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IMPACT OF DIGITAL LEADERSHIP ON SUSTAINABLE PERFORMANCE: EVIDENCE FROM INFORMATION TECHNOLOGY INDUSTRIES

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	Abstract
<p>Mehraban Alam*</p> <p>*Lecturer, Department of Management Science, University of Shangla, Khyber Pakhtunkhwa, Pakistan</p> <p>*mehar.mann26@gmail.com</p> <p>Murad Hussain</p> <p>Assistant Professor, Department of Management Science, Shaheed Benazir Bhutto University, Sheringal, Khyber Pakhtunkhwa, Pakistan</p> <p>muradhussain@sbbu.edu.pk</p> <p>Afraseyab Khattak</p> <p>PhD Scholar, Institute of Business and Management Science, The University of Agriculture Peshawar, Khyber Pakhtunkhwa, Pakistan</p> <p>afraseyabhkhattak4@gmail.com</p>	<p>Digital transformation and sustainability represent dual imperatives for modern organizations. The Information Technology (IT) sector is central to this challenge, acting as both a driver of innovation and a contributor to ecological burdens such as energy-intensive data centers, electronic waste, and resource-heavy hardware production. This inconsistency highlights the need for leadership that can integrate technological advancement with sustainability objectives. This study investigates how digital leadership influences sustainable performance, addressing the limited empirical evidence on the mediating effect of green self-efficacy and green innovation processes, as well as the moderating role of top management innovativeness in emerging economies. Data were collected from 363 IT professionals in Khyber Pakhtunkhwa, Pakistan, using a structured survey. Hypotheses were tested through regression analysis and mediation/moderation models in SPSS to ensure robust statistical validation. Findings reveal that digital leadership positively influences sustainable performance. Green self-efficacy and green innovation processes significantly mediate this relationship, while top management innovativeness strengthens the effect of digital leadership on sustainability performance. The research has theoretical value in the sense that it builds on Upper Echelons Theory, Dynamic Capabilities Theory, and the Resource-Based View using a combination of the three elements, which are leadership, innovation, and self-efficacy. In practice, it provides advice to IT managers and policymakers to pursue the digital transformation in ways that respond to the sustainability demands, especially in resource-limited situations. It is contextual evidence of an emerging economy with its own peculiar challenges and opportunities to IT firms. The combination of the latter with innovation and sustainability creates a strategic way to resilience and competitive advantage in the digital era, dubbed digital leadership.</p>
<p>Keywords:</p>	<p>Digital leadership, sustainable performance, green self-efficacy, top management innovativeness, green innovation process, IT industry</p>

1. Introduction

Digital transformation and sustainable development is a two-fold challenge facing organizations in the modern business environment. On the one hand, digital technologies, including the artificial intelligence (AI), cloud computing, blockchain, and the Internet of Things (IoT) are transforming industries, making them efficient, innovative, and globally connected. Conversely, the pressure on sustainability-focused approaches has grown due to the increasing environmental anxieties, such as the climate change, exhaustion of resources, and carbon emissions (Ahmad et al., 2022; Stephenson et al., 2025). The introduction of sustainability as a strategic requirement in companies of different industries and the emergence of environmental, social, and governance (ESG) reporting alongside the global frameworks like United Nations Sustainable Development Goals (SDGs) have elevated sustainability to a moral duty rather than a strategic necessity (Ghani et al., 2022; Billi and Bernardo, 2025). The Information Technology (IT) sector finds itself in an oxymoronic place in this argument. It is a driver of digital innovation, offering mechanisms that help organizations to track, streamline and minimize their environmental footprint. However, it is also a major cause of ecological degradation and this is mostly attributed to the energy-consumptive data centers, electronic waste and the resource-consumption of the hardware production (Khan et al., 2022; Ma et al., 2023). An example is that globally, nearly 1-2 percent of electricity is used in data centers, and it is predicted to rise as the use of clouds fastens (IEA, 2024). This twofold position highlights the urgency of leadership to be able to unite the digital transformation and sustainability goals.

