Assessing Impact on Operational Performance with Green Information System and Mediation of Green Innovation

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Abstract

Using green production methods is the need of the situation and the only solution to the issue of sustainability. With this, the optimization of resources is the major concern contributing to maximum output. In the context of Pakistan's manufacturing business, this study presents significant literature on green information systems (GIS), green innovation performance (GIP), and operational performance (OP). This study explores the connection between OP and GIS as well as the mediating role of GIP. The partial least square-structural equation modeling (PLS-SEM) method has been opted for in this paper. About 180 usable responses were examined for the study. The structural model reveals about 60% variance in OP and 40% in GIP stating the predictive validity. The findings of the study reveal that GIS has a significant impact on OP and GIP. GIP has a direct influence on OP and a mediating role between GIS and OP highlighting the importance of greening, and its positive effect on OP. proposed for further investigation and the development of prototype design.

Keywords—Structural equation modeling, Green information system, Green innovation performance, Operational performance, Smart PLS.

1 Introduction

Sustainability is a multi-layered, complex idea that contains numerous components. Sustainability implies the balance and arranged utilization of assets before they arrive at the stage of weariness and the chance of self-restoration is ended. Social orders have now maintained their determination despite population growth and overconsumption of natural resources, understanding that there is a breaking point to the utilization of the environment and development. Sustainable development is defined as meeting existing demands without compromising the needs of future generations to meet their requirements. According to Vazquez-Brust and Sarkis [1] organizational sustainability and greening will be required to decrease social and environmental responsibility, but this will not be easy. Environmental sustainability is minimizing environmental burdens and providing a mutually beneficial solution between sustainability and economics this is a modern solution.

Industries, governments, and organizations have all taken notice of the growth and importance of "adopting green" and environmental sustainability. Green IT and IS have just lately started to demonstrate their intriguing, logical contributions to the environment. Through green innovation, businesses may increase the effectiveness of their assets. Additionally, businesses that lead the way in innovation will receive "principal mover benefits" that let them demand higher prices for green products. Chen, Lai [2] stated that green innovation is a software or hardware innovation related to green products or processes, including technological innovations that save energy, recycle waste, prevent pollution, and support corporate environmental management. He also stated that green innovation is positively correlated with corporate advantage meaning that in the long-run investment in green innovation will help a firm to establish itself more economically as well.

Green innovation is a unique way used with technologies that include waste recycling, preventing pollution, and energy-saving and green product design.

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Green innovation contributed a lot to organizational development toward sustainability. Green innovation is significant in a firm's performance management [3]. Green innovation is the modification and launch of new products, processes, and services that further reduce emissions and contribute to environmental sustainability [4]. In today's competitive environment firms adopting green innovation policies will give them a chance to advance. A system created to track these innovations and development is known as a green information system. By keeping track of the utilization of energy, resources, emissions, and other environmental effects of different business activities, an efficient GIS can assist a company in analyzing and reducing these effects. Green information system (GIS) is a social development since it includes making and applying innovations to screen, control, and reduce natural issues, especially regarding the environmental change, one of the most basic issues. According to Lai, Wen [5] green development is used to aid environmental management performance to satisfy the need for ecological protection. The Green Information System is an Energy Management System (EMS), which is an arrangement of computer-supported instruments in an organization to accomplish proficiency through properly laid out methodology and techniques to guarantee continuous improvement, and to spread awareness of energy productivity all through a whole association. According to Zhu, Sarkis [6] green information systems meant improving the flow and management of information. Various environmental software is there which support green information systems from managing emissions and keeping a check to reduce waste. Some other aspects include life cycle analysis (LCA), and Design for Environment (DfE) databases. Others also display integrated results of vendor data processes which would help to perform analysis the management of these hardware and software tools plays a significant role in organizations greening. Green information system adoption is the process of communicating green information to members of an organization over time through various channels.

Previously some researchers have pointed out the significant benefits of improving environmental performance practices and business performance by adopting environmental innovation strategies [7-9]. Environmentally relevant innovation, such as reduced energy usage, reuse of materials, and redefinition of industrial processes, can help organizations lower production costs and boost economic efficiency. Firms can improve their organizational reputation to get better green innovation performance [10].

