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The Effect of Information Sharing, External Enablers, and Internal Enablers on Sustainable Freight Transportation in the Manufacturing Sector of Pakistan: The Moderating Role of Green Information Systems and SC Ambidexterity

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ABSTRACT

Purpose: The study examined the effect of information sharing, external enablers, and internal enablers on sustainable freight transportation with the moderating role of green information systems and SC ambidexterity in the manufacturing sector of Pakistan.

Methodology: The study has gathered data from the SC professionals and executives of the manufacturing firms operating in Karachi city of Pakistan. 327 responses were collected using a self-administrated five-point questionnaire and survey method. The non-probability purposive sampling technique has been used to select respondents from the sample population. The study has used PLS-SEM for data analysis, including a measurement model for data quality assessment and a structural model for hypothesis testing.

Findings: The study concluded that EE insignificantly affects SFT. Similarly, IE also insignificantly affects SFT. Whereas IS significantly affects SFT. The finding showed that GIS significantly moderates the effect of EE on SFT, or GIS also significantly moderates the effect of IS on SFT. However, GIS insignificantly moderates the effect of IE on SFT. Moreover, the study found that SCA insignificantly moderates the effect of EE on SFT. Also, SCA significantly moderates the effect of IS and IE on SFT. Likewise, SSODC significantly moderates the moderating effect of SCA between EE and SFT. In a similar vein, SSODC also significantly moderates the moderating effect of GIS between IE and SFT. Lastly, findings showed that SSODC insignificantly moderates the moderating effect of SCA between IS and SFT.

Implications: The findings of this study could be used to enhance management practices and offer guidance for GSCM techniques. Companies should acquire the capacities and competencies necessary to integrate creative, sustainable business practices in specific manufacturing techniques, features, functionalities, or evolution processes. Companies should reduce transportation emissions since doing so can lead to obtaining supplies from suppliers in the area, reducing pollution from logistics and fulfillment.

Keywords: Information Sharing, External and Internal Enablers, Sustainable Freight Transportation, Manufacturing Sector, Pakistan.

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1. INTRODUCTION

1.1 Background

GSCM is an idea that outlines the concept of implementing environmentally friendly methods into the existing supply chain. This area includes processes such as product design, sourcing and choosing materials, production and manufacturing operation, and end-of-life management (Gawusu et al., 2022). GSCM focuses on fostering value creation within supply chain companies to reduce the overall ecological effect rather than simply seeking to reduce SC ecological consequences (J. C. Ho et al., 2022).

While reducing CO₂ emissions is frequently the specific objective of GSCM, there are other real advantages for an organization, such as improved asset efficiency, decreased waste production, increased innovation, decreases in production costs, reusability of raw materials, higher margins, but also client perception of value creation.(Sarkar et al., 2022). However, the strategy used by each stakeholder to interact with their inbound and outbound SC partners was crucial to the success of GSCM. For the program to be successful, there should be much more transparency, collaboration, and integration of supply chain systems and processes (Purwanto et al., 2022).

Any mode of transportation with minimal negative environmental impact is considered green. Public or private means of transportation, such as a quick e-bike (like an electric city bus). Walking is a green form of transportation (W. U. Khan et al., 2022).Sustainability is one thing that all environmentally friendly transportation has in common. Green transportation is propelled by resources that may be used indefinitely and do not deplete when consumed (Wang et al., 2022). Green transportation systems contribute to the communities' environmental, social, and economic well-being. People quickly seize the opportunities presented by greater mobility, and low-income households stand to gain the most from low-carbon transport options. Transport networks exist to facilitate social and economic connections(Saxena & Srivastava, 2022). It is also important to balance the benefits of greater mobility with the costs that transportation systems place on the environment, society, and the economy(Sohail et al., 2021). At the same time, long-term objectives include switching from fossil fuel-based energy to other options like renewable energy and using other renewable resources. However, short-term action frequently emphasizes incremental progress in fuel efficiency and vehicle emissions controls. Sustainability evaluation and improvement are applied to the entire life cycle of transportation systems(W. U. Khan et al., 2022).

