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PROMOTING SUSTAINABLE PRACTICES IN THE TEXTILE INDUSTRY: AN EMPIRICAL EXAMINATION OF MANAGEMENT SUPPORT, TECHNOLOGICAL ADVANCEMENTS, AND PROCESS INNOVATION

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Abstract

Textile industry is the most resource consuming manufacturing sector that puts a lot of stress on the environmental system through overconsumption of water, overuse of energy and commendable release of chemicals. The increases in regulatory awareness, the rise in stakeholder concern and the growing consumer demand of eco-friendly products have forced textile companies to incorporate environmental and social factors into their business and operational strategies. Based on resource-based view and sustainability theory, the research problem is to examine how top management support, technological innovation, infrastructure development, and process innovation affect sustainable performance in the textile organizations. Besides, this paper investigates how Industry 5.0, digital transformation, quality of human capital, and sustainable supply chain practices enable environmental and operational sustainability. Quantitative research design was adopted where the information was collected in the form of structured surveys with the participants being the professionals in the textile companies in various regions. The hypotheses about the relations and the moderating and mediating mechanisms were tested with the help of structural equation modeling (SEM).

The results show that the top management support in combination with the process innovation and the qualified staff contributes greatly to the sustainable performance through the efficiency of the resource usage, environmental compliance and the outcome of the operation. Technology innovation and infrastructure development is demonstrated to enhance sustainable supply chain practices and help in good performance measurement structures. Moreover, Industry 5.0 and digital transformation are both essential facilitators, as they moderate the correlation of leadership support and technological capability and sustainability outcomes. The research dwells on the links between organizational, technological and human-capital resources in realizing long-term environmental and operational resilience. In practice, it offers practical information to managers and policymakers who want integration of innovation, leadership, and human capital development to sustainable manufacturing goals, which, in the long-term, can result in long-term competitiveness and environmental stewardship.

1 1. Introduction

The modern industrialization has become one of the primary concerns of sustainability because of the growing environmental degradation, the issues of climate change, and the pressure of regulators and stakeholders. The manufacturing industries, especially the textile industry are receiving strong criticism due to the high water and energy use, the heavy usage of chemicals, and the volume of waste produced during the manufacturing and supply chain operations (Niinimaki et al., 2020). With the world keeping increasing its need in the textile products, the environmental and social effects relating to the production of textiles have escalated, which has forced companies to rethink the conventional production strategies and make them more environmentally and socially friendly.

Over the past few years, the concept of sustainability has changed to being a mandatory requirement to being a strategic necessity that determines the future competitiveness and organizational efficacy in the long run. Companies that have sustainability as part of their strategic plans are in a better position to develop operations efficiency, low costs and corporate image and reputation without compromising regulatory and social expectations (Porter and Kramer, 2011). The past studies indicate that internal organizational capabilities have a major role in sustainability performance, independent of external pressures, and emphasize the role of leadership, innovation, and resource management as the means of sustainable performance (Hart, 1995).

The top management support is Central to the realization of sustainability efforts through its role in organization vision, allocation of vital resources, and the establishment of a culture of valuing both the environment and the social responsibility (Daily & Huang, 2001). Effective leadership will mean that sustainability activities will not remain mere empty acts but will be translated into real performance gains. Nevertheless, the support provided by top management is usually moderated by other organizational processes like process innovation and quality of human capital, and it is important to ask how leadership, innovation and workforce capabilities work together to create sustainable performance in textile companies.

The further contribution of technological innovation and infrastructure developments is that they facilitate organizations to resolve the sustainability issues due to operational efficiency and decreasing environmental impact, as well as making monitoring and measurement of sustainability performance possible (Köhler et al., 2019). The high-end manufacturing technologies, robotization, and digitalization streamline the use of resources and establish the basis of cleaner production processes. This explains why research on how technological and infrastructural strengths can be used in ensuring sustainable supply chain practices and an effective performance measurement framework in the textile industry is critical.

New industrial paradigms like Industry 5.0 and digital transformation provide additional opportunities to increase the results of sustainability. Industry 5.0 is focused on human-oriented, sustainable, and resilient production that favors cooperation between intelligent technology and skilled workers (Nahavandi, 2019). At the same time, digital transformation uses artificial intelligence, the Internet of Things, and data analytics as a tool to enhance decision-making, streamline operations, and enhance transparency throughout operations (Vial, 2019). These changes indicate that there is a need to investigate the relationship between Industry 5.0 and digital transformation and management support and organizational capabilities in affecting sustainable performance within textile companies.

Additionally, sustainability program implementation depends on the quality of human capital and the introduction of sustainable supply chain programs. The talented workers allow implementing the new technologies and processes and keeping to the environmental and social standards (Youndt et al., 2004). Simultaneously, sustainable supply chain practices minimise the environmental

impacts outside the firm through incorporating social and environmental interests in procurement, production, and distribution procedures (Seuring & Muller, 2008).

Although there are growing academic concerns as to sustainable manufacturing, there is still little empirical research that has incorporated these factors in a single framework especially in developing economies. In the attempt to fill this gap, the current research aims to explore the following research questions that are interrelated and that will allow exploring organization, technology, and systemic factors that power sustainable performance within the textile sector.

RQ.1 How does top management support influence sustainable performance in the textile industry through process innovation and human capital quality?

