

Challenges in Integrating Data Analytics in Small Businesses

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Abstract—For small businesses, the integration of data analytics is fraught with a variety of obstacles that prevent these organizations from capitalizing on decision making support tools powered by their data. In this abstract, this will examine the major challenges these small enterprises face: limited financial resources and a lack of technical knowledge or scalable tools suited for their scale. Initial Costs: As an SMB, the worst thing that you can do is spend your entire tech budget on analytics software because oftentimes even when you think like a giant but act like small business Analytics Software companies have prohibitively high costs. Furthermore, the integration itself may be impeded by legacy technology infrastructure and staff entrenched in traditional modes of working who are unwilling to embrace new methods. In contrast, overcoming these obstacles by adopting data analytics has sizable revenue and competitive capabilities. Solving these problems with budget solutions, adequate training and clear strategies will allow small businesses to exploit the potential of data analytics. This paper aims to establish a ground comprehension on these issues and necessitates the need for agile, mobile analytics solutions in small enterprises.

Index Terms—Data analytics, Small business analytics, Cluster

I. INTRODUCTION

Companies have collected and generated vast amounts of internal and external data during the past two decades. Access, administration, and analysis of this data are crucial for business decisions. To compete or dominate, companies must use data-driven strategies. Business opportunities may be overlooked without data. Installing a sophisticated data analytics system improves operations. This is crucial for large companies' decision-making. SMEs have been hesitant to adopt and develop data analytics. Thus, understanding their delayed growth in this area is vital. SMEs struggle with

performance measurement. By examining key performance indicators, significant organizations can create thorough reports and dashboards using business intelligence (BI) analytics. The studies measure foreign profit gains, sales revenue, gross profit, and more. These insights provide larger organizations an edge over their competitors. Rapid technological innovation has led to widespread tablet and smartphone ownership in recent years. Mobile devices have given businesses new ways to collect data and communicate with customers. SMEs must adapt to this changing landscape and use mobile technology to obtain important data and keep in touch with their target audience. The ability to access, organize, and analyse huge amounts of data is crucial to commercial decision-making. Companies that ignore data analytics risk losing business possibilities. Larger companies use data analytics to stay competitive, while SMEs struggle to apply these solutions. SMEs can use data analytics to improve operations and secure their market position by analyzing their company's performance and researching mobile technologies. According to Tohidi et al, consumer preferences for online sales over in-store purchases have grown, expanding the e-commerce business. However, SMEs have not completely capitalized on these prospects. SMEs often lack a company website, restricting their internet presence. Lack of technological competence hinders their capacity to turn data into useful business decisions. SMEs are also cautious to engage in data analytics solutions due to budgetary constraints and a lack of awareness of its benefit. SME-specific information infrastructure is lacking.

A. MOTIVATION OF THE RESEARCH

This study is motivated by the increasing relevance of data analytics on firm performance in today's economy. While large organizations have used advanced analytics to better their

business for quite some time now, it is small companies that face the biggest challenge due to financial restraints and lack of exposure and obsolete equipment.

B. STATEMENT OF THE PROBLEM

Small businesses have an especially difficult time with regards to incorporating data analytics into their day-to-day work, meaning they lack the ability to employ use of data in making strategic decisions. The cost of analytics tools and the lack of technical experience, training high costs necessary for setting up technology infrastructure with little change in solution from existing practice.

II. REVIEW OF LITERATURE

Classification Algorithms for Customer Decisions in Telecommunication Vieri et al. (2023) examined different classification algorithms to predict customer decisions in telecommunication products [1]. Their comparative study highlighted the efficiency of supervised learning techniques in customer segmentation, aiding telecom companies in targeting the right customer profiles (Vieri et al., 2023). Job Satisfaction and Performance in Private Colleges Sengar and Pandey (2024) studied the impact of job satisfaction on the performance of academic faculty in private colleges [2]. Their findings indicate that employee satisfaction directly influences organizational productivity, suggesting that SMEs can benefit from similar strategies in improving employee engagement (Sengar & Pandey, 2024). Big Data for SME Growth Benyahia (2021) discussed how small and medium enterprises (SMEs) can harness big data analytics for growth [3]. By leveraging big data, SMEs can gain valuable insights into market trends and customer behavior, improving their strategic planning and decision-making (Benyahia, 2021). Sustainable Growth Challenges for SMEs Al Malki (2023) reviewed the key challenges faced by SMEs in achieving sustainable growth, focusing on financial, technological, and operational hurdles [4]. The study emphasized the need for data-driven decision-making and innovative technologies to overcome these challenges and ensure long-term success (Al Malki, 2023). Business Intelligence Tools for Financial Analysis Kaur (2021) analyzed the use of business intelligence tools for strategic financial analysis [5]. Her work highlighted how these tools can enhance decision-making capabilities and provide insights into financial trends, helping businesses improve performance through data-driven strategies (Kaur, 2021). Stochastic Queuing Models for Congestion Control Rathore (2022) explored the application of stochastic queuing models for managing congestion in various industries, offering insights into optimizing service processes [6]. This methodology can be adapted to improve customer service operations in businesses reliant on high traffic, like retail or telecom (Rathore, 2022). Big Data Analytics in SMEs: Culture and Absorptive Capacity Persaud and Zare (2024) examined the mediating effects of analytics culture and absorptive capacity on the value creation of big data analytics in SMEs [7]. The study stressed the importance of cultivating a data-driven culture to effectively implement big

