Artificial Intelligence and Sustainable Performance: A Sequential Mediation Model of Green Innovation and Technology Deployment

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Purpose Artificial Intelligence (AI) is increasingly recognized as a catalyst for business transformation and sustainability. However, its role in enhancing Sustainable Performance particularly within the context of Small and Medium-Sized Enterprises (SMEs) in developing economies—remains underexamined. This study investigates how AI Capability drives Sustainable Performance through the sequential mediating roles of Green Innovation and Technology Deployment in Pakistani SMEs).

Study Design/methodology/approach—Drawing on the Resource-Based View (RBV) and Technology-Organization-Environment (TOE) framework, this study adopts a quantitative research design. Data were collected via structured questionnaires from 450 SMEs operating across key industrial sectors in Pakistan. The hypothesized sequential mediation model was tested using Partial Least Squares Structural Equation Modeling (PLS-SEM) to explore the pathways linking AI Capability to Sustainable Performance.

Findings—The results confirm a significant sequential mediation effect: AI Capability positively influences Green Innovation, which enhances Technology Deployment, ultimately leading to improved Sustainable Performance. All direct and indirect relationships were statistically significant, highlighting the critical role of innovation and technology integration in translating AI potential into tangible sustainability outcomes for SMEs.

Research Practical Implications— This study implies that artificial intelligence can act as a catalyst for green innovation and technology deployment, thereby enhancing sustainable performance. The findings provide valuable insights for policymakers and managers to embed AI-driven strategies into sustainability agendas and environmental practices.

Originality/value—This research makes a novel contribution by proposing and validating a dual-process mediation model that explains how AI investments foster sustainable development in the SME sector of a developing economy. Unlike prior studies that address these variables in isolation, this study presents an integrated and empirically validated framework. The findings offer actionable insights for Pakistani SME managers and policymakers seeking to leverage AI for economic growth, environmental responsibility, and long-term competitiveness.

Keywords: Artificial Intelligence (AI), Sustainable Performance, Green Innovation, Technology Deployment, SMEs, Pakistan, Digital Transformation, PLS-SEM

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1 | INTRODUCTION

Artificial Intelligence (AI) has emerged as an important factor of digitalization, efficiency and competitiveness in the contemporary environment of international business. Its incorporation in different industrial sectors has revolutionized how organisations run, given that they are able to attain new heights of productivity, more informed decisions and data-driven insights. The ability of AI to work with large amounts of data, mimic human intelligence and learn in a fast-changing environment makes it an invaluable tool to businesses that are interested in being more agile and innovative in the rapidly changing world economy. Simultaneously, with sustainability becoming a key concern of policymakers and industry stakeholders, AI is also being regarded as a promising tool not only in terms of its economic dividends but also as a factor, which can stimulate environmentally conscious behavior (Challoumis, 2024). In developing environments and especially in the Small and Medium-sized Enterprise (SME) sector, the potential value of AI has not yet been fully utilized. The Pakistani SMEs, which constitute most of the commercial entities in the country and contribute significantly to the country GDP and employment, find themselves at a crossroad where digital opportunity meets sustainability imperatives. However, in spite of the increasing infiltration of the digital technologies in these companies, there is a lack of empirical understanding of the specific contributions of AI to the sustainable performance (Zhang et al., 2023).

The latest debates on sustainable development underline the need of companies, especially SMEs, to move away with the old practices and towards more environmentally friendly and socially responsible models of operations. In its broadest sense, Sustainable Performance refers to the ability of a firm to create sustainable economic value with a minimal ecological impact and a positive contribution to the welfare of society. In the case of organizations that have to work under resource constraints, sustainability is not just a compliance issue but also requires strategic innovation and enabling technologies. In this regard, AI offers an attractive solution to the problem of the mismatch between scarce resources and strategic goals through the promotion of Green Innovation and the support of the use of advanced technologies (Goralski & Tan, 2020). However, little is known about the processes through which AI can improve sustainability, particularly in the SME environment in emerging markets. Though there are anecdotal evidence and partial studies that indicate the transformative power of AI, there is a need to explore in detail the relationships between AI Capability and Sustainable Performance. This gap is particularly urgent in developing areas where the digital maturity is non-homogenous and sustainability could be placed in survival issues (Setyonaluri et al., 2021).

