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| RESEARCH ARTICLE

Digital Transformation in SMEs: Unlocking Competitive Advantage through Business Intelligence and Data Analytics Adoption

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| ABSTRACT

In an era where data-driven decision-making is becoming central to organizational success, understanding how emerging technologies influence business operations is critical. This study analyzed the application and impact of Business Intelligence and Data Analytics on digital transformation inside Small and Medium-sized Enterprises (SMEs), highlighting its role in enhancing competitive advantage. Our analysis highlighted the sector-specific disparity in BI/DA adoption, with the industrial leading at 60% and retail behind at 38%, underscoring differences in digital readiness among sectors. The principal barriers to adoption included inadequate skills (78%), financial concerns (62%), and data silos (43%), underscoring the need for digital training, affordable technology, and change management strategies. SMEs indicated substantial benefits from business intelligence and data analytics, including improved operational efficiency (68%), greater customer service (59%), and critical market insights (55%), highlighting their strategic significance. A significant correlation was observed between adoption levels and performance outcomes, with high adopters achieving 23% larger revenue growth, a 30% decreased in costs, and a 35% enhancement in client retention compared to low adopters. The crucial role of leadership, demonstrated by strong support from top management, was associated with higher BI/DA performance indicators (8.2 compared to 5.4). A strong positive correlation (0.64–0.75) was established between BI adoption, DA utilization, revenue growth, and customer retention, confirming that digital maturity enhances business performance. These findings emphasized that Business Intelligence and Data Analytics are not only technological improvements but strategic tools for transformation. For SMEs aiming to thrive in the digital era, the implementation of integrated BI/DA, supported by leadership and a data-driven culture, is essential for sustained growth and competitiveness.

| KEYWORDS

Digital Transformation, Business Intelligence, Data Analytics, SMEs, Competitive Advantage

| ARTICLE INFORMATION

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1. Introduction

A fundamental revolution has taken place in the business environment in the digital era because of the widespread use of new technologies. This transformation has therefore influenced the operations of organizations, the degree of competition, and the delivery of value. According to Wamba et al. (2015), the utilization of Business Intelligence (BI) and Data Analytics (DA) should be considered an absolute necessity to improve organizational agility and gain a competitive edge (Manik et al., 2022; Manik, 2022). More specifically, this is the case for small and medium-sized firms (often known as SMEs). There are more than ninety percent of

businesses all over the world that are categorized as small and medium-sized companies (SMEs). As well as being important contributors to economic resilience, employment, and innovation, these enterprises are also important contributors (OECD, 2017). On the other hand, small enterprises frequently do not have the resources that would enable them to take advantage of digital technologies and incorporate them into their operations. Vial (2019) defined digital transformation (DT) as the process of integrating new technology with the reconfiguration of organizational structures, business models, and decision-making procedures. DT is also referred to as "digital transformation." The application of business intelligence and data analytics by small and medium-sized firms (SMEs) boosts the ability to make choices in real time, enhances the ability to segment customers, optimizes operations, and supports in the forecasting of markets (Chatterjee et al., 2021).

According to Liu et al. (2020), the digital transformation of small and medium-sized businesses (SMEs) is hampered by a variety of problems. These factors included a lack of digital skills, intolerance to change, insufficient infrastructure, and worries around data governance. The increasing number of people using the internet in the aftermath of the outbreak is a significant factor that contributes to the significance of this study. Because of the COVID-19 outbreak, a great number of companies have been pushed to make use of remote workers, digital platforms, and online customer involvement. According to Gobakhloo and Ching (2019), small and medium-sized businesses (SMEs) are required to undergo rapid transformations to avoid falling behind the times and being irrelevant.