In this regard, digital leadership has become one of the essential competencies. It entails the capacity to combine technological foresight and strategic flexibility and manage enterprises in the intricacies of digital disruption, incorporating sustainability into the main functioning (Zada et al., 2023). In comparison with traditional leadership, digital leadership focuses on consistent innovation, ethical implementation of technologies, as well as the development of organizational cultures where environmental responsibility is a top priority. Recent research demonstrates that organizations that have digitally-competent leaders have a high chance of realizing ESG alignment and long-term resilience (Manzoor et al., 2023; Amjad et al., 2024; Sanchez-Garcia et al., 2024). Nevertheless, digital leadership is not a guarantee of success by itself, as it hinges on the organizational processes like green innovation processes, organizational self-efficacy of employees, and organizational innovative orientation of the top management. Although the importance of digital leadership has been realized, numerous IT companies are still grappling to realize sustainability in performance. Leaders can speak about a vision of digital transformation, but this is not always translated into the tangible results in the environment. Instead, it is more noticeable in the emerging economies, where the institutional issues, scarcity of resources, and weak enforcement of regulations contribute to the lack of sustainability in digital strategies (Manzoor et al., 2024; Zada et al., 2024; Khaw et al., 2022). Consequently, digital leadership can turn into a symbolic, but not transformative concept, the sustainability initiatives are either underfunded, underestimated, or opposed to. To illustrate, it is demonstrated that green self-efficacy, i.e., employees being confident in their own capacity to support environmental objectives, leads to pro-environmental actions, including writing energy-efficient codes or engaging in sustainability-related innovation projects (Chen et al., 2020; Sanchez-Garcia et al., 2024). In the same vein, the process of green innovation, which is the systematic advancement of environmentally-friendly technologies and practices, represents one of the most important avenues according to which digital leadership may facilitate sustainable performance (Pujari, 2006; Amjad et al., 2024). However, such mediators are rarely combined into digital leadership and sustainability models. In addition to that, little is known yet about the moderating nature of top management innovativeness. More innovative executives will invest in green R&D, take risks when pursuing sustainability, and consider environmental goals as part of corporate strategy (García-Morales et al., 2012; Zada et al., 2023). In the absence of these innovativeness, digital leadership might not be supported by the organization in order to realize its full potential. The IT industry has a crucial need on this gap as agility and innovation is vital to address both the technological discontinuity and environment. Thus, the research attempts to fill these gaps by assessing how digital leadership affects sustainable performance mediated by the effects of green self-efficacy and green innovation process, and how the association is moderated by the top management innovativeness. The study, by placing the IT sector within the framework of the emerging economy, makes contributions to the theoretical and practical levels of knowledge, as it provides the insights into how companies can make the digital transformation process meet the sustainability requirements.

2. Literature Review

2.1. Digital Leadership

Digital leadership in the industry is not only a technical skill but a strategic necessity to companies that are interested in surviving in a time of the rapid technological disruption and increasing sustainability demands (Bresciani et al., 2021). Good leaders in this field need to show their capability to unify long-term strategic focus as well as short-term operational flexibility so that the use of technology is innovation-based as well as accountable. Such a twofold nature demands that leaders drive innovative technologies, including artificial intelligence, blockchain, and cloud computing, and, at the same time, incorporate sustainability notions in their implementation (Kane et al., 2019). As an example, the analytics powered by AI can be used to minimize the level of energy consumption in data centers, whereas cloud-based technology can minimize the level of hardware dependency, which will subsequently minimize the environmental footprint. Digital leadership is, therefore, not only the adoption of technology, but also the development of an organizational culture in which constant innovation is ethically justified, and in which the issue of minimizing the digital carbon footprint becomes an organizational obligation. Such steps as optimizing the efficiency of servers, virtualization to reduce the use of hardware, and the promotion of renewable sources of energy in IT activities can be regarded as practical (Westernman et al., 2014).

2.2. Sustainable Performance

The concept of sustainable performance in the IT field must be perceived as a multidimension concept that goes beyond the conventional financial approaches of performance to include economic feasibility, environmental care, and social duty (Elkington, 1998). IT contribution to environmental damage is especially acute, as the energy-consuming nature of data operations, the growing issue of electronic waste, and the resource-intensive nature of the hardware manufacturing (Berkhout and Hertin, 2004). To overcome these issues, the IT companies should implement proactive and systemic green IT practices. These examples are enhancing data center power usage effectiveness (PUE), expanding the life cycle of hardware (refurbishment and recycling), and using digital technologies to track and minimize ecological footprints (Molla et al., 2008). Companies that are strong in terms of integrating sustainability into their IT practices are also likely to have competitive advantage, including improved brand loyalty, easier regulatory compliance, and ability to withstand

environmental and market uncertainty (Eccles et al., 2014). By so doing, sustainability is not just a regulatory need but a strategic differentiator that determines the success of an organization in the long term.