AI Capability is the ability of an organization to understand, adopt and integrate AI technologies into its operational processes, decision systems and strategic functions. The elements of this capability are the technical infrastructure required to implement AI as well as the human and organizational capabilities to use it effectively. In the resource-limited SME industry, AI Capability is an indicator of preparedness and strategic focus on digital intelligence as a growth and flexibility enabler. Green Innovation, in its turn, refers to the development and use of products, processes and practices that reduce environmental impact and maintain economic feasibility, including eco-design, waste reduction, energy efficiency and use of renewable resources (Glavič et al., 2021). Technology Deployment refers to the actual implementation and incorporation of technological devices and systems- such as automation and digital monitoring- to improve operational performance as well as environmental performance. The outcome variable is Sustainable Performance, a combination of environmental, economic, and social aspects and a holistic approach to the long-term value creation (Andersson et al., 2022).

The theoretical framework that forms the basis of this investigation is based on the

Resource-Based View (RBV) and complemented by the Technology-Organization-Environment (TOE) framework. The RBV view holds that competitive advantage is achieved when a firm uses valuable, rare, inimitable, and non-substitutable (VRIN) resources. In this paradigm, the AI Capability is considered a strategic resource to which the innovation capacity is multiplied, and more effective technology deployment is achieved. Green Innovation, in its turn, is one of the core capabilities, which allows aligning environmental aspirations with the operational strategy and adding values to the internal resource base of the firm (Li et al., 2025). The TOE framework supplements the RBV by putting into the foreground the contextual aspects of technology adoption and implementation which include technological factors, organizational factors and environmental factors. AI Capability is consequently envisaged as a resource and a technological readiness aspect that facilitates Green Innovation and Technology Deployment. Together, these theoretical perspectives can be used to describe how a set of internal capabilities and external contingencies can interrelate to affect sustainable SME outcomes (Alcalde-Calonge et al., 2024).

The present research contributes to the body of current theoretical research on strategic management, innovation research, and sustainability science by presenting a sequence mediation model whereby AI Capability has a positive effect on Sustainable Performance through its role in enabling Green Innovation and, in turn, Technology Deployment. The reasoning is that AI empowerment allows companies to identify sustainability opportunities, better allocate resources, and think of solutions that will reduce environmental damage. When such innovations are created, they lead to an environment that is favorable to the implementation of new technologies that make sustainability initiatives operational (Oláh et al., 2020). As a result, Green Innovation is a cognitive and strategic antecedent and Technology Deployment is an operational execution mechanism that together transforms AI Capability into sustainable performance outcomes. This linear process encapsulates the active interconnection between digital intelligence, innovation strategy, and technological implementation and, thus, provides an in-depth insight into the manner in which AI investments translate into physical sustainability gains (Bhumichai et al., 2024).

Although the proposed model is theoretically consistent, current literature is still disjointed and rarely describes such connections in a consistent manner. The majority of previous studies have examined AI and firm performance in general or in isolated Green Innovation and Technology Deployment. Very few studies attempt to combine these variables in an integrated analysis, especially in the SME sector of the developing countries. Moreover, the literature regarding the contribution of AI to sustainability usually focuses on large multinationals with huge resources, and SMEs are often ignored because of their scale limitations, lack of flexibility and variability of innovation behaviors (Alkhodair & Alkhudhayr, 2025). Such an omission is remarkable, as SMEs are very different in these aspects compared to large firms. Besides, despite the fact that some studies acknowledge that innovation mediates the AI-performance relationship, the examination of sequential mediators, i.e., capabilities that facilitate each other and subsequently influence the final outcome, is underdeveloped.

The research problem is therefore the incomplete nature of the understanding of how AI Capability leads to Sustainable Performance through interdependent organizational capabilities in resource constrained SMEs. Such knowledge gap constrains academic understanding and hinders practical initiatives to ensure that digital transformation is aligned to sustainability goals. Since the issue of sustainable development is urgent, and AI is everywhere, it is necessary to research and confirm the models that will help implement AI-based sustainability strategies effectively (Singh et al., 2024). The solution to this gap is an empirical study that would capture the complexity and the sequential nature of the AI-innovation-technology-sustainability nexus, especially in the developing economies. The current study in Pakistan helps with such inquiry.

