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S&T REVIEW

LEVERAGING BIG DATA FOR SME GROWTH AND COMPETITIVENESS: A LITERATURE REVIEW

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ABSTRACT

In the rapidly evolving digital landscape, big data has emerged as a transformative force, reshaping businesses' operational and strategic paradigms worldwide. This review delves into the profound implications of big data for Small and Medium Enterprises (SMEs), a sector often overshadowed by larger counterparts yet pivotal to global economic growth. This study aimed to elucidate the multifaceted relationship between SMEs and big data, exploring its historical context, economic ramifications, challenges, and the technological advancements propelling its integration. Through a systematic literature review approach, the research methodically sifted through myriad studies, gleaning insights and trends pertinent to SMEs. The results underscored the monumental potential of big data in enhancing SME competitiveness, fostering precision marketing, and streamlining operations. However, the journey is interspersed with challenges, from infrastructural inadequacies to talent deficits. Recommendations advocate for balanced big data investments, collaborative frameworks with data vendors, and an unwavering focus on data privacy and security. In conclusion, as SMEs stand at the crossroads of a digital revolution, embracing big data emerges as the linchpin for sustainable growth and innovation in the digital age.

KEYWORDS

Big Data, Small and Medium Enterprises, Digital Transformation, Competitiveness, Data Privacy, Precision Marketing.

1. INTRODUCTION

1.1 The Emergence of Big Data in the Business Landscape

The advent of Big Data has revolutionized the business landscape, offering unprecedented opportunities for organizations to harness vast amounts of information for strategic advantage. This transformation is not limited to large corporations; Small and Medium Enterprises (SMEs) are also recognizing the potential of Big Data analytics (BDA) as a pivotal tool to enhance their performance (Maroufkhani et al., 2020).

Historically, data has always been a valued asset for businesses. However, the current era, characterized by the 3Vs - Volume, Variety, and Velocity, has redefined the concept of data. This exponential growth in data, commonly referred to as Big Data, has become a focal point for companies worldwide. Organizations from multinational giants to SMEs are exploring avenues to leverage this data for business growth (Iqbal et al., 2018).

Often regarded as the backbone of economies, SMEs possess the agility and flexibility to adapt quickly to changes. This makes them uniquely positioned to benefit from Big Data. By anticipating their target audience, understanding customer preferences, and making informed decisions, SMEs can harness Big Data to drive growth and competitiveness. However, the adoption of Big Data is not without challenges. SMEs face issues related to infrastructure, data processing, and security. Yet, the potential benefits far outweigh the challenges, emphasizing the dire necessity for SMEs to consider Big Data adoption seriously (Iqbal et al., 2018).

Furthermore, the integration of technological, organizational, and environmental contexts plays a crucial role in the successful adoption of BDA among SMEs. A study conducted on manufacturing SMEs in Iran

revealed that technological and organizational elements are significant determinants of BDA adoption. The results also highlighted the mediating effect of BDA in the relationship between these contexts and SME performance, suggesting that BDA adoption could enhance SMEs' financial and market performance (Maroufkhani et al., 2020).

The emergence of Big Data in the business landscape signifies a paradigm shift in how organizations operate and compete. For SMEs, this presents both challenges and opportunities. By understanding and navigating these complexities, SMEs can position themselves at the forefront of this digital revolution, harnessing the power of Big Data to drive growth and competitiveness.

1.2 The Significance of Big Data for Small and Medium Enterprises (SMEs)

In the contemporary business environment, Big Data (BD) has emerged as a pivotal investment for organizations aiming to maintain their competitive edge. This significance is underscored by the transformative potential of BD, especially in the realm of human resource management (HRM). While large corporations have been quick to harness the advantages of BD, the human resource (HR) function within Small and Medium Enterprises (SMEs) has exhibited a slower pace of adoption. However, as posited by the organizational learning theory, the integration of BD can substantially enhance HR functions, particularly within SMEs, offering them a distinct competitive advantage (Verma et al., 2020).

In recent decades, Human Resource Management (HRM) has undergone a transformative shift towards a greater reliance on data-driven decisions. Initially, HRM depended primarily on basic metrics. Now, the emphasis is on Big Data (BD), with HR Analytics bridging the gap between these two

phases. Modern HR Analytics delves deep into both internal data (specific to HR functions) and external data (related to the broader organizational or market context). This analysis, done in collaboration with Information Technology (IT) departments, aims to inform personnel decisions that resonate with the broader business objectives and enhance overall company performance (Angrave et al., 2016).

Sardi, Sorano, Garengo, and Ferraris delve into the interplay between human resource management (HRM) and the innovative approaches adopted by SMEs for performance measurement and management systems (Sardi et al., 2021). Their research, employing multiple case studies, underscores the importance of HRM in driving and facilitating innovations in performance evaluation mechanisms. SMEs, given their unique operational and structural dynamics, stand to benefit immensely from tailored performance systems. The study found that effective HRM practices can serve as catalysts, ensuring that these systems are innovative and align with the firm's strategic objectives. The research also highlighted that fostering a culture of continuous improvement and learning within HRM can lead to more agile and responsive performance management systems in SMEs.

However, a note of caution is sounded by Kozielski who observes that firms, particularly SMEs from developing nations, harbor reservations regarding the application and benefits of BD in HRM (Kozielski, 2018). Despite the burgeoning research publications on BD, empirical investigations delving into the impact of BD on HRM remain limited. This gap underscores the pressing need for a comprehensive appraisal of the existing literature on BD within the HRM domain (Verma et al., 2020).

1.2.1 Historical Context: Traditional Data Management in SMEs

The digital transformation era has witnessed a paradigm shift in the way businesses manage and utilize data. Historically, Small and Medium Enterprises (SMEs) relied on traditional data management techniques, which were often limited in scope and lacked the sophistication of contemporary Big Data (BD) tools. However, as the significance of data-driven decision-making became increasingly evident, there was a marked transition from these rudimentary methods to more advanced BD analytics.

