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| RESEARCH ARTICLE

Strategic orientations and innovation performance in Bangladeshi SMEs: Dual role of big data analytics and innovation capabilities

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| ABSTRACT
This study investigates how innovation performance (IP) in Bangladeshi manufacturing SMEs is affected by three strategic orientations: entrepreneurial (EO), digital (DO), and environmental (E2O). In addition to examining the moderating influence of big data analytics (BDA) and the mediating function of innovation capabilities (IC) , it further uniquely integrates these perspectives. Through the application of structural equation modeling, data from 369 managers in textile SMEs (weaving, spinning, and dyeing) were evaluated. The data reveal that whilst E2O has no direct influence on IP, whereas EO and DO have a beneficial impact . All three orientation-IP interactions are favorably mediated by IC. BDA has no discernible impact on the E2O-IP relationship, but it does strengthen the EO-IP and DO-IP relationships. Even though EO, DO, IC, and BDA have been shown to improve invention, little is known about how they work together. As the survey suggests on fostering innovation, SMEs are expected to focus on BDA, digital, entrepreneurial, and even environmental strategies. This paper outlines actionable recommendations aimed at policymakers, practitioners, and the managers.

| KEYWORDS
Entrepreneurial Orientation, Digital Orientation, Environmental Orientation, Innovation Capabilities, Big Data Analytics, Innovation Performance

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1. Introduction

According to Jingwen et al. (2025), innovation performance (IP) represents a novel innovative advantage over competitors and resource that is essential for every business. Consequently, the drivers of innovation success are the foremost management focus in recent times. In this vein, Lopez-Torres (2023) asserts that innovation is a crucial aspect for the sustainable future, growth, and competitiveness of small and medium enterprises (SMEs). As such, innovation allows SMEs to sustain operations by responding to market demands, establishing competitive advantages, improving corporate processes, and optimizing expenses related to consumer happiness. Furthermore, innovation facilitates market access, adjusting to contemporary innovations, andresilience to external changes. Due to the fact that SMEs have limited resources; thus, creating new value and sustaining development via innovation is considered one of their most crucial strategies. Henceforth, inadequate innovation performance can significantly undermine the competitiveness of SMEs (Torres de Oliveira et al., 2022). For example, without having innovation, SMEs will be unable to meet the changing demands of their consumers, keep pace technologically, or remain competitive.

In this vein, the Global Innovation Index (GII 2023) indicates that economies exhibiting superior innovation performance generally make a more substantial contribution to GDP. However, Bangladesh ranks 105th out of 132 economies in the 2023 GII, and 8th among the 10 economies in Central and Southern Asia—indicating substantial room for improvement in innovation. In Bangladesh's manufacturing sector, weak innovation performance risks undermining competitiveness, environmental sustainability, and responsiveness to changing consumer demands. Henceforth, embracing innovation is thus essential for long-term resilience and growth in the sector (Parven, 2021; Titumir & Titumir, 2021), particularly in Bangladesh. Several studies highlighted that innovation can help to shield manufacturing SMEs from future uncertainties (Baumane-Vītoliņa et al., 2022; Del

Giudice et al., 2021; Laforet & Tann, 2006; Markatou, 2012; McAdam et al., 2007; Mosey et al., 2002; Quaye & Mensah, 2019; Raymond et al., 2013; Ukpabio et al., 2019) and observed multiple factors that may influence a firm's innovation performance.For instance, one of the key elements that could influence the performance of innovation is strategic orientation. Prior research has demonstrated that companies with strong strategic orientations are more likely to make innovative investments, create new goods, and successfully implement emerging technology. (Han & Zhang, 2021; Nugroho et al., 2022). However, most empirical research on strategic orientation has emphasized its effect on overall business outsome (Al-Ansaari et al., 2015; Habib et al., 2021; Yu & Moon, 2021), often overlooking innovation-specific outcomes. As such, this study tries to analyze the relationship between strategic orientations and innovation performance, particularly in the SME sector in Bangladesh. Furthermore, strategic orientation have three dimensions, such as entrepreneurial, digital, and environmental orientations which also needed to be considered exclusively to understand the association with innovation performance.

As a cornerstone of strategic management, marketing, and entrepreneurship, entrepreneurial orientation (EO) has been acknowledged for an extended period of time. Empirical research has consistently shown a link between EO and financial success for businesses. (Gupta & Gupta, 2015; Rezaei & Ortt, 2018); however, the evidence is inconsistent (Weinzimmer et al., 2021). Additionally, the area of scholarly study that connects EO directly to innovation performance is limited, and most of it comes from developed countries. Scholars suggest that innovation is less likely to be prompted by EO alone, leading to a greater focus on complementary frameworks such as digital and environmental orientations.

Digital orientation signifies a company's commitment to adopt and integrate information technologies into its operations and services.(Kindermann et al., 2021; Wang, 2022). Environmental orientation also considers societal stakeholders and integrates the firm’s activities into ecology. It has two components: internal environmental orientation, which is concerned with ethics and environmental responsibility, and external orientation, encompassing sustainability, social responsibility, and a positive corporate image (Keszey, 2020).

Previously, empirical research shows that innovation performance is enhanced by EO shaped by some component , such as the combination of learning (Song et al., 2019) with organizational commitment (Iqbal et al., 2021), knowledge sharing (Hanifah et al., 2022), and market orientation (Shaher & Ali, 2020). However, the importance of digital and environmental perspectives on innovation Regarding SMEs is relatively underexplored (Ardito et al., 2021b; Tseng et al., 2019). Although prior research has investigated the relationship between strategic orientation and innovation performance, scant attention has been given to the moderating influence of additional firm-level competencies.. In particular, how big data analytics (BDA) affects this relationship is unclear. Therefore, drawing on the resource-based view (RBV) theory, this investigation postulates BDA as a strategic capability and resource that helps firms transform collected data into actionable insights, thereby enhancing innovation. Furthermore, existing studies tend to examine individual orientations—such as entrepreneurial, market, learning, or technological orientation—in isolation. Among which very few have considered multiple orientations into a unified framework. To fill this gap, this study explores how three key strategic orientations, particularly entrepreneurial, digital, and environmental orientations, combinedly affect innovation performance, with innovation capabilities serving as a mediating factor.