RQ.2 What role does technology innovation play in enhancing sustainable supply chain practices and overall sustainability in textile manufacturing?

RQ.3 How does infrastructure development contribute to the implementation of a sustainable performance measuring system in the textile industry?

RQ.4 Does Industry 5.0 moderate the relationship between management support, digital transformation, and sustainable performance in textile firms?

RQ.5 How does a sustainable performance measuring system of the textile sector impact global sustainable performance?

This research offers a holistic view on the mechanisms and circumstances underpinning sustainable performance within the textile industry because of the combined analysis of these research questions. It is a source of academic research on sustainability and the operations management field, as well as provides a practical contribution to managers and policymakers who want to hit the threshold of productivity, technological advancement, and sustainable environmental responsibility.

2.1 Study Context and Contributions

The textile sector is a very competitive and sensitive environment and the companies in the industry have to balance between cost-efficiency, environmental and social responsibility. Sustainability in this industry goes beyond protecting the environment to economic sustainability and a social equity in international supply chains (Elkington, 1997). Historically research has paid attention to individual elements of sustainability, including, environmental management systems and green supply chain efforts, without acknowledging the interrelationship between managerial leadership, technological capabilities, and human capital in determining sustainable performance (Seuring and Muller, 2008). The latest sources emphasize that digital transformation is an essential factor in increasing competitiveness and sustainability, though its effects on textile companies in particular are not studied thoroughly (Khan et al., 2021).

This paper will add to the existing literature since it incorporates several organizational factors of sustainability, such as top management support, infrastructure development, technological innovation, process innovation, and human capital quality, into one analytical model. In contrast to the previous literature when researchers were mainly interested in Industry 4.0 automation technology, the current study takes into consideration new paradigms like Industry 5.0 and new digital transformation models as one of the next phases of the manufacturing evolution, in which human-technology interaction is the key aspect (Smith and Lee, 2023). Moreover, putting the analysis into perspective in the textile industry of a developing economy, the current research offers empirical evidence to a sector that is globally important and at the same time environmentally important, responding to recent demands of sector specific and context sensitive research methods (Patel and Ahmad, 2022).

2.2 Research Gap

Despite the growth of sustainability research in the last 20 years, there are still a number of gaps. First, the empirical research specifically on the textile industry remains rather limited in comparison with other manufacturing industries, i.e. chemicals or electronics, although the textile industry is among the most resource intensive and globally distributed industries (Kozlowski et al., 2019). Second, most of the previous studies have focused on sustainability drivers separately, e.g., green supply chain practices or technological development, without considering how leadership, infrastructure, technological innovation, and process redesign affect sustainable performance (Zhang and Wang, 2020). Recent literature points to the fact that it has been observed that digital transformation and sustainability integration is a significant performance driver, but has not been empirically studied in details to determine the linkages within the textile setting (Gonzalez et al., 2021). Third, the recent paradigms such as Industry 5.0 and more advanced models of digital transformation are not studied yet in the empirical sustainability literature. Industry 5.0 aims at human centric manufacturing and resilience and digital transformation is the introduction of AI, IoT, and data analytics into basic processes (Rossi & Bianchi, 2022). The inclusion of these concepts in studies of sustainability will contribute to the theoretical knowledge and address the challenge of the practical implementation. The holistic model, which has been empirically established in the given research to prove the connection between managerial, technological, infrastructural and human factors and the results of sustainable performance, applies specifically to the context of a developing economy of the textile industries.

2.3 Top Management Support

The importance of top management support is well known with regard to the determinant of sustainability performance and organizational change (Daily & Huang, 2001). Top management helps steer the strategic path, instills the sustainability oriented culture, and directs resources needed to execute environmental and social projects in the textile companies (Rahman and Alam, 2020). According to the resource based view, the support of the top management helps firms to formulate valuable, rare, and difficult to replicate capabilities that are essential in sustaining sustainability oriented strategies (Barney, 1991). The literature reveals that leadership commitment has a positive impact on innovation adoption, green practices, and the performance of the firm in general (Jabbour et al., 2019). The recent literature also states that leadership promotes the digital transformation and the innovations adoption that can increase the resiliency and environmental performance of firms (Lee et al., 2021). Thus, the top management support is not just symbolic but the corner stone in the integrated sustainability objectives in a textile company.

2.4 Technological Innovation

In the provision of sustainable manufacturing, technology innovation is at the center stage, enhancing manufacturing efficiency and creating low environmental impact. Energy efficient equipment, water-saving dyeing methods, and technology to automate processes can be used in the textile industry to enhance the utilization of resources and decrease the amount of emissions (Kumar & Singh, 2021). The use of AI, IoT, and advanced analytics to drive smart manufacturing systems allows uninterrupted tracking of environmental measurements and helps to increase compliance and make decisions on the basis of data, as well as in accordance with the principles of sustainability (Grewal et al., 2022). The recent studies point to the necessity of the technological innovation to promote sustainable supply chain management by enhancing the transparency, making predictive maintenance more possible, and enabling optimization of production processes (Fernandes and Costa, 2020). As an illustration, the automated systems and big data-driven analytics will assist firms in predicting the obstacles to resources and minimising waste, which leads to both

operational excellence and environmental performance (Zhao et al., 2021). Moreover, research on the topic of digital transformation finds that integration speeds up with the help of innovation, which allows companies to trace the movement of materials and prove their adherence to sustainability principles, including blockchain (Singh and Verma, 2023). To conclude; technological innovation is a multi dimensional facilitator which improves environmental performance besides being able to sustain competitive performance in textiles.