2.3. Green Innovation Process

Green innovation in IT is a process of developing and applying technologies in a systematic manner to lessen the negative impact on the environment and generate business value (Chen et al., 2006). Such an innovation can be in various forms, including creating energy-efficient algorithms, which can decrease the size of the computation load, the design of hardware that is durable and can be recycled, and Internet of Things (IoT) platforms that can be used in real time to monitor the environment and optimize the use of resources (Pujari, 2006). Notably, green innovation is not a single project but a cyclic, systemic process that adheres to agile development cycles, making sure that the concept of sustainability would be incorporated in all phases of technological change (Pernici et al., 2012). Companies with green innovation focus will be more prepared to handle the changing regulatory requirements, capitalize on consumer demands of eco-friendly solutions and access new markets in the field of sustainable technology (Dangelico & Pujari, 2010). This makes IT organizations agents of systemic change and all they can do is to impact the industry as well as societal progress towards sustainability.

2.4. Green Self-efficacy

Green self-efficacy of the IT professionals, their belief in the ability to use technical skills to support environmental objectives, is one of the key facilitators of these steps (Chen et al., 2015). Employees who feel that they can make a positive contribution towards sustainability will become more pro-environmental when they write optimized code to minimize server traffic, attend sustainability-themed hackathons, or push their organizations toward greener procurement practices (Chen et al., 2020). The development of green self-efficacy takes specific organizational interventions of specific training programs, leadership support, and visible organizational sustainability commitments. Such attempts would make employees feel that they own the idea and are motivated, which enhances the success of corporate green programs (Bandura, 1977; Tsai et al., 2020). By doing so, personal empowerment will be a foundation of overall organizational change.

2.5. Top Management Innovativeness

Lastly, organizational climate is the role played by top management innovativeness in the creation of a sustainable IT practices environment (Damanpour and Schneider, 2006). At the executive level, innovative leaders can create a culture of sustainability through resource allocation, the integration of eco-friendly measures into performance appraisals, and support of innovative projects like shifting the organization to carbon-neutral operations or purchasing start-ups in green technology (Ling et al., 2008). Their readiness to take a risk and make courageous moves is an indication that the organization is committed to sustainability as one of the strategic priorities (García-Morales et al., 2012). Such a top-down assistance would mean that sustainability dreams do not get regulated to the peripheral programs but converted into practical results in the day to day operations. Simply, the innovativeness of top management is the driver in institutionalizing sustainability, which associates technological growth with long-term objectives of environmental security and establishes IT companies as the pacesetter in the worldwide sustainability process.

2.6. Hypotheses development and theory

2.6.1. Digital leadership and sustainable performance

In the modern fast-paced business world, the digital leadership must be adopted to improve the level of competitiveness and long-term sustainability of organizations (Du et al. 2023). Digital leadership provides a strategic facilitator, and it incorporates modern technologies in business to deliver efficiency and encourage environmentally and socially responsible practices (Ávila- Robinson et al. 2022). Digital mindset leaders have a central role in increasing green innovation, building a culture of life long learning, experimentation and collaboration, and leading companies to sustainable and technology-enabled business models (Ahmed et al. 2024). The aftermath of the COVID- 19 has only deepened the need to undergo digital transformation, as companies in all sectors have embraced modern digital approaches to overcome changing consumer demands, decentralization of operations, and a new form of sustainability (Chatterjee et al. 2023). The pandemic has highlighted the need to have agile leadership that is resource-efficient, low-impact, and creates the resilience of business (Hsieh 2024).

Successful digital leaders use data analytics, establish well-defined sustainability goals, and transform their businesses to be green by using technology and taking strategic moves (Del Soldato and Massari 2024). Digital leadership is relevant to the Sustainable Development Goals (SDGs), in particular SDG 9 (Industry, Innovation, and Infrastructure) and SDG 12 (Responsible Consumption and Production) (Leal- Rodrigues et al. 2023). Green innovation and digital inclusion allow firms to be in compliance with regulations, as well as contribute towards higher overall environmental and social objectives. OLT reinforces this transformative process through instilling sustainability concepts into the learning experience that increases the resilience of firms in the long term (Nascimento et al. 2024). Dynamic Capabilities Theory (DCT) as the complement to OLT will help to underpin further the role of digital leadership in sustainable business transformation by focusing on the capability of firms to sense, seize and transform opportunities in accordance with changes in the environment (Malakar et al. 2025). Good digital leaders demonstrate dynamic capabilities through consistently tracking the developments in technology, bringing in digital innovations with sustainability in mind, and reorganizing resources strategically to meet the long-term environmental and economic objectives. This study posits the below hypothesis;

H1: Digital leadership positively influence sustainable performance.

2.6.2. Mediating role of Green self-efficacy

H2: Green self-efficacy mediates the link between digital leadership and sustainable performance.

