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ORIGINAL PAPER

IMPACT OF INFORMATION TECHNOLOGY RESOURCES ON ENVIRONMENTAL PERFORMANCE: MEDIATING ROLE OF INTERNAL GREEN SUPPLY CHAIN INTEGRATION

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Abstract. Background: Information technology (IT) resources can play an important role in helping firms overcome the environmental issues they face by facilitating green supply chain management. This study examines the relationship between IT resources, specifically IT infrastructure resources, IT human resources and IT relationship resources, and the environmental performance of textile firms. Further, the study examines the mediating role of green supply chain integration on this relationship.
Methods: The study collected data from 512 executives working in the textile sector in the Punjab province of Pakistan, where green supply chain integration is being practiced. Smart PLS has been used for estimation results.
Results: The results of the study show that IT resources in the form of IT infrastructure resources, IT human resources and IT relationship resources have a significant association with the environmental performance of firms. Likewise, structural equation modeling (SEM) confirms that green supply chain integration mediates this relationship.
Conclusions: The results of the study demonstrate that the improvement of IT resources can help companies achieve their environmental performance targets. Likewise, the results also suggest that companies should work on achieving green supply chain integration as it can improve their environmental performance.

Keywords: IT resources, Internal Green Integration, Environmental Performance, Pakistan, PLS-SEM

INTRODUCTION

Owing to increased pressure from regulators and the masses, organizations now clamor for practices that enhance their environmental performance and help them maintain their environment friendly status (Hashmi & Akram, 2022). Over the years, environmental performance has become an integral part of a firm's overall performance and supply chain practices have been found to have an impact on the environmental performance of firms.

In the modern age, information technology (IT) has become a critical success factor for almost every industry. With growing competitiveness, businesses are trying to get hold of IT specialists to improve their supply chain management (SCM) and use it to gain a competitive advantage (Jing, 2021). Research suggests that IT systems can improve coordination of the roles and responsibilities of supply chain participants (Ersoy et al., 2022; Nozari et al., 2021).

Evidence suggests that the sustainability of the supply chain industry is dependent on green supply chain practices. Additionally, these practices contribute to economic performance and competitiveness in a number of ways: by enhancing cost effectiveness, decreasing waste, and satisfying customer demand for eco-friendly products (Raut et al., 2021). However, if not effectively managed, the driving forces

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promoting the adoption of green supply chain (GSC) techniques can also obstruct the green transition (Jiang et al., 2022). At various stages of the process, green supply chain management (GSCM) is supported by a variety of software programs and cutting-edge technologies. These might include innovative manufacturing technologies that utilize less energy to produce products or lower the amount of hazardous materials used in the production process, and warehouse management systems (WMS) that increase warehouse efficiency (Tehrani & Gupta, 2021).

Thus, this study examines the relationship between IT resources—specifically IT infrastructure resources, IT human resources and IT relationship resources (IT-RR)—on environmental performance, as well as the mediating role of green supply chain integration. Many textile firms harness such technological capabilities to add value to their operations. Evidence suggests that information technology has revolutionized the textile sector supply chain in various ways, from improving textile production performance to stricter process control (Yuan et al., 2021). Thus, it is important to look at the role of information technology on the environmental performance of textile firms via green supply chain practices.

LITERATURE REVIEW

Information Technology Resources and Environmental Performance

The study defines IT infrastructure as shared IT resources made up of a technological physical base consisting of hardware, software, communications technologies, data, and core software applications, and a human component made up of skills, expertise, and knowledge (Pattnaik et al., 2022). These elements work together to produce IT services that are typically exclusive to an organization, or at the very least stand out from the alternatives.

Furthermore, by extending the resource-based view (RBV) to the context of green management, it is possible to define IT resources as the extent to which managerial and technical IT applications are employed to address environmental issues by encouraging green thinking both within and outside of organizational borders (Li, 2022). Previous studies have stated that IT resources include IT infrastructure, IT personnel, and IT relationship components, all of which allow the business to more successfully adopt and implement its IT-enabled initiatives (Lin, 2022). Because they assist businesses in concurrently developing and implementing a variety of green management practices, IT resources are a key driver of IT-enabled green innovations. An adaptable IT infrastructure, for instance, may help a company better track the costs, waste, and emissions associated with each stage of the supply chain (SC) and encourage employee participation in environmental efforts (Kurniawan, 2023).