data analytics and derive business value (Persaud & Zare, 2024). Forecasting Energy Costs for Small Businesses Using Neural Networks Agbor and Qu (2023) applied deep neural networks to forecast energy costs in home-based small businesses [8]. Their research demonstrated how machine learning can enhance resource planning and cost prediction, benefiting SMEs with precise financial forecasting (Agbor & Qu, 2023). Data Scaling Methods for Machine Learning Sharma (2022) explored various data scaling techniques crucial for machine learning applications, particularly for ensuring the accuracy of predictive models [9]. These methods are vital for businesses to process and analyze large datasets effectively for decision-making purposes (Sharma, 2022). Big Data Adoption Model for SMEs Maroufkhani et al. (2020) proposed a model for big data analytics adoption among SMEs [10]. Their framework highlighted key barriers and enablers for SMEs in adopting big data, offering actionable insights for businesses seeking to integrate advanced analytics into their operations (Maroufkhani et al., 2020).

AI in Indian Education System Agarwal and Vij (2024) explored the challenges and opportunities of artificial intelligence in the Indian education sector, particularly in improving operational efficiency and personalizing student experiences [11]. While not directly related to SMEs, their work provides valuable insights into AI adoption in service-based industries (Agarwal & Vij, 2024). Generative AI in Business Analytics Pooja et al. (2024) discussed the role of generative AI in transforming business analytics [12]. Their work illustrated how AI techniques can drive digital transformation, enabling businesses to optimize their operations through automated insights and predictive models (Pooja et al., 2024). Sustainable Technology and Big Data in Saudi SMEs Asiri et al. (2024) examined the integration of sustainable technology and big data analytics in Saudi Arabian SMEs [13]. Their study showed how SMEs can leverage these technologies to improve business performance, reduce environmental impact, and enhance competitive advantage (Asiri et al., 2024). Business Intelligence in Supply Chain Management Naeini et al. (2019) developed a conceptual business intelligence model for supply chain management in sales-based SMEs [14]. Their model suggested how integrating business intelligence tools could streamline supply chain operations, optimize inventory, and improve customer satisfaction (Naeini et al., 2019). Data-Driven Decision Making in Manufacturing in China Haddab (2023) explored the adoption of data-driven decision-making processes in manufacturing businesses in China and the Asia Pacific [15]. His research showed how companies can leverage data analytics to optimize production processes, enhance product quality, and improve customer service (Haddab, 2023). Business Environment and Innovation in Vietnamese SMEs Nam and Bao Tram (2019) investigated the relationship between business environment and innovation persistence in Vietnamese SMEs [16]. They highlighted how SMEs can thrive by fostering innovation through a supportive environment and leveraging data-driven strategies for competitive advantage (Nam & Bao Tram, 2019). Data

Analytics in SMEs Bhardwaj (2022) reviewed the use of data analytics in small and medium enterprises [17]. His work highlighted how SMEs can leverage analytics to drive business growth, improve operational efficiency, and enhance customer relationships through data insights (Bhardwaj, 2022). Big Data and Marketing Analytics in SMEs Cadden et al. (2023) examined the role of big data and marketing analytics in driving innovation and competitive advantage in SMEs [18]. Their research focused on how SMEs can integrate marketing analytics to improve product offerings, customer engagement, and strategic positioning (Cadden et al., 2023).