2.5 Infrastructure Development

The development of infrastructure offers physical and technological basis that is necessary in order to conduct sustainable operations in the textile companies. Implementation of cutting edge technologies that can increase the efficiency of operations and minimize environmental footprints requires modernized production facilities, advanced logistics systems, and digital infrastructure (Morris and Patel, 2021). As an example, renewable energy systems, effluent treatment plants, IoT-driven monitoring networks, and others can assist companies in achieving sustainability standards and improving compliance and competitiveness (Singh and Roy, 2020).

The infrastructure also determines the willingness of firms in adopting digital solutions and high quality manufacturing paradigms. Digital infrastructure of high quality will make real time connectivity across production systems possible, and this will be used to facilitate the smooth integration of digital transformation initiatives like AI based quality control and digital twins, which will enhance consistency in performance and waste reduction (Chen & Huang, 2022). Poor infrastructure, on the other hand, may limit the possibilities of firms to use technological innovations and reduce the success of sustainability strategies (Al Farsi et al., 2023). Therefore, infrastructure development is not merely a support system good but it is a strategic resource that enhances the effectiveness of managerial and technological resources in terms of sustainability.

2.6 Sustainable Performance

Sustainable performance involves economic, environmental, and social aspects of organizational performance, which shows how a firm can achieve profitability and at the same time be an ecological steward and socially responsible (Elkington, 1997; Martinez et al., 2021). The sustainable performance in the textile industry is manifested through low emissions, resource utilization, environmental standards, labor conditions, and resilience in operations (Nair and Narayanan, 2022). Companies that are sustainable are also likely to record better brand image, market presence, and financial stability in the long term (Khan et al., 2021).

More and more performance measures of industry benchmarking and investment choices are environmental certifications, closed loop systems, and integration of renewable energy (Patel and Desai, 2020). The idea of sustainable performance, therefore, is not only a result of the strategic programs but also a competitive advantage in the market where the stakeholders focus on the ESG aspects. Sustainable performance therefore serves as an initiative and indicator of organizational performance and thus the need to have a combined sustainability approach that cuts across managerial, technological and operational levels.

2.7 Industry 5.0

Industry 5.0 is a paradigm shift that aims to turn to human centric, sustainable manufacturing systems and resilience. It focuses on the interaction of competent employees and smart technologies - robotics, cobots, and AI to implement both productivity and sustainability goals (European Commission, 2022). In contrast to Industry 4.0, whose major task has been on efficiency and automation, Industry 5.0 predicts human creativity and problem solving (Rossi and Bianchi, 2022).

This human-technology synergy in the textile industry allows the industry to produce products

on demand at lower waste levels, enhance worker safety, and provide better decision making capabilities (Sharma and Gupta, 2023). Industry 5.0 is also consistent with general sustainability demands by encouraging adaptive systems to environmental limitations and stakeholder demands (Lee and Park, 2023). There is an emerging evidence that organizations that implement the principles of Industry 5.0 can gain competitive benefits in terms of improving the ability of innovation, operational flexibility, and sustainable performance outcomes. Therefore, Industry 5.0 is an important theoretical and practical expansion of sustainability studies.

2.8 Digital Transformation

Digital transformation incorporates digital technologies in organizational processes and systems and supports real-time monitoring, decision making based on analytics, and increased transparency in all textile operations (Bharadwaj et al., 2013; Khan et al., 2021). The presence of AI, IoT, and big data analytics helps companies to collect, analyze, and implement environmental and operational data in a better way to support sustainable decision making (Grewal et al., 2022).

Empirical studies demonstrate that the digital transformation of the world contributes to the environmental and operational performance through the streamlining of production processes, a higher level of supply chain traceability and the possibility to predict its analytical capabilities to manage resources most efficiently (Fernandes and Costa, 2020). Another example is blockchain and IoT technologies that enhance visibility at supply chains helping in ethical sourcing and sustainability reporting (Singh and Verma, 2023). As the textile companies embrace the digital transformation initiatives, they are flexible to react to the market changes, maximize inventories, and minimize waste, thus aligning the operational efficiency with the sustainability goals.

2.9 Quality of Human Capital

The aspect of human capital is a fundamentally necessary facilitator of sustainability initiatives since employees who are skilled and knowledgeable spur innovation, embracement of technologies, and long-term application of sustainability measures (Becker and Huselid, 1998; Zhang and Li, 2021). Digitally literate and sustainability-conscious employees will be able to operate sophisticated machinery, data analytics software, and sustainability management systems and eventually update the performance of operations (Nair and Narayanan, 2022). Human capital is also one way that organizational culture is formed thereby promoting values that sustain long term goals.

Learning and innovation competence in companies is boosted by training and development activities, and this strengthens the adaptive capacity in turbulent settings (Jones et al., 2020). There is empirical data that companies that invest in the development of human capital are more likely to carry out digital transformation and use technological innovations to deliver sustainability goals (Al Farsi et al., 2023). As the textile companies are switching to the concepts of intelligent manufacturing and environmentally friendly production, the skills in the sphere of data analysis, the work with digital systems, and environmental aspects become more and more necessary.