The business may exchange and communicate any kind of information thanks to compatible IT infrastructure, which makes it simple to incorporate the efficient flow of information into IT applications. A high degree of flexibility makes it simple for the company to reconfigure IT applications and integrate them into supply chain planning systems. The company may also use this flexibility to adapt its IT applications in order to comply with environmental protection laws (e.g., in e-GSCM). As a result, it is expected that IT infrastructure resources will be needed to enable internal integration and external collaboration involving e-GSCM. It is possible that a more flexible IT architecture that makes it easier to keep track of expenses, waste, and emissions at various levels of the SC may encourage greater employee engagement in environmental programs (Li et al., 2020). IT experts who are knowledgeable in the field may advocate for the use of environmentally friendly technology and solutions that are efficient in terms of energy consumption. In addition, they will be able to successfully combine IT strategy with environmental objectives. It is envisaged that a sizable IT team will be able to facilitate communication, coordination, and transparency between a firm and its SC partners in order to build external trust in the company's commitment to environmentally responsible practices (Shah & Soomro, 2021).

Also, because e-GSCM demands tight cooperation and information sharing within and

between enterprises enabled by IT applications, IT resources are essential. In order to deploy e-GSCM, businesses need to maintain a portfolio of IT resources (such as IT infrastructure, staff knowledge, and IT-RR; Lo et al., 2018). Therefore, three categories of IT resources (including IT infrastructure, IT human resources, and IT-RR) may be taken into account as possible predictors of e-GSCM deployment from the standpoint of RBV. Additionally, prior research has failed to offer empirical support for a particular class of IT resources and instead concentrated mostly on the impact of general information services support (e.g., IT investments, internal IT usage, and IT assets) on the adoption of IT-enabled green innovation (Sun & Sun, 2021).

In the context of green management, the RBV may be used to define the level at which managerial and technical information technology applications are utilized to promote green thinking both within and outside of organizational boundaries and to lessen environmental concerns. It can be applied in order to minimize the negative effects of these applications on the environment (Benzidia et al., 2021). The need for a solid IT infrastructure, as well as appropriate IT specialists and partnerships, in order to support IT-enabled business processes has been shown in a number of studies conducted in the past. IT resources play an essential part in the process of promoting IT-enabled green innovations since they make it possible for companies to create and put into practice a variety of green management systems all at once (Jena & Ghadge, 2021).

In the current study, IT human resources (IT-HR) relate to the level of technical and business expertise that IT staff members possess, allowing them to anticipate the development of future technologies and successfully utilize them to align business processes with activities that support the environment (Du et al., 2018). Businesses with excellent IT-HR are more likely to create dependable IT solutions that satisfy their business requirements more quickly than their rivals. Similarly, the right IT personnel may be deployed to take on particular responsibilities within and across SC companies. According to Shaar et al. (2022), the capacity of the IT staff to comprehend "what is" and "what may be" in IT initiatives in connection to environmental sustainability is a prerequisite for the successful implementation of e-GSCM. It is crucial to link corporate social responsibility to the achievement of environmental sustainability through multiple stakeholders (such as employees and SC partners). These factors suggest that IT resources can be crucial for achieving environmental performance. Thus, the current study proposes that:

H1: Information technology infrastructure resources have a positive relationship with environmental performance

H2: Information technology relationship resources have a positive relationship with environmental performance

H3: Information technology human resources have a positive relationship with environmental performance

Mediating Role of Internal Green Integration in the relationship between Information Technology Resources and Environmental Performance

A supply chain that incorporates green components into its operational procedures, including green materials management, green production, green manufacturing, green distribution/marketing, and green reverse logistics is referred to as green integration. The degree of mutual dependency, trust, communication, and coordination between the IT department and SC partners who can utilize IT applications effectively is the key element of IT-RR (Ryoo & Koo, 2013). The business is able to undertake collaborative learning exercises and stimulate green innovation thanks to integrated and synergistic IT-RR, improving the likelihood of supporting a significant e-GSCM deployment (Tran et al., 2020). Therefore, it is hypothesized that more IT-RR will boost the possibility of effective internal e-GSCM integration.

Software and other tools used to automate the human resources function in firms are

referred to as "HR technology" or "human resources information technology." The following are all included: payroll and employee compensation, talent acquisition and management, performance management, and benefits administration (Popa et al., 2021). The term "human resource management" (HRM) refers to the processes of selecting, training, encouraging, and rewarding personnel. A firm's HRM team must strive to become competitive in the HR field by consistently providing educational and training programs for the staff to support the organization's personal and professional growth.