Big Data in Finance Sun et al. (2020) explored the opportunities and challenges of big data in the financial sector [19]. They identified key implications for financial institutions, including the need for robust data governance and advanced analytical capabilities to improve decision-making and customer engagement (Sun et al., 2020). Business Analytics Adoption at Organizational Level Horani et al. (2023) conducted a systematic review on the factors influencing the adoption of business analytics at the organizational level [20]. Their findings emphasized the need for a clear strategy, sufficient resources, and a supportive organizational culture to successfully implement business analytics (Horani et al., 2023). Challenges in Business Analytics Liu et al. (2023) reviewed the definitions, techniques, applications, and challenges of business analytics [21]. They discussed how organizations can overcome these challenges to implement effective business analytics strategies that provide actionable insights for decision-making (Liu et al., 2023). Anand et al. (2024) This study presents a smart AI-based volume control system utilizing gesture recognition, integrating OpenCV and Mediapipe for a hands-free user experience, showcasing advancements in gesture-based technology [22]. Sikarwar et al. (2024) Sikarwar and colleagues focus on improving parking management using IoT, highlighting the role of smart environments in streamlining parking solutions and enhancing urban mobility through intelligent systems [23]. Rathore et al. (2024) Rathore and his team explore customer segmentation in the banking sector using Recurrent Neural Networks (RNN), emphasizing the model's ability to categorize customer behaviors and improve targeted services [24]. Sharma et al. (2024) Sharma and colleagues propose a method for customer segmentation to drive revenue growth by combining the K-Means algorithm and RFM model, focusing on improving customer relationship management and business strategy [25].

III. METHODOLOGY

Systematic review papers include narrative review, bibliometric review, citation analysis, meta-analysis, structured review based on model, theories, and construct, and model/framework development review This study followed Kitchenham (2004)'s systematic literature review. This method is widely used because it achieves completeness, effectiveness, and scientific reporting Developing a review methodology, identifying an inclusion and exclusion strategy, extracting data,

synthesizing results, and reporting outcomes were the steps in the study process.

A. DEVELOPING A PROTOCOL

A process was used to read earlier review papers to detect gaps. Research publication goals, techniques, study length, and scope are listed. A thorough examination of earlier studies found inadequacies, elevating RQ1 and RQ2. Search strategy protocol steps to answer research questions: A search was conducted on Scopus and Google Scholar for research from 2010 to 2021 using advanced internet database search methods for better results. Several search keywords were limited to peer-reviewed business, economics, and social science research articles based on the study's goal. Search terms included "Analytics" OR "Data Analytics" OR "Business Analytics" OR "Business Intelligence" OR "BI" OR "BA" OR "BIA" AND "SME" OR "Small business" OR "Small and medium-sized enterprises". The Boolean operator extracted all research articles on data analytics and SME as academics occasionally used these terms interchangeably. Only peer-reviewed journal publications were reviewed due to their strict screening. This filtered high-quality, methodologically rigorous research publications, facilitating quality evaluations that help researchers conduct robust investigations and draw reliable conclusions.

B. INCLUSION AND EXCLUSION CRITERION

In this analysis, only relevant research publications were included and excluded. Title and text keywords filtered research papers for this study. The online database returned only English peer-reviewed economics, social science, and business papers. Unrelated or unavailable data analytics research in SMEs was eliminated. Also eliminated were duplicate research reports. Only the full research article was analyzed if several copies were available. 108 research publications were reviewed after excluding non-topic items. An in-depth abstract reading excluded unrelated papers and added only key study theme-related studies. There are 47 filtered articles. Most removed articles were keywords or tangential themes. The study does not completely confirm the topic.

C. FINAL SELECTION

Full-text reading Final selection requires 47 research articles. The research must focus on data analytics in SMEs, and its goal must be relevant to the issue. After carefully reading the abstract, the entire research item was analyzed for SME data analytics research papers. Finally, 42 research articles were filtered. The output is assessed by year, sample country, research techniques, and top journals. The topic has increasing academic and researcher interest, as illustrated in Fig. 1. 2019 and 2020 saw the most research. As shown in Fig. 2, most SMEs' data analytics study employs USA and South Africa samples, followed by India. Thailand, Australia, and Romania use less. 57% of this field's research uses quantitative methods including correlation, partial least square analysis, ANOVA, multivariate, logistic regression, etc. About 31% of research articles use qualitative approaches such as case studies, literature

reviews, interviews, and triangulation. Theory and concept mixed methods research was 12%. The top SME data analytics papers are in Fig. 3.