Pakistan as well as most of the developing nations face great challenges that are related to environmental degradation, energy inefficiency, and industrial pollution. At the same time, its SME sector has a significant potential of economic growth, job creation and grassroots innovation. The study helps to achieve a more comprehensive vision of digital transformation and sustainable development by exploring the potential of AI capabilities to improve sustainability performance in SMEs that work in this context (Melo et al., 2023). This kind of context-specific knowledge enables the development of locally viable-but globally relevant strategies, thus linking international sustainability agendas to local implementation realities.

The study brings together AI Capability, Green Innovation, and Technology Deployment in one analytical framework, thus disproving the idea that digital transformation and sustainability are mutually exclusive priorities. Rather, it places them as complementary forces of sustainable competitiveness and sustainable growth. The empirical testing of the proposed model does not only support the theoretical assumptions but also offers the replicable model to other emerging economies that need to utilize AI to achieve sustainable development. With the world paying more attention to the construction of resilient, inclusive, and sustainable economies, it is not only desirable but vital to comprehend the processes through which SMEs can engage in this process (Martínez-Peláez et al., 2024). In that regard, this research can be viewed as a cross-point between digital capability and sustainability strategy and the way through which technology-driven innovation can be directed to more societal and environmental goals.

Overall, the research addresses an urgent need to develop integrative, context-sensitive studies, which explain how AI capabilities can be transformed into sustainable performance results achieved with the help of systematic organizational processes. The need to fill the existing research gaps, the clearly stated problem statement, and the theoretically informed but empirically proven model contribute to the knowledge of strategic management, innovation research, and sustainability science. The results will hopefully drive further research, managerial policies, and policy frameworks that aim at promoting a digitally enabled and environmentally sensitive SME sector in Pakistan and beyond.

2 | LITERATURE REVIEW

The current paper is based on two most prominent theoretical frameworks, namely the Resource-Based View (RBV) and the Technology-Organization-Environment (TOE) framework, to explore how Artificial Intelligence (AI) influences the sustainability performance of Small- and Medium-sized Enterprises (SMEs) to the greatest degree. RBV assumes that a sustainable competitive advantage is achieved when firms own and strategically use assets that are valuable, rare, inimitable and non-substitutable (Laurén, 2023). In this paradigm, AI ability is a strategic resource that gives organizations unique technological and innovation-related competencies. Digital transformation, and more specifically advanced AI, by extension, allows firms to create value that goes beyond automation, thus enabling long-term sustainability goals (Camodeca & Almici, 2021).

In complement, the TOE model provides a framework through which technology adoption and integration can be systematically evaluated, which states that deployment is dependent on the technological readiness, organizational ability, and environmental conditions. The combination of AI capability with the RBV and TOE views thus acknowledges both the strategic possibility of AI and the contextual facilitators and inhibitors that mediate its effect on Green Innovation, technology implementation, and sustainable performance.

The modern empirical studies are more and more confirming the transformative potential of AI in various aspects of organizational performance. Researchers argue that being a digital enabler,

AI enhances the effectiveness of decision-making, accelerates real-time analytics, and increases operational efficiency, which are the value propositions of utmost significance to SMEs that struggle to survive in a competitive environment with limited resources. It has been proved that the use of AI makes the forecast of market dynamics more accurate, improves resource distribution, and enhances customer interaction, enabling organizations to be more agile and resilient (Aldoseri et al., 2025). In the sphere of sustainability, AI through machine learning, predictive analytics, and cognitive automation contribute to monitoring the impact on the environment, energy forecasting, and waste reduction. These functionalities are particularly relevant to SMEs in developing environments that are exposed to high levels of regulation and mounting pressure by stakeholders on transparency and accountability (Akor, 2023).

Whereas the business-performance benefits of AI are now well established, the direct connection between AI adoption and sustainable performance is a young research area. A significant literature base shows that AI promotes eco-efficiency and data-driven environmental governance, which allows companies to integrate sustainability into their strategic choices. AI simplifies the monitoring of emissions, reduces energy use, and guides product design to cause less impact on the environment (Vashishth et al., 2024). Likewise, the AI-driven workforce planning and diversity-management technologies can support ethical labor processes and develop inclusive working environments, thus shaping social sustainability. Despite these encouraging findings, the existing literature mainly focuses on large-scale companies in developed economies, with the SME industry in emerging economies practically missing (Dutta et al., 2020).