This study provides several significant contributions to the literature on innovation performance in small and medium-sized enterprises (SMEs) First, previous studies have concentrated on individual strategic orientations like digital orientation (Ranjan, 2024; Zhang et al., 2025), entrepreneurial orientation (Hanifah et al., 2022; Song et al., 2019), or environmental orientation (Ardito et al., 2021; Sáez-Martínez et al., 2014), focusing on innovation performance. This study uniquely integrates all three aspects into a unified conceptual framework, which is not only significant to achieve innovation performance but also necessary for the firms to achieve sustainability. This further explores the significance of the relationships between strategic orientations and innovation performance, a fact that highlights the underexplored nature of the intertwining of many strategic orientations in the literature. Second, innovation performance is often treated as the result of BDA in other studies overlooking its effect on strengthening the relationship between strategic orientations and innovation performance as a moderator. This research addresses this deficiency Third, this study continues to explore the literature on innovation capabilities by claiming that strategic orientations define innovation outcomes through innovation capabilities, which act as a mediating mechanism. Prior study (Basterretxea & Martínez, 2012; Maldonado-Guzman et al., 2019) has addressed the importance of innovation capabilities and big data analytics; however, few studies have examined innovation capabilities as a mediator in the relationship between strategic orientation and innovation performance, moderated by big data analytics. The study provides practical consequences by illustrating how manufacturing SMEs may synchronize their strategic orientations, cultivate innovative capabilities, and utilize BDA to improve innovation performance. This comprehensive approach offers practical insights for managers and policymakers aiming to enhance innovation in resource-limited SME contexts, particularly in emerging economies, where empirical evidence is scarce.

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The subsequent sections of this work are structured as follows: Section 2 provides a comprehensive overview of the pertinent literature concerning strategic orientations, innovation capabilities, big data analytics, and innovation performance. Section 3 delineates the research methodology and measurement strategy. Section 4 presents the analysis and conclusions, whereas Section 5 addresses the theoretical and managerial implications, study limits, and avenues for further research.

2. Literature review and hypothesis development

2.1 Entrepreneurial Orientation and Innovation Performance

Entrepreneurial Orientation (EO) has become a prominent term in contemporary entrepreneurial literature. (Aftab et al., 2024). According to Miller (2011), a business that is entrepreneurial is one that takes chances, innovates in the market, and is aggressive in introducing new ideas in order to beat its competitors. Lumpkin and Dess (1996) introduced two more characteristics, including "autonomy and competitive aggression," to encompass entrepreneurial orientation (EO) and emphasize its complex character. This study adopts Miller's (1983) definition of entrepreneurial enterprises, conceptualizing seeing it as a one-dimensional construct that seeing it as a one-dimensional structure that includes risk-taking, proactiveness, and innovativeness (Miller, 2011).

Moreover, other elements such as organizational culture, corporate strategy, and business situation affect how an entrepreneurial mindset is linked to SME success (Arabeche et al., 2022). Most studies concentrate on objective performance metrics, such as financial success, rather than subjective performance indicators, such as innovation performance. Limited research examines the innovative performance of SMEs in emerging nations. The effectiveness of EO may fluctuate based on the circumstances of the investigation. In consideration of the above discussion, we offer the subsequent hypothesis.

H1: The relationship between entrepreneurial orientation and innovation performance is positive and statistically significant.

2.2 Digital Orientation and Innovation Performance

In the current business landscape, digital orientation is crucial for organizational streamlining. Nambisan et al. (2019) highlight the importance of digital transformations are essential for enhancing productivity and operational efficiency in SMEs. Nambisan et al. (2019) also shows that there are four components of the digital orientation construct are digital architectural setup, digital ecosystem coordination, digital capabilities, and digital technical scope . Firms that are focused on the digital scope are able to technologically enhance the range as well as services and goods they offer their clients, to include more digital or digitized options. This is demonstrated by the range of digital technologies , which is the the initial component of the framework for digital orientation (Kindermann et al., 2021). The second part of digital orientation is digital capabilities, which, from an affordance point of view, highlight the organizational and personnel components. . The digital ecosystem's coordination is the third component of digital orientation. It shows how businesses effectively engage with their stakeholders within open technology ecosystems. The coordination of the ecosystems is the third component of digital orientation. In conclusion, a digital orientation is digital architectural arrangement and Zittrain (2009) argues, the technology of organizations is greatly impacted by the capacity of digital technology to cause unplanned change to their structures and processes.

In a study of 153 manufacturing companies in Pakistan, Sarwar et al. (2023) shown that digital platforms enhance organizational innovation performance. Digital platforms have a direct influence on strategy, financial performance, and organizational efficiency, they provide. Digital technology is seen to be a catalyst for increasing the rate of innovation and improving an organization's innovation performance, according to another study (Kastelli et al., 2022). Examining how digital capacity affects innovation performance, the study ends by arguing that absorptive capacity acts as a mediator in the context of digital transformation. Digital orientation and the performance of both product and process innovation are positively and directly correlated, according to a study that looked at how digital orientations affected the performance of product and process innovation in small and medium-sized businesses (SMEs) in North America (Ardito et al., 2021) .Other studies' findings suggest that innovation performance is positively impacted by the use of digital technologies. According to the findings, digital technologies are essential for success in an innovative firm on a practical level (Usai et al., 2021).According to study conducted in Pakistan's small and medium-sized businesses (SMEs), using digital platforms can help to promote an innovative culture and innovation performance (Khattak, 2022).

The association between digital orientation and performance dimensions has been extensively studied, but the relationship between digital orientation and innovation performance—particularly in emerging countries with manufacturing SMEs—has received less attention. In light of this, the following hypothesis is given forth:

H2: The relationship between Digital orientation and innovation performance is positive and statistically significant.

2.3 Environmental Orientation and Innovation Performance

Research suggests that environmental orientation can improve business performance through cost savings, enhanced consumer demand, risk avoidance, and employee retention (Wisker & Kwiatek, 2018). Nidumolu et al. (2009) assert that sustainability and environmental orientation are now considered essential drivers of innovation, rather than just passing trends among enterprises. Environmental knowledge could improve the performance of process and product innovation. As a result, consumers may contribute market data on environmental expectations for new products and practices (Morgan & Anokhin, 2020). The link between environmental orientation and innovation performance underscores the significance of an environmental strategy that includes strategic elements dedicated to broader issues such as customers, human rights, and so on, as well as helping to depict firm-level decisions(Capelle-Blancard & Petit, 2017).

Earlier works have noted a positive relationship between organizations' environmental orientation and business performance (Aboelmaged, 2018; Feng et al., 2018) . Companies are more willing to invest in green product and process innovation activities if there is a high level of internal and external environmental orientation within the company and its surroundings. As discussed by Porter and Van der Linde (1995), proactive environmental strategies can be economically advantageous and help in product and service differentiation, which in turn provides a sustained competitive advantage to the firm. Leonidou et al. (2016) found that smaller manufacturing firms in Cyprus that adopted eco-friendly strategies reported improved financial performance. Many meta-analytical studies have found significant positive relationships between environmental orientation and firm performance (Golicic & Smith, 2013). Several studies demonstrate that environmental orientation and business performance are positively correlated (Baah et al., 2021; Cheema et al., 2020; Ozgul, 2022) . Therefore, the following hypothesis is proposed:

H3: The relationship between Environmental orientation and innovation performance is positive and statistically significant.