Pakistan's manufacturing industry is essential to its economy since it supports a wide range of social and economic objectives and employs a sizable workforce(Saeed et al., 2021). Even though the manufacturing sector in Pakistan contributes greatly to economic growth, it also has a big impact on the environment(M. T. Khan et al., 2022). Environmental effects of economic growth include elevated temperatures, smog, noise, and air pollution. Manufacturers in a developing nation like Pakistan should pursue long-term economic growth that's also sustainable and does not affect the environment (Khan et al., 2021). It is also challenging for industrial companies in this environment to cut carbon emissions, improve sustainable practices, and boost their long-term economic growth. Nevertheless, cost-effective and effective green innovation programs could revolutionize the manufacturing industry(Umar et al., 2021). However, the implementation of GSCM is currently in its early stages in Pakistan, considering that it is a relatively new concept. Pakistan has a serious pollution problem, and firms are compelled to utilize GSCM strategies of community pressure and environmental

concerns. Only a small portion of Pakistan's manufacturing has implemented green practices due to a lack of research on GSCM and its impact on a firm's development(Azam et al., 2022a).

The lack of commitment and varied GSCM methods among manufacturers can be explained by the need for a clear correlation between profitability and GSCM involvement among corporate organizations(Bechtsis et al., 2022). Poor environmental conditions have already become a problem in developing nations, which could negatively affect how well companies perform there. Most businesses in developing nations need more incentives to implement green practices. Rasheed (2022) claimed that Companies are still determining which green practices to adopt, and which will be most beneficial to their organizational performance and maximize shareholder wealth. Therefore, it is also crucial to examine performance variances between the highly dedicated firm and the lowly committed firm of GSCM(Amjad et al., 2022).

Additionally, there needs to be more in the current full understanding of green resources and how they relate to different performance metrics. Investigating the topic in a complex environment is crucial since GSCM policy execution could be more effective, in environments that are less conducive to business. It is important to note that a firm's approach and perception of GSCM may influence its ability to devote resources to GSCM operations and reap their economic and ecological benefits(Yu et al., 2022).

1.2 Statement of the problem

GSCM is a relatively new concept in Pakistan, and firms are currently working to implement it. However, the initial costs of creating a GSCM may be high for smaller enterprises. These costs also affect the price of the goods, and some companies find it difficult to justify them to numerous consumers who might need to be completely aware(Seuring et al., 2022). No incentives are in place to encourage innovation and the overall implementation of the concept of GSCM. Therefore, the government supports companies through taxes, equipment, and so on (Huma et al., 2022).

Further, Many companies realize that there are simply no sustainable component options available or that their suppliers might need to adhere to sustainable standards. Also, even a slight adjustment in a straightforward procedure can have repercussions across the whole supply chain network in a complicated supply chain network where the stages are interrelated and interdependent(M. T. Khan et al., 2022). Keeping track of every sustainability measure in such a supply chain also becomes a highly onerous operation, which would be a significant challenge for companies. Nevertheless, the organization will only be able to adopt GSCM with the management's support, willingness, and commitment to sustainability(Saeed et al., 2021). Establishing environmentally friendly logistics systems that support sustainable growth is a significant obstacle to obtaining a GSCM(Qalati et al., 2022b). Lastly,sustainable processes may involve a longer lead time, making it difficult for companies to justify them to clients(Rasheed, 2022).

1.3 Gap Analysis

Though GSCM is an important factor that warrants consideration, several research gaps remain in the existing literature (Yu et al., 2022). A wide range of empirical studies has examined the significance of GSCM and its impact on both environmental and organizational performance. These studies, primarily conducted in developed countries, consistently highlight that firms implementing green practices such as eco-design, effective waste management, and reverse logistics tend to achieve improved operational efficiency, reduced costs, and enhanced brand reputation. The findings suggest that integrating sustainable practices contributes positively to long-term business performance and customer satisfaction (Qalati et al., 2022b). However, these results often stem from environments with strong regulatory frameworks, advanced technological infrastructure, and higher environmental awareness, which limits their direct applicability to developing economies. Furthermore, the focus of many of these studies has remained on isolated practices or specific industries, neglecting broader institutional and cultural contexts, particularly in regions like South Asia, where such practices are still evolving and less systematized (Purwanto et al., 2022).