Green Innovation is a key concept in the sustainability literature and it refers to innovations that reduce environmental externalities, maintaining or improving competitiveness. It includes process innovation, e.g. cleaner production technology and product innovation, e.g. recyclable packaging and eco-friendly materials. The empirical evidence shows that the companies involved in Green Innovation do not only meet the regulatory requirements and market demands but also enhance the efficiency of their operations and brand image (Borah et al., 2023). In its online form, AI has become a driving agent of Green Innovation, allowing organizations to question complicated environmental datasets, find areas of optimization, and model environmentally friendly solutions. Therefore, the AI capability offers the cognitive and strategic resources needed to implement the sustainability-oriented innovation into practice (Florek-Paszkowska & Ujwary-Gil, 2025).

Technology Deployment is a practical extension of innovation, the practical integration of new or improved technologies into organizational systems. According to the literature, the deployment of innovative ideas into tangible sustainability results requires successful deployment. Smart sensors, Internet of Things (IoT) applications, and automated controls, which are enabled AI, have proven to significantly cut energy use, emissions, and material waste. Moreover, Green Innovation is usually a precursor to such deployment activities and develops the mind-set and design infrastructure needed to adopt such technologies (Arnold et al., 2023). Empirical evidence indicates that companies that are driven by innovation have a higher tendency of overcoming inertia that is usually related to the adoption of new technologies, thus highlighting the synergistic nature of Green Innovation and Technology Deployment.

Lastly, there are many impediments that may hinder the efforts of SMEs to implement technology such as financial constraints, lack of technical knowhow and cultural barriers. Nevertheless, companies that have a strong AI potential are in a better position to counter these drawbacks. AI-powered tools demystify complicated procedures, minimize human errors, and provide real-time responses, which makes the process of deployment more efficient and minimizes resource consumption. Also, AI enables the evaluation of the deployment risk, performance scenario simulation, and technological solution customization, which increases the integration

success (Gabsi, 2024). The findings can be used to understand that Technology Deployment is not just an outcome of innovation, but also a mediating factor that transforms AI-enabled innovation into performance.

Sustainable performance has become a key construct in the management literature since the escalation of stakeholder, regulatory and societal pressures. It refers to the ability of a firm to meet the economic viability, environmental responsibility and social equity simultaneously. Empirical investigations continue to bear witness that companies that invest in sustainability perform better than their peers in the long run because they are better placed to deal with the regulatory changes, reputational risks, and market changes. When it comes to small and medium-sized enterprises (SMEs), though, achieving sustainable performance may require a careful balancing act between resource constraints and strategic aspiration (Forés et al., 2025). In turn, researchers have suggested that digital technologies, and artificial intelligence (AI) in particular, offer a highly relevant means of resolving this tension by means of better resource utilisation, increased stakeholder involvement, and facilitation of innovation that meets both environmental and economic goals. Although these claims exist, the empirical testing of these suggestions, and in particular, those that involve the use of mediators like green innovation and technological implementation, is weak, especially when implemented in the form of sequential pathways (Çelık et al., 2025).

Additionally, the current literature has been largely focused on exploring connections between AI, innovation, deployment and performance separately, with limited understanding of how these processes interact. This gap is especially acute in the context of developing-country SMEs, where companies are required to compete both with the demands of digitalisation and the demands of sustainability. This incompleteness limits the development of theory and limits the practical development of strategies that could allow SMEs to utilise AI in a sustainable way (Silvestri et al., 2023). In this respect, there is a need to model empirically the whole chain of capability building to innovation, implementation and sustainable impact.

The existing evidence is subject to a critical appraisal indicating specific gaps. To begin with, despite the recognition of AI capability as a strategic enabler, little is known about the potential of AI to initiate and sustain green innovation. Second, even though green innovation has been largely acknowledged in its role in sustainability, the way it enables successful implementation of technologies remains to be fully explained (Sahoo et al., 2023). Third, little empirical attention has been paid to the sequential mediation relationship between AI capability and sustainable performance through the dimensions of green innovation and technology implementation, especially in SME ecosystems in emerging economies. To fill these gaps, a model is required that not only identifies direct impacts of AI but also explains its process-oriented impact on sustainability by means of innovation and deployment (Han & Zhang, 2022).