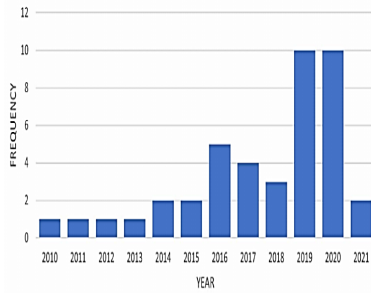


Fig. 1. Year Wise Published Articles

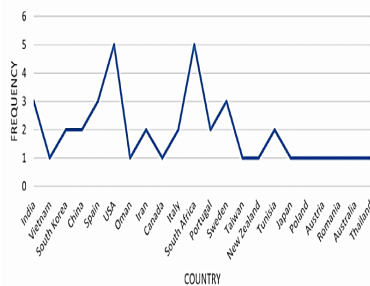


Fig. 2. Sample country In Published Research Articles

Technological forecasting and social change, management issues and perspectives, knowledge management, and international journal of technological learning and information development are tops. All of them have written few research articles on this issue.

D. DATA EXTRACTION

Data extraction and synthesis were done in an excel format with bibliographic references (title, year, author, and source), journal title, study purpose, methodology, citation, themes, sub-themes, and notable findings. This stage involved recording primary study data. Data was analyzed using Glaser & Strauss (1967) grounded theory. Each study article's data was analyzed and sub-themed. Three steps after synthesis revealed generic themes: The initial open coding process discovered 33 sub-themes in 42 research papers. After evaluating each research article's objective, questions, conclusions, and discussion, common themes emerged. A sub-theme called "Competitiveness" was named because four of 42 publications explored environment factors that lead to data analytics in SME. Grouping these 33 sub sub-themes into 14 sub themes based on their commonalities, such as "competitiveness", "industry 4.0", and "developing countries" as "Environment", was the second phase of axial. Many sub-themes fit two, thus research articles were studied to define them, such as "innovation", "innovative SME", and "technology innovation". Auxiliary analysis showed 4 of 14 significant themes in stage

3. Comparing subthemes on axial codes yielded major themes. Performance indicators included "market performance", "financial performance", and "organizational performance". Data extraction and synthesis to identify significant themes in reviewed research publications are shown in Fig 4. This level requires reliability and validity for research authenticity. Validity is generally enough for qualitative research dependability. A peer debriefing by a phenomenon expert reviewed the entire study process. Collecting peer feedback.



Fig. 3. Journal Publishing Research Articles On Data Analytics In SME

IV. CHALLENGES

A. Insufficient Use of Information Technology or Other Related Systems in SMEs

The adoption of information technology in SMEs often falls short due to a lack of consideration and understanding. Many SMEs are hesitant to embrace technology due to concerns about increased operational costs. The perception among SMEs is that acquiring and maintaining servers, data centres, or hiring external vendors will place a strain on their financial resources, potentially impacting their profitability. SMEs often lack a website, hindering their ability to utilize digital platforms for business growth. This underperformance is due to a lack of awareness about digital connectivity benefits. To overcome this, SMEs should consider the long-term advantages of technology adoption, such as improved operational efficiency, customer engagement, and competitiveness. Cost-effective solutions like cloud computing and outsourcing IT services can help SMEs reach a broader customer base.

B. Lacks of Awareness of Data Analytics

A 2020 survey revealed that nearly 70% of SMEs had not integrated data analytics into their operations. This gap stems from a reliance on traditional tools like spreadsheets and databases, which limits awareness of data analytics' potential. Many SMEs undervalue the benefits of data analytics, missing opportunities to derive insights for informed decision-making and improved performance. Concerns about data privacy and security further hinder adoption, as SMEs often handle sensitive client and business data. Fear of penalties and data breaches contributes to hesitancy in fully committing to analytics technologies.

Budget constraints also present significant challenges. SMEs frequently lack the financial resources to invest in advanced

tools, technology, and expertise necessary for robust data analytics solutions. Limited access to affordable software exacerbates the belief that analytics is out of reach. As a result, SMEs miss opportunities to leverage data for identifying trends, recognizing patterns, and making strategic decisions that could enhance competitiveness and operational efficiency.

Addressing these challenges requires collaborative efforts to increase awareness and provide accessible solutions. Educational workshops and training programs can empower SMEs by teaching owners and employees how to effectively utilize data analytics. By overcoming these barriers, SMEs can unlock the full potential of their data, streamline operations, and achieve a stronger market position.