Research on GSCM practices in developing countries like Pakistan remains considerably limited and fragmented. GSCM practices in textiles and manufacturing have been studied in some depth, with results indicating that firms face several constraints ranging from limited financial resources, lack of skilled labor, and weak institutional support to resistance to change (M. T. Khan et al., 2022). There has been increasing interest in environmental sustainability; however, these studies often work with a narrow perspective, analyzing either one specific industry or just some isolated GSCM practices. Their findings indicate that while there might be some awareness, the actual application of green practices remains uneven due primarily to external factors, such as pressure from international buyers, rather than intrinsic motivation or strategic planning (Huma et al., 2022).

The limited development and application of context-specific conceptual frameworks to explain GSCM adoption in developing economies represent a crucial theoretical gap in existing research. In contrast, most studies are based on Western theoretical models without consideration of the unique local socio-economic, regulatory, and cultural environment of these countries, such as Pakistan. Such models fail to capture the intricate nature of local business operations, stakeholder dynamics, and institutional challenges, which further limits their explanatory power. Besides, very few studies integrated both internal organizational drivers as well as external institutional factors into a single coherent framework that explains GSCM performance variations across firms and industries (Azam et al., 2022b; Rasheed, 2022).

1.4 Purpose of the study

The purpose of this study is to investigate how information sharing, external enablers, and internal enablers influence the adoption and performance of sustainable freight transportation practices within Pakistan's manufacturing sector. As sustainability becomes an increasingly critical issue, especially in developing countries, this research aims to explore the mechanisms that drive greener transportation systems in complex and resource-constrained environments. In particular, the study focuses on the moderating roles of green information systems and supply chain ambidexterity, assessing how these elements enhance or hinder the relationship between the enablers and sustainable freight outcomes. By examining the dynamic interaction

among these factors, the study seeks to provide a comprehensive understanding of the conditions necessary for effective green transportation strategies. The findings are intended to support manufacturing firms in making more informed, sustainable logistics decisions and offer practical insights for policymakers aiming to promote environmentally friendly freight practices across industrial sectors. Additionally, the study has gathered data from the SC professionals and executives of the manufacturing firms operating in Karachi city of Pakistan. The study has used the natural resource-based view (NRBV) theory and dynamic capability theory (DCT) as theoretical foundations and hypotheses support. Moreover, 327 responses were collected using a self-administrated five-point questionnaire and survey method. The nonprobability purposive sampling technique has been used to select respondents from the sample population. The study has used PLS-SEM for data analysis, including a measurement model for data quality assessment and a structural model for hypothesis testing.

1.5 Research questions

RQ1. What is the effect of information sharing, external enablers and internal enablers on sustainable freight transportation?

RQ2. Do green information systems moderate the effect of information sharing, external enablers and internal enablers on sustainable freight transportation?

RQ3. Does SC ambidexterity moderate the effect of information sharing and external and internal enablers on sustainable freight transportation?

1.6 Significance of the study

The study has contributed several important ways to empirical research on the subject. It has produced a wealth of helpful and instructive data that might be further examined. The development of sustainable growth within the supply chain can be facilitated by utilizing the most current methods, technology, and supply chain innovations and making the most of the currently in-place supply chains. This is due to the research model employed in this study to explore the GSCM through supplier management comprehensively. As a result, the study is based on GSCM practices to increase awareness and enhance corporate performance. The study provides details on how organizations have handled adopting green practices and how productivity has been affected. By strengthening the currently in place environmentally conscious framework that tries to protect the environment and resources while also increasing the performance level of the firms, the goal is to raise awareness among businesses of the significance of GSCM practices in optimizing performance.

2. LITERATURE REVIEW

2.1 Theoretical background

2.1.1 The natural resource-based view (RBV) theory

Stuart Hart first put out the theory of the natural resource-based view (NRBV) in 1995. A progression from RBV, NRBV focuses on locating strategic assets and competencies that contribute to environmental and competitive sustainability. The NRBV framework developed a model of three interrelated competencies that businesses may achieve: sustainability, green purchasing, or contamination avoidance. It acknowledges how companies may gain a competitive edge through skills which encourage sustainable growth (Andersen, 2021). Capabilities for pollution control aid in reducing emissions and waste. Through the use of extended producer responsibility abilities, equipment lifetime costs were decreased. Developing abilities for sustainable development, corporate expansion, and advancement incur less ecological impact. This concept explains a relationship between complex-valued competencies and competitive benefits but also suggests that businesses look within instead of outside the corporation for sources of advantage (Verbeke et al., 2006).