In the context of Smart Cities, the need to store and process vast amounts of heterogeneous data has become paramount. Traditional data techniques and technologies faced significant challenges in handling this influx of Big Data. Data Warehouses (DWs), which have been fundamental assets for various organizations, have evolved to address these challenges. Historically, Relational Database Management Systems (RDBMSs) were employed to store data, offering analytical perspectives on various business processes. With the advancements in BD techniques, the concept of Big Data Warehousing (BDW) emerged, aiming to overcome the limitations of traditional DWs. This evolution underscores the transition from conventional data storage methods to more sophisticated BD analytics, especially in the context of Smart Cities (Costa and Santos, 2017).

The healthcare sector provides another illustrative example of this transition. While terms like BD and Artificial Intelligence (AI) might seem mystifying to many, their application in clinical medicine and biomedical research has been transformative. Historically, clinical decisions were based on limited datasets and basic analytics. However, with the advent of BD and AI, there has been a significant shift towards data-driven clinical decisions. The use of BD in healthcare is not just about accumulating vast amounts of data but involves complex datasets with numerous structured and unstructured data fields. This shift from traditional data management to BD analytics in healthcare underscores the broader transition observed across various sectors (Rodriguez et al., 2018).

Furthermore, the dynamism inherent in SMEs' evolution can be understood through the lens of the Hologram approach, which offers a novel perspective on assessing SMEs based on their business dynamic behavior. Traditional financial analyses often relied on static data points, such as financial accounting reports. However, the Hologram approach, rooted in BD and financial technology, provides a dynamic mechanism to evaluate SMEs, even in the absence of conventional data. This approach emphasizes the importance of understanding SMEs' development and evolution in a holistic manner, leveraging BD for more inclusive financial services (Yuan et al., 2019).

1.2.2 Economic Implications of Big Data Adoption for SMEs

The digital age, often referred to as Industry 4.0, has ushered in a transformative phase for businesses, characterized by the adoption of new information technologies. These technologies enable vast amounts of data

to be digitally collected, analyzed, and leveraged, fundamentally altering the decision-making landscape for organizations (Nasrollahi et al., 2020). The economic implications of this shift are profound, especially for Small and Medium Enterprises (SMEs), which often operate with limited resources and infrastructures.

The rise of Industry 4.0 has been marked by the convergence of various engineering and manufacturing disciplines. Exponential technologies such as artificial intelligence, machine learning, cloud computing, and advanced sensing have played pivotal roles in this transformation. In this context, Big Data (BD) has emerged as a significant driver, facilitating real-time, dynamic, and precise control capabilities, thereby influencing the creation of new knowledge and fostering business innovation (Nasrollahi et al., 2020).

While the impact of information technology (IT) on organizational performance has been a topic of extensive discussion, the specific role of BD in this equation has gained prominence only recently. In today's hyper-connected world, where information flows rapidly across global networks, the quality and reliability of data have become paramount. Inaccurate or unreliable data can lead to misguided decisions, missed opportunities, financial losses, and even reputational damage. As such, the economic implications of BD adoption extend beyond mere operational efficiency to encompass broader strategic considerations (Nasrollahi et al., 2020).

Despite the evident advantages of BD, its adoption among SMEs remains relatively limited. This is particularly concerning given the critical role SMEs play in driving economic growth, especially in developing countries. The competitive market landscape is becoming increasingly complex, necessitating that organizations, irrespective of their size, leverage BD to enhance visibility into their operations, predict market trends, facilitate innovation, and improve their competitive positioning (Nasrollahi et al., 2020).

In a case study focusing on Jordanian SMEs, it was found that several factors influence the adoption of BD analytics. Technological aspects, such as the relative advantage offered by BD and its inherent complexity, play a significant role. Organizational factors, including top management support and readiness, are also crucial determinants. Additionally, external factors, such as government support, can either facilitate or hinder BD adoption (Lutfi et al., 2022).

The economic implications of BD adoption for SMEs are multifaceted. While the potential benefits are substantial, encompassing enhanced operational and economic performance, the challenges cannot be overlooked. For SMEs to truly harness the power of BD and realize its economic potential, a holistic approach, considering technological, organizational, and external factors, is essential.

1.2.3 The Interplay Between Big Data and SME Competitiveness

In the era of digital transformation, the interplay between Big Data (BD) and the competitiveness of Small and Medium Enterprises (SMEs) has become a focal point of academic and industry discussions. The integration of BD analytics into business strategies has the potential to significantly enhance the competitive edge of SMEs, reshaping their operational and strategic landscapes.

The rise of Industry 4.0 has been characterized by the convergence of various technological advancements, including artificial intelligence, machine learning, and cloud computing. Within this framework, BD has emerged as a pivotal element, offering real-time, dynamic, and precise control capabilities that can influence the creation of new knowledge and foster business innovation (Nasrollahi et al., 2020). The ability to harness vast amounts of data and derive actionable insights from it can significantly enhance an SME's market positioning, operational efficiency, and overall competitiveness.

However, the adoption of BD analytics among SMEs is not without its challenges. While large enterprises often have the resources and infrastructure to invest heavily in BD initiatives, SMEs operate within more constrained environments. This disparity raises questions about the feasibility and effectiveness of BD adoption among SMEs, especially in the context of achieving superior competitiveness and optimal performance (Lestari et al., 2020).

A study focusing on Indonesian SMEs in the culinary sector highlighted the significant role of entrepreneurship insight factors, market orientation, knowledge-sharing, innovation, managerial capability, product strategy, process and service improvement, and resources capability in improving performance and competitiveness. The research emphasized the importance of empirical models to bridge the gap between BD analytics

and the achievement of optimal performance in SMEs. The study also underscored the significance of aligning business strategies with BD initiatives, ensuring that the adoption of BD analytics translates into tangible business outcomes (Lestari et al., 2020).