2.4 Entrepreneurial Orientation and Innovation Capabilities

Innovation capabilities and entrepreneurial orientation (EO) are interconnected concepts that have attracted significant attention in management and entrepreneurship literature (Makhloufi et al., 2021). Entrepreneurial Orientation (EO), initially described by Miller (1983) and then expanded by Lumpkin and Dess (1996) to include autonomy and competitive aggressiveness, denotes a firm's strategic posture characterized by innovativeness, proactiveness, and risk-taking. Enterprises exhibiting robust entrepreneurial orientation are more inclined to undertake calculated risks, anticipate market trends, and explore novel concepts—all of which foster innovation. Innovation capabilities relate to a business's ability to transform resources and knowledge into new products, services, or processes (Jin & Choi, 2019). Empirical studies indicate a favorable correlation between entrepreneurial orientation and creativity capabilities (Khedhaouria et al., 2015). scholars shown that entrepreneurial orientation (EO) enhances innovation potential in Chinese businesses(Wang, 2022; Wang & Liu, 2020; Wang et al., 2023), whereas Rauch et al. (2009) indicated that EO boosts corporate performance via its impact on innovation.

Despite extensive research on creative capacities and entrepreneurial orientation (EO), significant gaps remain in the literature. A significant percentage of the current research is context-specific, predominantly focusing on Western and Chinese enterprises, while other regions—such as Africa, the Middle East, and Southeast Asia—remain underexplored. Secondly, while innovation skills are often perceived as fixed entities, there is limited understanding of how entrepreneurial orientation fosters the development of dynamic innovation capabilities that evolve and adapt over time in response to changing external conditions. Third, the majority of study is on high-tech or service-oriented firms, social entrepreneurs, and informal enterprises, where entrepreneurial orientation and innovation may operate distinctively. A possible hypothesis was consequently formulated.

H4: The relationship between Entrepreneurial Orientation and innovation capabilities is positive and statistically significant.

2.5 Digital Orientation and Innovation Capabilities

The increasing importance of digital technology in shaping organizational strategy and performance is seen in the recent surge of research on innovation capabilities and digital orientation (Khin & Ho, 2019; Shen et al., 2022). "Digital orientation" refers to a company's strategic dedication to the adoption, integration, and utilization of digital technologies such as cloud computing, big data, and artificial intelligence to enhance business operations and value creation(Liu et al., 2024; You & Brahmana, 2024). Firms with strong digital capabilities are more likely to develop advanced innovation competencies, which enable them to adapt to market and client shifts in real-time (Shen et al., 2022). As noted by Hess et al. (2016) and Verhoef et al. (2021), possessing a digital orientation fosters innovation through a culture of proactive experimentation and adaptive learning, enabling continual innovation in turbulent environments. The use of digital technologies facilitates the sharing and distribution of information,

promotes collaboration, and enables the use of data to drive innovation. However, some shortcomings still exist in this area. The majority of research focuses on large, technologically advanced corporations, thus ignoring the small and medium-sized enterprises (SMEs) in emerging markets. Consequently, potential hypothesis was formulated.

H5: The relationship between Digital Orientation and Innovation Capabilities is positive and statistically significant.

2.6 Environmental Orientation and Innovation Capabilities

The concepts of environmental orientation and innovation capabilities have emerged as key areas of focus in sustainability and strategic management (Kang & He, 2018). Environmental orientation is defined as the strategic commitment a firm undertakes to manage the environment, encompassing a company's internal principles and its responses to ecological challenges externally (Yasir et al., 2020). Firms with a strong environmental emphasis generally integrate ecological concerns into their strategies, product and developments, thereby stimulating innovation and enhancing overall innovative capabilities (Mukhtar et al., 2025). Numerous researches have emphasized the beneficial correlation between environmental orientation and innovation results. Organizations with proactive environmental plans frequently create eco-friendly goods, use cleaner technology, and pursue sustainable process improvements (Kang & He, 2018; Tseng et al., 2019).

Studies by Tseng et al. (2021) demonstrate that environmental orientation promotes compliance and stimulates innovation, potentially resulting in competitive advantage for enterprises. Nonetheless, despite increasing attention, significant gaps persist in the literature. A significant portion of current research is confined to industrialized nations, neglecting the impact of environmental orientation on innovative capacities in emerging or resource-limited economies. There is a paucity of investigation of sector-specific dynamics, especially in businesses characterized by significant environmental impact and minimal innovation intensity. These limitations indicate the necessity for more contextually diversified, mechanism-oriented, and time-sensitive study to comprehensively comprehend how environmental orientation fosters the development of strong innovation capacities.

H6: The relationship between Environmental Orientation and Innovation Capabilities is positive and statistically significant.

2.7 Innovation Capabilities and Innovation Performance

In the subject of innovation and strategic management, innovation capabilities and innovation performance have been extensively studied. Scholars have emphasized the crucial role that a firm's internal capabilities play in generating effective innovation results (Yeşil et al., 2013). The methods, tools, and competences that allow businesses to create and execute new goods, services, or procedures are referred to as innovation capabilities (Rajapathirana & Hui, 2018). Improved innovation performance, which includes the efficacy and efficiency of innovation initiatives, including the quantity of new goods offered, time-to-market, and market success, is frequently associated with these characteristics. According to different studies Strong innovation capabilities increase the likelihood of exceptional innovation performance (Andersson et al., 2020; Iddris, 2019). Nevertheless, there are still a number of gaps in the literature despite this acknowledged connection. First of all, different research operationalizes innovation skills differently due to disagreements over their precise dimensions and quantification. Second, the majority of research is focused on established economies, with little study done in emerging and developing nations where resource limitations and environmental uncertainties may change the innovation process. A more thorough grasp of how businesses might develop and use innovation capabilities to improve innovation performance in a variety of dynamic situations would be provided by filling in these gaps.

H7: There is a significant positive relationship between Innovation Capabilities and Innovation Performance

2.8 Mediation of Innovation Capabilities

A company's strategic approach to innovation, proactivity, and risk-taking is referred to as its entrepreneurial orientation (Miller, 2011). Numerous studies indicate that although EO promotes a company's openness to innovation, it does not guarantee successful innovation performance. According to recent research, innovation capabilities—the organizational competencies, resources, and practices that allow a company to successfully develop and implement creative ideas—are the missing piece (Urgal et al., 2013; Yang et al., 2019; Ylijoki et al., 2018).

Firms with a high EO only get better innovation results provided they had the internal ability to take in, modify, and apply new concepts (Alegre & Chiva, 2013). Even while EO can cultivate an entrepreneurial mindset, the company can find it difficult to transform concepts into successful innovations if the right skills aren't in place(Goyal & Mishra, 2024). Furthermore, Makhloufi et al. (2021) demonstrated that possessing innovation capabilities within the particular learning orientation of the firm magnifies the impact that EO has on innovation performance. The idea that innovation capabilities act as the operational connection between strategy and performance is further supported by Saunila (2016); Saunila et al. (2014) and concluded that EO works best

when firms are organizationally prepared to manage innovation processes. consequently, the following hypothesis was developed.