This study highlights the relationship between the Green information system and operational performance with the mediating role of Green innovation performance for manufacturing industries in Pakistan.

This study points to an environment-friendly method of production, innovation performance, and operational performance, with possible approaches of adopting a green information system and the benefits of implementing green production. How implementing a green information system and practicing green innovation performance can boost operational performance to reduce cost and boost efficiency are discussed in this paper. Firstly this study refers to previous studies and literature related to green production systems, secondly, it bridges the gap between the literature regarding green innovation performance and its relation with green information systems and operational performance and thirdly this measures the direct relation between green information system and operational performance with mediating role of green innovation performance.

2 Literature Review

2.1 Green information system

According to Stair and Reynolds [31] information system comprises interconnected components that work together to, process, store, and distribute information to support important business work. Baltzan, Phillips [32] says green information system is based on three components, information technology, information, and people. According to Zheng [33], a green Information System is an Energy Management System (EMS), which is an arrangement of computer-supported instruments in an organization to accomplish proficiency through properly laid out methodology and techniques to guarantee continuous improvement and to spread awareness of energy productivity all through a whole association. By increasing its information-processing capability and fostering the flow of information throughout the whole supply chain, the implementation of a green information system (GIS) can assist a business in its operations for sustainable development [34]. A proficient GIS can explicitly follow, screen, store, and blend a few ecological viewpoints and information connected with asset and energy use, squander age, emanations, and contamination. It likewise incorporates highlights to assist with ecological administration (i.e., carbon impression examination, emanation decrease, asset improvement,

TABLE 1: Summary of previously published studies on Green information systems

Authors	Title/Objective
[11]	Adoption of green information technology theoretical model
[12]	Green Information System Research Review and Future Research Directions
[13]	Perspective from the Technology Acceptance Model on sector diversity in green information technology practices
[14]	In the Direction of A Green Information Systems Design Theory
[15]	An Academic Review of the Literature on Green Information Systems Integration in Information Technology-Based Organizations
[16]	Green Information Technology Practices: A Hierarchical View of Key Drivers and Their Effects
[17]	Sustainable production Using re-enactment demonstrating to recognize the advantages of green data frameworks
[18]	Representatives' cooperative utilization of green data frameworks for corporate manageability: inspiration, exertion, and execution
[19]	Data frameworks and feasible inventory network the board towards a more practical society: Where we are and where we are going
[20]	The forerunners of green data framework and effect on ecological execution
[21]	The functional fit between green production network the executives and the green data framework
[22]	Sustainable Information Systems for the Environment
[23]	Environmental activism and the adoption of green technologies: Social Movements as Catalysts for Corporate Social Innovation
[24]	Research on green information systems: a decade in review and future directions
[25]	Green Data Center for Information Systems Research: COVID-19 Led Virtualization
[26]	Perspectives on Research Streams in Green Information Systems: Yesterday, Today, and Tomorrow
[27]	Research on Green Information Technology and Green Information Systems: A Bibliometric Network Analysis
[28]	Toward the Energy Internet: A Cross-Layer Green Information-Centric Networking Design
[29]	Design Science Research Approach for Developing Design Principles for Green IS Facilitating Sustainable User Behavior
[30]	Using technological innovation as a conduit, the effect of green supply chain management practices on operational performance is examined.

cost decrease, etc.). By effectively following energy use, asset utilization, discharges, and other business-related factors, a powerful GIS can help associations in following, breaking down, and diminishing negative natural outcomes from different business exercises [23]. GIS is a helpful device that can help a business in advancing reasonable exercises, for example, thinking up green systems, facilitating correspondence between different utilitarian regions, and improving functional viability and the board's abilities [20].