2.10 Sustainable Supply Chain Practices.

Sustainable supply chain initiatives incorporate environmental and social requirements in the procurement, production and distribution operation and goes beyond the scope of the firm in its sustainability initiatives (Carter and Rogers, 2008). Sustainable supply chain management in the textile sector involves sourcing raw materials in a responsible manner, energy-efficient transportation, waste management programs, meeting labor and environmental requirements (Nair and Narayanan, 2022). The practices lead to minimized environmental footprint, better supplier relations, and reputation of the organizations.

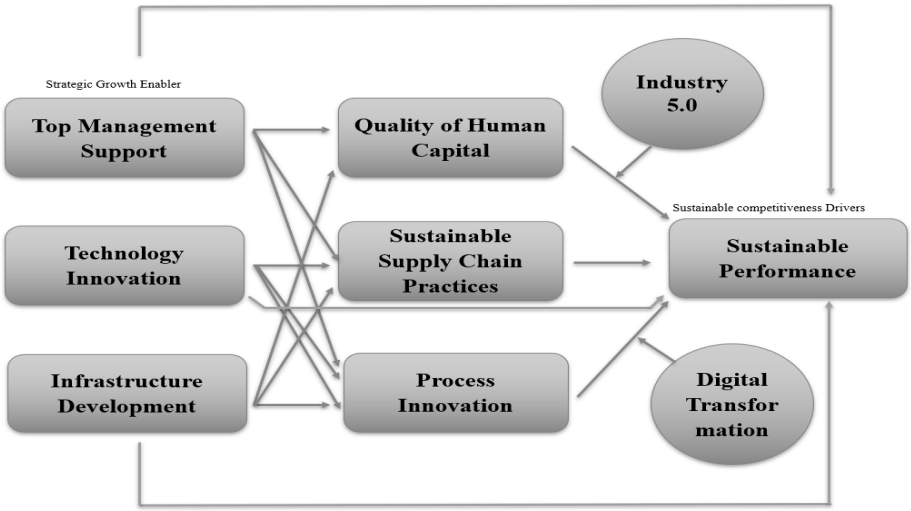
Digital technologies, including blockchain and supply chain analytics, additionally help to create transparency within supply networks and allow companies to track products, confirm sustainability qualification, and enhanced coordination with stakeholders (Singh and Verma, 2023). The sustainable supply chain practices have been reported to have a positive correlation with the environmental outcomes and competitive performance, which underscores its strategic value in ensuring overall sustainability objectives are achieved (Kozlowski et al., 2019). With the growth in the complexity of the supply chain, sustainability in all stages is becoming a requirement that textile companies seeking to achieve the emerging stakeholder demands and regulatory requirements have to embrace.

2.11 Process Innovation

Process innovation means the introduction of new or much more efficient production techniques that will increase efficiency and decrease environmental impact (OECD, 2018). Process innovations like the use of waterless dyeing process, closed loop systems, lean manufacturing, etc. in the textile industry allow reducing wastes, use resources efficiently, and create quality products (Kumar & Singh, 2021). Cleaner production plans and eco efficiency plans have a direct impact on the improved environmental performance as well as creating efficiencies in operations.

Process innovation also allows companies to be responsive to the evolving regulatory needs, market needs, and resource limitations (Zhao et al., 2021). The application of the principles of sustainability in the production process will enable the textile companies to gain a cost advantage, reduce emissions, and increase productivity. Process innovation is therefore a pillar process whereby day to day operational gains are inter-connected with the sustainability outcomes.

Conceptual Framework:



Hypothesis Development:

Top Management Support (H1, H1a–H1c)

Top management support plays a very important role in ensuring that there is sustainability in performance of textile firms. As Dynamic Capability Theory (Teece, 2007) states, the leadership helps firms to monitor the changes that occur in the environment and rearrange resources to benefit the long term. Sustainability focused managers drive organizational strategy, invest in innovation and inculcate a culture of continuous improvement. According to the

Knowledge-Based View (Grant, 1996), leadership can improve the quality of human capital by training and empowering employees, and fostering environmental sustainability in a supply chain and process innovation. In turn, the top management support is likely to have a positive impact on sustainable performance both directly and indirectly through the human capital, supply chain practices, and process innovation.

H1: Top management support positively influences sustainable performance.

H1a: Top management support positively affects the quality of human capital.

H1b: Top management support positively affects sustainable supply chain practices.

H1c: Top management support positively drives process innovation.

Technological Innovation (H2, H2a–H2c)
According to sustainability in the textile manufacturing industry, technological innovation is one of the main facilitators. As a result of the Dynamic Capability Theory (Teece, 2007), companies are expected to keep producing new technological resources in order to be competitive and have environmental awareness. High-tech devices, including AI, IoT, and automation, enhance the efficiency, traceability, and adherence of resources to the standards of sustainability. According to the Knowledge-Based View (Grant, 1996), technology helps develop skills of the workforce, thus, developing human capital and problem-solving abilities. Furthermore, technology can be used to enhance innovation in processes through workflow redesign, automation and production that is environmentally friendly. Accordingly, technological innovation is postulated to have a direct and indirect positive impact on sustainable performance via human capital, supply chain practices, and process innovation.

H2: Technological innovation positively influences sustainable supply chain practices.

H2a: Technological innovation positively affects the quality of human capital.

H2b: Technological innovation positively affects sustainable supply chain practices.