This study gives pragmatic guidance for SMEs, politicians, and digital consultants to design tailored plans for the integration of business intelligence and data analytics. This advice was provided by mixing theoretical principles with practical facts. Consequently, the amount of information concerning the digital transformation of small and medium-sized enterprises (SMEs) is improved. This focused an emphasis on the requirement of adopting a digital strategy that was both dynamic and iterative, and that fits the strategic aims and capabilities of the business. Moreover, it indicates that this strategy must be adopted. The objective of this study was to investigate the ways in which small and medium-sized enterprises (SMEs) adopt business intelligence and data analytics in their digital transformation initiatives, as well as the role that these technologies play in obtaining a competitive edge. Specifically, the research will focus on the ways in which SMEs deploy these technologies.

2. Literature Review

The significance of this concept for SMEs has gained prominence in the context of quickly expanding digital technologies. Although the concept of digital transformation is not a new one, it has gained prominence in recent years. As stated by Bharadwaj et al. (2013), digital transformation is the process of infusing digital technology into every aspect of a firm, so bringing about a fundamental shift in the manner in which the company runs and provides value to its customers. In other words, digital transformation is the process of adopting digital technology. Given the immediate potential that these tools must improve decision-making, this transition often begins with the adoption of Business Intelligence and Data Analytics tools in SMEs. This is because these tools can improve decision-making (Rialti et al., 2020; Pan et al., 2022; Miah et al., 2018, 2019).

2.1 BI and DA in the Context of SMEs

Data analytics is the process of interpreting data patterns through the application of statistical tools and algorithms (Chen et al., 2012). Business intelligence refers to the technologies and processes that are used to collect, integrate, analyze, and present business information. Data analytics is the process of analyzing data patterns. The ability to make decisions based on data is provided to small and medium-sized businesses (SMEs), which helps to minimize the need for guesswork and enhances the process of strategic planning (Rialti et al., 2020).

Wixom and Watson (2010) conducted research that revealed that companies that have attained more business intelligence maturity outperform their competitors in terms of market responsiveness and financial performance. This was proved by the fact that these companies have a higher level of success. As a result of the availability of solutions that are not only affordable but also scalable, business intelligence tools like Microsoft Power BI, Tableau, and Qlik have made analytics more accessible to small and medium-sized businesses (SMEs) (Sharma et al., 2014).

2.2 Adoption Drivers and Challenges

When it comes to comprehending the adoption of business intelligence and data analytics, the Technology-Organization-Environment (TOE) framework and the Diffusion of Innovation (DoI) theory are employed to a significant degree. In accordance with Oliveira and Martins (2010), the most significant roles were played by factors that are associated with technology (such as compatibility and complexity), organizational preparation (such as information technology infrastructure and support from senior management), and external pressures (such as customer demand and competitiveness).

The authors Gonzalez and Melo (2021) stated that some of the most typical challenges consist of a lack of competence, data silos, and resistance to positive change. It is commonly known that these challenges have been reported. A significant number of small and medium-sized businesses (SMEs) have a tough time building a culture that is data-driven and includes analytics into the decision-making process (Kwon et al., 2014).

2.3 Competitive Advantage through Digital Transformation

Businesses could acquire a competitive edge through the use of digital technology, as stated by Porter and Heppelmann (2014). This may be accomplished by reducing costs, distinguishing their products, and offering better experiences for their customers. The outcomes of a study that was carried out by Brynjolfsson and McAfee (2017) indicated that organizations that are digitally advanced have higher earnings and faster growth. The competitive advantages of business intelligence and data analytics are reflected in small and medium-sized firms (SMEs) by higher product-market fit, improved financial forecasting, and enhanced supply chain agility (Hazen et al., 2014). These advantages are essential for SMEs to remain competitive in their respective industries. However, in order to reap the benefits, it is vital to have strategic alignment and to make continuous investments in digital capabilities. Only then would it be possible to reap the rewards.