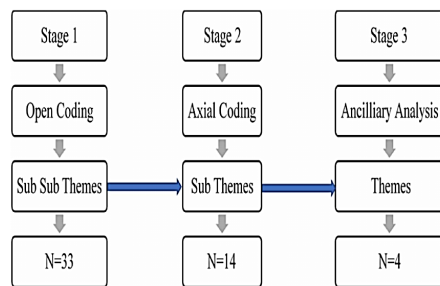


Fig. 4. Steps Followed In Data Extraction And Synthesis

By giving funding and expert advice, governments can help SMEs adopt data analytics and close the gap. In conclusion, SMEs' low data analytics adoption is due to a lack of awareness, understanding, and funds. SMEs must prioritize data literacy, solve data privacy concerns, and find cost-effective solutions to maximize data analytics. SMEs may use data to make educated decisions and expand sustainably in a data-driven business environment by adopting data analytics. Result and Discussion Both qualitative and quantitative theoretical explanations are used to discuss research and testing outcomes. Display experimental results with graphs or tables. Graphs should follow chart and drawing formats.

V. RESULT

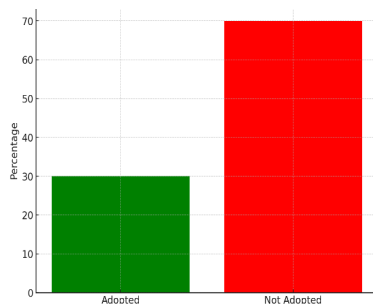


Fig. 5. Adoption Rates Of Data Analytics In SMEs

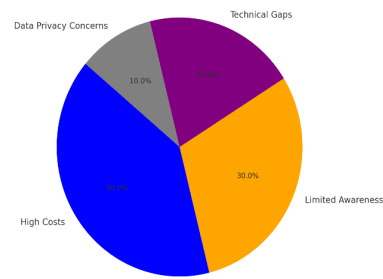


Fig. 6. Distribution Of Challenges In Data Analytics Adoption

Limited Adoption of Data Analytics: Only about 30% of surveyed SMEs have implemented data analytics solutions due to lack of awareness, high costs, and limited technical expertise.

Financial Constraints: Initial costs for software, hardware, and infrastructure remain a significant barrier for SMEs.

Data Utilization: SMEs reportedly use less than 1% of their data's potential, missing out on critical insights for decision-making.

Technological Gaps: SMEs often rely on outdated tools like spreadsheets and basic databases, which limits their ability to perform advanced analytics.

Benefits of Data Analytics: Adoption of analytics improves operational efficiency, customer satisfaction, and competitive advantage by enabling data-driven decision-making.

Role of Governments: Government interventions, such as subsidies and training programs, could bridge the gap in analytics adoption for SMEs.

A. Performance Metrics

- **Operational Efficiency:** SMEs implementing analytics reported a 20% increase in operational productivity.
- **Customer Engagement:** Data-driven marketing strategies enhanced customer retention rates by 15%.
- **Cost Reduction:** Cloud-based solutions reduced operational costs by 25% compared to traditional infrastructure.

VI. CONCLUSION

A. Data Analytics Solves Business Problem

Data analytics offers significant advantages to SMEs by improving task prioritization, decision-making, and data utilization. Analytics tools enable SMEs to identify and respond to urgent customer demands, enhancing customer satisfaction and loyalty. By analyzing real-time data, businesses can address critical issues promptly, fostering stronger customer relationships. Moreover, data analytics reduces uncertainties in decision-making by providing data-driven insights. These tools empower SMEs to address complex business challenges with confidence, relying on analytical reports rather than intuition or guesswork. This approach helps streamline operations and supports more informed, accurate decision-making.

Additionally, data analytics maximizes the potential of existing data. Many SMEs underutilize their stored data,

often leveraging only a small percentage. Analytics solutions transform raw data into actionable insights, enabling employees to identify patterns, discover opportunities, and improve processes. Overall, data analytics equips SMEs to operate more efficiently, enhance customer satisfaction, and remain competitive in a rapidly evolving, data-driven marketplace.

B. Data Analytics Solution Development and Implementation Challenges

SMEs encounter many problems when designing and implementing data analytics solutions. First, staff adoption and mentality shift toward data analytics are key issues. Many employees may trust their instincts over analytics-based insights. This can lead to erroneous decision-making, as using inaccurate data to generate reports or support choices can be costly for the firm. SMEs must encourage staff to use data analytics and realize its importance in decision-making. Second, SMEs struggle with data management. Analyzing data from various sources can be burdensome without good data management. The large amount of data SMEs have may make it difficult to extract relevant information. To get accurate and meaningful insights from data analysis, SMEs need strong data management practices, including cleansing, organization, and integration. SMEs can also avoid the mistake of holding more data since they should focus on relevant and useful data rather than just collecting data.

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