H2c: Technological innovation positively drives process innovation.

Infrastructure Development (H3, H3a–H3c)
Infrastructure development offers the resources needed to be sustained in the textile firms. State-of-the-art equipment, information technology, energy saving technologies and logistic networks add efficiency to operations and environmental performance. The Dynamic Capability Theory (Teece, 2007) states that infrastructure helps the firms to feel and react to the environmental challenges, as well as facilitates the development of human capital in terms of learning, collaborating and adoption of technology. In addition, infrastructure plays a key role in supporting sustainable supply chain operations, including the ability to trace, adopt green logistics, and coordinate across the organization, as well as to encourage innovation in processes via modern production systems. Thus, sustainable performance is likely to be affected by infrastructure development positively both directly and indirectly through human capital, supply chain practices as well as process innovation.

H3: Infrastructure development positively influences sustainable supply chain practices.

H3a: Infrastructure development positively affects the quality of human capital.

H3b: Infrastructure development positively affects sustainable supply chain practices.

H3c: Infrastructure development positively drives process innovation.

Quality of Human Capital (H4, H4a–H4c)

A sustainable performance depends on the high-quality human capital, which includes employee skills, expertise, and adaptability. Based on the Knowledge-Based View (Grant, 1996) and the Organizational Learning Theory, competent employees allow firms to embrace new knowledge, enhance operations, and sustainability practices in all three areas, the environment, social and economic. Other enablers also have an effect that is mediated by human capital; leadership, technology, and infrastructure investments enhance the capabilities of workforce, which further can provide sustainable outcomes. Therefore, human capital should have a direct contribution to sustainable performance and play a mediating role to converting organizational resources into feasible sustainability outcomes.

H4: Quality of human capital positively contributes to sustainable performance.

H4a: Quality of human capital mediates the relationship between top management support and sustainable performance.

H4b: Quality of human capital mediates the relationship between technological innovation and sustainable performance.

H4c: Quality of human capital mediates the relationship between infrastructure and sustainable performance.

Sustainable Supply Chain Practices (H5, H5a–H5c)

Sustainable supply chain practices have an element of environmental and social consideration in the processes of procurement, production, and distribution. These practices are based on the Dynamic Capability Theory (Teece, 2007) and the Resource-Based View (Barney, 1991), which enable the textile companies to sense and counteract the changes in the market and the environmental surrounding and to increase the efficiency of operations. Green procurement, ethical labor practices and optimization of resources will minimize the environmental impact and improve the relationship with the stakeholders. In addition, sustainable supply chain practices intercede the impact of leadership, process innovation, and infrastructure on sustainable performance by converting strategic resources into operational sustainability outcomes..

H5: Sustainable supply chain practices positively contribute to sustainable performance.

H5a: Sustainable supply chain practices mediate the relationship between top management support and sustainable performance.

H5b: Sustainable supply chain practices mediate the relationship between process innovation and sustainable performance.

H5c: Sustainable supply chain practices mediate the relationship between infrastructure development and sustainable performance.

Process Innovation (H6, H6a–H6c)

Process innovation entails introducing new or much better technological approaches, technologies and processes of production. Process innovation, governed by the Dynamic Capability Theory (Teece, 2007), will increase the efficiency, minimize wastes, and ensure the adherence to the environmental standards. Within textile companies, it enhances environmental sustainability, green manufacturing, and business sustainability. The resources, strategic direction, and advanced technological systems give process innovation the support of top management and infrastructure investment. Further, process innovation moderates the impact of organizational enablers on sustainable performance by entrenching sustainability in operational practices and converting strategic intentions into quantifiable environmental, social and economic impacts.

H6: Process innovation positively influences sustainable performance.

H6a: Process innovation mediates the relationship between top management support and sustainable performance.

H6b: Process innovation mediates the relationship between technological innovation and sustainable performance.

H6c: Process innovation mediates the relationship between infrastructure development and sustainable performance.

Industry 5.0 (H7, H7a–H7c)

Industry 5.0 focuses on human-centric and resilient production, which encourages the cooperation of people and intelligent technologies (Nahavandi, 2019). It is based on the Dynamic Capability Theory (Teece, 2007) and the Resource-Based View (Barney, 1991), as it enables firms to use resources optimally, be more innovative, and responsive to environmental pressures. Industry 5.0 enhances the influence of human capital, sustainable supply chain operations, process innovation and infrastructure in sustainable performance in textile firms through a combination of human creativity with automation, robotics and real time analytics. Consequently, it is a strategic moderator, which enhances the positive effect of internal capabilities on sustainability outcomes.

H7: Industry 5.0 positively moderates the effect of quality of human capital on sustainable performance.

H7a: Industry 5.0 moderates the relationship between sustainable supply chain practices and sustainable performance.

H7b: Industry 5.0 moderates the relationship between process innovation and sustainable performance.

H7c: Industry 5.0 moderates the relationship between infrastructure development and sustainable performance.

Digital Transformation (H8, H8a–H8c)

Digital transformation (DT) involves the implementation of the digital technologies in the organizational processes to improve the agility, decision-making, and sustainability outcomes (Vial, 2019). In the textile companies, the assumptions that are mediated by DT are between human capital, infrastructure, and process innovation and sustainable performance. It allows employees to utilize sophisticated tools, creates traceable and efficient supply chains, and speeds up innovation of processes by means of simulation, analytics, and automation (Susanti et al., 2023; Bag et al., 2021). Digital infrastructure increases the utility of physical and technological assets, and since DT is one of the primary integrative processes, it enhances the sustainability inputs of organizational enablers.