2.2 Green Innovation Performance

Green innovation is described in a variety of ways, some people refer to it as environmental innovation [35]. Ecological development is characterized as new or changed processes, techniques, frameworks, and items that improve the climate and thus help to guarantee natural manageability. According to Arundel and Kemp [36] eco-development is another idea critical to businesses and lawmakers. According to the Europe INNOVA panel, "eco-innovation" is defined as "the development of novel and price competitive goods, methods, structures, and practices that can meet human needs and improve people's quality of life by using natural resources efficiently and releasing toxic substances minimally. Green innovation facilities are a subtype of common innovation facilities that aim to improve environmental quality or make the most sustainable use of natural resources [37]. Different specific phrases or concepts are commonly used in the literature to characterize innovation types that occurred to reduce negative effects on the environment, such as green, eco, environmental, or sustainable [38]. Green innovation facilities are essential for a company's environmental performance [37]. Green innovation is divided into three groups based on how it is implemented and the potential consequences [39], green innovation that re-uses or recycles to decrease environmental effects, secondly green innovation that decreases the usage of hazardous components to solve environmental problems of the company, and lastly green innovation in the development of energy-efficient, environmentally

friendly products and processes. Based on its types green innovation is generally divided into two groups:

2.2.1 Green Product Innovation

Product innovation refers to both the introduction of new products and the improvement of current ones [40]. Product innovation also includes design improvements that result in significant changes in a product's use or functionality. The primary purpose of product innovations in an organization is to increase the value offered by the product while also increasing efficiency.

2.2.2 Green Process Innovation

Process innovation is the use of new or improved production or delivery systems that include significant modifications in processes, equipment, or software [41]. Process innovation improves the efficiency and productivity of manufacturing activities, improves quality, and lowers costs per unit. Improvements in manufacturing and logistic processes, as well as accounting, computing, purchasing, and maintenance, are all examples of process innovation [40]. Organizations that employ process innovation strive to create both innovative and new products. This may require the introduction of novel methods. In his study Chen, Lai [2] explored the advantage of green product innovation and green process innovation, handling environmental pressures organizations should not overreact, this pressure can be utilized into a momentum that will help them to conduct green innovation and will provide them a first mover advantage.

2.2.3 Operational Performance

Today's competitive world needs competitive strategies to sustain itself in the market for that it must have strong operational strategies, operational strategies are directly related to operational functions that play a significant role in determining operational performance. Each organization has its own cooperative competitive strategies, to achieve successful implementation of these strategies and to develop and sustain an operational function. Operational performance can be defined as the results achieved due to distinct operational capabilities [42]. Abdallah, Obeidat [43] also measured operational performance through effectiveness and efficiency. The most broadly involved metrics for measuring operational performance in the literature are delivery, quality, flexibility, and cost [43, 44]. According to Abdallah, Obeidat [43] productivity measures, internal operations efficiency, and effectiveness are also used to compute operational performance. Production cost and quality are used as variables in this study to measure operational performance as they are commonly used metrics [43, 45].

3 Hypothesis Development

3.1 *Green Information System → Green Innovation Performance*

Firms these days are in regular competition they need to keep evolving and keep developing their product and their production strategy, together with this the issue related to environmental concerns is continuously rising. The organization that goes green will have a first-mover advantage [46] as more and more greening is required new agendas and new issues will be needed to put on board. Firms can improve efficiency by introducing new goods and services, as well as unique manufacturing processes and non-technological features like management practices and marketing. There is a lot of empirical study on the impact of various types of innovation on productivity, as well as what the drivers of innovation are. Foster and Green [47] in their studies have concluded that if it is needed to speed up the process of going green more and related issues will be raised companies need to push this issue to end users to actively seek progress. More information and data about green research and the current state G-VSM of a particular organization will be required to track the current status of greening. GIS will be the system containing databases, software details, and green performances and will point out the areas of improvement where the green innovation process needs to be carried out. Systematic and well-organized GIS can play a significant role in the organization being efficient and effective. In their conclusion, Küçükoğlu and Pınar [48] mentioned that there is a strong relationship between green innovation and the environmental performance of the company. We can say, GIS is related to GIP.

- Hypothesis 1 (H1): GIS is positively related to GIP.