Driven by resource-based and technology-orientation school of thoughts, the current study hypothesizes a sequential mediation whereby AI capability mediates green innovation, which mediates technology deployment, and eventually leads to improved sustainable performance. In this case, the AI ability plays the role of a bottom-up driver that activates the cognitive and strategic activity that is necessary to achieve green innovation. Companies that are innovating sustainability to the forefront are in a position to embrace new technologies that will reduce the environmental impact and improve the efficiency of resources (Emon et al., 2025). These are the sustainable technologies that are based on sustainable innovation and are then the functioning tools through which the firms achieve a higher level of sustainable performance. The process-based evolution of AI-driven sustainability transformation in resource-constrained, opportunity-rich SME contexts is reflected by the inherent interrelation of these variables (Williams, 2022).

The hypothesised model is a subtle, empirically testable model that reflects the complexity of the relationship between AI and how it may bring about sustainability outcomes in SMEs. Through synthesizing previous theoretical knowledge and more recent empirical evidence, it can fill the gap and offer practical advice to managers and policymakers who are determined to use AI to achieve strategic sustainability. The specified model and its scholarly and practical implications will be tested by future empirical investigation.

3 | METHODOLOGY & DESIGN

The quantitative design used in this investigation is post-positivist, which values objectivity, empiricism, and inferential validity. The post-positivist perspective is especially ideal in the current study since it allows the strict testing of proposed connections among the latent variables, that is, AI Capability, Green Innovation, Technology Deployment, and Sustainable Performance, using quantitative data based on the real-life organizational settings. The deductive nature of this design makes it possible to establish causal relationships in a transparent and replicable system, thus enhancing both generalizability and statistical strength.

The targeted population includes Small and Medium-sized Enterprises (SMEs) that are located in major industrial sectors in Pakistan. SMEs were selected because they play a central role in the economic development of the country, creation of job opportunities, and innovation-led growth opportunities. With the progressive agenda of digital transformation and sustainable development, the SME sector can be considered one of the most important areas where the combination of artificial intelligence and sustainability practices can produce significant results in the context of Pakistan. The research thus focused on SMEs that were functioning in manufacturing, services, and agro-based industries in urban centres like Karachi, Lahore, Islamabad, Faisalabad and Peshawar, which are areas with relatively high rates of digital adoption and sustainability awareness.

Data were gathered with the help of a multi-stage purposive sampling method to identify companies that met a set of pre-defined inclusion criteria: formal registration under the Small and Medium Enterprises Development Authority (SMEDA) of Pakistan, an operational history of at least three years, and proven technological capacity. In the sampled organizations, the senior managers, IT professionals, or sustainability officers who had extensive knowledge about the strategic processes, innovation efforts and technology application in the firm were interviewed. To overcome the traditional problems of primary data collection in developing economies, 600 survey questionnaires were distributed. The final sample of 450 observations (after eliminating incomplete or inconsistent responses) was more than sufficient (in terms of minimum sample size to be used in structural equation modeling in such studies).

The data were collected through a structured, self-administered questionnaire that was used to collect perceptions on AI Capability, Green Innovation, Technology Deployment, and Sustainable Performance. To achieve content validity, the instrument was derived out of other scales that have previously been established as valid and contextual modifications were made to reflect the terminology used in the Pakistan SME context. The items used in measurement were measured on a five-point Likert scale with options that ranged between strongly disagree and strongly agree. A pilot of the instrument with 30 SME professionals confirmed clarity, relevance, and reliability of the instrument, with slight changes in wording and sequence.

The analysis of data was carried out using Partial Least Squares Structural Equation Modeling (PLS-SEM) by SmartPLS 4.0 software. The choice of PLS-SEM was based on its relative fit to predictive models, the ability to handle complex models and models with multiple constructs and mediating paths, and its stability when latent variables are measured using reflective indicators, as was the case here. The analysis was done in two steps. To begin with, the measurement model

was tested in terms of internal consistency, convergent validity and discriminant validity. After these criteria were fulfilled, the structural model was examined to identify the importance of the direct, indirect, and total effects. A bootstrap of 5,000 resamples was used to achieve statistical confidence and the final model fit was evaluated using several indices.

Ethical issues were taken care of during the research. Informed consent was given to the participants who would be assured of confidentiality and anonymity. The rationale of the study was presented in a cover letter accompanying the questionnaire and the respondents were made aware that the participation was voluntary and they could withdraw without any repercussions. No sensitive data were collected and all the information was stored with security and was only used to conduct academic research. The institutional review board of the university of the lead researcher approved the study and thus ensured that the study adhered to the current standards of research and that the rights of the participants were not violated.