2.6.3. Mediating role of Green innovation process

Digital leadership has become the strategic potency of green innovation, which helps organizations use digital opportunities to conduct eco-friendly business operations (Abbas 2024). Artificial intelligence (AI), blockchain, and the Internet of Things (IoT) are the latest technologies that visionary leaders use to create resource-efficient and environmentally responsible business models (Ávila- Robinson et al. 2022). Such leaders incorporate digital solutions into sustainability plans and, in turn, create an organizational culture that promotes managing learning, creativity, and adaptive innovation (Cai et al. 2024; Naqshbandi et al. 2023). The nature of digital leadership in promoting green innovation is that it helps in increasing the level of knowledge sharing and learning across the organizational borders (Islam and Ozcan 2013). Teams led by leaders championing technological advancements are enabled to identify sustainability innovations, enhancing the ability of the firm to become eco-innovative, as well as responsive to environmental and regulatory forces (Erhan et al. 2022; Shahzad 2024). This leadership style promotes organizational flexibility whereby firms are able to develop eco-innovative processes automatically and proactively react to transforming market and sustainability needs (Borah et al. 2022). Digital leaders also focus on data-oriented decision-making by leveraging state-of-the-art analytics and real-time data to streamline sustainability-oriented strategies and streamline green innovation processes (Brunner et al. 2023). Digital leadership promotes the success of green innovation efforts by developing a collaborative digital ecosystem involving main stakeholders such as suppliers, buyers, and regulatory bodies (Awan et al. 2021, 2019). This structure that is based on ecosystem increases the capability of a firm to introduce innovations that are motivated by sustainability in such a way that the innovations of technology are coordinated with the long-term environmental goals. Green innovation process is the process of strategically developing sustainable products and services in the course of cross-functional cooperation and constant education (Shafait and Huang 2024). It is a unique asset that is not only valuable but also hard to imitate and this ability gives firms a long-term competitive advantage in the digital economy (Ávila- Robinson et al. 2022). The fact that green and social responsibility are integrated into the decision-making process, resource allocation, and product development lifecycle makes it important that the top management is committed to green innovation, which further increases the influence of digital leadership. The active implementation of the digital sustainability models by the executive will guarantee the green innovation be integrated into organizational capacity as opposed to a marginal program. This correspondence enables companies to pursue Sustainable Development Goals (SDGs) and ensure long-term business sustainability in the digital economy (Leal- Rodriguez et al. 2023). Therefore, the hypothesis of the present research is as follows:

H2: Green innovation process mediates the link between digital leadership and sustainable performance.

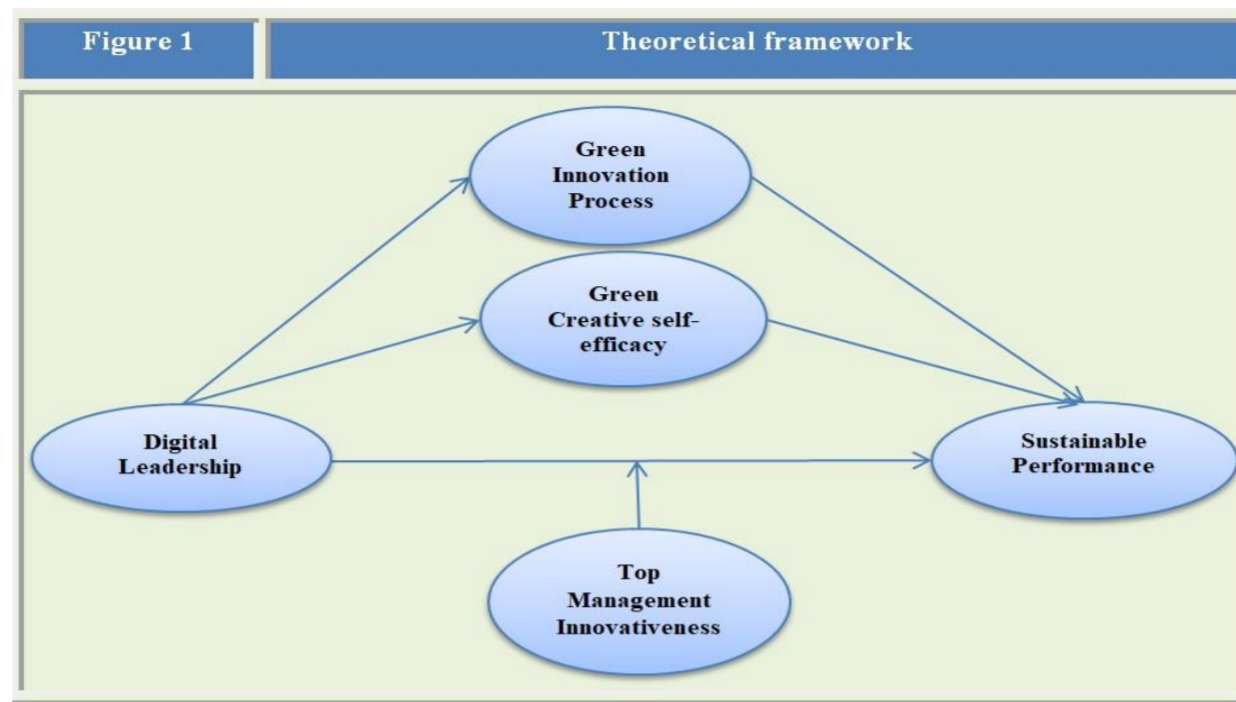
2.6.4. Moderating role of top management innovativeness