H8: Innovation Capabilities mediates positively on the relationship between entrepreneurial orientation and innovation performance

In the digital age, digital orientation (DO), which is characterized as a company's strategic focus on embracing, using, and integrating digital technology into its business operations, has become a vital source of innovation (Enkel et al., 2020; Khin & Ho, 2019). It's not always clear, though, how a digital orientation directly affects innovation performance. As the internal process via which digital orientation turns into actual innovation accomplishments, scholars are placing more and more emphasis on the role that innovation capabilities play in mediating this relationship.

This mediating relationship has been corroborated by several studies. Khin and Ho (2019) and Nasiri et al. (2022) discovered that robust dynamic skills in digital knowledge management and process reconfiguration enable a positive relationship between digital orientation and innovation performance in firms. Duan (2017) shown that digital technology enhances creativity only when paired with organizational learning. The results indicate that robust innovation capabilities must complement digital orientation to achieve superior innovation performance.

H9: Innovation Capabilities mediates positively on the relationship between digital orientation and innovation performance

Environmental orientation, seen recently as a catalyst for innovation and success, reflects a firm's strategic commitment to sustainability and emphasises its ecological responsibilities (Tseng et al., 2019). Regardless of focus, however, the connection may not always be obvious. Some innovation-centered organizations can turn environmental focus into tangible innovation outcomes, creating results due to strong innovation-centered environmental direction (Mikalef et al., 2019). It is unlikely a company will achieve exceptional innovation performance without an adequate organizational structure, advanced technological abilities, skilled personnel, and adequate civics support to drive green innovation. Research conducted by Tseng et al. (2019) and Hofmann et al. (2012) shows that companies demonstrating robust environmental orientation tend to possess advanced innovation abilities and are more likely to develop innovative, sustainable solutions to improve market standing and environmental compliance. Innovation capabilities act as the actual link to the strategic willingness to embrace the environment and the ability to act on that commitment. Research on the subject shows environmental orientation and innovation performance are interconnected, supporting the need to develop innovation aimed at internal skills to achieve sustainability-driven innovation results.

H10: Innovation Capabilities mediates positively on the relationship between Environmental orientation and innovation performance

2.9 Moderation role of Big Data Analytics

The application of big data analytics (BDA) as a moderating variable in organizational studies has created a wave of curiosity towards understanding its role in moderating the relationship between strategic orientations and performance outcomes. Big data analytics, as a field, focuses on the use of complex and advanced data analytics methods on large and dynamic sets of data to develop patterns and trends that aid in the decision-making process (Vassakis et al., 2017). As a moderator, BDA strengthens or alters the relationship among some strategic drivers like entrepreneurial orientation (Mahmood et al., 2023), environmental orientation (Bu et al., 2020; Seo et al., 2020), innovation capabilities (Urgal et al., 2013; Wu & Nachiangmai, 2024; Yu et al., 2022; Yusr, 2016) and innovation performance (Al-Khatib, 2022; Wang et al., 2025; Zhang et al., 2025) .

More recently,Akter et al. (2016) emphasized that BDA can significantly enhance the relationship between innovation skills and innovation performance by enabling firms to recognize evolving customer needs, optimizing R&D efforts, and reducing the time-to-market for new products. Mikalef et al. (2019) showed that dynamic capabilities such as innovation and absorptive capacity, in combination with strong big data analytics skills, has a positive impact on business performance by improving decision-making and organizational agility. Ghasemaghaei and Calic (2020) noted that using Big Data Analytics into environmental management techniques can enhance the influence of environmental orientation on green innovation performance.

The literature indicates that Big Data Analytics acts as a significant moderator(Al-Khatib, 2022; Hao et al., 2019; Niebel et al., 2019; Sun et al., 2020), enhancing the efficacy of strategic orientations and innovative capabilities in fostering innovation performance.

H11: Big Data Analytics moderates positively on the relationship between entrepreneurial orientation and innovation performance

H12: Big Data Analytics moderates positively on the relationship between digital orientation and innovation performance

H13: Big Data Analytics moderates positively on the relationship between Environmental orientation and innovation performance

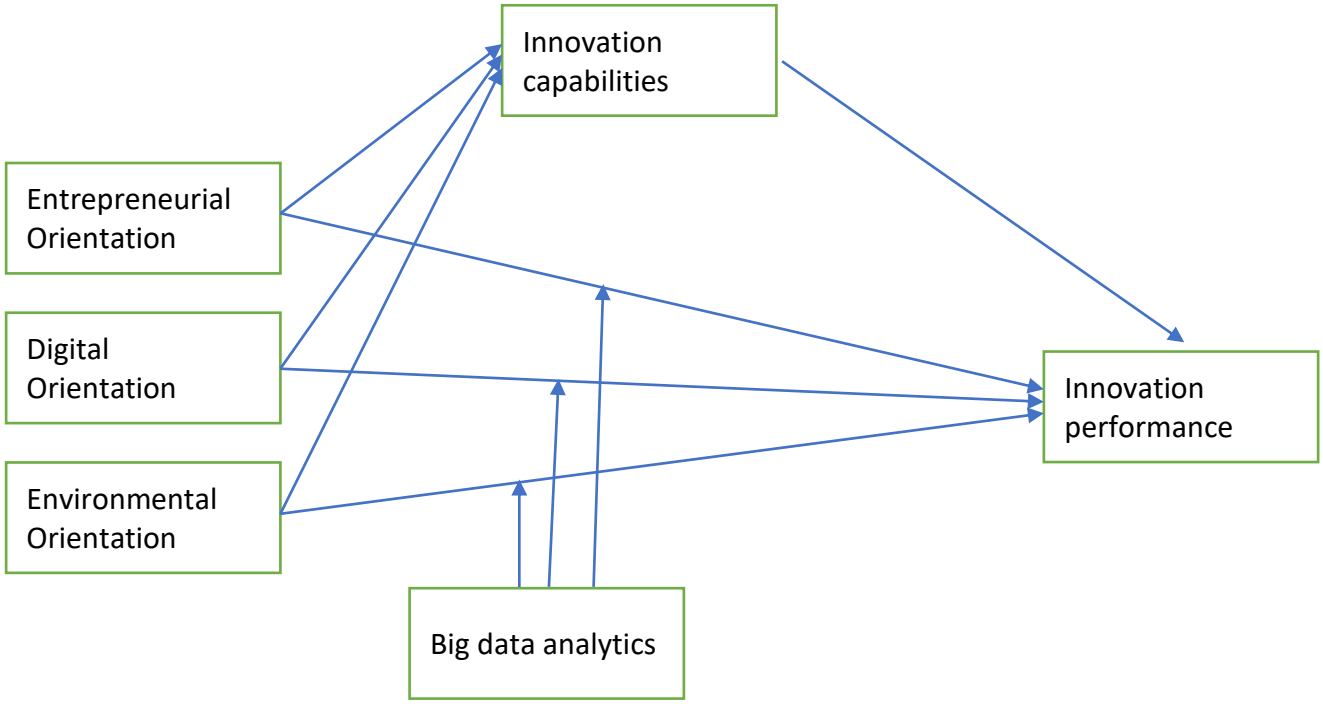


Figure 01: Conceptual Framework

3. Method

3.1 Research Design

This study utilizes a research design grounded in positivist philosophy, employing a quantitative methodology, a cross-sectional time horizon, a survey approach, and a probability sampling method through stratified random sampling.