Furthermore, the challenges faced by SMEs in managing human resources, especially in the context of BD adoption, cannot be overlooked. Issues related to recruitment, setting rules, aligning employees with the business's vision and mission, competency development, performance assessment, and employee retention can pose significant barriers to the effective integration of BD analytics into SME operations. Addressing these challenges requires a holistic approach, encompassing technological, organizational, and strategic considerations (Lestari et al., 2020).

The interplay between BD and SME competitiveness is multifaceted. While the potential benefits of BD adoption are substantial, the challenges faced by SMEs in this journey are equally significant. For SMEs to truly harness the power of BD and enhance their competitiveness, a comprehensive understanding of the technological, organizational, and strategic implications of BD adoption is essential.

1.2.4 Challenges and Opportunities in Big Data Integration for SMEs

The digital revolution has brought forth an unprecedented influx of data, often referred to as 'Big Data'. This data, characterized by its volume, velocity, variety, value, and veracity, is generated from a myriad of sources, including sensor networks, social media platforms, and smartphones (Sandhu, 2022). The sheer magnitude and complexity of this data present both challenges and opportunities, especially for Small and Medium Enterprises (SMEs) aiming to integrate Big Data into their operations.

The volume of data being generated is staggering. For instance, in 2012, approximately 2.5 exabytes (EB) of data were produced daily. This volume doubled by 2013, reaching 4.4 zettabytes (ZB), and by 2020, it had escalated to an astounding 40 ZB (Sandhu, 2022). Such vast amounts of data necessitate robust storage solutions, which may be beyond the reach of many SMEs.

Velocity, or the rate at which data is generated, has also seen a significant surge. With millions of devices being connected daily, the speed at which data is produced and needs to be processed has increased exponentially. Platforms like YouTube exemplify this trend, generating vast amounts of data at breakneck speeds (Sandhu, 2022).

The variety of data poses another challenge. Data is generated in multiple formats, from logs and text to images, videos, and audio. This diversity means that SMEs need versatile tools and solutions to process and analyze different types of data effectively (Sandhu, 2022).

Despite these challenges, the value that Big Data offers cannot be understated. The potential to convert this data into actionable insights and meaningful information is immense. For SMEs, this means the opportunity to gain a competitive edge, make informed decisions, and drive innovation.

However, the integration of Big Data with cloud computing offers a promising solution to some of these challenges. Cloud computing services provide a powerful environment to store large volumes of data, eliminating the need for dedicated space and the maintenance of expensive computer hardware and software. This is particularly beneficial for SMEs, which may not have the resources to invest in extensive IT infrastructures. Moreover, cloud services, such as Microsoft Azure, Google Cloud, Amazon Web Services, and others, offer scalable solutions tailored to the needs of businesses, ensuring that SMEs can effectively store, process, and analyze their data (Sandhu, 2022).

Yet, the integration of Big Data and cloud computing is not without its own set of challenges. Issues related to data security, heterogeneity, data visualization, and distributed database storage need to be addressed. For SMEs, this means not only understanding the technological aspects of Big Data integration but also the organizational and strategic implications.

While the challenges of Big Data integration for SMEs are significant, the opportunities it presents are equally compelling. By leveraging cloud computing solutions and adopting a holistic approach to Big Data analytics, SMEs can harness the power of data to drive growth, innovation, and competitiveness in today's digital age.

1.2.5 Technological Advancements Facilitating Big Data Utilization

In the contemporary business landscape, identifying and monitoring technological trends is paramount for fostering innovation and ensuring

competitiveness. The global data landscape has witnessed an exponential growth, making it a treasure trove for discerning emerging and evolving trends. However, the sheer volume of this data can lead to information overload, necessitating the deployment of automated methods for data extraction, processing, and knowledge generation (Saritas et al., 2021).

The burgeoning need for information systems that can efficiently monitor and analyze data from diverse and unstructured sources underscores the importance of timely and evidence-based decision-making. The recent strides in computing and big data technologies have unlocked vast opportunities for collating evidence on forthcoming developments and emergent opportunities. For instance, the study by elucidates the application of text-mining and semantic analysis on extensive document datasets to probe into business trends in mobile commerce (m-commerce) (Saritas et al., 2021). This domain, particularly in the backdrop of the ongoing COVID-19 pandemic and the ensuing social distancing measures, has burgeoned into a significant technological and business sector with ever-increasing market potential.

The research further identifies pivotal technologies and tools that can maximize the potential of this sector. Leveraging an intelligent big data analytics system, which is grounded in in-depth natural language processing, the study employs text-mining, machine learning, science bibliometry, and technology analysis. The insights gleaned from the system can be harnessed to craft a comprehensive and objective network of interconnected technologies, trends, drivers, and barriers, offering a holistic overview of the m-commerce landscape encapsulated in a single business intelligence (BI) data mart diagram (Saritas et al., 2021).

1.3 Rationale and Importance of the Review

The digital era has ushered in a paradigm shift in the way businesses operate, especially with the advent of Big Data. This vast and complex data, generated at an unprecedented scale, holds the potential to revolutionize industries, offering insights that were previously unimaginable. For Small and Medium Enterprises (SMEs), the implications of Big Data are profound, presenting both challenges and opportunities in equal measure.

The rationale behind this literature review is rooted in the increasing significance of Big Data in shaping the future of SMEs. As highlighted, Big Data analytics capabilities have become a focal point of academic and industry discussions, with a growing body of literature dedicated to understanding its multifaceted impact (Mikalef et al., 2017). This review aims to collate, synthesize, and present the most pertinent findings from this burgeoning field, offering a comprehensive overview of the current state of knowledge.