3. Materials and Methods

3.1 Study Design

This research was conducted with the intention of analyzing the ways in which small and medium-sized businesses deploy business intelligence and data analytics technologies, as well as the performance results that result from the installation of these tools. For the objective of this study, a quantitative survey approach that was using a cross-sectional methodology was applied to accomplish this goal. It was necessary to collect empirical data from many small and medium-sized firms that were functioning in three highly significant industries: retail, services, and manufacturing (Wamba et al., 2017; Pan et al., 2022; Manik et al., 2020; Manik, 2020; Bulbul et al., 2018). These industries were chosen because of the different levels of operational complexity and data management approaches that are utilized by these sectors. This selection was because these industries are used. This makes it feasible to have a thorough understanding of digital transformation across a wide variety of organizational situations (Pan et al., 2022). An examination of the present levels of digital maturity, the outcomes of the organization, and the obstacles that are linked with the deployment of business intelligence and data analytics was able to be carried out without any difficulty thanks to the utilization of the cross-sectional technique. The small and medium-sized firm (SME) that served as the unit of study was the subject of the research, and the owners, directors, and senior managers who were involved in the decision-making process were specifically asked to provide their comments (Rialti et al., 2020).

3.2 Data Collection

To collect primary data, a structured questionnaire was designed drawing upon validated frameworks such as the Technology-Organization-Environment (TOE) model and prior studies on Business Intelligence and Data Analytics implementation (Tornatzky & Fleischer, 1990; Oliveira & Martins, 2011). The survey combined closed-ended and Likert-scale questions to ensure response consistency and was electronically disseminated to a purposive sample of 400 SMEs through professional networks, business directories, and SME forums. A total of 126 valid responses were collected, yielding a response rate of 31.5%. The questionnaire was organized into five core sections: (1) BI/DA tool usage, including platforms such as Power BI, Tableau, Google Analytics, and CRM systems; (2) digital maturity, evaluated via a 5-point Likert scale measuring system integration and data-driven practices; (3) organizational performance, encompassing metrics like cost efficiency and customer retention; (4) adoption barriers, such as technical limitations and change resistance; and (5) firm demographics. A pilot test with 10 SME managers ensured clarity and validity.

3.3 Data Analysis

The collected data were encoded and analyzed using IBM SPSS Statistics version 27. Descriptive statistics, comprising frequencies, means, and standard deviations, were employed to summarize the characteristics of participating SMEs and their patterns of BI/DA utilization (Field, 2018). Multiple regression analysis was utilized to examine the relationship between BI/DA adoption and performance results, emphasizing key characteristics such as digital maturity and leadership support for revenue enhancement and customer retention. Cluster analysis was utilized to classify SMEs into three tiers of adoption low, medium, and high based on reported usage and maturity scores. An ANOVA was conducted to assess significant performance differences across these groups (Hair et al., 2019). The reliability of multi-item scales was validated by Cronbach's alpha, with values exceeding 0.80, indicating strong internal consistency (George & Mallery, 2016).

4. Results

4.1 BI/DA Adoption Rates Across SME Sectors

Our research showed over three major SMEs manufacturing, services, and retail the adoption rates of Business Intelligence and Data Analytics products. According to studies, BI/DA has been introduced into operations with just 38% in the retail sector, 47% in the services, and 60% in the manufacturing sector SMEs (Figure 1). These variants catch operational complexity and apply especially to an industry. Typically handling complex supply chains, inventory control, manufacturing scheduling, and cost control, manufacturers also resulted with real-time data visibility and predictive insights. These components enabled operational efficiency, waste reduction, and throughput increase in BI/DA solutions essential ones. On the other hand, because of intangible services, service-based SMEs sometimes found it difficult to organize and evaluate customer contact data even with plenty of data. Lean

budgets, scattered data systems, and high turnover rates limiting investment in sophisticated analytics help to explain the weak retail business adoption rate to some degree.