3.2 Study Population and Sample

Using a survey questionnaire, the study gathered information from textile small and medium-sized businesses (SMEs) in Dhaka, Bangladesh. The majority of Bangladesh's small and medium-sized businesses (SMEs) are based in Dhaka, which is the country's main commercial and economic center. According to Bangladesh's 2016 industrial strategy, medium-sized businesses employ between 121 and 300 individuals, while small and medium-sized enterprises (SMEs) employ between 31 and 120 workers. Consequently, the study focused on small and medium-sized textile businesses with 21–300 employees. A list of 1,557 SMEs located in Bangladesh was provided by the Bangladesh Textile Mills Association (Bangladesh Textile Mills Association, 2023). In the textile manufacturing industry, there are specifically 871 SMEs engaged in weaving, 418 in spinning, and 268 in dying. In order to guarantee appropriate stratification, precisely 38% of the samples were chosen from these three textile SMEs, yielding a sample size of 592, as 38% of SMEs are based in Dhaka (SME Foundation, 2018). A total of 592 samples—331 weaving samples, 159 spinning samples, and 102 dying samples—make up the stratified sample. A total of 375 questionnaires were returned after being sent to them. Accordingly, in the field of social science research, the 63.34% response rate is regarded as quite good. Following the screening procedure, 15 instances with multiple replies and missing numerical values were removed from the list of responses. As a result, 369 cases in all were eventually examined.

3.3 Respondent's selection criteria

Each textile SME is represented by a single respondent. The specific focus of the study is the textile SMEs (Organization) in Dhaka. Senior and intermediate management supervisors from small and medium-sized manufacturing textile enterprises in Dhaka participated in this study. Respondents at the supervisory level were selected based on their substantial expertise in implementing innovation inside their organizations. This feature allowed for the collection of data of high quality for this research.

3.4 Pre-test and pilot test

The validity and reliability of the questionnaire were assessed by a pre-test (Fornell & Larcker, 1981) . After reviewing the questionnaire, five subject matter experts offered recommendations. Expert advice led to modifications to the questionnaire that verified its face validity. The operationalized constructs were measured using a five-point Likert scale. Data from 40 respondents were gathered for the pilot test. Respondents were provided with privacy and confidentiality. Based on the respondent's feedback, the questionnaire was modified to collect final data. The internal consistency and reliability of the data are assessed using Cronbach's alpha (a). Partial least squares equation modeling (PLS-SEM) was used to analyze the data. Because Smart-PLS has greater statistical capability and can handle complex models—suitable in cases where the model has a weak theoretical basis—it is utilized (Hair et al., 2017).

3.5 Measurement items and data collection

Consistent with existing literature, we measured EO with the 9-item scale proposed by Covin and Slevin (1989) who borrowed from the work of Miller (1983)(Morgan & Anokhin, 2023).To measure digital orientation, this study adapted the measures of Zhou et al. (2005), who adapted the original measures of Gatignon and Xuereb (1997). The items assess a firm's commitment to using digital technologies in new product development as well as their tendency to take digital opportunity. There were four items for digital orientation, measured by a five-point Likert-like scale ranging from 1 = "strongly disagree" to 5 = "strongly agree"(Khin & Ho, 2019). We measured internal environmental orientation and external environmental orientation using a six-item scale adapted from Banerjee (Banerjee, 2002; Feng et al., 2018). Innovation capability was measured with a 4-item scale from (Kyrdoda et al., 2023; Yang, 2012). Big data analytics were measured by a five item scale adapted from Abdelhalim (2024). While innovation performance was measured by six item scale adapted from (Kankisingi & Dhliwayo, 2022).

Distribution of both Google Forms and printed questionnaires was undertaken to enhance the response rate of the survey. After a month passed since the initial distribution, further phone calls were made.

4. Analysis and results

4.1 Non-response bias and common method bias

This study utilizes the Wallace and Cooke (1990) methodology to evaluate non-response bias (NRB). Non-response bias (NRB) is assessed to guarantee the precise representation of a survey about the target research population. Responses are gathered within 30 days following the distribution of the surveys to respondents. Responses received within 30 days are categorized as early responses, while those obtained beyond 30 days are designated as late responses. The author determined the mean and standard deviation for the initial 30 and final 30 respondents. The analysis revealed no statistically significant difference between the two groups, indicating that the study is free of any non-response bias (NRB). The research employed the single-factor Harman test to identify the presence of common method bias (CMB) (Podsakoff et al., 2003). The computed variance of 28.76%, which is below 50%, indicates that the existence of CMB is not a substantial concern within the study's setting.

Table 1: Demographic Profile

Respondents		**Frequency**	**Percentage**
Gender	Male	287	77.7
	Female	82	22.2
Age (years)	Less than 20	27	7.4
	20-29	93	25.2
	30-39	86	23.4
	40-49	105	28.4
	50 and above	58	15.6

Education	Basic/Secondary	17	4.5
	Undergraduate	110	29.8
	Master's	160	43.5
	Others	82	22.2
Age distribution of Business	Less than 3 years	44	12
	03-05 years	53	14
	06-10 years	38	10
	11-15 years	86	23
	More than 15 years	148	40
No. of employee	0-30	74	20
	31-120	199	54
	121-300	96	26
Position	Owner	119	32.3
	Executive	157	42.5
	Manager	93	25.2
Industry Classification	Weaving	207	57
	Spinning	96	26.2
	Dyeing	66	17.8

Source: Authors estimation.

4.2 Demographic Data

Out of 369 respondents, 287 were male, and the remaining 22.2 % were female. Nearly 28.4% were aged between 40-49, and 23.4% were aged between 30-39. Regarding education, approximately 43.5% has a master's degree, followed by undergraduate with nearly 29.8%. Most of the participants were executives 42.5%, followed by owners 32.3% and managers 25.2%. Regarding organization size, 199 had 31-129 employees. While 369 textile SMEs were analyzed, with 57% specializing in weaving, 26.2% in spinning, and 17.8% in dyeing (Table 1).

4.3 Measurement Model

Primary data were analyzed using SPSS v25 and SmartPLS 4.0. Before testing the hypothesized relationship, the study confirmed the model's expected reliability and validity.

4.4 Convergent Validity

The results (Table 2) indicated that all items exhibited factor loadings exceeding 0.5 (Hair et al., 2017), average variance extracted (AVE) surpassing the 0.5 threshold (Hair et al., 2017), and Cronbach's alpha and composite reliability (CR) greater than 0.7, signifying acceptable reliability and higher internal consistency (Hair et al., 2017).