In the current study, IT-HR relate to the level of technical and business expertise that IT staff members possess, allowing them to anticipate the development of future technologies and successfully utilize them to align business processes with activities that support the environment. Businesses with excellent IT-HR are more likely to create dependable IT solutions that satisfy their business requirements more quickly than their rivals. Similarly, the right IT personnel may be deployed to carry out particular responsibilities within and across SC companies. The capacity of the IT staff to comprehend "what is" and "what may be" in IT initiatives in connection to environmental sustainability is a prerequisite for the successful implementation of e-GSCM. It is crucial to link corporate social responsibility to the achievement of environmental sustainability through multiple stakeholders (such as employees and SC partners). The success of green IT projects will be facilitated by businesses with IT staff who possess superior green expertise and IT solutions that can communicate environmental values to internal and external stakeholders (workers and SC partners, respectively). These ideas led us to the hypothesis that IT-HR enable businesses to achieve a seamless digital transition and expand the use of e-GSCM.

IT infrastructure resources (IT-IR) encompasses the company's common technical resources (such as computer platforms, databases, and networks for electronic communications), which are defined by factors like connection, interoperability, and modularity (Benzidia et al., 2021). They are the meticulously constructed technological pillars on which present and future IT applications are constructed. Since IT-IR offer a reliable foundation to support environmentally friendly activities, they are likely to result in the deployment of e-GSCM (Lin, 2022). As an illustration, IT infrastructure connections are a crucial link in creating cross-functional and cross-firm process integration, which subsequently makes it possible to align IT applications with green management initiatives. Additionally, the business may exchange and communicate any type of information thanks to compatible IT architectures, which makes it simple to incorporate the efficient flow of information into IT applications (Al-Sheyadi et al., 2019; Sahoo et al., 2022).

Companies with greater levels of internal environmental integration are more dedicated and driven to guarantee that the environmental performance (EP) of their suppliers is strong as well. They have a higher propensity to manage and oversee their suppliers and enhance the sustainability of their operations, safeguarding their reputations and reducing environmental threats (Shaar et al., 2022).

Businesses with well-integrated internal systems can effectively combine data and transfer knowledge from multiple business units. It is more practicable for them to incorporate elements related to external partners into their internal processes when communicating with suppliers (Waqas et al., 2021). This makes it easier to quickly and completely access the supplier's environmental data and to identify and categorize any environmental issues it may have. Businesses with a high internal green integration (IGI) level are better able to communicate to their suppliers the enormous benefits of environmental input. These manifest as an increase in financial profits and the fulfillment of client demands (Kalyar et al., 2019). The competitiveness of the product is improved; suppliers transition from being passive to active environmental collaborators; businesses proactively use green manufacturing; and suppliers are inspired (while also confirming their own commitment) to engage in green projects.

H4: Internal green integration mediates the relationship between information technology infrastructure resources and environmental performance

H5: Internal green integration mediates the relationship between information technology relationship resources and environmental performance

H6: Internal green integration mediates the relationship between information technology human resources and environmental performance

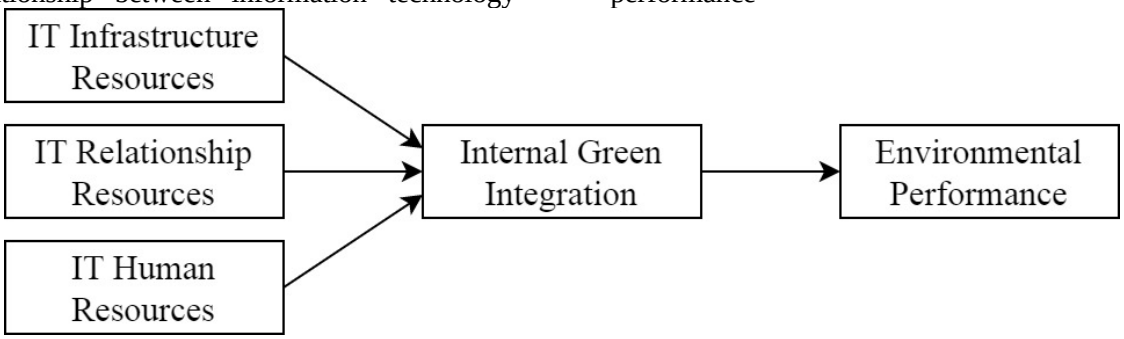

Fig. 1: Research Model

METHODS

Sample and data collection procedure

Data were collected from executives working in the textile sector in Punjab, Pakistan where green supply chain integration is being monitored. Initially, we approached 631 executives using the professional links of one of the authors. We received 512 accurate responses. Thus, the response rate of the study is 81.14%. Participation in the survey was voluntarily and the anonymity and confidentially of the respondents were ensured. The demographic statistics of the respondents revealed that 49.2% were male and 50.8% were female. 51.8% of respondents had experience of less than 10 years and 50.2% were middle managers while 49.8% were senior managers.

