and prescriptive alike.

2.2 Boost Company Performance

The financial and non-financial elements of an organization are brought together to produce company performance. They can be examined to find areas for improvement and determine how successfully a company is carrying out its business strategy. Due to its significant operational and strategic advantages, BDA has emerged as a catalyst capable of increasing a company's efficiency and effectiveness (Wamba, S. F., Gunasekaran, A., Akter, S., Ren, S. F., Dubey, R., & Childe, S. J., 2017). Research efforts by Chen, Preston, and Swink (2015) and Maroufkhani, W., Wan Ismail, B., and Nourani (2019) have proposed for big data approaches to be used by businesses to transform data into intelligent and understandable vision for improving their performance. BDA could, therefore, boost a company's performance by enhancing the firm agility as it hastens the processes to complete jobs (Ghasemaghahi, Hassanein, & Turel, 2015). Wamba et al. (2017) have further underlined BDA's significant effect on how well businesses function across a wide range of industries. For example, most of the retail companies that are using big data do so to create a management-customer interaction. Moreover, Rajabion, Shalooki, Taghikhah, Ghasemi, and Badfar (2019) and Wang, Kung, and Byrd (2018) have highlighted anticipations on how BDA can improve commercial values in the healthcare sector as it permits more precise medical judgements. Similarly, it has emerged as a facilitator for the advancement of supply chain management in other industries such as manufacturing (Raut et al., 2019; Rehman, Chang, Batool, & Wah, 2016). In fact, SME performance is improved by the usage of BDA since they are more adaptable than large corporations (Ogbuokiri, Udanor, & Agu, 2015).

In the work by Maroufkhani et al. (2020), SMEs' market and financial performance have been shown to be enhanced by the use of BDA. In this regard, knowledge management has reportedly been identified as one of the greatest methods for assisting SMEs in improving their capacity to embrace BDA (Mangla et al., 2021). Akpan et al. (2020) have particularly highlighted digitalizing processes and internal operations, improving the efficacy and efficiency of performance, revamping business models, and ensuring business sustainability are all significant potential benefits of BDA for these entities. As such, BDA is lauded by scholars Saleem, Li, Ali, Mehreen, and Mansoor (2020) as one of the technologies that SMEs may employ to create successful strategies, and ultimately, provide the greatest organizational performance.

2.3 Technology Organization Environment (TOE)

The Technology Organization Environment (TOE) framework can help SMEs identify the factors that influence their decisions to adopt new information technology (IT) (Tornatzky & Fleischer, 1990). It is often utilized by businesses in technology application studies because it is thought to be adaptable (Hsu, Ray, & Li-Hsieh, 2014). Scholar Ajimoko (2018) from New Jersey has analyzed the main criteria for cloud-based BDA (CBBDA) adoption in SMEs based on three models, namely the diffusion of innovation theory, the technology acceptance model, and the TOE framework. The outcomes classified significant adoption criteria into two categories: internal and external. The internal criteria include technological and organizational factors, which play a critical role in the adoption of BDA, where the external criteria consist of vendor-related and environmental factors, posing less effect on its adoption in SMEs. Researchers from South Korea, Park, Kim, and Paik (2015) conducted a study to pinpoint the crucial elements of BDA implementation in SMEs. As a result of their findings, the adoption factors were divided into three categories: environmental, organizational, and technological factors.

An organizational-level innovation adoption theory known as the TOE framework (Tornatzky and Fleisher, 1990) describes the numerous elements that influence an organization's decision to accept new technology or not. The concept contends that the technological, organizational, and environmental circumstances are appropriately influential when businesses or SMEs must decide whether to adopt a new technology. These factors offer both opportunities and constraints for adopting technological innovation (Tornatzky and Fleisher, 1990). As a result, it is hypothesized that the three elements affect how technological innovations like CBBDA are adopted by SMEs, as shown below:

2.3.1 Technology Factor

According to Kapoor, Dwivedi, and Williams (2015), the technology pillar in India includes intra- and inter-organizational drivers that affect business decisions on the adoption of new IT. Ghobakhloo, Arias-Aranda, and Benitez-Amado (2011) assert that SMEs will only adopt new technology if its benefits outweigh the capabilities of current technology. As a result, the technology context includes important components linked to technological usage and functionality (Davis, 1986). This context also covers all technologies pertinent to SMEs, which includes both those that an organization now owns and others that are currently on the market but have not yet been adopted. The adoption of existing technologies in SMEs is particularly crucial since they place strict restrictions on the breadth and speed of technical change that a company is able to make (Baker, 2011). Tornatzky and Fleisher (1990) defined this category of adoption criteria as including both the availability of new technology, such as CBBDA, and the motivational factors that promote its adoption in companies. But it has been found that Italian SMEs frequently lack IT resources, which limits their capacity for data gathering and analysis (Del Vecchio, Di Minin, Petruzzelli, Panniello, & Pirri, 2018).

2.3.2 Organization Factor

The organizational dimension depicts many organizational factors that influence their readiness for BDA implementation. The first component, management support, is absolutely essential for SMEs to implement innovation (Jahanshahi & Brem, 2017). The organizational characteristics of management support and organizational readiness are those that affect BD adoption among SMEs. This comprises an organization's size, culture, official and informal connection structures, communication methods, and amount of change-striving zeal (Tornatzky and Fleisher, 1990). The first level is top management, where managers are able to comprehend and adopt the new technological capabilities (Sanders, 2008). Due to their higher likelihood of belonging to the top management team, SME decision-makers are therefore more likely to support such efforts, which is essential for a successful adoption of innovation (Jahanshahi & Brem, 2017). Therefore, managers that recognize the advantages of adopting BDA will recognize the necessity of allocating the resources required for its execution. Top management, on the other hand, will be against technology integration into their processes if they do not see the financial benefits of its adoption (Shamim, Zeng, Shariq, & Khan, 2019).

2.3.3 Environmental Factor

According to Xu, Ou, and Fan (2015), the environmental context includes aspects that are external to the organization in China yet are part of its dynamic external ecosystem, to which it is sensitive. According to Tornatzky and Fleisher (1990), the environmental context includes a number of unique forces that are beyond the control of SMEs, including industry characteristics and market structure, competition pressure, technology support infrastructure (such as reliable access to electricity and the Internet), and government regulation pressure. Oliveira and Martins (2011) made a discovery that established competitors and the level of industry stress as significant

environmental factors influencing the adoption of a new technology in SMEs. The consequences of the outside environment on a SME that encourages it to use BDA are a more precise definition of competitive pressure (Baig, Shuib, & Yadegaridehkordi, 2021). In essence, a company experiences competitive pressure from its suppliers, clients, and rivals. Previous research on SMEs found that the presence of this pressure had changed how openly these companies were willing to adopt new technology (Lutfi, Al-Okaily, Alsyounf, Alsaad, & Taamneh, 2020; Asiaei & Ab. Rahim, 2019). Government regulation is one of the key environmental factors that can either encourage or deter the adoption of new technology among SMEs, according to Acheampong and Moyaid's (2016) integrated model for determining business intelligence system adoption in the banking sector. Here, public data provision, expert development, intellectual property protection, and privacy and security rules are examples of government support and policy that have an impact on how businesses use big data (Kwon, Kwak, & Kim, 2015).

2.4 Improve Market Performance

Businesses may manage and use the hidden values of big data using BDA apps in their efforts to improve decision-making, product development, and marketing strategies (Baesens, Bapna, Marsden, Vanthienen, & Zhao, 2016; Lycett, 2013). SME's that use BDA can benefit from customer involvement in the business and improve market performance (Saldanha, Mithas, & Krishnan, 2017). Market performance is defined as an organization's capacity to achieve a higher level of market share, penetrate new markets as rapidly as feasible, and regularly launch new products and services with a better success rate (Vitari & Raguseo, 2019). Scholars have detailed how BDA would greatly benefit businesses and improve their performance in the market as a result of better decisions made regarding their innovation and marketing plans (Dong & Yang, 2020).