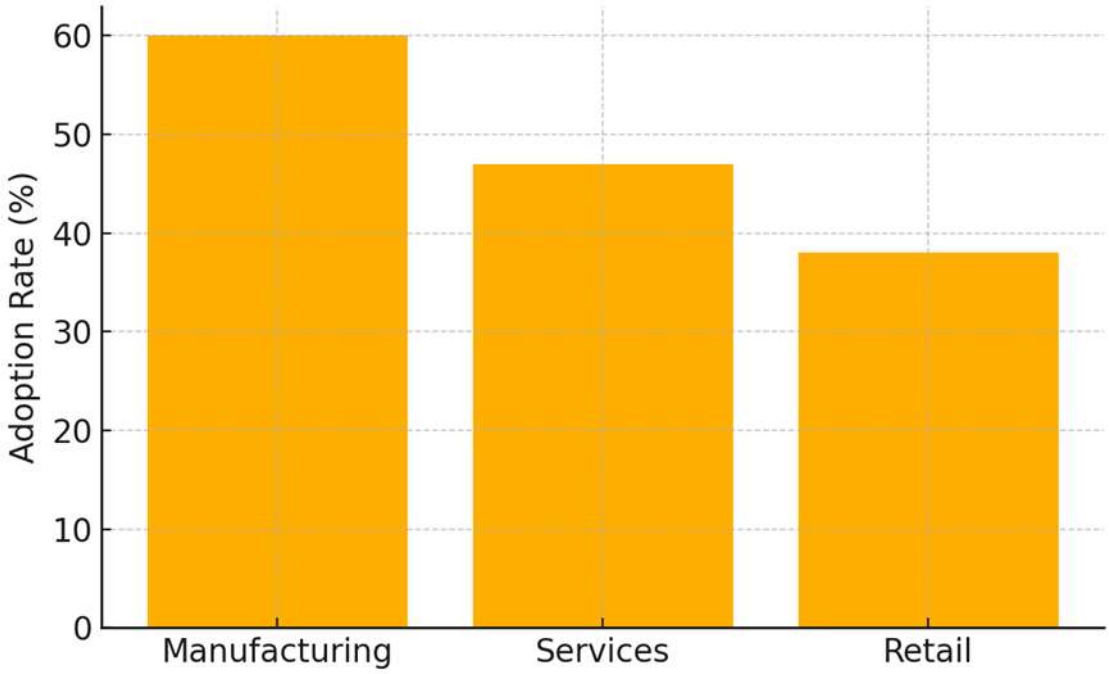

Figure 1. BI/DA Adoption Rate by Industry.

This points to a somewhat low cost, scalable BI solution appropriate for retail.

The tendency highlighted even more the need for BI/DA projects targeted for different sectors. Although bigger manufacturing companies might spend on enterprise-grade solutions, SMEs in retail and services need more easily available tools like Tableau, Google Data Studio, or Power BI. Reducing the digital divided between many sectors also depends on government incentives, vendor relationships, and sector-targeted education. Policymakers and technology firmed seeking to raise SMEs' competitiveness using digital transformation depend on understanding of these adoption patterns.

4.2 Key Barriers to BI/DA Adoption in SMEs

The Adoption in SMEs highlighted the main obstacles SMEs must overcome to implement data analytics and business intelligence solutions. Of the respondents, 78% said their major obstacle was either lack of digital knowledge or abilities (Figure 2). This highlighted the human capital difference in smaller companies when often lacking IT experts or experienced data analysts. Financial worries followed closely and influence 62% of SMEs. These expenses paid for first software licenses, cloud infrastructure, maintenance and training related hidden expenses. Forty-three percent of reported data silos point to structural and technological problems that is, several systems stopping smooth data integration and analysis.