3.2 *Green Information System → Operational Performance*

Green information system affects the operational performance of the organization, According to Küçükoğlu and Pınar [48] green innovation has a beneficial impact on environment-sensitive company performance as well as the competitive advantage in terms of performance of a company. The principles of recycling or reusing are crucial when building a GIS. Recycling requires additional investment in new infrastructure, but the reduction in raw material usage is noticeable very immediately. GIS aids in the creation of integrated supply chains, resulting in increased efficiency. The efficient use of resources can assist in reducing manufacturing costs, allowing a company to

become more competitive in the marketplace. A company's technological superiority can give it a competitive advantage, several researchers including Khan, Idrees [30] have mentioned technological innovation positively supports operational performance. A well-executed GIS may be a useful tool for a company, enabling it to increase productivity and efficiency. An increase in efficiency and effectiveness is a sign of better operational results [6]. Implementing GIS will save raw materials and make the system more efficient we can say that GIS positively impacts operational performance. Based on their study Bhadauria, and Toms [49] claim that implementing GIS in a manufacturing organization will likely see results in form of environmental performance.

- Hypothesis 2 (H2): GIS is positively related to OP.

3.3 *Green Innovation Performance → Operational Performance*

Operational performance is the core concern for any manufacturing industry. Many researchers have measured operational performances with different variables that include, efficiency, quality, and costs. Controlling and converting effluents generated by manufacturing operations plays a significant role in environmental performance. By executing advancements associated with green and natural insurance, like bringing down energy utilization, reusing creation materials, and upgrading creation processes, organizations might additionally reduce creation and working expenses and increment financial proficiency and execution [7]. Organizations invest money to build waste treatment plants that aid in the management of toxic chemical emissions into the environment. This helps companies in securing tax benefits and avoid penalties. As a result, increased economic performance both by direct and indirect means. Reduced toxic effluents are the main cause of improved environmental performance. It helps to lower the company's overall carbon footprint. According to researchers, green practices might have an "innovation offsets" impact that gives them distinct competitive advantages over rivals and boosts the performance of an organization [50]. Consumers may prefer to purchase products from a company that they believe is environmentally friendly. Government can reward these organizations for being good, improved environmental performance will result in sustainability and ensure the short-term survival of companies. Environmentally friendly technology not only generates a direct economic benefit for the company, but it can also help build its brand. Companies can enhance their business performance by following quality standards [51]. ISO 14001 certification can also be aided by GIS. Businesses with a high level of environmental dedication tend to develop a stronger ecological reputation and higher levels of societal acceptance, establishing supremacy in the marketplace. Businesses could receive premiums and boost their income by matching the demands of environmentally conscious consumers for environmental products [52].

- Hypothesis 3 (H3): GIP is positively related to OP

3.4 Mediation of Green Innovation Performance

Green innovation organizations can gain the upper hand and be empowered to market their ecological innovations, improve their corporate image, and even launch new enterprises [2]. Organizations putting more responsibilities in green advancement effectively can limit the creation of waste, yet in addition improve the general efficiency, increase reputation, and in this way provides a competitive advantage. Innovation in this period of the information economy is a vital source of competitive advantage. In his studies, Chang[53] expressed that organizations ought to contribute more assets to upgrade and coordinate with environmental performance as it is positively connected with green development. Innovation performance has been assessed with a mediating role in previous studies such as Jermsittiparsert, Sutduean [54] used with green supply chain practices and environmental performance, Aboelmaged [55] used this with knowledge management and operational performance. Prior studies Santos, Lannelongue [56] have focused on the impact of green practices on operational performance. This study measures the impact of green information systems on operational performance with the mediation of green innovation performances.

- Hypothesis 4 (H4): GIP mediates the relationship between GIS and OP.