Measures

All study variables were measured using Likert scales ranging from 1 to 7 for IT-based variables and from 1 to 5 for green integration and environmental performance, where 1 was the lowest rank for the variable and 5 or 7 represented the highest rank.

IT- Infrastructure Resources

IT infrastructure resources were measured using the 5-item scale of Mao et al., (2016). One sample item used in the study was: "The quality of IT application and services (e.g., ERP and ASP) can meet the organizational needs." The Cronbach's alpha reliability of the scale was 0.864.

IT-Relationship Resources

IT relationship resources were also measured using the 5-item scale of Mao et al., (2016). One sample item used in the study was: "My organization has technology-based links with customers." The Cronbach's alpha reliability of the scale was 0.891.

IT-Human Resources

IT human resources were also measured using the 5-item scale of Mao et al., (2016). One sample item used in the study was: "The staff in my organization can evaluate and control IT projects." The Cronbach's alpha reliability of the scale was 0.754.

Internal Green Integration

Internal green integration was measured using the 5-item scale of Shah & Soomro (2021). One sample item used in the study was: "Our firm integrates environmental responsibility and objectives into various functional management systems (e.g., finance, human resource, and manufacturing)." The

Cronbach's alpha reliability of the scale was 0.902.

Environmental Performance

Environmental performance was measured using the 5-item scale of Shah & Soomro (2021). One sample item used in the study was: "Our firm has achieved a reduction in pollution and waste." The Cronbach's alpha reliability of the scale was 0.875.

RESULTS

Measurement model

The estimation of the relationship between indicators and constructs, as explained in the theory, relies on a measurement model based on the PLS algorithm (Hair, Hult, et al., 2017). The measurement model in PLS-SEM is comprised of construct, convergent and discriminant validities (Hair, Matthews, et al., 2017; Shiau et al., 2019). Table 1 shows the statistics for reliability and validity.

Table 1: Construct Reliability, Convergent and Discriminant Validity

	1	2	3	4	5	α	CR	AVE
1. Environmental Performance	**0.850**					0.902	0.928	0.723
2. IT Human Resources	0.260	**0.738**				0.754	0.825	0.545
3. IT Infrastructure Resources	0.301	0.136	**0.806**			0.864	0.902	0.649
4. IT Relationship Resources	0.332	0.198	0.491	**0.867**		0.891	0.924	0.752
5. Internal Green Integration	0.757	0.292	0.382	0.452	**0.817**	0.875	0.909	0.667

EP = Environmental Performance; ITHR = IT Human Resources; ITIR = IT Infrastructure Resources; ITRR = IT Relationship Resources; IGI = Internal Green Integration

Hair et al. (2011) recommended that alpha and CR coefficients should be greater than 0.70 and 0.80 respectively for acceptable internal consistency of the latent constructs, while AVE should be higher than 0.50 for considerable convergence and relatedness between indicators and constructs (Hair et al., 2013; Hair et al., 2014). In this regard, the above table shows that IT-HR has the lowest alpha coefficient of 0.754 and CR coefficient of 0.825; therefore, all constructs achieved acceptable reliability in the structural model. Moreover, IT-HR has the lowest AVE coefficient, which is 0.545 (i.e. higher than the recommended 0.50 threshold); thus, the indicators and constructs all achieved substantial relatedness in the structural model. Hence, adequate convergent validity was achieved in the model.

In the above table, the square roots of the AVE coefficients for latent constructs (bold diagonal values) are higher than their respective correlations with other constructs (non-bold values in the horizontal and vertical settings), and therefore, the shared variance of constructs is higher than their correlation with other constructs (Fornell & Larcker, 1981), manifesting no relation between latent constructs to substantiate their theoretical dissimilarity in the structural model (Hair et al., 2011, 2013; Hair et al., 2014). Hence, discriminant validity using the FLC method has been validated.

The above table shows that there was higher shared variance among the indicators (measured by their loadings) in the constructs with theoretical linkage than among their cross loadings with other constructs with weak or undefined theoretical linkage (Hair, Hult, et al., 2017; Hair et al., 2011, 2013). Therefore, discriminant validity using the cross-loadings method was achieved. Figure 2 shows the outer loadings data. All values are within the defined limits, indicating the validity of the construct.