Moreover, natural RBV (NRBV) uses resources focused on the natural environment to offer a foundation to compete. Environmental harm will be reduced through environmentally responsible corporate practices. Similarly, NRBV advises businesses to consider environmental factors while using their resources continuously. These internal resources are the basis for creating crucial capabilities (Rehman et al., 2023). Nevertheless, there has yet to be much empirical study on NRBV, and as far as we know, no NRBV-based studies have been done to determine if companies that actively pursue climate change plans outperform those that do not (Tjahjadi et al., 2023).

2.1.2 Dynamic capability theory (DCT)

Teece and Pisano (1994) developed the concept of dynamic capacities. Over the past years, in the research on strategic planning, the DCT has emerged as one of the predominant theoretical stances (Teece & Pisano, 2003). Dynamic capability is an organization's ability to adapt, combine, or create internal and external assets and abilities to adapt to and impact rapidly shifting business conditions. The idea of DCT has received much study interest partly because of its potential effect on significant outcome factors (Abu-Rumman et al., 2021). Theoretically, operational or ordinary capabilities may be separated by dynamic capabilities, which relate to how an organization operates. Contrarily, A firm's capacity to intentionally expand, contract, or modify its endowment is called dynamic capacity (Ilmudeen et al., 2021).

Additionally, the three categories of activities focused on change initiatives include identifying novel possibilities, capitalizing through business model design through equity acquisitions, or converting or redesigning current strategies and models of operation that make up dynamic capabilities (Roundy & Fayard, 2019). According to dynamic capability theory, sensing incorporates analytical systems that scan, seek, and explore various innovations and economies. The process of grasping, in contrast, necessitates consideration of both existing and emerging abilities, as well as possible investments in functional designs and innovations which are most likely to succeed in the market. However, the essential tenet of the dynamic capacity

theoretical foundation is that responsibilities should be used to influence relatively brief economic circumstances that may be used to generate a long-term market edge (Conboy et al., 2020).

2.2 Theoretical connectivity

2.2.1 External Enablers

An "external enabler" (EE) would be a nontrivial transformation to the business environment that makes it possible for organizations to pursue their goals. Examples of such changes include modern technology, regulatory changes, demographic and sociocultural trends, economic and financial whacks, and changes to the natural environment(Ashiru et al., 2022). By dynamic capacity theory, the external enablers were created to further knowledge accumulation in innovation and strategy research addressing the impact of environmental variables on entrepreneurial initiatives(Seles et al., 2022). EE mechanisms specify the benefits that certain endeavors may receive from us. These include lowering costs, supplying resources, enabling the development of new or improved goods and services, and increasing demand. According to EE roles, these (expected) mechanisms play initiating, shaping, and outcome-enhancing roles in entrepreneurial processes(Y. Li et al., 2022).

2.2.1 (a) Public and regulatory pressure

Stakeholders have proposed additional standards for environmental protection and low-carbon development for businesses due to the intensity of the global greenhouse effect, which has increased public and regulatory pressure on firms to comply(Y. Zhang et al., 2022). According to the dynamic capacity theory, an enterprise's viability is the basis for its long-term survival. If a business breaks the "contract," there will be repercussions(C.-I. Ho et al., 2022). Businesses voluntarily provide environmental information in response to public and regulatory pressure to protect their reputations from being damaged by claims that they have broken their explicit agreements with stakeholders(Yuan & Cao, 2022). Based on dynamic capabilities, academics think public pressure is crucial for boosting enterprise information disclosure.