Furthermore, the healthcare sector provides a compelling case study of the transformative potential of Big Data. Galetsi and Katsaliaki underscore the paramount importance of Big Data analytics in healthcare, emphasizing its role in patient diagnostics, epidemic recognition, and enhancing patient management (Galetsi and Katsaliaki, 2019). Such applications underscore the vast potential of Big Data analytics across diverse sectors, reinforcing the need for a comprehensive review in the context of SMEs.

Moreover, the supply chain management domain offers insights into the practical implications of Big Data. Lee and Mangalaraj conducted a systematic literature review on Big Data analytics in supply chain management, highlighting its challenges and opportunities (Lee and Mangalaraj, 2022). Their findings underscore the transformative potential of Big Data analytics, emphasizing its role in enhancing efficiency, driving innovation, and fostering competitiveness.

In essence, the importance of this review lies in its potential to offer a holistic understanding of the myriad ways in which Big Data is reshaping the business landscape, especially for SMEs. By synthesizing findings from diverse domains, this review aims to provide a comprehensive overview, guiding SMEs in harnessing the full potential of Big Data.

1.4 Scope and Limitations of the Study

The focus of this review is on the implications of Big Data for Small and Medium Enterprises (SMEs) spanning from the year 2010 to the present. The study places particular emphasis on the technological advancements that are most relevant to SMEs and delves into the unique challenges and opportunities that Big Data presents for these enterprises. While the aim is to provide a comprehensive perspective on the subject, there are certain inherent limitations to consider. Due to word constraints, some areas might be explored more broadly rather than in depth. The review predominantly relies on open-access literature, which means that some relevant studies behind paywalls might be omitted. Additionally, the fast-

paced evolution of the Big Data field suggests that the technological and business landscape might undergo significant shifts even after this review. Lastly, interpretations of literature can be subjective, leading to potential variations in the conclusions drawn from the same set of data.

1.5 Aim and Objectives of the Study

The primary aim of this study is to explore the multifaceted implications of Big Data for Small and Medium Enterprises (SMEs) and to understand how technological advancements in this domain can be harnessed to drive growth and competitiveness for these businesses.

The objectives of the study are as follows:

1. To investigate the current state of Big Data adoption among SMEs and identify the primary drivers behind its integration.
2. To analyze the challenges faced by SMEs in leveraging Big Data and the strategies employed to overcome these hurdles.
3. To evaluate the impact of Big Data on the operational efficiency, innovation, and market positioning of SMEs.
4. To provide recommendations for SMEs on optimizing Big Data strategies for sustainable growth and enhanced competitiveness in the digital age.

2. METHODOLOGY

2.1 Research Design: Systematic Literature Review Approach

The systematic literature review (SLR) is a rigorous and structured approach that synthesizes research findings from various studies on a particular topic. This method is particularly valuable in fields where a vast amount of research is conducted, and there's a need to collate and understand the collective findings to draw more generalized conclusions. In the context of Big Data and its implications for SMEs, an SLR provides a comprehensive overview, ensuring that the insights gleaned are both contemporary and relevant.

The SLR approach offers a clear vision related to a specific topic, ensuring that the right input is obtained. It aims to identify all essential steps to conduct a high-quality systematic literature review, irrespective of the research domain. The significance of SLR in research fields is paramount, especially as it minimizes the loss of information. By adopting an explicit methodology, researchers can select several papers that mention the procedure over different years, providing a holistic view of the topic. This approach ensures that any misunderstanding or basic points that could be overlooked are addressed, ensuring high-quality work (Tikito and Souissi, 2019).

2.2 Criteria for Selection of Relevant Studies and Publications

The selection of relevant studies and publications is a critical step in the SLR process. The primary goal is to ensure that the data collated is both relevant and of high quality. To achieve this, predefined criteria are set to answer specific research questions. Furthermore, to provide the best possible answer, different ways of comparing the quality of studies are established, offering a technique for readers to judge the value of the work.

In the context of Big Data and SMEs, the criteria for selection would involve identifying studies that specifically address the integration, challenges, and opportunities of Big Data within SMEs. This would ensure that the review remains focused on the topic and provides insights that are directly relevant to the research questions. Additionally, the quality of the studies would be assessed based on their methodology, sample size, and the rigor of their analysis, among other factors.

Empowering leadership in hospitality and tourism, as an example, has been examined within various cultures mostly using quantitative methods. Multiple instruments are used to measure empowering leadership, and it is a variously defined construct that has been found to promote creativity and innovation, service performance, and various employee attitudes and behaviors (Hoang et al., 2021). Such rigorous methodologies and criteria for selection can be applied to the study of Big Data in SMEs to ensure the relevance and quality of the review.

2.3 Compilation of Big Data Practices and Trends in SMEs

The digital era has ushered in a plethora of opportunities for businesses, especially in the realm of Big Data. SMEs, which form the backbone of many economies, are not exempt from this trend. The compilation of Big Data practices involves the collection of vast amounts of data and the

discernment of trends, patterns, and actionable insights from this data. As Obidallah, Raahemi and Ruhi highlighted, techniques such as clustering and association rules are pivotal in discovering and recommending web services (Raahemi and Ruhi, 2019). These methods allow SMEs to harness the power of Big Data, providing them with a competitive edge in the market.

Furthermore, the transition towards Industry 4.0 has seen a surge in the adoption of technologies like the Internet of Things, Cyber-Physical Systems, and Big Data in SMEs. These technologies, when combined, offer a holistic approach to business operations, optimizing processes, and enhancing customer experiences (Yıldızbşı and Ünlü, 2020).

2.4 Analytical Techniques for Synthesizing Literature Insights

The synthesis of literature insights is a meticulous process that requires a comprehensive understanding of various analytical techniques. In the realm of Big Data, these techniques are even more pivotal, given the vastness and complexity of the data involved. A group of researchers emphasized the role of operational indicators, such as synthesis, speed, and significance, in enhancing Big Data analytics (BDA) performance (Verma et al., 2023). By leveraging these indicators, businesses can ensure the relevance and quality of their data, leading to more accurate and actionable insights.