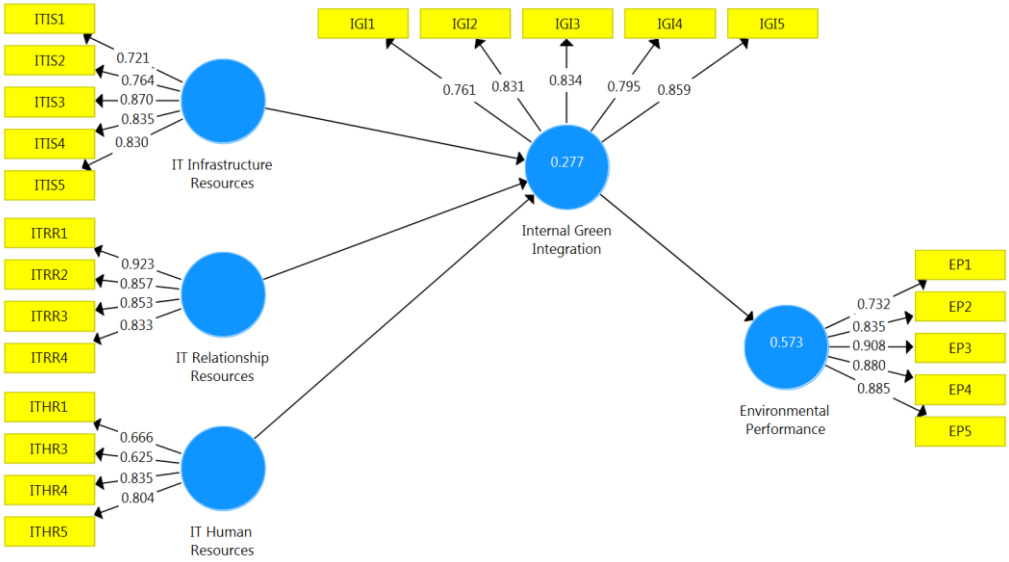

Fig. 1: PLS Algorithm using SmartPLS

Predictive power using R-Square

The statistical estimation of the predictability of the endogenous latent constructs in the structural model relies on predictive power based on R^2 and adjusted R^2 coefficients (Hair et al., 2011). Table 2 shows the predictive power for all endogenous constructs in the model.

Table 2: R-Square and Adjusted R-Square

	R Square	R Square Adjusted
Environmental Performance	0.573	0.572
Internal Green Integration	0.277	0.273

The above table demonstrates that environmental performance has a moderate predictive power of 57.3 percent in the structural model (Hair et al., 2011), while internal green integration has an acceptable predictability of 27.7 percent in the structural model (Hair et al., 2011).

Structural model

The statistical method for assessing the hypothesized relationship between latent constructs in the structural model for hypothesis-testing is referred to as a structural model in PLS-SEM (Hair, Hult, et al., 2017), based on a PLS bootstrapping technique with a recommended 5,000 subsamples and two-tailed analysis with a probability level of 5 percent (Hair et al., 2011).

Hypothesis-testing using direct-effect analysis

Table 3 provides the result of path analysis for hypothesis-testing of the direct-effect estimations based on PLS bootstrapping (Lee et al., 2011; Roemer, 2016).

The above table shows that IT human resources ($\beta = 0.202$; $p < 0.05$), IT infrastructure resources ($\beta = 0.200$; $p < 0.05$), and IT relationship resources ($\beta = 0.314$; $p < 0.05$) all have a significant positive effect on internal green integration while internal green integration ($\beta = 0.757$; $p < 0.05$) has a significant positive effect on environmental performance.

IT human resources ($\beta = 0.153$; $p < 0.05$) have a significant positive effect on environmental performance with the mediation

of internal green integration. Similarly, IT infrastructure resources (β = 0.152; p < 0.05) have a significant positive effect on environmental performance with the mediation of internal green integration. Lastly, IT relationship resources (β = 0.238; p < 0.05) have a significant positive effect on environmental performance with the mediation of internal green integration.