2.2.1 (b) Adoption of green practices

Adopting green practices under duress or inducement may enhance environmental performance. From the perspective of NRBV theory, Farrukh et al. (2022), firms often adopt green practices and have strong environmental and social performance, including appropriate adherence to environmental rules. In order to compete and boost sales by gaining market share, businesses are adopting green practices (Abdellatif, 2022). Similarly, Green practices have been identified in the middle of the supply chain through the NRBV theory. These practices include waste management, choosing suppliers with a good environmental reputation, producing more green products to cut operational pollution, educating downstream suppliers to improve environmental performance, and working with suppliers within their own companies(Afum et al., 2022). The advantages of cost management, which boost profitability,

are crucial motivators for businesses to adopt environmental practices and affect their capacity to compete in the market.

2.2.1 (c) Adoption of environmental standards

According to NRBV theory, the maximum permitted deterioration of environmental media is set by an environmental quality standard, which sets a limit for environmental disturbances, particularly those caused by ambient concentrations of pollutants and trash(Appannan et al., 2022). Moreover, Companies frequently adopt these standards due to pressure from authorities, customers, or environmental interest organizations. They could do this to reduce both now and future expenses associated with complying with environmental rules(Akram et al., 2022). Further, implementing environmental regulations can serve as a tool to simplify and improve standards management and convey the company's commitment to the environment to its various parties(Abdellatif, 2022).

2.2.2 Internal enablers

The internal enablers that support the growth of a successful sustainability risk management system inside the supplier network are represented by a dynamic capability developed(Wu et al., 2022). The dynamic capability theory effectively supports the claim that institutions handling public funds require internal control(Pérez-Rave et al., 2022). This viewpoint not only minimizes the potential commercial value of internal control, particularly its function as a business enabler, but it also contradicts the idea that outcomes are a product of planning and that, notwithstanding variations in organizational scale(Herath & Harrington, 2022). Moreover, internal enablers aid in the advancement of corporate goals and the support of methodical decision-making.

2.2.2 (a) Top management support

Whenever the Leader and other top managers, including executive leaders, spend quality time addressing organizational problems, reviewing strategies, and monitoring results, this is referred to as top management support(Özgül & Zehir, 2022). The executive's need for top management support in ethical products is highlighted by McDougall et al. (2022), identifying top management's environmental awareness as a dynamic eco-skill throughout the NRBV. The intrinsic top management mindset and the amount of assistance should be considered when discussing the effects of environmental cooperation among partners involved in sustainability impact within the GSCM. By encouraging information exchange and communication between companies, top companies' backing by certain organizational initiatives helps overcome potential internal and external opposition to change(Tan et al., 2022).

2.2.2 (b) Transportation planning and distribution network

An SC distribution network is a connected system of facilities or transport networks that accept goods while sending them to consumers. It acts as a link between the producer and the buyer, perhaps immediately or through a chain of stores(Cherrafi et al., 2022). The NRBV theory states that various distribution-related operations, including packing and shipping, have a significant environmental impact. Consider this in terms of the ecological impact of the company. This phrase describes how much of the planet's biological capacity the company requires to function(Shaharudin et al., 2023). Since the corporation must consider everything from the waste products and CO2 emissions you create to the urban infrastructure and highways the company depends on for distribution, calculating this properly is far from straightforward(Song, 2022).

2.2.2 (c) Commodity consideration

A commodity is a basic good used in business that may be traded for other commodities of a similar sort. Commodities are typically used as raw materials to produce other items and services (Wei et al., 2022). Commodity prices often increase when inflation picks up speed, which is why investors frequently turn to them for protection during periods of higher inflation—especially unanticipated inflation according to dynamic capabilitiesIdries et al. (2022), commodity consideration. Commodities are the materials utilized to manufacture those products and services, and as the demand for goods and services rises, so do their prices(ur Rehman et al., 2022).

2.2.3 Information Sharing

Green information management gives the data necessary to collaborate with customers in enviro, manufacturing, marketing, shipping, repurposing, dumping, and waste rate (Syed et al., 2022). According to NRBV, information sharing via green information systems is a key facilitator for SCM in terms of synchronization and integration. Also, green information systems give the data necessary to make greener choices regarding substance and energy use, reusing, composting, or reusing materials(Samadhiya et al., 2023). Information sharing helps suppliers assist manufacturers' environmental sustainability initiatives and guarantees that environmental results are not compromised elsewhere in the supply chain. Companies might cooperate in an SC against one another while attempting to enhance environmental performance inside a firm and along the production process if they cannot communicate information(McDougall et al., 2022).