4 Research Methodology

To verify the relevance of (Green information system) GIS on GIP (Green innovation performance), GIS on OP (operational performance), and GIP on OP, this study conducted a survey of manufacturing industries in Pakistan. Companies are working to reduce hazardous impacts on the environment by working on innovating new processes and designing eco-friendly products and developing a system of recycling and reusing products. It took over three months to collect data that yielded 180 usable responses. This sample

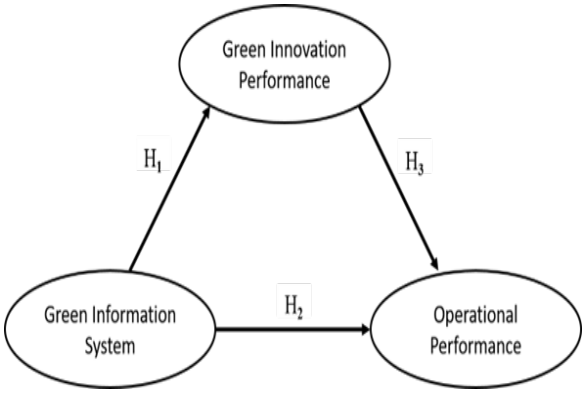

Fig. 1: Theoretical framework

TABLE 2: Demographics of Participants

Demographics		
Types of Organizations	**Responses received**	**Percentage (%)**
Automotive/Auto part Manufacturing	32	18%
Textile and garments	98	54%
Food industries	7	4%
Pharmaceuticals	9	5%
Others	34	19%
Total	*180*	
Large Scale	*Medium Scale*	*Small Scale*
90%	*6%*	*4%*

size is enough to use partial least squares (PLS-SEM) [57]. According to Hair, Hult [58] the data volume should be 10 times the number of measurement parameters. This makes PLS suitable for this research study the number of measurement parameters in our study is a maximum of eight for each factor and the data set is 180 samples. The population sample of this study consists of different production companies in Pakistan. The quality of the data collection process is further increased by employing some solutions. An initial draft of the survey instrument was examined by a panel of business academics with knowledge of the subject area to support the questionnaire's validity.
Employees among executives, engineers, and managers were among the respondents. After then, respondents were divided into small, medium, and large-scale businesses. Small businesses choose to have a maximum of 99 employees, whereas medium-sized businesses assign a maximum of 250 workers. A corporation is considered to be large-scale if it employs more than 250 people [59].

4.1 Data Collection

To gather information from numerous assembling businesses, for example, steel manufacturing, textiles, automobiles, and drugs, a survey-based questionnaire was devised based on previous literature. There were two components to the questionnaire items. The first portion included demographic details such as the respondent's qualifications, work experience, job title, and company size. The other portion had 20 questions. For measuring GIS, six indicators are adopted from Qu and Liu [60]. For operational performance (OP), six indicators were adopted from Hong, Liao [61], and eight indicators of GIP are adopted from Albort-Morant, Leal-Rodríguez [62]. For measuring the questionnaire items, this study applies a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree).

4.2 Structural Equation Modeling

According to Munim and Zeng [63, 64]. PLS-SEM method is used to test and evaluate complex statistical models. Hence PLS-SEM method is used here. Using smartPLS-3 firstly we tested for the reliability and validity of the instruments in the next step SEM analysis is performed to test the hypotheses. PLS path modeling contains a well-structured method for estimating complex cause-effect relationship models [65, 66].PLS-SEM has a great ability it can provide solutions to highly complex models [58]. It is also suitable for the development of a model and in its testing phase allows testing constructs and relations of a complex structural model. It also does not require a large data set and has no assumptions about the data set [58]. PLS-SEM was proven to be a good fit for evaluating the hypotheses in this investigation. As previously stated, it provides several advantages when it comes to studying higher-order constructs. As described by, Sarstedt, Hair Jr [67] the "Two-stage Approach," is employed to investigate the link between constructs.

4.3 Data Analysis

The lower order constructs (LOC) measurement model's construct validity, convergent validity, and discriminant validity are investigated. The measurement model with LOC is shown in Figure 1. The correlation between constructs and latent variables is investigated using convergent validity. The degree of relationship between each measurement item (indicator) and its concept is explained by a standardized factor loading value. According to Vinzi, Chin [68] factor loading greater than 0.7 is considered desirable. To adjust the

TABLE 3: Convergent Validity

	Cronbach's Alpha	Composite Reliability	Average Variance Extracted (AVE)
GIP	**0.904**	**0.923**	**0.6**
GIS	0.916	0.935	0.705
OP	0.867	0.9	0.602