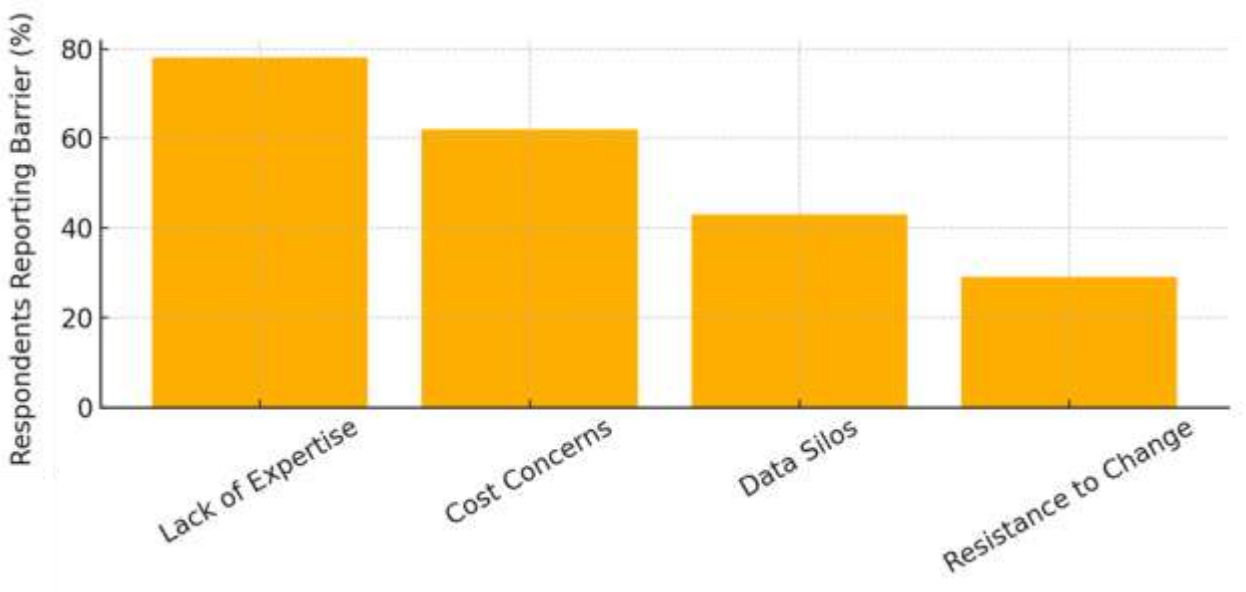

Figure 2. Major Barriers to BI/DA Adoption.

This dispersion tested the departments to deliver consistent insights. Finally, opposition to change (29%) catches the cultural inertia of conventional SMEs, especially those run under non-digital-native leadership or with legacy business models. Targeted upskilling initiatives and sponsored BI toolkits help to address the talent gap as well by means of public-private cooperation. In essence, human, financial, and technological limitations limited actual adoption even if BI/DA technologies present great potential and necessitate for coordinated action to overcome.

4.3 Perceived Benefits of BI/DA Adoption in SMEs

Dashboard-based monitoring and data-driven automation can improve operations, save costs, and eliminate repetitions depending on operational efficiency. First among the most typically cited benefit operational efficiency (68%). Usually generating better labor and resource allocation, these efficiencies help to organize supply chains and reduce turn-around times (Figure 3). Enhanced customer service (59%) showed how successfully analytics can segment audiences, understand consumer behavior, and design custom engagement approaches. Among other things, CRM-integrated BI systems helped SMEs to evaluate attrition rates, measure client loyalty, and customize messaging. SMEs revealed 55% of market insights, which suggested that analytics-driven forecasting helps businesses to understand competitiveness plans, predict demand changes, and adopt pricing policies, so controlling competition.

Figure 3. Perceived Benefits of BI/DA.

This was especially crucial in uncertain markets or during the post-pandemic recovery since fast decisions and flexibility define competitive advantages. These declared benefits and actual organizational performance statistics of BI/DA deployment as a strategic facilitator instead of a technology enhancement. Including analytics into their business models helped SMEs to go from reactive to proactive decision-making, therefore improving not just short-term performance but also long-term strategic orientation.

4.4 SME Performance by BI/DA Adoption Level

The degree of BI/DA adoption indicated low, medium, and high-performance differences between SMEs. Three measurements like client retention, expense control, and revenue growth showed the clearest variations. SMEs with strong BI/DA adoption reported a 23% increase in revenue growth, compared to low adopters (Figure 4). This matched their ability for data-driven decision-making, demand forecasting, and identification of new market opportunities. Cost-cutting thirty percent more in high adopters underlined even more how leaner operations, automation, and process optimization enhance financial stability. Of high adopters, customer

retention rose by 35%; so, BI/DA technologies improve the customer journey by means of customizing, personalizing, and service responsiveness. These businesses were more suited to recognize risks related to turnover and move quickly for corrections.