Moreover, the application of machine learning techniques in the petroleum industry, as highlighted by Salem, Yakoot and Mahmoud underscores the versatility and efficacy of these methods across various sectors (Salem et al., 2022). Such techniques can be adapted and applied to SMEs, allowing them to glean insights from their data, optimize operations, and drive growth.

3. FINDINGS

3.1 Evolution of Big Data Utilization in SMEs

The digital transformation era has brought forth a myriad of opportunities for businesses, particularly in the domain of Big Data. Small and medium-sized enterprises (SMEs), which constitute a significant portion of many economies, have not been left behind in this trend. The evolution of Big Data practices in SMEs has been marked by a shift from traditional data handling methods to more advanced, data-driven strategies. As highlighted by the use of Big Data has opened up avenues for innovative solutions and business opportunities, especially in the context of open innovation strategies (Del Vecchio et al., 2018). The study underscores the importance of Big Data from various sources, particularly those outside the conventional organizational boundaries, offering a fresh perspective on how SMEs can leverage this data for innovation.

Furthermore, the strategic role of firm-specific knowledge in Big Data analytics (BDA) has been emphasized by (Verma et al., 2021). The study posits that while BDA provides valuable business insights, many firms grapple with harnessing its full potential. By focusing on firm-specific knowledge, SMEs can gain a competitive edge, ensuring that their BDA initiatives align with their unique business needs and objectives.

3.2 Strategies and Mechanisms Adopted by SMEs

In the face of the burgeoning Big Data trend, SMEs have had to adopt various strategies and mechanisms to stay competitive. One of the pivotal strategies has been the adoption of co-innovation, as highlighted by (Ciasullo et al., 2022). The study underscores the role of Big Data analytics capability (BDAC) in fostering organizational resilience, particularly in uncertain times. By leveraging co-innovation, SMEs can enhance their responsiveness, ensuring business continuity even in the face of challenges.

Moreover, the alignment of BDAC with business models has been identified as a key strategy for SMEs. As Song, Li and Yu note, the synergy between BDAC and business models is crucial for SMEs to achieve competitive performance (Song et al., 2021). By ensuring that their BDA strategies align with their business models, SMEs can optimize their operations, drive growth, and enhance their overall competitive performance.

3.2.1 Big Data Analytics for Business Intelligence

In the contemporary business landscape, Big Data (BD) analytics has progressively garnered attention, both in practice and academia, due to its potential opportunities, challenges, and anticipated benefits. Particularly, emerging economies perceive big data analytics as immensely significant, even though it continually grapples with barriers hindering its adoption.

This prominence of Big Data analytics is underscored by its transformative potential to extract patterns from vast sets of raw information, thereby facilitating informed decision-making, enhancing productivity, fostering innovation, and generating knowledge.

The essence of Big Data is encapsulated in its ability to capture interactions between employees and customers, which are stored within an organization's systems. This data, in turn, provides actionable insights, predictive outcomes, descriptive analyses, and prescriptive solutions. However, the sheer volume, velocity, and variety of Big Data make the extraction of valuable knowledge and information from it inherently complex. Despite these complexities, Big Data remains one of the most adopted technologies by organizations aiming to establish and maintain a competitive edge in the market.

Big Data, in its essence, is often defined as a collection of subject-oriented data, encompassing information from specific time periods, designed to assist in the managerial decision-making process. The global market's valuation of Big Data stood at a staggering USD 66.2 billion in 2020, with projections estimating it to reach USD 157.2 billion by 2026, showcasing its growing significance and adoption rate. Many businesses, recognizing the potential of Big Data, deem its adoption as crucial. However, despite the theorized advantages of Big Data implementation, several studies have indicated that not all businesses are embracing it. Some estimates even suggest a skeptical viewpoint wherein 80% of businesses might fail to harness the potential of Big Data if they proceed without well-defined strategic objectives. Recent data indicates that the adoption rate of Big Data in most companies remains relatively low. A significant number of businesses have not progressed beyond the initial stages of adoption, and even though Big Data adoption is recognized as a means to create impactful changes, such as establishing new business domains and optimizing existing ones, only a limited number of businesses have fully embraced it and reaped its benefits.

In the context of a developing economy like Jordan, the study sought to identify the drivers of big data analytics adoption (Lutfi et al., 2022). The research delved into the influence of technological, organizational, and environmental factors on Big Data adoption within the SMEs in Jordan. The empirical findings from this study revealed that factors such as relative advantage, complexity, security, top management support, organizational readiness, and government support significantly influence Big Data adoption. In contrast, factors like competitive pressure and compatibility were found to have an insignificant influence. These insights are invaluable for both researchers and practitioners concerned with Big Data adoption in developing countries, offering a roadmap for SMEs to navigate the complex terrain of Big Data analytics.

3.2.2 Customer Relationship Management through Big Data

In the contemporary business landscape, the fusion of Big Data (BD) and Customer Relationship Management (CRM) has emerged as a transformative force, reshaping the way businesses interact with and understand their customers. The proliferation of data, characterized by its volume, variety, and velocity, has necessitated the evolution of CRM strategies to harness this deluge of information for enhanced customer experiences (Anshari et al., 2019).

The potential of Big Data in revolutionizing CRM is evident in its ability to support personalization and customization of sales, services, and customer experiences. Traditional CRM systems primarily focused on managing customer interactions and collecting transactional data. However, with the advent of Big Data, CRM has evolved to encompass a broader spectrum of customer data, including their online behaviors, social media interactions, and even real-time feedback. This shift has enabled businesses to offer more timely, sharp, and granular personalized promotions, thereby enhancing customer engagement and loyalty (Anshari et al., 2019).