Top management innovativeness refers to the ability and willingness of senior executives to embrace new ideas, take risks, and allocate resources toward experimentation and innovation (Damanpour & Schneider, 2006). In the IT sector where technological disruption and sustainability is an order of the day, innovative top managers will be decisive in influencing organizational reactions. They do not only promote the use of innovative technologies but also make sure that the idea of sustainability is incorporated into the strategic decisions. Indicatively, creative executives can support such efforts as carbon-free cloud systems, greener research and development, or collaborations with technology startups with environmentally friendly technologies (García-Morales et al., 2012). Recent research proves that the effect of digital leadership on sustainability is even more outstanding when top management innovativeness is elevated because executives can offer the needed support and resources to transform the vision into reality (Zada et al., 2023; Khaw et al., 2022). On the contrary, in companies with low innovativeness levels, the digital leadership can be symbolic, sustainability efforts are under-invested or opposed. Several theoretical approaches can be used to explain the moderating role of top management innovativeness. According to the theory of Upper Echelons (Hambrick and Mason, 1984), the cognition, values, and innovativeness of top executives determine the organizational results. In this perspective, the role played by innovative leaders is on how digital leadership strategies are implemented which boosts their impact on sustainable performance. On the same note, the Dynamic Capabilities Theory (Teece, 2007) holds the view that companies should keep on creating and restructuring competencies in response to the fluctuating environment. Innovativeness of the top management is a dynamic capability that allows the digital leadership to revise the sustainability practices in accordance with technological and environmental changes.

Lastly, is the Resource-Based View (Barney, 1991), which places the innovativeness as a strategic resource, which builds on competitive advantage. Together with digital leadership, innovativeness will enable firms to use IT resources to achieve sustainability by developing unique value. The combination of these theories gives a solid basis to the hypothesis that the positive correlation between digital leadership and sustainable performance is reinforced by top management innovativeness. Even though the topic of digital leadership and sustainability has increasingly gained scholarly interest, a number of gaps still exist. To begin with, the majority of research focuses on the direct impact of digital leadership on sustainability (Kane et al., 2019; Westerman et al., 2014), yet there is a lack of research on how this mechanism is determined by top management innovativeness. Second, most of the current literature in research is typically manufactured or corporate (Dangelico and Pujari, 2010) but the IT industry, with its high power data processing and pace of innovation, is still under-researched. Third, although green innovation and leadership have been examined independently, the dynamic between digital leadership and the top management innovativeness in creating sustainable performance is less developed (Zada et al., 2023). Lastly, as the world grows more and more conscious of a carbon neutral and more digital responsible environment, as part of the various frameworks like the UN Sustainable Development Goals (UN SDGs, 2021), there is an urgency to learn how executive innovativeness mediates the sustainability of leadership. This gap will offer practical and theoretical value in battling the gap to guide IT firms in taking digital transformation and environmental goals closer to each other.

H4: Top management innovativeness moderates the link between digital leadership and sustainable performance.

2.7. Theoretical framewok



3. Methodology

3.1. Population, sample, and technique

This research study targets professionals and managers who work in Information Technology (IT) industries in the province of Khyber Pakhtunhwa, Pakistan. The scholars used simple random sampling as their method to select participants because it provided every person in the study population equal chances to be selected. The research team achieved a final sample size which included 363 valid responses that met requirements for effective statistical analysis. Present study conducted data collection through three separate phases to improve data reliability while reducing common method bias. The researchers used SPSS software to analyze collected data which generated complete statistical information about the study variable relationships. The research study achieved sufficient statistical power for its regression analysis and other inferential methods through its selected sample size and research methodology.