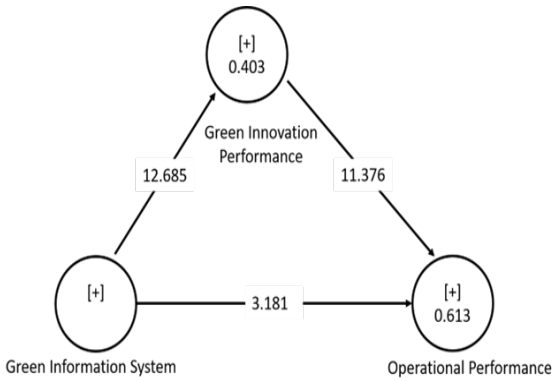

Fig. 2: Model Evaluation Results

factor loadings some indicators are usually eliminated. Items are removed only in case they lie between 0.4 to 0.7 and removal increases composite reliability [58]. As per the evaluation of the loadings, none of the outer loadings includes zero hence no items are removed in a study from further study. Table 3 shows the results. This demonstrates that the measuring model for our construct is accurate and adequate for the analysis. In an SEM model, AVE (average variance extracted) is used to verify the convergent validity of several indicators [69]. The AVE values were all greater than 0.50 and ranged from 0.600 to 0.705, demonstrating that this model's convergent validity is generally accepted [70].

Fornell and Larcker's criteria, HTMT (Heterotrait-Monotrait ratio), and cross-loading verification are used to verify the discriminant validity. The square root AVE as the off-diagonal element is less than the diagonal correlation in rows and columns, this shows Fornell and larcker criteria are satisfied [69]. Fornell and larcker's criteria are tested and are displayed in table 4. HTMT was analyzed and displayed in table 5. A discriminant validity test was performed afterward that revealed constructs are different by measuring factor loading. Factor loading describes the degree to which each correlation matrix item corresponds with a particular main component. Larger absolute numbers indicate a stronger relationship between the item and the underlying component. Factor loadings can range

TABLE 4: Discriminant validity: Fornell-Larcker criterion

	GIP	GIS	OP
GIP	0.775		
GIS	0.635	0.84	
OP	0.766	0.608	0.776

TABLE 5: HTMT Test

	GIP	GIS	OP
GIP			
GIS	0.69		
OP	0.861	0.675	

from -1.0 to +1.0 [71]. According to the guidelines, none of the items have a factor loading of less than 0.50. As a result, no item was eliminated from the investigation. Factor loading is shown in Table 6.

4.4 Structural Model

Figure 3 shows a structural model that is used to build relationships between variables and to compute the results. The theories were put to the test in two different methods. Initially, the significance of the route coefficient in direct path analysis with set variables was examined using 5000 bootstrapping samples. Then, to determine the mediation effect of Green innovation performance on the Green information system and operational performance, a mediation analysis is conducted. The structural model represents the study framework's hypothesis. The model predicts a 40% of the variance in Green innovation and a 60% of the variance in operational performance, indicating its predictive validity.

The value of SRMR (standardized root mean square residual) is found to be 0.057 this was justified below 0.10. (Hair et al., 2017). The link between independent and dependent variables is tested by path coefficient and T-statistics. At first, H1 was evaluated, and positive and significant impact on GIP was measured by GIS (β=0.051, t=12.448, p¡0.001) hence H1 is supported. In further assessment, H2 is evaluated GIP has a significant positive effect on OP (β=0.057, t=11.309, p¡0.001), and H2 is supported. Further H3 is measured as GIS has a significant positive effect on OP (β=0.059, t=10.300, p¡0.001) as shown in table 8. Through the mediation of GIP, we can observe that GIS has a considerable indirect significant effect on OP. This shows that the relationship between GIS and OP is partially mediated by GIP.