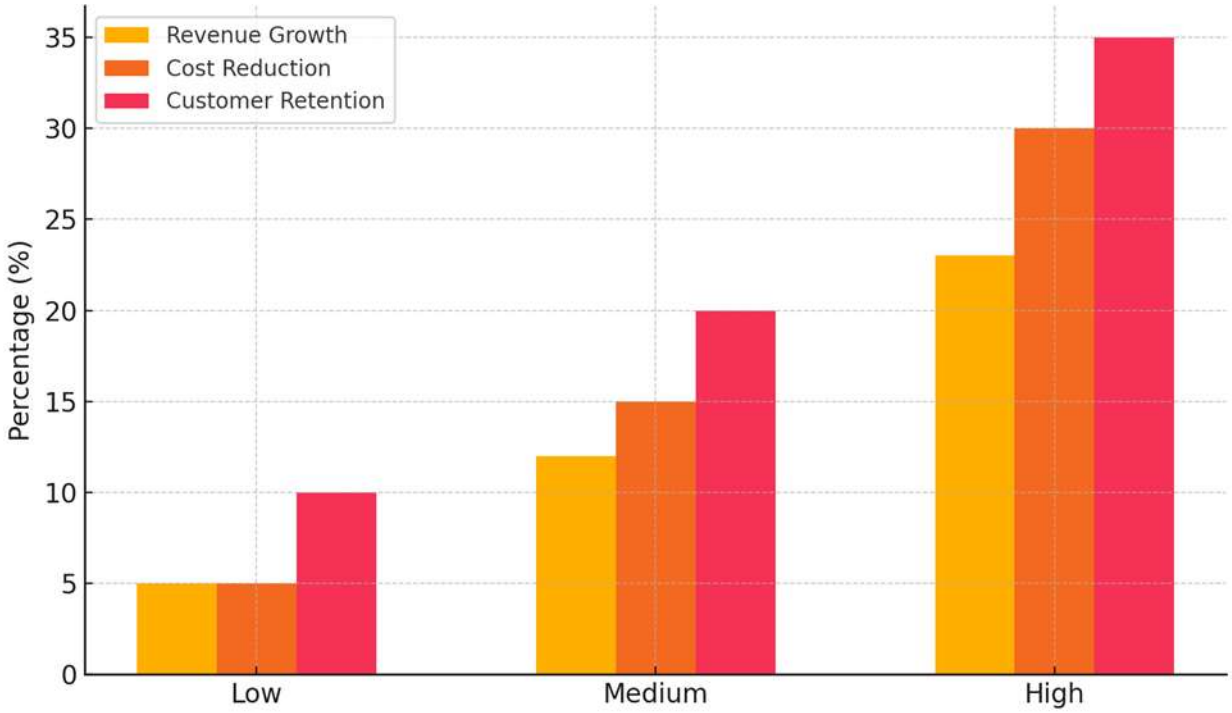

Figure 4. Performance Comparison by Adoption Level.

Although at the high adoption level the difference between medium-level adopters and low adopters was somewhat tiny, yet they show noticeable changes. This underlined how crucial strategic alignment, system integration, and regular use were for actual impact; partial or superficial deployment of BI/DA does not provide the complete spectrum of benefits.

4.5 Impact of Top Management Support on BI/DA Performance

On a 10-point rating system, figure 5 showed the relationship between top management support and the seeming performance of BI/DA initiatives. Average of 8.2 SMEs showed clearly good leadership; those without this kind of support averaged only 5.4. This clear difference emphasized how important leadership was for the digital transition. Executive sponsorship guarantees data-driven decision-making, helped to distribute funds, and establishes strategic priorities. Advocates of BI/DA were more likely to support internal silos dismantling data integration, training, and experimental financing. Conversely, sometimes a lack of support for leadership generated scattered or abandoned BI initiatives. Teams may balk to using new tools without clear direction, and analytics projects may suffer from low ownership, unclear objectives, and little impact. Thus, our study underlined that SMEs have to spend not only in tools and training but also in top-level strategy alignment and leadership development if they are to reach the complete possibilities of BI/DA acceptance (Figure 5).