Table 2: Reliability and validity assessment

Constructs	Items	F.L	CA	CR	AVE
Entrepreneurial Orientation	**EO1**	0.848	0.944	0.953	0.691
	EO2	0.836			
	EO3	0.860			
	EO4	0.841			
	EO5	0.737			
	EO6	0.812			
	EO7	0.878			
	EO8	0.758			
	EO9	0.899			
Digital orientation	**DO1**	0.836	0.823	0.882	0.651
	DO2	0.763			
	DO3	0.782			
	DO4	0.843			
Environmental Orientation	**E2O1**	0.877	0.908	0.930	0.689

	E2O2	0.883			
	E2O3	0.885			
	E2O4	0.843			
	E2O5	0.691			
	E2O6	0.784			
Innovation capabilities	**IC1**	0.821	0.852	0.900	0.693
	IC2	0.817			
	IC4	0.798			
	IC5	0.890			
Big Data Analytics	**BDA1**	0.856	0.853	0.894	0.629
	BDA2	0.703			
	BDA3	0.800			
	BDA4	0.856			
	BDA5	0.739			
Innovation performance	**IP1**	0.863	0.878	0.908	0.623
	IP2	0.796			
	IP3	0.745			
	IP4	0.843			
	IP5	0.688			
	IP6	0.790			

Source: Authors estimation

4.5 Discriminant validity

To verify discriminant validity, the Heterotrait-Monotrait (HTMT) ratio and the criteria of Fornell and Larcker (1981) were used. The square root of AVE is greater than its connection with other factors, as table 3 illustrates. Table 3 confirms adequate discriminant validity by showing that none of the values in the table are larger than or equal to any of the two thresholds < 0.90 (Hesseler et al., 2015) and <0.85 (Kline, 2015).

Table :3 Discriminant validity using assessment of Fornell Larker Criteria

	BDA	**DO**	**E2O**	**EO**	**IC**	**IP**
BDA	0.793					
DO	0.427	0.807				
E2O	0.317	0.425	0.830			
EO	0.099	0.256	0.138	0.832		
IC	0.410	0.509	0.568	0.337	0.832	
IP	0.297	0.382	0.277	0.276	0.404	0.790

Source: Authors estimation

Table 4: Discriminant validity using assessment of Heterotrait-Monotrait (HTMT)

	BDA	**DO**	**E2O**	**EO**	**IC**	**IP**
BDA						
DO	0.509					
E2O	0.358	0.477				
EO	0.105	0.283	0.148			
IC	0.484	0.589	0.630	0.369		
IP	0.336	0.427	0.301	0.299	0.458	
BDA x EO	0.034	0.060	0.030	0.038	0.071	0.127
BDA x E2O	0.313	0.216	0.244	0.024	0.238	0.169
BDA x DO	0.135	0.225	0.228	0.041	0.207	0.162

Source: Authors estimation

Henseler et al. (2015) proposed that the HTMT approach verifies discriminant validity between each pair of variables if the correlation values are below 0.90. Table 4 demonstrates that the HTMT values are within the threshold of 0.90.

4.6 Assessment of the structural model

Scholars specified six criteria for assessing the structural model utilizing PLS-SEM (Hair et al., 2017). In the initial stage of assessing the structural model, it is essential to address latent collinearity issues. Moreover, it is crucial to assess the significance and pertinence of the structural model link by analyzing the variance accounted for by the dependent variable (R2), the effect size (f2), and the predictive relevance (Q2). Additionally, it is imperative to assess the corresponding t-values of the path coefficient by bootstrapping with 5,000 resamples. Table 5 presents the results of R-square, effect size (f-square), collinearity (inner VIF), and predictive significance (Q-square).

Table 5: Assessment of the structural model

R-square	Endogenous Variables	R-square	R-square adjusted	0.26: Substantial 0.13: Moderate 0.02: Weak (Hair et al., 2017)	
	IC	0.450	0.444		
	IP	0.257	0.237		
Effect size (F-square)	Exogenous Variables	IC	IP	0.26: Substantial 0.13: Moderate 0.02: Weak (Hair et al., 2017)	
	BDA		0.013		
	DO	0.109	0.019		
	E2O	0.264	0.000		
	EO	0.073	0.028		
	IC		0.031		
	IP				
Collinearity (inner VIF)	Exogenous Variables	**(IC)**	**(IP)**	VIF <= 5.0 (Hair et al., 2017)	
	BDA		1.388		
	DO	1.283	1.585		
	E2O	1.222	1.588		
	EO	1.072	1.168		
	IC		1.916		
	IP				
Predictive relevance (Q-square)	Endogenous Variables	**Q^2predict**	**RMSE**	**MAE**	Value larger than zero (0) indicates predictive relevance (Hair et al.;2017)
	IC	0.427	0.765	0.577	
	IP	0.186	0.910	0.691	