2.2.3 (a) Information quality

The standard of information systems' content is known as information quality. It is frequently described pragmatically as the suitability of the information presented(S. Zhang et al., 2022). According to NRBV, for the effective development of green improvement initiatives, the organization's quality information systems must collect data on environmental green initiatives

or results of the firm's production, procurement, marketing, and transportation activities(Johnson-Hall & Hall, 2022).Green quality information systems are the cornerstone of emission reduction operations by enabling the company's inner sustainability practices and taking care of the reporting entities for diverse participants (Chuang & Chen, 2023).

2.2.3 (b) Manufacturer information

Manufacturers are companies that produce products or provide services. This category includes either companies that produce simple ingredients or companies that produce finished goods. Manufacturers of natural resources include businesses that extract minerals, pump for petroleum and natural gas, and gather lumber(Borazon et al., 2022). manufacturer information interchange through green information systems is a key accelerator for SCM coordination (Abobakr et al., 2022). According to (Samadhiya et al., 2023), logistical integration also encompasses the degree of collaboration in controlling essential manufacturer information and product moves from across the logistics system.

2.2.3 (c) Customer information

Identifying and acknowledging the customer information function in green supply chain management is necessary as a significant study field. Thus according to NRBVChuang and Chen (2023), a manufacturing company's capacity to simultaneously communicate knowledge about providers or customers instantaneously, as well as the adoption of green information systems, work together to affect a production sector favorably (Huang et al., 2022). Green information systems give the data necessary for collaborating with clients on environmentalist, manufacturing, container, distribution, composting, removal, and garbage proportion. Additionally, environmentally friendly information systems offer data that encourages customers to make environmentally friendly decisions and enhances executive decision-making around sustainability issues(Kühl et al., 2022).

2.2.3 (d) Information sharing support technology

According to the dynamic capability theory, technology and information exchange plays a crucial part in the GSCM by speeding up business processes and preventing blockages. Businesses are getting nearer to attaining on-time purchasing, decreased stock, and improved efficiency, especially in manufacturing (Al-Shami & Rashid, 2022). Companies in the SC can now meet client needs due to technological advances and information exchange (Singh et al., 2022). Moreover, technology and information sharing enable suppliers to support manufacturers' environmental sustainability initiatives and guarantee that no other parts of the SC compromise ecological impacts (Yoshikuni et al., 2022). If they cannot exchange information, stakeholders in a supply chain can work against each other to enhance ecological effectiveness at the organizational and layers of production processes.

2.2.4 Sustainable freight transportation

According to NRBV, Sustainable transportation can take many forms and focus on one specific aspect. These include culture (embracing mobility), ecology (clean mass transit), and economics (efficient and competitive transport). Although in general, sustainable freight transportation tries to strike a balance between the sector's economic, social, and environmental aspects to ensure complementarities, synergies, and coherence(Kumar, 2022).Similarly, the government should take the initiative to create an environment conducive to sustainable freight transport(Pfoser, 2022). This can include policies like phasing out fuel subsidies, transport pricing that considers externalities, offering guarantees, and other risk-mitigating measures for projects promoting sustainable freight transport(Noorliza, 2023).

2.2.4 (a) Economic dimension

The economic dimension deals with the financial results and consequences of the event company and the specific event(Kumar, 2022). Furthermore, the ability of the public and private sectors to conduct lucrative business strategies without jeopardizing the balance concerning social and environmental considerations is referred to as the economic dimension in the NRBV theory(Suleiman, 2022). Theoretically, the two remaining characteristics are intimately related to sustainable economic activity. Economic sustainability is connected to the social and ecological dimensions, such as via establishing and protecting workplaces and efficient use of resources and energy(Yavuz et al., 2023).

2.2.4 (b) Environmental dimension

According to NRBV theory, the environmental dimension focuses on how susceptible ecologically, or biological processes are to harm or compromise inherent efficiency during difficult circumstances (Samadhiya et al., 2023). Moreover, The environmental dimension is usually ignored in modern assessments because of a dearth of understanding of the factors that contribute to ecological degradation and its consequences on disasters, as well as the fact that economic considerations often "supersede" environmental problems(Appannan et al., 2022). Nevertheless, as it can provide in-depth insights for mid-to-long-term percussions, particularly in climate change, the external issue merits further attention(Bendig et al., 2023).