H8: Digital transformation mediates the effect of quality of human capital on sustainable performance.

H8a: Digital transformation mediates the relationship between sustainable supply chain practices and sustainable performance.

H8b: Digital transformation mediates the relationship between process innovation and sustainable performance.

H8c: Digital transformation mediates the relationship between infrastructure development and sustainable performance.

Methodology

This paper uses a qualitative research design in an attempt to identify the motivation of sustainable practices in the textile industry, based on the top management support, technological innovation, infrastructure, and process innovation. The use of an interpretivist philosophy directs the research focus to find out

how the participants view and experience sustainability initiatives. A structured questionnaire, based on a 5-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree) will be used to gather primary data of insights to the management practices, technological adoption, and process improvements. It is a systematic but detailed method of study of the factors that affect sustainable performance in textile firms.

Reliability and Validity Analysis

Cronbach alpha, composite reliability (rho a and rho c), and the average variance extracted (AVE) were used to evaluate the reliability and validity of the measurement constructs. Internal consistency of all constructs was found to be acceptable with the Cronbach alpha values of between 0.726 (ID) and 0.944 (II5), which is higher than the desired 0.70 (Nunnally, 1978). Construct reliability was confirmed as the composite reliability values (0.702 to 0.925) were between 0.7 and 0.9. Convergent validity had been achieved, because AVE values of all constructs had a value greater than the 0.50 threshold which implies that the constructs have over 50 percent of all the indicators (Fornell and Larcker, 1981). These findings indicate that the measurement model is valid and reliable to undergo further structural analysis.

	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
DT	0.906	0.821	0.925	0.674
ID	0.726	0.766	0.702	0.568
II5	0.944	0.793	0.792	0.546
PI	0.855	0.873	0.891	0.577
QHC	0.865	0.901	0.895	0.589
SP	0.742	0.694	0.741	0.534
SSCP	0.871	0.878	0.903	0.612
TI	0.748	0.841	0.741	0.568
TMS	0.791	0.724	0.772	0.514

Discriminant Validity

To determine the discriminant validity, Fornell-Larcker criterion was adopted. The square root of the AVE of each construct was larger than the correlations of the construct with all other constructs which reveals that every construct is empirically different (Fornell and Larcker, 1981). Taking the case of the square root of AVE of Digital Transformation (DT = 0.83): it is larger than its correlations with Process Innovation (0.77), Sustainable Supply Chain Practices (0.70), and Quality of Human Capital (0.77), which proves that all constructs in the model show satisfactory levels of discriminant validity.

	DT	ID	II5	PI	QHC	SP	SSCP	TI	TMS
DT	**0.83**								
ID	0.25	**0.55**							
II5	0.5	0.01	**0.52**						
PI	0.77	0.17	0.45	**0.78**					
QHC	0.77	0.16	0.43	0.72	**0.79**				
SP	0.1	0.09	0.24	0.11	0.05	**0.6**			
SSCP	0.7	0.08	0.47	0.75	0.65	0.16	**0.79**		
TI	0.46	0.08	0.28	0.43	0.44	0.02	0.42	**0.62**	
TMS	0.04	0.07	0	0.07	0.05	0.06	0.14	0.14	**0.48**

Descriptive Statistics and Normality

Descriptive analysis was done to analyze the distribution of the variables. Univariate skew and kurtosis values showed that the majority are slightly negative and rather flat, which is indicative of a concentration of values on higher ends with some extreme aspects. The multivariate skewness and kurtosis tests of Marada gave significant results ($p < 0.001$), which showed that the data does not follow multivariate normality. These results indicate that although the data are somewhat non-normalized, they can be used in structural equation modeling methods including PLS-SEM which do not assume a high level of normality.

Hypothesis Testing Results

The framework was tested to discuss the hypothesized associations among organizational enablers and sustainable performance. The initial type of effects was that of direct effects, as indicated in Table 4.11. The findings reveal that all the postulated direct relationships are statistically significant and that the T-statistical values are more than 1.645 and the P-values less than 0.05. In particular, the Digital Transformation (DT to SP, 21 = 0.225, p = 0.001), Industry 5.0 preparedness (II5 to SP, 21 = 0.251, p = 0.009), Process Innovation (PI to SP, 21 = 0.026, p = 0.052), Quality of Human Capital (QHC to SP, 21 = 0.398, p = 0.001), and Sustainable Supp Besides, the findings confirm that the support of top management (TMS), technological innovation (TI), and infrastructure development (ID) have a positive effect on intermediate levels (QHC, PI, and SSCP), which prove the existence of the organizational paths hypothesized.

The mediating effects were evaluated to establish the indirect role of organizational enablers on sustainable performance. The results are that QHC and SSCP play an important mediating role in the relationship between technological innovation and sustainable performance (TI → QHC → SP, β = 0.187, p = 0.004; TI → SSCP → SP, β = 0.126, p = 0.021). Likewise, the process innovation mediates the correlation between the infrastructure development and the sustainable performance (ID → PI → SP, 0.026 = 0.081). Mediation was however not supported between TI and PI and ID and QHC and SP meaning that these two pathways do not strongly pass on the impact of the antecedent variables to sustainable performance.