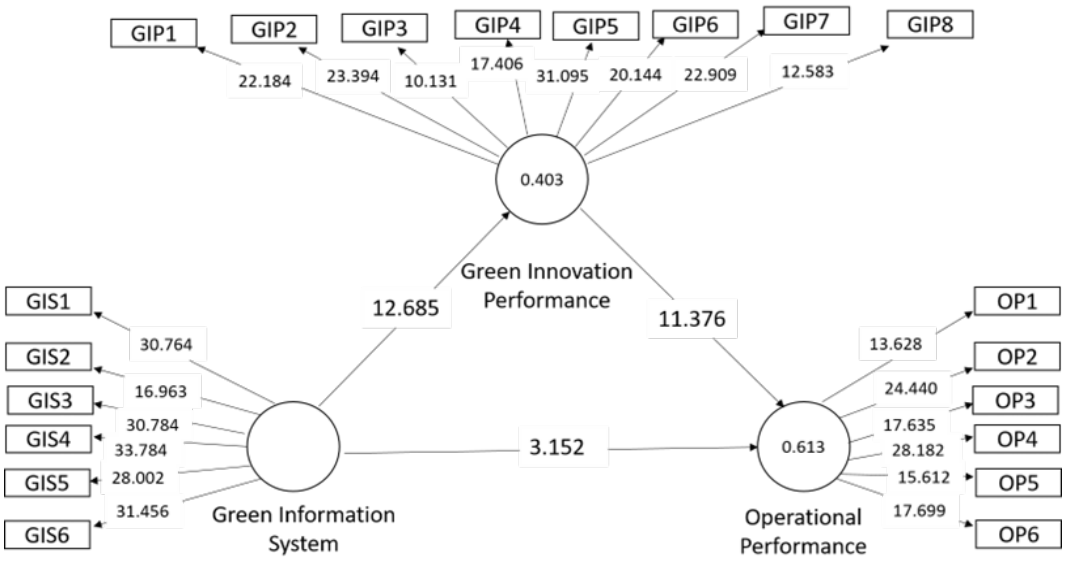

Fig. 3: Structural Model

TABLE 6: Factor loadings

	GIP	GIS	OP
GIP1	0.794	0.569	0.665
GIP2	0.8	0.476	0.536
GIP3	0.695	0.472	0.512
GIP4	0.774	0.391	0.519
GIP5	0.85	0.556	0.675
GIP6	0.775	0.504	0.592
GIP7	0.791	0.514	0.625
GIP8	0.705	0.418	0.588
GIS1	0.506	0.844	0.487
GIS2	0.494	0.795	0.479
GIS3	0.575	0.839	0.585
GIS4	0.582	0.878	0.514
GIS5	0.51	0.844	0.454
GIS6	0.522	0.837	0.528
OP1	0.583	0.441	0.734
OP2	0.561	0.521	0.826
OP3	0.591	0.482	0.763
OP4	0.61	0.569	0.854
OP5	0.565	0.349	0.7
OP6	0.655	0.447	0.767

TABLE 7: R^2 and Q^2

	R Square	Q² (=1-SSE/SSO)
GIP	0.411	0.234
OP	0.62	0.353

TABLE 8: Mediation Analysis (a)

	Coefficient
GIP → OP	0.641
GIS → GIP	0.635
GIS → OP	0.606

TABLE 9: Mediation Analysis (b)

Total Effect(GIS → OP)		Direct Effect(GIS → OP)	
Coefficient	**P value**	**Coefficient**	**P value**
0.606	0	0.199	0.002

4.5 Mediation analysis

A mediation investigation was further performed to evaluate the mediating job of GIP. The P-value is less than 0.1 as shown in table 9, this reveals GIP has a mediating role. The result revealed that the total effect of GIS on OP was significant (H2: β=0.606, t=10.3, p¡0.001). With the inclusion of mediating variable the impact of GIS on OP becomes insignificant (H2: β=0.199, t=3.106, p=0.002). The indirect effect of GIS on OP through GIP was found significant (β=0.407, t=7.836, p¡0.001). This shows that the relationship between GIS and OP is mediated by GIP. This shows that green innovation performance in products or processes will make an impact on overall organizational performance as hypothesized above.