Currently, BDA is receiving extensive research attention (Dong and Yang, 2020), with SMEs highly interested in its implementation in view of extractable business values and expository insights from the area towards shaping organizational decision-making (Dong and Yang, 2020; Mikalef, Krogstie, Pappas, & Pavlou, 2020). Predictive, descriptive, and prescriptive schemes denote the three main types of BDA used (Kamble, Gunasekaran, & Gawankar, 2020), whereby its utilisation allows these businesses to generate the most accurate predictions about consumer behavior and the market. As a result, firm uncertainty is minimized and time efficiency can be achieved with regards to implementing organizational system changes (Dong and Yang, 2020; Mangla et al., 2021), as well as shaving off production costs as a whole (Saleem et al., 2020). Accordingly, Maroufkhani et al. (2020) have spotlighted that SME market and financial performance would be enhanced by BDA adoption, while its role in improving SME knowledge capabilities, business strategies, data management, and data governance has been stated by Coleman et al. (2016). Parallel to this, knowledge management has been cited as one of the best methods for assisting SMEs towards improving their BDA adoption capacity (Mangla et al., 2021). Other scholars such as Akpan et al. (2020) have also listed its potential benefits for these organizations, which include digitalizing processes and internal operations, improving performance effectiveness and efficiency, redesigning business models, and ensuring business sustainability. Saleem et al. (2020) have echoed such sentiments, specifying BDA as one of the technologies usable by SMEs to create effective strategies, and ultimately, produce the best organizational performance.

More research has shown that implementing BDA can improve a company's capacity for change, enabling it to recognize threats and opportunities in the market, seize those opportunities to gain a sizable market share, and improve new products and services with technological advancement (Côte-Real, Oliveira, & Ruivo, 2017; Davenport, 2014; Shirazi & Mohammadi, 2019). The business' competitive edge would be amplified and its marketing success would be improved in particular by efficiently employing organizational resources and competencies, including BDA (Raguseo & Vitari, 2018). Similar to this, once their competitive edge in the market is improved and increased, SMEs might improve their performance in terms of market share, market development, and sales growth (Chakphet, Saenpakdee, Pongsiri, & Jermittiparsert, 2020). Similarly, discoveries made by prior research have underlined cutting-edge BDA solutions pertaining their capacity and capability to strengthen business' marketing positions by allowing swifter identification of market opportunities and trends. Here, the use of BDA techniques enables organizations to outline, decide, and identify the most suitable market, marketing strategies, products, and services for their growth (Vitari & Raguseo, 2019).

3. Conclusion

This study investigated various adoption criteria that IT professionals in SMEs find beneficial for making the right decisions pertaining about the adoption of CBBDA or any future technological advancements. Its findings succinctly demonstrated important adoption criteria that past studies did not take into consideration, with discoveries made regarding internal and external criteria both as the major drivers influencing BDA adoption in SMEs. External criteria include BDA vendor-related elements and environmental characteristics common by all SBEs, whilst internal

criteria include technological and organizational features unique to each SME. Future research may benefit from looking at the outcomes of manufacturing SMEs that have embraced BDA in the setting of other nations and performing a cross-cultural analysis of the results. Applying BDA can significantly increase an organization's ability to innovate, as well as the TOE (Technology Organization Environment) and market performance.

As such, entities such as SMEs, providers, and policymakers will find it imperative to develop better policies and strategies for BDA adoption subsequent to this work. In terms of managers, the amount of data generated in organizations, particularly SMEs, is increasing at an exponential rate and renders an effective analysis of big data to be of great interest to such entities today. The proposed model can help businesses determine their readiness to implement BDA, driven by scholars recommending for SMEs to increase their expenditure on research and development in order to maximize their organizational effectiveness (Isaac, Abdullah, Ramayah, Mutahar, & Alrajawy, 2017; Isaac, Abdullah, Ramayah, & Mutahar, 2017). The output from using this framework is critical as proven research has demonstrated the role played by transformational leaders to promote employee creativity, thereby bringing forward positive organizational change (Franke & Felfe, 2011; Jacobs et al., 2013; Jiang, Zhao, & NiThe, 2017). The findings of this study can further help policymakers and training providers for developing the necessary action plan to synthesize leadership as an important predictive variable in increasing SME enthusiasm for learning BDA.

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