2.2.4 (c) Social dimension

In order to reduce wealth disparity and enhance social fairness, the social dimension refers to a society's ability to put in place policies that ensure acceptance of human rights, variety, cultural heritage, and all (Jayarathna et al., 2023). According to NRBV, the social dimension of sustainability is the hardest to understand and receives the least amount of attention in discussions on a sustainable future(Johnsen & Caniato, 2022). Similarly, the social dimension is tied to several (scientific) areas, and it takes work to quantify a couple of the reasons for this(Fernando et al., 2022). As a result, social sustainability still needs to be understood clearly and more widely acknowledged.

2.2.4 (d) Efficiency dimension

A concept, a tool, and a complex variable concerted and synergistic, the firm efficiency communicate the company's whole performance and its economic value. It reveals numerous facets of its business outcomes from multiple viewpoints when evaluating the company's comprehensive income(Ruiz-Ortega et al., 2023). A multi-dimensional evaluation of the firm is necessary to thoroughly determine its effectiveness(You & Zhang, 2023). Moreover, Dynamic capabilities enable businesses to gain sustained competitive advantages in a dynamic, complex, and uncertain environment by gradually integrating and enhancing current capabilities and dimension efficiency(El-ata & Salah, 2023). Dynamic capabilities assist businesses in acquiring resources, reallocating assets, and responding to changing market conditions and business environments.

2.2.4 (e) Safety dimension

Safety Dimensions assists all employees in becoming become safety leaders. By doing this, we change cultures, encourage workers to put safety first, and lower the risk of workplace accidents for the organization. Thus, this favors an organization's bottom line(Abou-Foul et al., 2023). Concerning the theory of dynamic capability, Safety Dimensions is an expert in changing human behavior. For the past three decades, Safety Dimensions has successfully applied this specialty to work, health, and safety(Olarewaju & Ajeyalemi, 2023). Further, Organizations may successfully address difficulties with safety performance with the help of Safety Dimensions (Weiss et al., 2023). Companies educate and prepare leaders to take the necessary action to genuinely alter organizational safety behavior, promote compliance, and guarantee due diligence.

2.2.4 (f) Green information system

Green information technology (IT) is the theory and application of using IT and computing assets in a more effective and ecologically friendly manner. The term "green information systems" (IS) refers to the application of IS to sustainability goals (Bukhari et al., 2023). NRBV, IS, and IT have significantly altered social habits over the previous several decades and, as a result, have the potential to support the transition to a more sustainable society. Green business concepts are being used by many companies(Noorliza, 2023). The company's experience found that implementing green IT options enables them to meet their investors' requirements and enhances their companies' corporate image while providing cost-saving advantages(Cheng et al., 2023).

2.2.5 Supply chain ambidexterity

A manufacturer's attempts to improve/extend its current resources, build new supply chain capabilities, and provide performance gains are referred to as supply chain ambidexterity, especially for major manufacturing enterprises(Ochie et al., 2022).Lambourdière et al. (2022)claimed that, despite the applicability of the many theoretical frameworks used to

explain Ambidexterity, the best lens to investigate Ambidexterity is still dynamic capacity. This reasoning supports the preceding theory that supply chain ambidexterity is a dynamic capability. Further, Ambidexterity can also exist inside a supply chain's specialized functional domain. According to this theory, adopting environmentally friendly supply chain operations, including sourcing raw materials, green manufacturing, environmentally friendly packaging, and recycling, may be made more effective and efficient with supply chain ambidexterity (van Lieshout et al., 2021).