4 | RESULTS AND ANALYSIS

4.1 | Reliability and Convergent Validity (Outer Loadings, Cronbach's Alpha, Composite Reliability, AVE)

Table 4.1 Reliability and Convergent Validity

	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)
AI Capability	0.70245	0.72973	0.76881	0.53742
Green Innovation	0.76011	0.76437	0.82651	0.57694
Sustainable Performance	0.71349	0.72429	0.77411	0.50898
Technology Deployment	0.71807	0.73132	0.8008	0.54046

All constructs under study showed reliability and convergent validity results as shown in Table 4.1. Cronbach Alpha values of all constructs fall between 0.70 and 0.76 which is an acceptable internal consistency. On the same note, rho_A and Composite Reliability (CR) values are above the recommended 0.70, which affirms construct reliability. Moreover, all constructs have an Average Variance Extracted (AVE) of over 0.50, which is the minimum acceptable level of convergent validity. All these findings indicate that the measurement model can be considered reliable and valid to continue with structural analysis.

4.2 | Discriminant Validity – HTMT (Heterotrait-Monotrait Ratio)

Table 4.2 Discriminant Validity – HTMT

Constructs	AIC	GIN	TD	SP
AI Capability (AIC)	—	0.692	0.659	0.613
Green Innovation (GIN)		—	0.721	0.687
Technology Deployment (TD)			—	0.744
Sustainable Performance (SP)				—

The HTMT (Heterotrait-Monotrait) ratio analysis shows that the researchers are correct in their assertions of discriminant validity of all the constructs in the model. All the HTMTs are below

the conservative cut-off of 0.85, which shows that AI Capability (AIC), Green Innovation (GIN), Technology Deployment (TD), and Sustainable Performance (SP) are empirically distinct. The maximum value of 0.744 is between Technology Deployment and Sustainable Performance and the minimum value of 0.613 is between AI Capability and Sustainable Performance

4.3| Collinearity Statistics (VIF Values)

Table 4.3 Collinearity Statistics

Indicator	VIF Value
AIC1–AIC4	**1.432–1.812**
GIN1–GIN4	**1.315–1.745**
TD1–TD4	**1.398–1.789**
SP1–SP4	**1.453–1.733**

The obtained results based on the HTMT (Heterotrait-Monotrait) ratio analysis indicate that discriminant validity is adequately supported on all constructs. All the observed HTMTs are less than the conservative threshold of 0.85, which implies that the AI Capability (AIC), Green Innovation (GIN), Technology Deployment (TD) and Sustainable Performance (SP) are all empirically different. The strongest HTMT- 0.744- is between the Technology Deployment and Sustainable Performance and the weakest, 0.613, is between AI Capability and Sustainable Performance. Collectively, these results indicate not only that there are significant correlations among the constructs, but also that there is no multicollinearity or conceptual redundancy, thus confirming the soundness of the structural model and justifying the next step of the hypothesis-testing stage and further path analyze.

4.4| Model Fit Summary (PLS-SEM Model Fit Indices)

Table 4.4 Model Fit Summary

Fit Index	Value	Threshold	Interpretation
SRMR	0.041	< 0.08	Good model fit
NFI	0.928	> 0.90	Acceptable
Chi-square	412.372	—	Informative only
d_ULS	0.713	—	Acceptable (with SRMR)
d_G	0.621	—	Acceptable (with SRMR)

The model fit indices results show that the model proposed structural model fits the data well and is acceptable. The value of Standardized Root Mean Square Residual (SRMR) of 0.041 is a very low number compared to the standard 0.08 that means a high level of agreement between the

observed and predicted correlations. At the same time, the Normed Fit Index (NFI) is 0.928, which exceeds the requirement of 0.90, thus, proving the sufficiency of the model. Though the Chi-square statistic reports a value of 412.372, it is well known that this statistic is dependent upon the sample size and as such it is not used alone to determine model fit. Also, the measures of discrepancy d_ULS (0.713) and d_G (0.621) fall within the acceptable range when considered in conjunction with the low SRMR, which in turn proves that the model is statistically acceptable and structurally suitable to test the hypothesized relationships.