3.2. Respondents and Collection

The researchers used descriptive statistics to summarize the demographic characteristics of respondents, which included their gender and age and educational background and job role and total work experience.

Table 1: Profile of study respondents

Study constructs	Categories	Frequencies	(%)
Gender	Male	250	68.9
	Female	113	31.1
Age	20–29 years	120	33.1
	30–39	150	41.3
	40–49	70	19.3
	50+	23	6.3
Education	Bachelor's	180	49.6
	Master's	140	38.6
	M.Phil/PhD	43	11.8
Experience	<5	100	27.5

5-10	140	38.6
11-15	80	22.0
> 15 years	43	11.8

The study showed that 68.9% of the participants were male while 31.1% of the participants were female. The age distribution of respondents showed that 41.3% belonged to the 30-39 years age group while 33.1% belonged to the 20-29 years age group. The 40-49 years age group contained 19.3% of participants while 6.3% of participants reached 50 years of age or above. Almost half of the respondents who participated in the study completed their Bachelor's degree while 38.6% achieved their Master's degree. The group with advanced educational qualifications includes 11.8% of respondents who hold M.Phil or PhD degrees. The group with 5-10 years of work experience formed the largest respondent group with 38.6% while 27.5% of respondents reported having less than 5 years of work experience. About 22% of participants had 11-15 years of work experience while 11.8% of participants had more than 15 years of work experience.

4. Statistical analysis and results

4.1. Reliability

The study used established multi-item scale which past researchers had validated to measure all study constructs through a five-point Likert scale that ranged from 1 (strongly disagree) to 5 (strongly agree).

Table 2: Summary of study items and alpha values

Construct	Source	Items	α
Digital Leadership (DL)	Meier et al. (2017)	06	0.891
Sustainable Performance (SP)	Del Soldato and Massari (2024)	05	0.773
Green Self-efficacy (GSE)	Chen et al. (2015)	06	0.858
Green Innovation Process (GIP)	Al Halbusi et al. (2023)	04	0.944
Top Management Innovativeness (TMI)	Truong et al. (2024)	06	0.867

Table 2 shows the reliability analysis of the study constructs by the Cronbachs alpha (α). All constructs findings to excellent levels of internal consistency, which determines the strength of the measurement scales. Digital Leadership (DL), which was assessed using six items based on a study by Meier et al. (2017), had a high reliability value (0.891), which means that the six items are highly consistent. Sustainable Performance (SP) with a 5-item scale adapted by Del Soldato and Massari (2024) had an average level of reliability (0.773), which may be considered a respectable figure in social science studies. In the same way, another measure, including six items, Green Self-efficacy (GSE) by Chen et al. (2015) also had a high reliability (.858). The best internal consistency was observed when the scale was evaluated as the Green Innovation Process (GIP) scale, based on four items created by Al Halbusi et al. (2023) with the highest reliability of the scale (0.944). Lastly, the top management innovativeness (TMI) with six items per Truong et al. (2024) also showed a high reliability (= 0.867). Thus, the alpha values of Cronbach verify the reliability of the used measurement tools in this study; all the constructs are above the required recommended value of 0.70. Hence, this make sure that scale capture the desired views makingfuture statistical analyses more valid.

4.2. Correlation test

Table 3: Summary of corroration test

Variable	Mean	SD	DL	SP	GSE	GIP	TMI
DL	4.12	0.76	1				
SP	3.98	0.81	0.527**	1			
GSE	4.05	0.73	0.486**	0.612**	1		

GIP	3.89	0.78	0.503**	0.589**	0.554**	1
TMI	4.20	0.69	0.441**	0.498**	0.472**	0.460**

The correlation matrix reveals that there are significant and positive correlations between all the variables in this study; digital leadership (DL), green self-efficacy (GSE), green innovation process (GIP), sustainable performance (SP), and top management innovativeness (TMI) with all the correlations having a $p < 0.01$ level of significance. Digital leadership has moderate positive relationships with sustainable performance ($r = 0.527$), green self-efficacy ($r = 0.486$), green innovation process ($r = 0.503$), and top management innovativeness ($r = 0.441$), which demonstrates its pivotal position in enabling sustainability and innovation performance. Green self-efficacy ($r = 0.612$) and green innovation process ($r = 0.589$) are closely related to the sustainable performance, which means that the confidence of employees in their green performance and organizational innovation practices is a key factor in achieving sustainability. Likewise, the top management innovativeness is modestly related to all other variables, which serves to support the significance of leadership commitment and innovative mentality towards the development of the digital transformation and sustainable practices. In general, the results indicate the presence of a coherent model, in which leadership, innovation and self-efficacy have a joint positive influence on sustainable performance.