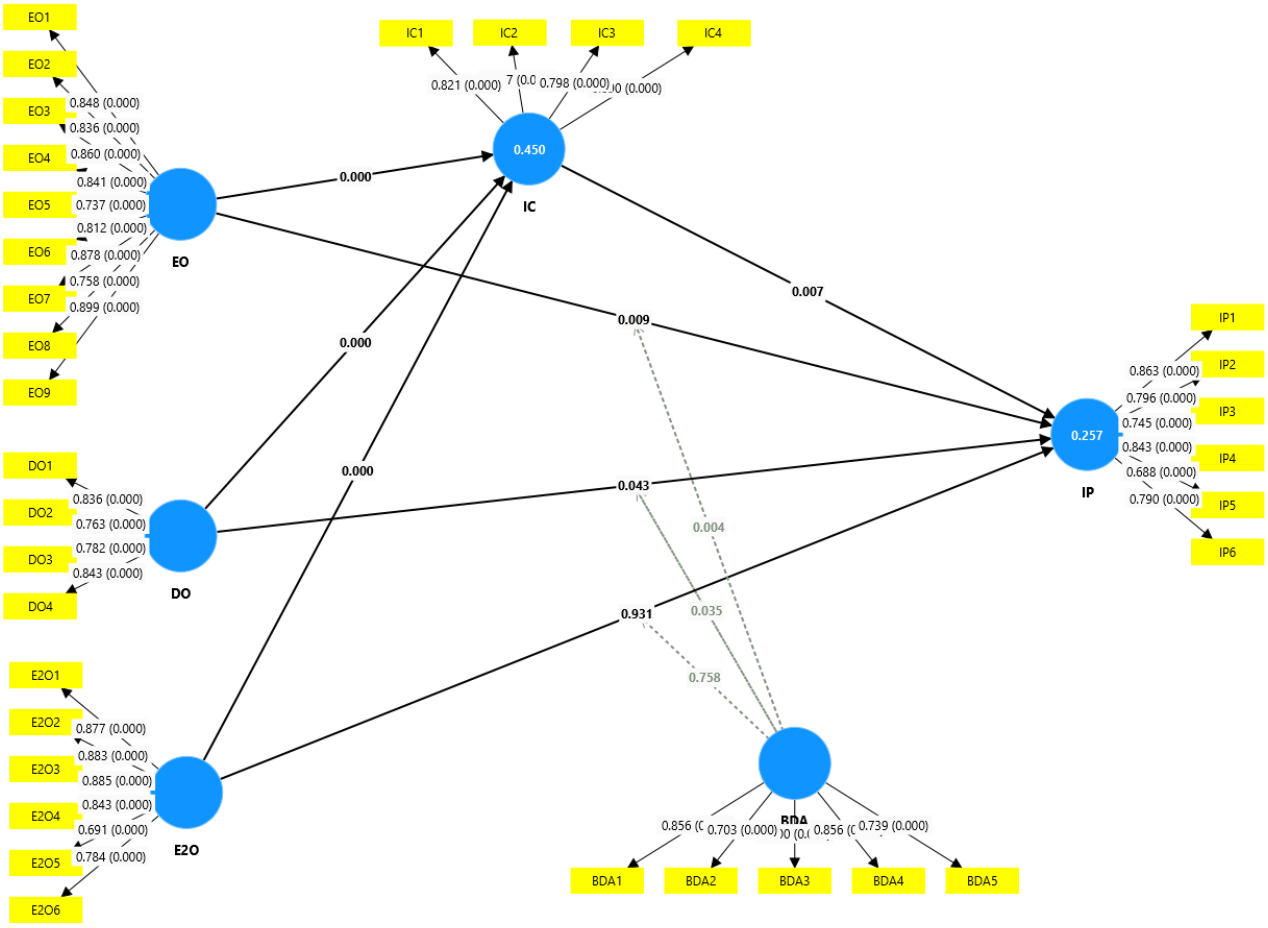
Notes:	RMSE= Root-mean-square error MAE= Mean Absolute error

Source: Authors estimation

5. Hypothesis test

Table 6 and Figure 2 show the result of the direct effect examination of the effect of EO, DO, and E2O on SMEs' innovation performance. The relationship of EO-IP and DO-IP was found to be positive, and E2O-IP was found to be insignificant, H1 (P=0.009), H2 (0.043), and H3 (0.931). Hence, H1 and H2 were supported except for H3. Second, EO, DO, and E2O on IC was examine.

Figure 2: Structural Model with Inner Model t-value



The findings showed that three variables have a significant positive relationship with IC as H4, H5, and H6 supported (H4, P=0.000; H5, P=0.000; and H6, P=0.000). Thirdly, H7, the impact of IC on IP also examined and supported with p=0.007. Fourth H8, H9, and H10 tested the mediation effect of IC on the relationship among EO, DO, E2O, and IP. The findings confirmed positive mediation for three hypotheses .H8 (t value = 2.320, p=0.021), H9 (t value =2.207, p=0.028) and H10 (t value =2.490, p=0.013). The positive value of three hypotheses confirms a significant mediation effect. Finally, the study examines the moderating effect of BDA on the relationship among EO, DO, E2O, and IP. Findings showed that Big data analytics positively moderate the relationship between EO-IP and DO-IP except the E2O-IP relationship .H11 (t value =2.921,p=0.004), H12 (t value =2.117,p=0.035) supported and H13 (t value =0.309,p=0.758) not supported. In summary of moderating effect of BDA strengthens the relationship between EO-IP and DO-IP.

Table 6: Hypothesis Testing

	Original	Sample	Standard	T	statistics	P values	Remarks

		sample (O)	mean (M)	deviation (STDEV)	(|O/STDEV|)		
Direct relationship							
H1	EO -> IP	0.157	0.160	0.060	2.616	0.009	Supported
H2	DO -> IP	0.150	0.155	0.074	2.025	0.043	Supported
H3	E2O -> IP	0.005	0.004	0.062	0.087	0.931	Not supported
H4	EO -> IC	0.208	0.212	0.048	4.367	0.000	Supported
H5	DO -> IC	0.277	0.276	0.061	4.574	0.000	Supported
H6	E2O -> IC	0.421	0.423	0.067	6.305	0.000	Supported
H7	IC -> IP	0.209	0.202	0.076	2.731	0.007	Supported
Mediating effect							
H8	EO -> IC -> IP	0.043	0.043	0.019	2.320	0.021	Supported
H9	DO -> IC -> IP	0.058	0.056	0.026	2.207	0.028	Supported
H10	E2O -> IC -> IP	0.088	0.086	0.035	2.490	0.013	Supported
Moderating effect							
H11	BDA x EO -> IP	0.145	0.144	0.050	2.921	0.004	Supported
H12	BDA x DO -> IP	-0.117	-0.112	0.055	2.117	0.035	Supported
H13	BDA x E2O -> IP	0.015	0.016	0.047	0.309	0.758	Not supported

Source: Author's estimation

6. Discussion

This study employed a quantitative methodology to examine the effects of entrepreneurial orientation (EO), digital orientation (DO), and environmental orientation (E2O) on innovation performance (IP). Additionally, the mediating function of innovation capabilities (IC) and the moderating function of big data analytics (BDA). The study conclusions were deemed intriguing, considering that entrepreneurial orientation and digital orientation exert a large and beneficial impact on innovation performance, but environmental orientation does not affect innovation performance. The RBV theory posits that achieving competitive advantage relies on the use of an organization's bundle of productive resources.

The EO-IP and DO-IP relationship was found to be positive (p=0.000), supporting H1 and H2. Besides, the E2O-IP relationship was found to be insignificant (p=0.931), not supporting H3. Regarding H1, result showed that two concepts are relevant, supporting that EO is the essential element that accelerates an organization's innovation performance. According to RBV, EO is an intangible resource considered the main source of competitive advantage to improve SMEs' innovation performance. Study findings are consistent with previous studies (Oduro, 2023; Seo, 2020; Tang et al., 2015). In the case of H2, result showed that digital orientation and innovation performance are relevant, supporting that DO is an important factor that fosters the SMEs' innovation performance. RBV theory also supports the relationship. Result also consistent with previous studies (Ardito et al., 2021; Borah et al., 2022; Ferreira et al., 2019; Khattak, 2022; Sarwar et al., 2024). Regarding H3, environmental orientation and innovation performance are not relevant, not supporting the notion of RBV theory. A possible reason can be explained that manufacturing SMEs in developing nation such as Bangladesh, are not well concerned about environmental issues that generate competitive advantages. Another reason can be explained that environmental orientation might be costly to employ, or environmental orientation need long term to see the outcome, whereas innovation outcomes are short-term oriented. Regarding H3, the result is not consistent with the previous study (Ardito et al., 2021; Briones Penalver et al., 2018; Doluca et al., 2018; Gabler et al., 2015) but consistent with another study (Zhang & Walton, 2017).