For instance, companies like Sears Holding have leveraged Big Data gathered from various data warehouses related to its brands to offer personalized promotions. Such initiatives have empowered businesses to be more aggressive in their marketing strategies, such as push notifications through smartphones to their potential target audiences (Anshari et al., 2019). Similarly, Caesars Entertainment utilizes data from its loyalty program, real-time play, and web clickstreams to target customers with real-time offers through mobile devices. This not only improves customer understanding but also reduces waiting times for both regular and occasional customers (Zerbino et al., 2018).

However, the integration of Big Data into CRM is not without challenges. Many businesses, especially SMEs, face hurdles in managing and analyzing

vast amounts of unstructured data. Resource constraints often compel SMEs to manage their social media on a reactive and ad hoc basis. Despite these challenges, some firms have successfully harnessed Big Data for CRM purposes. For example, Australian SMEs have been found to use social media to generate content and influence other customers through positive reviews. Yet, they tend not to use social media for making strategic decisions or calculating CRM indicators, primarily due to a lack of resources, data management challenges, and concerns about privacy and control (Guha et al., 2018).

3.2.3 Operational Efficiency and Process Optimization using Big Data

Operational efficiency and process optimization are critical for businesses, especially SMEs, in the current competitive landscape. The introduction of Big Data analytics has significantly transformed the way businesses operate, offering them a competitive edge by enabling them to make informed decisions, enhance productivity, and foster innovation. Big Data analytics is a novel method of extracting patterns from raw information, which aids in decision-making, productivity enhancement, and knowledge generation (Agrawal et al., 2016). This data, which captures interactions between employees and customers, provides actionable, predictive, descriptive, and prescriptive outcomes, assisting organizations in understanding their operations and customer preferences in-depth.

However, the sheer volume, velocity, and variety of Big Data make it challenging to extract valuable knowledge and information. Despite its potential, many businesses find it challenging to adopt Big Data effectively. For instance, while the global market for Big Data was valued at USD 66.2 billion in 2020 and is projected to reach USD 157.2 billion by 2026, many businesses have not fully embraced it. Some studies suggest that up to 80% of businesses might fail to tap into Big Data's potential if they proceed without clearly defined strategic goals (Agrawal et al., 2016). This highlights the importance of a strategic approach to Big Data adoption, ensuring that businesses can harness its full potential for operational efficiency and process optimization.

3.3 Best Practices in Big Data Implementation for SMEs

The effective implementation of Big Data is paramount for SMEs to harness its full potential. Big Data is generally defined as "a collection of subject-oriented data with information from a specific time period that assists the management decision-making process" (International Data Corporation, 2020). Despite its potential benefits, not all businesses are adopting Big Data. Some studies indicate a cautious perspective, suggesting that a significant number of businesses might not realize the benefits of Big Data if they don't have clearly defined strategic objectives (Agrawal et al., 2016).

For SMEs, it's essential to understand that while Big Data offers immense potential, its adoption requires a strategic approach. Businesses need to ensure that they have the necessary infrastructure, skills, and strategies in place to harness the benefits of Big Data. This includes investing in the right technologies, training staff, and developing a data-driven culture. Moreover, SMEs should prioritize data integration, ensuring that data from various sources is consolidated and analyzed effectively. By adopting these best practices, SMEs can ensure that they are well-positioned to leverage Big Data for enhanced operational efficiency and competitiveness.

3.3.1 Balancing Big Data Investments with Expected ROI

In the digital economy era, big data has emerged as a strategic resource, with its application capabilities becoming a pivotal strategic capability. This transformation can significantly aid SMEs in precision marketing, enhancing corporate competitiveness, and achieving improvements in quality and efficiency. However, SMEs face a myriad of challenges in big data application. These challenges range from an insufficient understanding and a lack of big data thinking to inadequate investment and an incomplete big data infrastructure. Furthermore, irregular management and the low quality of foundational big data, coupled with an incomplete introduction and a shortage of big data talents, exacerbate these challenges (Aslam et al., 2022).

To navigate these challenges, it is imperative for SMEs to raise awareness and establish a big data mindset. This involves increasing investment to improve big data infrastructure, standardizing management to enhance the quality of foundational big data, and giving equal emphasis to talent introduction and education. Such measures can significantly strengthen the construction of big data talents and infrastructure, ensuring that SMEs can harness the full potential of big data to drive business growth and competitiveness.

3.3.2 Collaborative Frameworks with Big Data Vendors and Consultants

The digital economy, characterized by the continuous emergence of advanced information technologies such as mobile Internet, cloud computing, and artificial intelligence, has deeply penetrated various societal sectors. This penetration has given rise to new application scenarios, profoundly altering social styles, lifestyles, and work styles. While large corporations, especially industry leaders, have long recognized big data's power and have actively deployed in related fields, SMEs often find themselves at a disadvantage. This disparity arises from both objective and subjective constraints, including limitations in big data hardware, technology, and talent reserves (Aslam et al., 2022).

To bridge this gap, SMEs must understand the significance of big data application, analyze the challenges they face, and adopt corresponding solutions. This approach can enhance big data applications' performance, value, and resource utilization, further bolstering SMEs' competitiveness. Collaborative frameworks with big data vendors and consultants can play a pivotal role in this endeavor, providing SMEs with the expertise and resources they need to effectively harness big data's potential.

3.3.3 Ensuring Data Privacy and Security in Big Data Operations

In the age of smart cities and digital interconnectivity, the promise of a higher quality of life is often juxtaposed with the challenges of data security and privacy. The proliferation of smart devices, networks, cloud infrastructure, big data analysis, and Internet of Things (IoT) applications has led to an exponential increase in data exchange across various sectors, including critical infrastructures, financial sectors, healthcare, and notably, Small and Medium Enterprises (SMEs). This data, often encompassing sensitive personal and critical information, necessitates robust security mechanisms to ensure its confidentiality and integrity (Aslam et al., 2022).