4.3. KMO and BTS test

Table 4: Summary of KMO and BTS test

Variable	KMO	χ^2	p	Decision
Digital Leadership (DL)	0.842	312.45	.000	<i>Adequate</i>
Sustainable Performance (SP)	0.876	298.72	.001	<i>Adequate</i>
General Self-Efficacy (GSE)	0.791	254.18	.000	<i>Adequate</i>
Green Innovative Process (GIP)	0.815	276.93	.000	<i>Adequate</i>
Top Management innovativeness (TMI)	0.867	341.56	.000	<i>Adequate</i>

The KMO and BTS results show that the data is adequate to perform the factor analysis. Each variable retains a KMO value greater than threshold value of 0.70. In specifically, there is a high sampling adequacy of the Sustainable Performance (0.876) and Top Management Innovativeness (0.867), Digital Leadership (0.842), Green Self-Efficacy (0.791), and Green Innovative Process (0.815). Moreover, Bartlett Test is also very important to each of the constructs suggesting that the associations between items are not arbitrary. All of these findings confirm the suitability of the factor analysis and the fact that the measurement model is statistically fit.

4.4. Hypotheses testing

Table 5: Summary of (H1, H2, H3, and H4)

Hypotheses	Path / Effect	β / Indirect Effect	SE	t / Boot LLCI-ULCI	p	Decision
H1	DL \rightarrow SP (Direct)	0.527	0.053	t = 9.876	0.001	Accepted
H2	DL \rightarrow GSE \rightarrow SP (Mediation)	0.118	0.032	[0.059, 0.186]	0.001	Accepted
H3	DL \rightarrow GIP \rightarrow SP (Mediation)	0.135	0.036	[0.068, 0.211]	0.001	Accepted
H4	DL \times TMI \rightarrow SP (Moderation)	0.142	0.049	t = 2.894	0.004	Accepted
Additional	Direct effect after mediation (DL \rightarrow SP,	0.329	0.071	t = 4.634	0.001	-

		controlling for GSE & GIP				
Additional	Simple slope: DL → SP at Low TMI	0.325	0.081	t = 4.012	< 0.001	-
Additional	Simple slope: DL → SP at High TMI	0.609	0.077	t = 7.909	< 0.001	-

The findings of all the hypotheses are shown in above table 5. In (H1) there is positive and significant relationship between DL and SP (0.527, 0.001), meaning that the leaders who believe in digital transformation provide a direct effect on achieving the outcomes of sustainability. Thus, this study accepted H1. Similarly, in (H2) Self-Efficacy (GSE) partially mediates the relationship between DL and SP, and because zero does not exist in LLCI and ULLCI (0.059, 0.186). Further, green innovative process (GIP) also partially mediate the relationship between DL and SP, and zero does not exist (0.068, 0.211) respectively. thus, confirming hypotheses H2, and H3. Additionally, top management innovativeness (TMI) moderate the relationship between DL-SP, ($t=2.89$, $p=0.04$). Thus, we identified confirmation of H4. Simple slope analysis showed that the effect of DL on SP is significantly greater under a high TMI (= 0.609) than under low TMI (= 0.325). This highlights the magnifying aspect of strategic leadership support in transforming digital initiatives into performance sustainability.

4. Discussion

The results of this research give good explanations to believe that digital leadership has boundless influence to improve sustainable performance of IT companies. The findings support the thesis that those leaders combining technological foresight and strategic agility are in a better position to match the digital transformation to the environmental goals. This confirms previous research by Zada et al. (2023), who note that digital leadership is a key determinant of sustainability in the context of organizational innovation. Likewise, Amjad et al. (2024) indicated that digital leaders can create resilience and alignment to ESG by integrating sustainability in digital strategies. Notably, the paper shows that green self-efficacy and green innovation processes mediate the relationship between digital leadership and sustainable performance. The self-efficacy in employees regarding their contributions towards environmental objectives (green self-efficacy) was observed to play a significant role in strengthening the sustainability results, which aligns with the results of Sanchez-Garcia et al. (2024). Similarly, the green innovation process, as a structured process of developing environmentally friendly technologies and practices, turned out to be an important channel according to which the digital leadership can be transformed into a concrete impact on the environment, which is in line with the position of Pujari (2006) and Abbas (2024). The mediating effect of top management innovativeness further supports the role played by executive orientation. The findings indicate that the positive impact of digital leadership on sustainability is increased when the executives are innovative. This conclusion builds on the research of García-Morales et al. (2012) and Khaw et al. (2022), who posited that innovative leaders invest in the development of green R&D and make the corporate strategy more sustainable. On the other hand, in companies that are not highly innovative, the risks that digital leadership can turn out to be a mere symbol, the sustainability initiatives are underfunded or opposed.