Regarding the direct relationship of EO-IC (p=0.000), DO-IC (p=0.000), and E2O-IC (p=0.000) were found to be positive. The result showed that three strategic orientations, EO, DO, and E2O are relevant to innovation capabilities and support the RBV theory. To accomplish IC in the organization, entrepreneurial, digital, and environmental orientations significantly influence the relationship. Findings of the study result confirm that the entrepreneurial orientation, digital orientation, and environmental orientation accelerate the SMEs' innovation capabilities and supporting RBV theory. EO, DO, E2O are considered as intangible and diversified resources that foster competitive advantages. Study finding also consistent with previous studies (Aljanabi, 2018; Dost et al., 2018; Fan et al., 2021; Fang et al., 2022; Ferreira et al., 2020; Khattak, 2022; Kyrdoda et al., 2023; Le & Chakrabarti, 2023; Makhloufi et al., 2021; Maldonado-Guzman et al., 2019; Onwu et al., 2023; Ramanathan et al., 2018; Ribau et al., 2017; Vigren et al., 2022).

Regarding the effect of innovation capabilities on innovation performance (p=0.007), H7 supported. result showed that the robust effect of IC on innovation performance, suggesting that SMEs in emerging countries benefit from investment in IC. Finding also consistent with previous studies (Alaskar, 2023; Camisón & Villar-López, 2014; Fan et al., 2021; Fang et al., 2022;

Ferreira et al., 2020; Jin et al., 2022; Khattak, 2022; Laksana et al., 2022; Lau et al., 2010; Le & Chakrabarti, 2023; Li et al., 2024; Maldonado-Guzmán et al., 2019; Ramanathan et al., 2018).

Big data analytics (BDA) significantly influenced innovation performance (p=0.040), hence supporting H8. This indicates that BDA is an instrument for processing substantial volumes of data. It enhances detection capacity, optimizes processing, and improves decision-making to promote innovation performance. The growing influence of big data compels enterprises to prioritize the successful implementation of big data analytics (BDA) to enhance their competitive capabilities. Existing studies demonstrate that the use of Big Data Analytics (BDA) may assist organizations in generating essential insights, enhancing competitive capabilities, facilitating informed decision-making, and managing new opportunities and risks (Abbasi et al., 2016).The study results are also similar to prior research (Tseng et al., 2024).

IC partially mediates the relationship between EO-IP and DO-IP, supporting hypotheses H9 and H10. Besides that, IC fully mediates the relationship between E2O-IP in the SMEs context. Results showed that IC mediates the entrepreneurial orientation and digital orientation towards innovation performance, as the RBV theory supported. But in the case of the environmental orientation and innovation performance relationship, IC fully mediates the link. The study findings suggested that the E2O-IP link is positive only when employing the IC in the organizations.

Regarding the moderation effect of big data analytics (BDA), the relationship between EO-IP and DO-IP was supported, but the E2O-IP relationship was not supported. Study findings suggest that if SMEs have low BDA, EO, and DO will have little influence on innovation performance, and vice versa. To summarize, the effect of EO and DO on innovation performance is greater when SMEs engage in BDA. The study findings were consistent with a previous study (Abdelhalim, 2024).

6.1 Theoretical and practical contributions

This study provides substantial theoretical advances by merging strategic orientation with big data analytics (BDA) and innovation performance within the previously unexamined context of manufacturing SMEs in a developing nation. This study enhances the current literature on entrepreneurial, digital, and environmental orientations by investigating their collective impact on innovation performance, a subject that has been inadequately addressed in previous research. Secondly, by using BDA as a moderating variable, the study enhances our comprehension of how digital infrastructure and data capabilities might affect the intensity and trajectory of strategic orientations in promoting innovation. This advances the developing theoretical discourse on technology-facilitated dynamic capacities, especially in resource-limited contexts. Furthermore, the research contributes to the strategic management and innovation literature, focusing on the SME sector in Bangladesh—an economy defined by its limited institutional, infrastructural, and technical resources, providing a unique empirical case with sparse scholarly attention.

The research findings have practical implications for SME managers and policymakers. It emphasizes the need for a more integrated approach—harmonizing entrepreneurial ambition, digital preparedness, and environmental accountability—to improve innovation results. Furthermore, it demonstrates how, when applied properly, BDA can act as a leverage on performance and help organizations achieve their strategic goals through meaningful and successful innovations. The conclusions outline actionable measures for managers of SMEs in Bangladesh to adopt and leverage data-based decision-making in the face of pressure from digital and sustainable transformations to improve sustainability and competitiveness. The report underlines the urgent need for the government to enable the digitization of SMEs and the BDA adoption through infrastructure, training programs, and other budgetary supports. Taken together, these insights spark both academic and empirical innovation in the rapidly evolving landscape of sustainable innovation and digital strategy in the context of developing economies.

7. Conclusion, Limitation, and Future Research Direction

This research illustrates the importance of innovation performance (IP) for the growth and competitiveness of SMEs, especially in the resource-constrained context of Bangladesh's manufacturing sector. The research combines entrepreneurial, digital, and environmental orientations to build a more comprehensive understanding of their collective impact on innovation performance. In addition, the research applies the resource-based view (RBV) to highlight the role of big data analytics (BDA) as a moderating strategic capability that strengthens the relationship between strategic orientations and innovation performance. Moreover, the study identifies innovation capabilities as a mediating mechanism, providing insights into the internal processes through which strategy is translated into innovation success. The findings contribute to both theory and practice, offering clear guidance to SMEs and policymakers on how to leverage orientation, capability, and analytics to drive innovation-led growth.

Despite its contributions, this study has several limitations that future research should address. First, the data were collected cross-sectionally, which restricts the ability to draw causal inferences. Longitudinal studies could better capture the dynamic nature of innovation processes. Second, the research is geographically limited to manufacturing SMEs in Bangladesh, which may

limit the generalizability of the findings to other sectors or countries. Cultural, regulatory, and economic factors might influence how strategic orientations and BDA interact in different contexts. Third, while BDA was examined as a moderating factor, other organizational resources—such as leadership style, absorptive capacity, or organizational learning—were not included and may also play crucial roles. Lastly, the study relied on self-reported data, which may introduce response bias.

Future research can pursue several directions. First, scholars should consider testing the proposed framework across different industries and countries, particularly in developed markets, to compare the influence of strategic orientations and BDA under varying institutional conditions. Second, future studies could incorporate a longitudinal research design to examine how strategic orientations and innovation capabilities evolve over time and influence innovation trajectories. Third, there is a need to explore additional moderating and mediating variables—such as dynamic capabilities, organizational learning, or digital maturity—to develop a more nuanced understanding of the mechanisms influencing innovation performance. Lastly, qualitative or mixed-methods approaches could be employed to capture in-depth insights into how SMEs operationalize strategic orientation and analytics capabilities in real-world innovation practices.

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