5 Discussion

As increasing understanding of the negative consequences of industrial activity on the environment

TABLE 10: Mediation Analysis (c)

The indirect effect of (GIS → OP)				
Coefficient	**SD**	**T value**	**P value**	**BI[2.5%: 97.5%]**
0.407	0.052	7.836	0	0.303:0.508

grows and as the burden on the environment grows, more effort is being put into finding environmentally-friendly productions to lessen environmental impact and attain sustainability. Green operations of a company are important in this process because they can address customer environmental concerns by adopting green production processes and innovating new green products, this separates the company from its rivals, and strengthen its position. According to Wang and Liu [75], a well-developed GIS supports the organization's integration and supplier and customer orientation on its green product and process innovation. He further likewise expressed, that associations these days should pay attention to reinforcing green supply chain combinations through an advanced GIS to upgrade their green process and product development. According to Albort-Morant and Hashim [62, 76]. Organizations' ability to get information from outside sources and use that in unique ways by joining it with the existing information base is a vital source to guarantee the introduction of new green items in the market. Successful development of a GIS is based on the main principles of recycling and re-using material which results in a reduction of raw material consumption and saves energy in different ways.

6 Implications

This study contributes to the study of GIS in several ways, firstly developed and analyzed the conceptual model of green information systems and operational performance with the mediation of green innovation performance. These results are in line with previous studies Wang and Liu [75] which shows how a well-implemented GIS can contribute to improving organizations' connection with supplier showing the impact of supplier integration with green product innovation [75]. As per previous Cao, Q, and Wu [77, 78] IT researches, the Quality of a system and information databases are fundamental aspects of implementation which means that the integration of a system is influenced by the quality of information i.e. completeness, accuracy, and suitable format. GIS resources include an environmental management system with all tools, and software with a properly defined methodology to increase awareness about its adaptability. As suggested by Mao, and Liu [79] associations that have skillful IT staff are better situated to integrate innovations with existing business processes. As for the social implication mechanism, a good relationship between the IT department, the Production department, and supply chain personnel can help an organization to get a good ground for successful GIS implication. Although one initiative toward establishing a green practice is ISO 14000 series. However as per a common perception, a decrease in profit ratio for implementation of GIS may curtail its adoption, but different studies including Bhadauria, Toms [49] have presented the economic benefits of a well-implemented GIS.

7 Conclusion

This study presented a relationship between the Green information system (GIS) and operational performance with the mediating role of GIP (green innovation performance) for the study data was collected from multiple manufacturing industries located within Pakistan. To perform the analysis and testing the hypothesized model data was imputed in SmartPLS3 software. This software performed structural equation modeling to conduct analysis. The result revealed that GIS is positively and technically related to Green innovation performance (GIP) and Operational performance (OP). The mediating relation of GIP is observed in between the relation. According to our study findings, implementing GIS will push operational performance to bring excellence to firms operation, this optimized performance through the use of well-developed GIS will support the innovation process by utilizing the external information and databases of the organizational system a new and unique product can be developed that will use recycled material as its raw material which wills firstly reduce waste disposal as more and more material will be recycled. Secondly installing a waste disposal unit that will control and converts toxic effluents from the manufacturing process. Thirdly contributing to the innovation process organization using its GIS database and customer behavior, organizations can develop an eco-friendly designed product. By practicing these mentioned methods organization can develop itself together with this an organization may get first-mover advantage and a competitive edge against a competing firm. Organizations may also receive government incentives or tax relives for compelling environmental considerations. For sustainable environmental growth, there is great room for improvement in Pakistan. Organizations should utilize energy, material, water, and efforts effectively while considering an environment-friendly production method. By and large, this study makes a significant

commitment to the writing on Green data systems, (green development execution) and functional execution along with this, this study features the possible advantages of becoming environmentally viable and specifies the administrative worries in regard to the worthiness of green data framework. Consequently giving a basis to professionals, supervisors, and climate board specialists to underline the significance of greening in hierarchical supportability. There are certain limitations in this study, Firstly this study conducts analysis based on data from Pakistan's manufacturing sector, Secondly, this contains data mostly from large manufacturing companies only a small portion of small enterprises were considered. Future research may be conducted by considering data in a different context from Pakistan and also considering small enterprises into account the relationship with different dimensions from Green Information system (GIS), green innovation performance (GIP), and Operational performance (OP).

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