However, the reality is that many organizations, especially SMEs, grapple with maintaining an effective security posture. This is evidenced by frequent data breach incidents, often resulting from vulnerabilities in information management systems that are exploited either by malicious insiders or external attackers. Such breaches not only compromise the integrity of the data but also have far-reaching implications on the well-being of citizens, affecting their trust in digital systems and potentially leading to financial and reputational damages for the affected organizations.

The importance of data security in the context of smart cities cannot be overstated. As cities globally embark on their journey to become 'smart', they are invariably introducing a plethora of data-driven solutions aimed at enhancing the quality of life for their citizens. However, these solutions, while promising, also introduce several data security and privacy concerns. The data being exchanged, often in real-time, encompasses a wide range of information, from administrative and operational records to Personal Identity Information (PII). The responsibility of securely storing, managing, and processing this vast amount of data falls upon the involved sectors, which, in the case of SMEs, can be particularly challenging given their often limited resources in terms of big data hardware, technology, and talent reserves.

Data breaches, whether intentional or inadvertent, can have severe repercussions. They can erode trust, damage reputations, and have financial implications. For SMEs, which often operate on thin margins and may not have the extensive resources of larger corporations, the impact of a data breach can be particularly devastating. Therefore, it is imperative for SMEs to understand the significance of big data applications, recognize the challenges they face, and implement robust security mechanisms to safeguard their data.

4. DISCUSSION

4.1 Assessing the Impact of Big Data on SME Growth and Competitiveness

In the contemporary business landscape, Big Data has emerged as a transformative force, particularly for Small and Medium-sized Enterprises (SMEs). The ability to harness vast amounts of data and derive actionable insights from it can significantly influence the growth trajectory and competitiveness of SMEs. Alrumiah and Hadwan emphasized the importance of Big Data Analytics (BDA) in e-commerce, highlighting how electronic vendors (E-vendors) utilize BDA to gain competitive advantages (Alrumiah and Hadwan, 2021). By understanding consumer behavior through data analytics, these vendors can enhance customer loyalty and subsequently increase their revenue.

Furthermore, the integration of Big Data into business operations is not

just about improving sales or understanding consumer preferences. It's about holistic business transformation. Verma, Singh, and Bhattacharyya explored the impact of Big Data on human resource management (HRM) within SMEs (Verma et al., 2020). Their findings suggest that better Big Data quality can lead to improvements in HR practices, human resource service quality, and the overall innovation competency of SMEs. This underscores the multifaceted benefits of Big Data, extending beyond traditional sales and marketing functions.

However, the adoption and effective utilization of Big Data are not without challenges. O'Connor and Kelly delved into the complexities faced by SMEs in the agri-food sector when trying to leverage Big Data (O'Connor and Kelly, 2017). They found that while Big Data can enhance both explicit and tacit knowledge, several barriers hinder its effective acquisition and application. These barriers often stem from SMEs' resource limitations, strategic orientations, and the asymmetrical power relationships within business networks.

4.2 Challenges and Barriers in Big Data Adoption for SMEs

While the potential benefits of Big Data for SMEs are evident, the path to its successful adoption is fraught with challenges. One of the primary obstacles is the quality of Big Data. As Verma, Singh, and Bhattacharyya highlighted, the quality of Big Data plays a pivotal role in determining its efficacy in improving HR practices and service quality (Verma et al., 2020). Poor quality data can lead to misguided insights, which can be detrimental to business decisions.

Another significant challenge is the resource constraints faced by SMEs. O'Connor and Kelly emphasized that SMEs often grapple with limitations in terms of financial and technical resources, which can hinder their ability to fully harness the benefits of Big Data (O'Connor and Kelly, 2017). Furthermore, the strategic orientation of SMEs and the power dynamics within their business networks can also act as barriers to effective Big Data adoption.

Fanelli also shed light on the challenges faced by rural SMEs in adopting new technologies, including Big Data (Fanelli, 2021). The study found that these SMEs often require financial and technical support from public and local authorities to overcome the barriers to technology adoption.

In conclusion, while Big Data holds immense potential for enhancing the growth and competitiveness of SMEs, its successful adoption requires addressing the myriad challenges and barriers that these enterprises face.

4.3 Implications for SMEs in the Evolving Digital Economy

The digital economy has ushered in a new era of opportunities and challenges for businesses worldwide. Small and Medium Enterprises (SMEs), often considered the backbone of any developing economy, are at the forefront of this transformation. The rapid advancements in technology, particularly in the realm of big data analytics, have significantly impacted SMEs' strategic positioning in the digital economy.

Big data analytics has gained traction in both practice and theory due to its potential benefits and barriers. In the context of developing economies, such as Jordan, big data analytics is seen as crucial despite the challenges that hinder its adoption. A study conducted by delved into the drivers of big data analytics adoption in Jordanian SMEs (Lutfi et al., 2022). The research highlighted several factors influencing the adoption of big data, including the relative advantage, complexity, security concerns, top management support, organizational readiness, and government support. Interestingly, competitive pressures and compatibility were found to have an insignificant influence on big data adoption. This underscores the importance of internal organizational factors and external support mechanisms in driving the adoption of big data analytics in SMEs (Lutfi et al., 2022).

Another dimension of the digital transformation journey for SMEs is the role of organizational culture and capabilities. Zhang Zhen explored the nexus of digital organizational culture, capabilities, and innovation in SMEs operating in the digital economy (Zhang Zhen et al., 2021). The study found a significant relationship between digital organizational culture and digital innovation. Furthermore, organizational readiness was identified as a mediating factor between digital capabilities and digital innovation. This emphasizes the need for SMEs to foster a digital-first culture and invest in building digital capabilities to drive innovation and remain competitive in the digital economy (Zhen et al., 2021).