Table 3: Path Analysis

	Estimate	S. D.	t-Stats	Prob.	Decision
ITHR -> IGI	0.202	0.034	5.899	0.000	Accepted
ITIR -> IGI	0.200	0.053	3.747	0.000	Accepted
ITRR -> IGI	0.314	0.040	7.794	0.000	Accepted
IGI -> EP	0.757	0.021	36.427	0.000	Accepted
ITHR -> IGI -> EP	0.153	0.027	5.750	0.000	Accepted
ITIR -> IGI -> EP	0.152	0.040	3.762	0.000	Accepted
ITRR -> IGI -> EP	0.238	0.031	7.558	0.000	Accepted

EP = Environmental Performance; ITHR = IT Human Resources; ITIR = IT Infrastructure Resources; ITRR = IT Relationship Resources; IGI = Internal Green Integration

Predictive relevance using Q-Square

The statistical measure for relevance of the endogenous latent constructs in the structural model is referred to as predictive relevance in PLS-SEM (Hair, Hult, et al., 2017). It is based on the PLS blindfolding technique with 7 omissions (Hair et al., 2011, 2013), as recorded in the table below.

Table 4: Predictive Relevance using Q^2

	Q Square
Environmental Performance	0.408
Internal Green Integration	0.180

Environmental performance has 40.8 percent (i.e. strong) relevance in the structural model (Hair et al., 2013), whereas internal green integration has 18 percent (i.e. moderate) relevance in the structural model (Hair et al., 2013).

DISCUSSION AND CONCLUSIONS

The sustainability of the supply chain industry and the health of our world depend on GSC practices. The current study examined the effect of IT resources on environmental performance and the mediating role of internal green integration among textile firms in Punjab, Pakistan. It investigated these effects since there is a noticeable gap in the relevant literature with reference to developing economies. The study proposed six hypotheses in total, with the theoretical background based on natural resource based view i.e. NRBV theory. All the hypotheses can be accepted based on the in-depth data analysis.

The findings of this research indicate that green integration has a considerable impact on environmental performance. Moreover, IT-IR exerts a substantial amount of pressure on environmental performance. The findings of this research indicate that IT-RR do, in fact, have a major impact on environmental performance. Environmental performance is also significantly impacted by IT-HR's role in the organization. According to the findings of this research, internal green integration has a significant effect upon EP. According to the results, green integration acts as a connector between IT-RR and EP. IGI acts as a mediator between EP and IT-HR at the very end of the process.

These results are in line with the theory and previous research. They are similar to those

of Wang et al. (2015), who suggested that a firm's environmental performance is highly influenced by its IT technical infrastructure, IT HR resources and IT-business alignment. Likewise, Li et al. (2021) suggested that a firm's IT resources can influence its environmental performance. However, it is important to note that both these studies were conducted in China, and thus the results of our study also validate those from a different context.

IT resources play a crucial role in supporting the efficacy of information because they act as catalysts in the process of information production. Since the quality of the information produced by IT infrastructure heavily depends on IT resources, they are also occasionally referred to as information system elements. IT systems are crucial to the efficient and effective use of information resources, and they also determine the quality and security of information resources. IT combines multiple supply chain procedures carried out by many businesses. It expedites company operations and avoids bottlenecks. Businesses, particularly those in manufacturing, are getting closer to attaining on-time procurement, reduced inventory, and improved efficiency. As a result, IT is viewed as a crucial component of SCM because it offers visual and aural information, through which it is possible to absorb and analyze crucial data in order to make wise judgments.

The study's conclusions will be helpful to Pakistani businesses since they will provide guidance on how they can enhance their EP. The study shows that creating the right standards is essential since IT management is a crucial phenomenon for operations and has to be backed up by a support system in case of unanticipated events.

The knowledge base and applications of green integration are expanded by this research. First of all, it provides a more comprehensive conceptual framework for comprehending both the direct and indirect impacts of green integration on EP. Our findings clearly demonstrate that it is critical to optimize the interaction impact of IT-HR and relationship resources when enterprises are interested in improving their green performance by concentrating on the potent effects of these resources, which have generally been ignored by prior research. They also offer empirical proof that the relationship between IT-HR and EP is indirectly mediated by internal integration.

Even while scholars have acknowledged the significance of internal integration, conflicting results have made it difficult to fully understand how it relates to IT-HR. This study expands our knowledge of internal integration's mediating influence on the effects of EP, giving businesses additional alternatives for enhancing EP.

This also makes it easier to understand how infrastructure resource conditions affect EP. The empirical research used in this study also enables academics and practitioners to better comprehend how various green integration traits, indicators, and aspects affect an organization's success and may help them to compare the effect of profitability drivers across an organization that is integrating a green internal environment. Finally, the results can help managers understand the significance of internal factors and their impact on performance. Prospective managers will be aware of how important these factors are to their decision-making.

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