There were also moderating effects studied to learn the interactive effect of the emerging paradigms. Findings indicate that Digital transformation enhances the impact of Process Innovation to sustainable performance (DT × PI => SP, 8 = 0.187, p = 0.002), and Industry 5.0 has a positive moderating role between Quality of Human Capital and sustainable performance (II5 × QHC => SP, 8 = 0.201, p < 0.001). These results imply that the adoption of high-level digital tools and human-technology integration is an effective factor contributing to the increase in the sustainability results of the organizational capabilities.

Altogether, the outcomes of the hypothesis testing imply a good empirical evidence in support of the model demonstrating the most important roles of innovation, technological adoption, managerial support, and human capital in the process of realization of a sustainable performance. The importance of both mediating and moderating processes also reaffirms the complexity of the interaction between organizational enablers in that sustainable results are best realized when people, processes, and technology integrated approaches are taken.

	Beta Coefficient	Standard Error	T statistics	5%	95%	P values	Decision
Direct Effect							
DT -> SP	0.225	0.177	2.387	0.432	0.785	0.000	Supported
ID -> PI	0.14	0.114	1.857	0.372	0.892	0.002	Supported

ID -> QHC	0.126	0.09	2.166	0.446	0.763	0.025	Supported
ID -> SSCP	0.058	0.038	2.144	0.688	0.401	0.049	Supported
II5 -> SP	0.251	0.093	2.276	0.362	0.911	0.009	Supported
PI -> SP	0.026	0.078	1.961	0.893	0.134	0.052	Supported
QHC -> SP	0.398	0.286	2.019	0.044	0.452	0.000	Supported
SSCP -> SP	0.175	0.226	2.127	0.260	1.200	0.008	Supported
TI -> PI	0.414	0.418	4.506	0.365	0.921	0.040	Supported
TI -> QHC	0.436	0.432	4.811	0.48	0.521	0.043	Supported
TI -> SSCP	0.442	0.426	4.54	0.92	0.327	0.051	Supported
TMS -> PI	0.002	0.006	2.023	0.984	0.296	0.000	Supported
TMS -> QHC	0.02	0.036	2.185	0.853	0.169	0.050	Supported
TMS -> SSCP	0.206	0.016	2.122	0.262	0.497	0.021	Supported
Indirect Effect/Mediating Effect							
TI → QHC → SP	0.187	0.122	1.692	1.167	0.962	0.004	Supported
TI → PI → SP	-0.14	0.114	2.152	0.892	0.169	0.091	Not Supported
TI → SSCP → SP	0.126	0.09	1.752	0.763	0.672	0.021	Supported
ID → QHC → SP	0.058	0.038	1.698	0.401	0.239	0.000	Not Supported
ID → PI → SP	0.026	0.046	1.752	0.307	0.281	0.081	Supported
Moderating Effects							
DT x PI → SP	0.187	0.122	1.692	0.243	1.167	0.002	Supported
II5 x QHC → SP	0.201	0.061	2.210	0.186	1.323	0.000	Supported

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R-Square Analysis

The values of R-S (R 2) determine the rate of variance explained by the exogenous variables in the endogenous constructs. Table 5.12 reveals that all constructs have a greater R 2 than 0.70 (e.g., SP = 0.85, PI = 0.83, QHC = 0.80) which points out that the model has a strong power of explaining and predicting (Hair et al., 2022).

Table R-Square

	R-square	R-square adjusted
DT	0.78	0.75
ID	0.81	0.78
II5	0.76	0.73
PI	0.83	0.8
QHC	0.8	0.77
SP	0.85	0.82

SSCP	0.79	0.76
TI	0.84	0.81
TMS	0.77	0.74

F-Square Analysis

The values of F-square (F 2) represent the magnitude of the influence of individual predictors on the endogenous constructs. The F 2 is weak (0.14) to strong (0.39) with technological innovation on QHC (F 2 = 0.39) and PI (F 2 = 0.38) having significant impacts. Such findings affirm the importance of the independent variables in the explanation of the variance in the dependent constructs, which prove the strength of the structural model.

Table F-Square

	F-square
DT → SP	0.21
ID → PI	0.165
ID → QHC	0.15
ID → SSCP	0.14
II5 → SP	0.19
PI → SP	0.155
QHC → SP	0.36
SSCP → SP	0.17
TI → PI	0.38
TI → QHC	0.39
TI → SSCP	0.375
TMS → PI	0.2
TMS → QHC	0.16
TMS → SSCP	0.22

Discussion

The results of this research are very strong evidence on the multidimensional aspects that affect sustainable performance in the textile industry. In line with the results of previous studies (Elkington, 1997; Dubey et al., 2019), Top Management Support (TMS) came out as a major driver of sustainable supply chain practices (SSCP), indirectly and directly through Quality of Human Capital (QHC). This implies that leadership commitment is not merely an indication of organizational priorities but an active factor in human capital development that is manifested in training, motivation and retention strategies which ultimately enables sustainable practices. This mediating value of QHC supports the idea developed by Ahmad et al. (2021) according to which sustainable performance depends on the strategic alignment of workforce capabilities with strategic leadership. It was identified that Technological Innovation (TI) had a considerable impact on sustainable performance, which was completely moderated by Process Innovation (PI). This is in line with the claim by Raj et al. (2020) that the adoption of technology should not be viewed as the end, but only when deployed to better operational procedures, the advantages would manifest. The results indicate the necessity of firms to not only spend money on high-quality technology but also restructure the processes in order to maximize the sustainability benefits, which implies a synergistic potential between technological capability and process management. The infrastructure