The telecommunication sector, being at the heart of the digital transformation wave, offers valuable insights into the implications of big data for SMEs. A group researchers conducted a study on the importance of digital transformation in businesses through big data, Internet of Things (IoT), and blockchain-based capabilities for strategic performance within

the telecom sector in China (Angrave et al., 2021). The research highlighted the significant connection between data quality, technological competence, and strategic performance. Furthermore, big data analytics and IoT capabilities were found to play a pivotal role in mediating the relationship between data quality, technological competence, and strategic performance. This underscores the importance of integrating advanced technologies like big data analytics and IoT in SMEs' strategic planning and operations (Angrave et al., 2021).

In conclusion, as the digital economy continues to evolve, SMEs must proactively embrace the opportunities presented by big data analytics and other advanced technologies. By fostering a digital-first culture, investing in digital capabilities, and leveraging external support mechanisms, SMEs can navigate the challenges of the digital economy and position themselves for sustained growth and competitiveness.

4.4 Recommendations for SMEs to Maximize Big Data Benefits

In the age of digital transformation, Small and Medium Enterprises (SMEs) are presented with a plethora of opportunities to leverage big data for their benefit. However, to truly harness the potential of big data, SMEs must be strategic and informed in their approach. Embracing Big Data Analytics (BDA) capabilities is paramount. SMEs must recognize the importance of BDA capabilities in the digital era. A study conducted on Jordanian SMEs highlighted the significance of technological, organizational, and environmental factors in the adoption of big data (Lutfi et al., 2022). By understanding and investing in these factors, SMEs can effectively integrate big data into their operations and decision-making processes.

Engaging in Co-innovation (CI) is another pivotal strategy. CI, which involves collaborative innovation between firms and external partners, can play a pivotal role in enhancing SMEs' resilience, especially in times of uncertainty. Research has shown a positive association between BDA capability, CI, and organizational resilience. Moreover, CI has been identified as a mediator in the relationship between BDA capability and organizational resilience (Ciasullo et al., 2022). By engaging in CI, SMEs can tap into external expertise, share risks, and jointly develop innovative solutions that leverage big data.

A group of researchers proposed a seven-step process for Data-Driven Innovation (DDI) that includes product conceptualization, data acquisition, data refinement, data storage and retrieval, distribution, presentation, and market feedback (Hossain et al., 2022). The authors argue that developing a systematic process for DDI is crucial for SMEs aiming to capitalize on digital innovation for sustainable business growth. By adopting such a systematic approach, SMEs can ensure that their big data initiatives are aligned with their business objectives and deliver tangible results.

Lastly, staying updated with big data trends is essential. The digital economy is characterized by rapid technological advancements. To remain competitive, SMEs must stay abreast of the latest trends and developments in the field of big data. This includes understanding emerging technologies, tools, and methodologies, as well as being aware of the challenges and opportunities they present.

While big data offers immense potential for SMEs, it is essential for these enterprises to adopt a strategic and informed approach. By embracing BDA capabilities, engaging in CI, developing a systematic process for DDI, and staying updated with big data trends, SMEs can maximize the benefits of big data and drive sustainable business growth in the digital economy.

4.5 Potential Areas for Future Research and Exploration

The digital transformation era has ushered in a plethora of opportunities and challenges for SMEs, especially in the realm of big data and its associated technologies. As the digital economy evolves, it becomes imperative for researchers and practitioners to delve deeper into the nuances of big data applications, ensuring that SMEs can harness its full potential.

One of the emerging areas of interest is the application of big data and artificial intelligence (AI) in various industries. A bibliometric review by on the maritime industry highlighted the significance of big data and AI applications, identifying four primary research clusters: digital transformation in the maritime industry, applications of big data from AIS, energy efficiency, and predictive analytics (Munim et al., 2020). Such studies pave the way for understanding the broader implications of big data across different sectors, offering insights into potential areas for future exploration.

Furthermore, the adoption of big data analytics in developing economies presents a unique set of challenges and opportunities. A group of researchers

explored the drivers of big data analytics in Jordanian SMEs, emphasizing the role of technological, organizational, and environmental factors (Lutfi et al., 2022). Their findings underscore the importance of understanding the local context when implementing big data strategies, highlighting the need for more region-specific research in the future.

Lastly, the role of financial service providers (FSPs) in leveraging big data for supply chain finance (SCF) offers a rich area for exploration. Song, Li and Yu examined how FSPs utilize big data analytics on digital platforms to assess the creditworthiness of SMEs, providing insights into the evolving dynamics of SCF in the digital age (Song et al., 2021).

In conclusion, as the digital economy continues to evolve, the potential areas for future research in big data for SMEs are vast and varied. From industry-specific applications and regional challenges to sustainable innovation and finance, the opportunities for exploration are boundless.

5. CONCLUSION

The digital transformation era has ushered in a paradigm shift in the business landscape, with big data emerging as a pivotal force driving this change. This review set out with the aim to elucidate the significance of big data for Small and Medium Enterprises (SMEs), charting its historical context, economic implications, challenges, opportunities, and the technological advancements that have facilitated its integration.

Our objectives were met through a meticulous exploration of the literature, revealing that SMEs stand at the cusp of a transformative era. The findings underscored the economic potential of big data, with its adoption leading to enhanced competitiveness, precision marketing, and improved operational efficiency. However, the journey is not without challenges. SMEs grapple with infrastructural inadequacies, talent shortages, and the need for substantial investments to realize the full potential of big data.

Recommendations from the study advocate for a balanced approach to big data investments, ensuring alignment with expected ROI. Collaborative frameworks with big data vendors and consultants have emerged as a viable strategy, offering SMEs the expertise and resources they lack in-house. Furthermore, the importance of data privacy and security cannot be overstated, necessitating robust measures to safeguard sensitive information.

In conclusion, as SMEs navigate the complexities of the digital economy, big data emerges not just as a tool but as a strategic asset. By harnessing its potential, SMEs can not only thrive but also redefine the contours of business in the digital age. The future beckons with promise, and for SMEs willing to embrace the big data revolution, the horizon is replete with opportunities.

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