This study is novel in that it provides an integrated framework, comprising of mediators (green self-efficacy and green innovation) and moderator (top management innovativeness) to understand how digital leadership increases sustainable performance. The broad based approach applies more especially when it comes to IT sector of an emergent economy where institutional and resource constraints usually hinder the uptake of sustainability. The overall connotation is that digital leadership is not really cosmetic but radical in the presence of employee confidence, innovation process, and executive innovativeness.

4.1. Theoretical implications

This research is a contribution to the theory in various facets. First, it builds on the Upper Echelons Theory (Hambrick and Mason, 1984) since it proves that executive innovativeness defines the manner in which digital leadership strategies are executed, thereby affecting sustainability outcomes. Second, it is based on the Dynamic Capabilities Theory (Teece, 2007) indicating that the combination of digital leadership and top management innovativeness are dynamic capabilities that allow firms to respond to technological shock and environmental influences. Third, it supports the Resource-Based View (Barney, 1991) by placing green innovation and self-efficacy as resources as highly valuable, scarce and inimitable, which generate competitive advantages in the long term. The originality of the study is the combination of leadership, innovation and self-efficacy in one framework of sustainability in performance in the field of IT. The research contributes to sustainability and leadership literature by empirically confirming this model in an emerging economy environment with a more detailed insight into the interaction of digital leadership with organizational and executive variables to produce environmental results.

4.2. Practical implications

The implications of the findings are of great consequence to the managers, executives and policy makers. Among the IT managers, the findings indicate the worth of investment in training programs that can cultivate a green self-efficacy in the employees. Sustainability oriented hackathons, code optimization and green skill development programs can enable the employees to play their own roles towards environmental objectives. To the executives, the study highlights the importance of promoting innovativeness in the top management. This is possible through promoting risk-taking, investing in green R&D, integrating sustainability KPIs in performance reviews, and promoting transformative projects including carbon-neutral cloud infrastructures. To policymakers, the findings indicate that IT companies within emerging economies need institutional support and incentives to implement green innovation and sustainable digital infrastructure. Sustainability can be speedily integrated by promoting the use of renewable energy in IT operations, availing tax incentives



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toward green innovation, and enhancing the regulatory frameworks. In general, the research confirms that sustainability is not an obligation but a competitive tool, which improves brand loyalty, strength, and compliance.

4.3. Future directions and limitations

The research has useful information, it has a number of limitations that should be recognized. To begin with, the data were gathered in a single province (Khyber Pakhtunkhwa), and this might reduce the scope of generalization. Second, the cross-sectional design does not allow making causal inferences because the relationships were captured at one time. Third, the use of self-reported measures is associated with the risk of bias since the respondents could exaggerate their practices of sustainability. This can be overcome by conducting future studies that will cover these limitations by including other sectors of the economy like manufacturing, healthcare and tourism among others where the issues of sustainability vary. The longitudinal designs would have the ability to measure sustainability over time, which would be better causally. It may also be possible to investigate additional moderators like organizational culture, regulatory environment, or stakeholder pressure to develop further insight into the circumstances in which digital leadership leads to sustainability. It would also be helpful to compare the emerging and developed economies to determine whether the findings can be generalized to other institutions.

5. Conclusion

This study aimed at investigating the relationship between digital leadership and sustainable performance in IT companies, the mediating variables of green self-efficacy and green innovation process, and the moderating variables of top management innovativeness. The results affirm that digital leadership is an excellent predictor of sustainability, though its aspects are highly enhanced when the employees have the assurance that they can make contributions, when the innovation processes are engrained and when the executives are innovative. The work of this study has threefold contributions. In theory, it combines leadership, innovation, and self-efficacy into a unified system that adds further to the already existing theory, including Upper Echelons, Dynamic Capabilities, and the Resource-Based View. In practice, it provides advice to IT managers, executives, and policymakers concerning how they can reconcile digital transformation with sustainability requirements. In context, it provides empirical data in an emerging economy, which is a gap in the literature and represents the special issues and opportunities of IT companies in such environments. It can be noted that digital leadership, together with innovation and sustainability, is not only a management competency but a strategic pipeline towards resilience and competitive advantage in the digital era. The IT firms can make digital transformation a catalyst of long-term sustainable performance by creating employee confidence, introducing green innovation, and developing executive innovativeness.

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