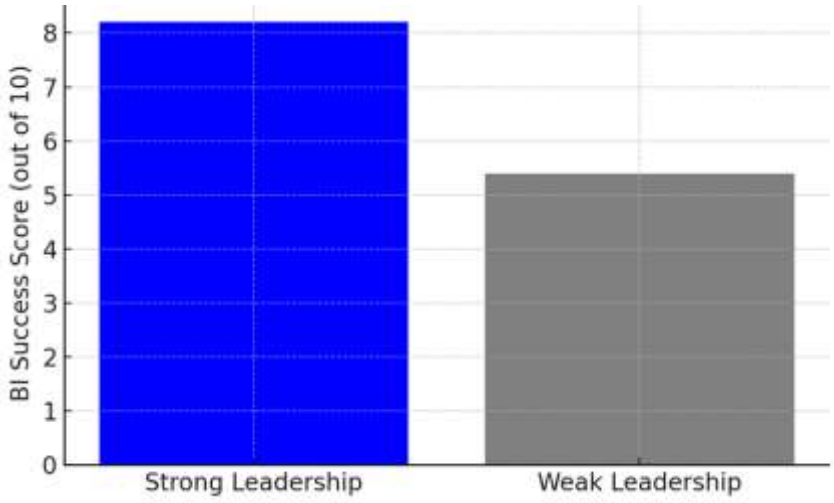

Figure 5. Leadership Support vs BI Success Score.

4.6 Correlation Heat Map: BI/DA Adoption and Performance Metrics

The heat map showed the connection matrix among four basic dimensions: bi adoption, DA use, income rise, and client retention). Having values between 0.64 and 0.75, the findings exposed unambiguous positive connections among all the variables. The highest association was showed by DA use and revenue growth (0.75), hence data-driven decisions clearly affect top-line development (Figure 6).

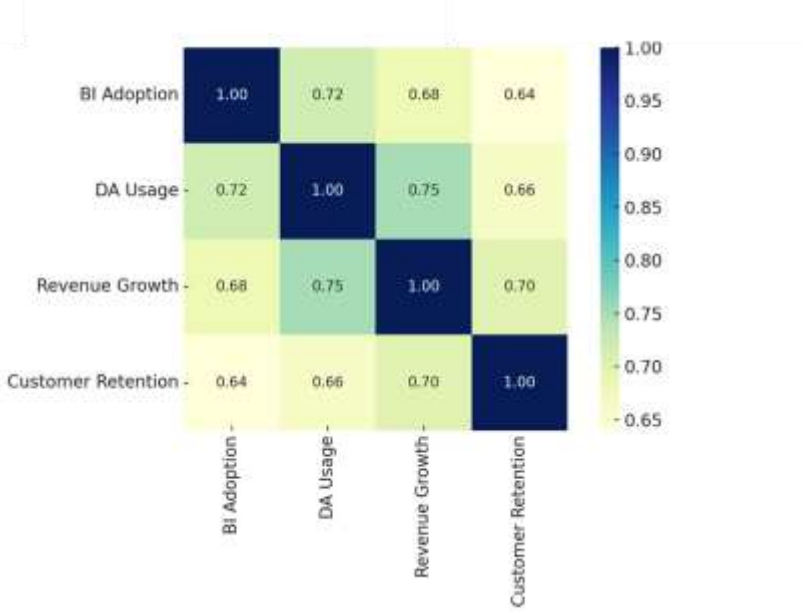

Figure 6. Correlation Between Digital Capabilities and SME Performance.