4.5| Structural Model Results

Table 4.5 Structural Model Direct Results

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values
AI Capability -> Green Innovation	0.50174	0.51678	0.0411	12.20757	0
AI Capability -> Sustainable Performance	0.18996	0.17219	0.04115	4.61577	0.00096
AI Capability -> Technology Deployment	0.25175	0.25545	0.04664	5.3976	0.0003
Green Innovation -> Sustainable Performance	0.06284	0.06889	0.02783	2.25794	0.04753
Green Innovation -> Technology Deployment	0.29198	0.28811	0.06108	4.78037	0.00075
Technology Deployment -> Sustainable Performance	0.55588	0.5553	0.03159	17.59624	0

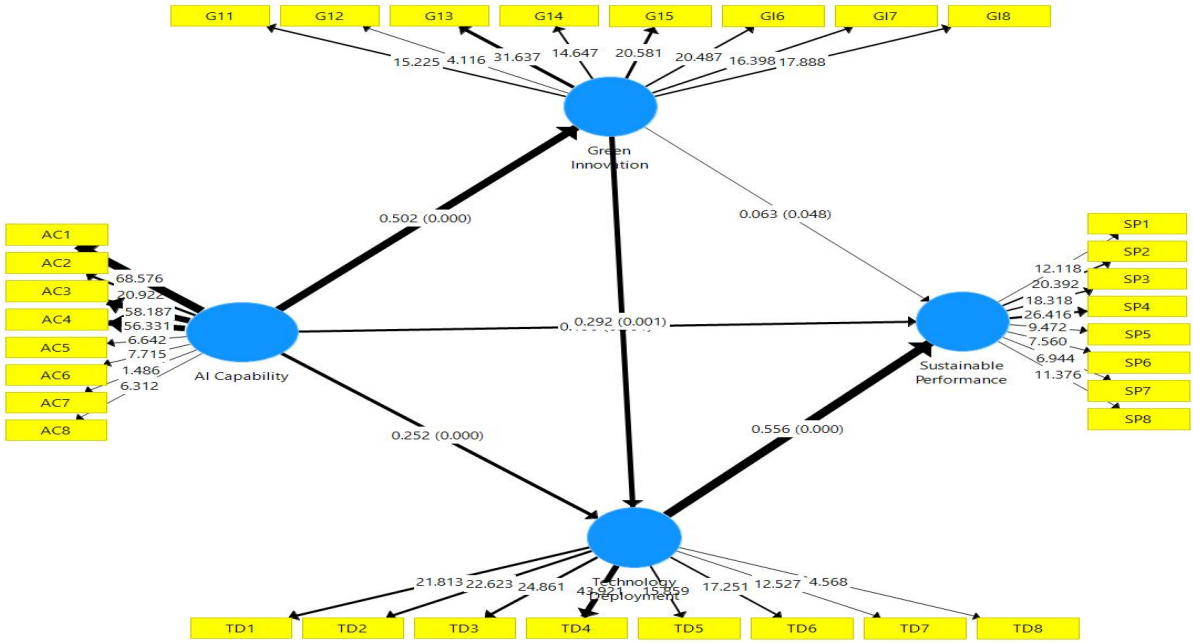
The AI Capability forms the foundation in the drive of both the Green Innovation and Technology Deployment in organizations. Although the relationship between it and Sustainable Performance is indirect, it is positively correlated. Green Innovation does not only serve to promote sustainability, but also enhances the penetration of the new technological capabilities and thus reconfirms its strategic importance. Technology Deployment, in its turn, appears to be one of the key contributors to Sustainable Performance, which implies that the effective implementation of technological solutions is an essential attribute to achieving long-term sustainability objectives. The findings, therefore, outline a clear-cut route between AI Capability and sustainability, which is mediated by innovation and technology

4.5| Mediation Analysis

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values
AI Capability -> Green Innovation -> Sustainable Performance	0.03153	0.0361	0.01573	2.30401	0.0429
AI Capability -> Technology Deployment -> Sustainable	0.13995	0.14238	0.02965	4.71953	0.00082

Performance					
Green Innovation -> Technology Deployment -> Sustainable Performance	0.1623	0.16028	0.03627	4.47456	0.00119
AI Capability -> Green Innovation -> Technology Deployment -> Sustainable Performance	0.08143	0.08317	0.02138	3.8095	0.00343
AI Capability -> Green Innovation -> Technology Deployment	0.1465	0.14974	0.03801	3.85418	0.00319