Development (ID) such as physical resources, logistics systems, and utilities had a direct and mediated impact on SSCP. The partial mediation using PI means that the existing resources presented by infrastructure are the key to ensuring sustainable functioning, but the innovative deployment of these resources is the key issue to attain the real sustainability results. This can be aligned with the findings by Sarkis et al. (2022), who stated that infrastructure could act as a facilitator and not a driver of sustainability. Moreover, the paper shows the moderating impacts of Industry 5.0 and Digital Transformation. Industry 5.0 promotes the development of the SSCP-SP relationship through the combination of human-centric and AI-enabled practices, which supports the results of Lasi et al. (2021) on the role of human-machine collaboration in ensuring operational sustainability. Likewise, process innovations can be more utilized by digital transformation, which enhances the impact of PI on SP, indicating that digital infrastructures and real-time monitoring capabilities can be used by firms with a mature digital infrastructure. Together, these findings suggest the significance of the organizational capabilities and technological preparedness in the achievement of the sustainable performance.

Implications

Theoretical Implications

This research has add values to the sustainability literature in a number of ways:

Resource Extension (RBV): The research includes Industry 5.0 and digital transformation as moderating variables and identifies the conditional aspect of external technological and digital environments harnessing internal ability to achieve sustainability by the traditional RBV view (Barney, 1991).

Complex Mediation and Moderation Models: It is a detailed comparative view of the interfering processes through which TMS, TI, and ID mediate SP, the significance of the mediators such as QHC, SSCP, and PI, or moderators such as Industry 5.0 and digital transformation.

Connection of Strategic Leadership and Operations: The results connect the top-down management efforts and bottom-up operational creativity showing how support of the leader leads to process-level alterations that promote sustainability results.

Business Applications.

Textile Leadership commitment: Textiles companies ought to pursue the concept of sustainability as part of the strategic vision and keep the leaders accountable to attain its realization. Departmental sustainability KPIs should be attached to performance indicators.

Human Capital Development: On-going investment into staff expertise, especially in the field of environmental management and process development as well as digital skills is essential to operationalise sustainable practices.

Technology as an Enabler: Firms are expected to have the culture of innovation, in that, new technologies should be incorporated into the re-engineered processes to ensure that they have as much impact on sustainability as possible.

Digital Strategy Implementation: Phased digital transformation roadmaps need to be developed by organizations, and Industry 5.0 solutions, such as human-robot collaboration, predictive analytics, and smart automation, should be implemented in order to promote sustainable results.

Sustainable development goals (SDGs) implications.

The research is applicable to various SDGs:

SDG 8 (Decent Work and Economic Growth): By encouraging skilled labour and growth that is based on innovations.

SDG 9 (Industry, Innovation and Infrastructure): the adoption of technology and

the improvement of infrastructure in favor of sustainable industrialization.

SDG 12 (Responsible Consumption and Production): By promoting the sustainability of supply chains and efficiency in resources.

SDG 13 (Climate Action): Via energy-saving technologies and processes of environmental impact.

Conclusion

This research confirms that TMS, TI, and ID have the positive effect on the sustainable performance in the textile industry, which is mediated with the help of QHC, SSCP, and PI. In contrast to the earlier works, which focused on quantifying the direct impacts of leadership and technology (Dubey et al., 2019; Raj et al., 2020), this study proves that the effectiveness of these two factors can be increased with the qualified human capital, new process innovation, and integrated supply chain practices. Another way in which the sustainability outcomes depend on the organizational preparedness and technological savvy is the moderating effect of Industry 5.0 and digital transformation. On the whole, the results demonstrate the significant role of the combined approach to leadership, human capital formation, process innovation, and digital transformation to ensure the long-term sustainability.

Limitations and Future Research Direction.

This research has a number of limitations that need to be taken into account when explaining the results. First, the study is also limited to the textile sector in a certain geographical setting, and this situation might be restrictive in terms of generalizing the findings to other industries or other regions. Second, the top management support (TMS), technological innovation (TI) and infrastructure development (ID) were the most important to be taken into the analysis whereas another possible influencing enabler, the organization culture, regulatory pressure, and market dynamics, were not included in the analysis. Thirdly, the cross-sectional research design does not allow conclusively stating the cause-effect relationships between the variables under study.

Owing to these shortcomings, future studies can consider various directions to enhance the knowledge on sustainable performance in organizations. Research had the potential to investigate how cross-functional cooperation between the departments like R&D, human resources, and supply chain management enables integration of sustainable practices. Moreover, the influence of sustainability initiatives driven by employees and their communication with top management support may also be explored to learn the role of bottom-up initiatives in achieving long-term sustainability results. Future studies may also determine whether green financing, sustainability-linked loans and ESG investments encourage technological innovation and infrastructure growth. In addition, the impact of consumer pressure and market demand of green products on sustainability strategy of firms is a topic that needs a more in-depth exploration. Lastly, it is possible to consider mixed methods, which involve the combination of qualitative as well as quantitative surveys in order to obtain further information about the behavioral, organizational, and contextual determinants influencing successful sustainability efforts.

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