Analogous to customer retention (0.64), BI acceptability was strongly linked with data visibility of consumer behavior and feedback implied that better loyalty programs result from greater data visibility. The matrix also illustrated that BI and DA were complementary companies successful in one area more likely to adopt the other successfully, hence improving performance benefits. The heat map also showed a linked digital ecosystem: rising digital maturity brings general advantages rather than only ones. These insights supported the methodical approach of digital transformation, according to which integrated use across departments and decision-making influences success not only in general but also in tool installation.

5. Discussion

Our study validated the hypothesis that, using BI and DA, digital transformation greatly improved the performance of SMEs. The higher manufacturing acceptance rate was considering complex supplier networks and production optimization standards. The

limited acceptance in retail highlights the need for competitively priced bi-products and targeted awareness campaigns. The challenges presented from our research matched with other studies (Sharma et al., 2014; Manik, 2023), thereby underscoring the continuous difficulty with data literacy in SMEs. Still, clear benefits illustrated that, if used, BI/DA systems do add value in customer management and process efficiency. The solid evidence was presented that high adopters outperform low adopters in retention, cost, and revenue. This confirmed the outcomes of Hazen et al. (2014) and emphasizes the strategic opportunities of digital technologies. Between BI/DA use and competitive measures, strong statistically validated association by $p < 0.05$.

Although this study presents fascinating analysis, its cross-sectional structure and dependence on self-reported data place restrictions. Future studies combining qualitative interviews with longitudinal methods could help to better understand organizational behavior across digital transitions. These patterns support those of Hazen et al. (2014) and Wamba et al. (2015), therefore confirming the fact that digital maturity greatly affects organizational performance. Emphasizing that seen value was a main driver of ongoing investment in digital skills, our findings match those of Sharma et al. (2014) and Chatterjee et al. (2021). Reflecting Kwon et al. (2014) and Vial (2019), these results highlighted how more organizational change and attitude define digital transformation than technological innovation. This representation aligned with earlier studies (Brynjolfsson & McAfee, 2017; Chatterjee et al., 2021) stressing data-driven skills as multi-dimensional and their combined influence spurs great SMEs change. Companies whose top management promote digital transformation typically see better success rates. This was in accordance with the findings of Kwon et al. (2014), who stressed the need of visionary leadership to create a society based on facts. Emphasizing that BI/DA are not autonomous tools but rather basic components of business strategy, these results match another research (Chatterjee et al., 2021; Hazen et al., 2014; Kwon et al., 2014; Manik et al., 2021a,b). Strong SMEs were identified by investments in digital literacy, BI/DA alignment with corporate goals, and backing of strong leadership. The results also emphasized the importance of constant evaluation and iterative implementation to ensure lifetime value from digital investments.

6. Conclusion

Based on the findings of this study, it can be concluded that small and medium-sized firms (SMEs) who make use of business intelligence and data analytics are substantially more likely to acquire a competitive edge than business organizations that do not apply these technologies. However, it is abundantly obvious that the benefits of implementing business intelligence and data analytics surpassed the initial investment difficulties. This was the case despite the fact that problems such as a lack of expertise, high implementation costs, and resistance to change continue to exist. The fact that the problems associated with the initial investment were readily apparent does not change the reality that this is the case. Adoption rates differed from industry to industry, with small and medium-sized manufacturing firms being at the forefront of the adoption trend. The results, which were accompanied by data visualizations, reveal that adoption rates vary from industry to industry. As a result of the fact that there is still a significant presence of obstacles, it is abundantly evident that there is an immediate requirement for specialized training programs in addition to a solid digital infrastructure. The significance of small and medium-sized organization (SME) management was brought to light by these findings, which emphasized the importance of aligning digital operations with core business objectives, giving priority to the upskilling of staff members, and constructing a culture that was driven by data and emphasizes constant learning and innovation. On the other hand, it is for governments to acknowledge the vital role that small and medium-sized firms (SMEs) play in the digital economy and to provide them with supportive measures such as tax incentives, digital training programs, and access to scalable analytics platforms.

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