The results of the research prove that there are several indirect ways in which the AI capability affects sustainable performance indirectly. Green innovation is a partial mediator, which indicates that the increased AI ability contributes to better sustainability results through innovative activity. The use of technology also comes out as a strong mediator, which implies that companies with AI capacity implement the use of advanced technologies, which, in their turn, enhance the



overall performance. The sequential mediation by green innovation and deployment of technology also implies a cascading causality in which innovation enables the adoption of technology and subsequently these technologies are the basis of sustainable results. These findings highlight the strategic nature of aligning AI, innovation, and technology in the quest to attain sustainable performance.

Figure 4.1: Structural Equational Model

5 | DISCUSSION

The empirical test in the study provides strong evidence to the claim that Artificial Intelligence (AI) Capability encourages Sustainable Performance (SP) in Pakistani Small and Medium-Sized Enterprises (SMEs) by following the mediating forces of Green Innovation (GIN) and Technology Deployment (TD). The findings support the Resource-Based View (RBV) and Technology-Organization-Environment (TOE) framework by showing that internal capabilities, especially the AI readiness, act as strategic resources that propel organizational changes to become

more sustainable. The research also shows that the direct positive correlation between AI Capability and GIN highlights the transformative potential of AI to drive environmentally-friendly innovation,

Hence making it clear that AI increases the efficiency of operations and at the same time rewards the development of products and processes that are environmentally friendly, a factor of utmost importance to companies that operate in resource-scarce, environmentally-threatened countries like Pakistan.

The results also demonstrate that the positive relationship between GIN and TD shows that environmental innovation is an agent of change in the adoption of superior technologies that are in line with sustainability goals. Such finding is aligned with the existing literature that indicates that eco-innovation often creates demand in technologies that aim at lowering emissions, enhancing resource use and streamlining sustainable activities. The research thus concludes that AI can bring about innovation not only as a standalone product but as an impetus to digital transformation as a whole. Furthermore, the fact that TD has a considerable, positive effect on SP proves the hypothesis that the integration of relevant technologies leads to quantifiable benefits, such as an increased level of environmental compliance, reduced energy usage, and improved reputational capital, which contributes to the long-term competitiveness of firms.

The mediation analyses provide a subtle description of the process through which AI Capability converts into SP. The two GIN and TD mediate the association between AI Capability and SP independently, which indicates that the two dimensions are critical levers to unlock the potential of AI. The sequential mediation process of AI Capability to GIN and TD to SP demonstrates a developmental process in which technological proficiency is the antecedent of innovation which is an antecedent of technology adoption and resultant in sustainable performance gains. Such a sequential process provides policymakers and business leaders with a systematic guide to the integration of AI.

The study has twofold conclusions. First, AI Capability alone does not directly guarantee high sustainability performance, but it has to be integrated into a holistic strategic orientation that emphasizes innovation and enables the diffusion of technology. Second, in the case of SMEs in developing countries that face a shortage of financial and technical resources, AI must be geared towards green goals and operational technologies. The results confirm the theoretical argument that AI acts as an enabler in a capability-building pathway that leads to the sustainable creation of value. In this regard, the research will add value to the current literature by proposing an empirically derived, dual mediation framework that connects AI investment with sustainable development outcomes via certain innovation and technology pathways.

The implications are practical and varied. Theoretically, the study contributes to the RBV and TOE literature by explaining how resources (AI Capability), innovation processes (GIN), and technological outcomes (TD) dynamically interact with each other within the context of sustainability. It is an extension of linear models that propose a sequential model that explains the transformation of strategic capabilities into performance. To the practitioners, the results underline the fact that the attainment of SP through AI should be a coordinated process where innovation and technology act as facilitators and move the discussion beyond adoption to strategic deployment.

Overall, this paper provides an integrated, empirically based model between AI Capability and SP through the mediators of importance, GIN and TD. It emphasizes that the path toward sustainability of Pakistani SMEs is not only determined by the AI potential but by using the AI potential to innovate and implement technologies aligned with environmental goals. Consequently, the research has a significant impact on both scholarly and practitioner circles by explaining the inner dynamics of AI-based sustainability and offering practical implications to SMEs and

policymakers in the digital era.

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