2.3 Development of the hypotheses

An external enabler has significantly changed the business environment that enables organizations to achieve their objectives. Modern technology, legislative shifts, sociocultural and demographic trends, economic and financial shocks, and environmental alterations are a few examples of such changes (Shamseldin & Shendy, 2022). Furthermore, (Karuppiah et al., 2022) investigated how the sustainability enablers of economic growth, environmental protection, social progress, and performance management interact, providing useful information for the manufacturing industry. Similarly, a wide field of sustainable freight transportation has recently drawn substantial interest from both an academic and practitioner's standpoint for why key activities related to transportation and infrastructure are considerably involved in GSCM (Rajalehto, 2023). Results about the effectiveness of sustainable commercial vehicles in the company strategy for freight logistics and transport operators are impacted by several factors (Bassi et al., 2022). Also, the way that the environmental imprint of 3PL delivery companies is disclosed in terms of energy usage and fleet optimization, as well as other factors, is influenced by public and regulatory pressures, as well as the federal government's enforcement of environmental standards that lead to the utilization of green practices on the transportation industry along with broadly, but transportation professionals specifically (Hinderer & Kuckertz, 2022). These metrics can be used as a proxy for measuring sustainable freight transportation operations. Hence, the hypothesis is formed:

H1. External enablers have a significant positive effect on sustainable freight transportation.

In the supplier network, a dynamic capacity produced represents the internal enablers that support the evolution of a successful sustainability risk management system (Karuppiah et al., 2022). Similarly, in the context of third parties logistics (3PL) companies, effective transport planning and distribution network architecture are crucial to ensure lower fuel usage, shorter fleet wait times, and shorter delivery distances (Gonçalves et al., 2022). In terms of reducing carbon footprints, analytical models and many specific instance analysis techniques have shown the value of distributing plus shipping design (Akbari & Hopkins, 2022). Additionally, the overall energy footprint of the transportation industry is significantly influenced by commodity factors (for example, elastic elements require a frigid conveyance system to retain the necessary practical qualities of essential elements). Further, in their work, (Shehzad et al., 2022a) emphasized the importance of ongoing implementation or assessment of steps at the actual level to promote ecology in the transportation and logistics industry, especially with the perspective related to commodities and transport planning (Bassi et al., 2022). However, rather than relying on anecdotal evidence, such claims must be empirically tested. Hence, the hypothesis is formed:

H2. Internal enablers have a significant positive effect on sustainable freight transportation.

Customers and businesses can make (the right) decisions and solve problems due to information. Entities share information in multi-actor service ecosystems by seeking and disclosing information (with each other)(Pamucar et al., 2022). The deliberate gathering of information from particular sources is information-seeking behavior(Fu et al., 2022). Similarly, transit needs more knowledge and comprehension of a big part in most areas. Enhancing this information is crucial for information exchange in these cities' feasible transportation value chains. One of the important topics that efficient information and Communications Technology (ICT) technologies like the Internet of Things (IoT) may enable is the phenomena of information sharing(Chatti & Majeed, 2022). Smart solutions to enhance freight movement in big centers are being considered because of the intricacy occurring in transportation networks and the sometimes contrasting demands to investors. These days, "smart transportation" (IOT) refers to a wide range of information as well as hundreds of different systems that use data to make smart transportation-related choices(S. A. R. Khan et al., 2022). Additionally, internet technologies provide economic gains since chain participants intend to exchange useful information and make better sensible choices to cut down on travel time and expenses as well as the negative effects of travel on society and the environment(Sislian & Jaegler, 2022). Therefore, the hypothesis is formed:

H3. Information sharing has a significant positive effect on sustainable freight transportation.

The efficacy of the function of external enablers, which could promote the sustainable performance of the 3PL enterprises taken into account in the study, can be influenced by information-sharing dimensions(Karuppiah et al., 2022). An example would be when the company, the end user, requests that components be packaged into reduce the company's waste expenses and use paper-based wrapping instead of polycarbonate containers (Rajalehto, 2023). Consumer knowledge transfer at the individual 3PL firms would undoubtedly play a moderating role in implementing green practices in such a situation, positively impacting greenhouse gas reduction (measured in terms of lower energy footprint) or slower productivity (Shamseldin & Shendy, 2022). Therefore, the hypothesis is formed:

H4. Green information system significantly moderates the effect of external enablers on sustainable freight transportation.

The effectiveness of information sharing and the degree of sustainability in supply chains and freight transportation are positively correlated, as shown by empirical researchAkbari and Hopkins (2022); (Karuppiah et al., 2022; Shoaib et al., 2022)analytical research and reviews of relevant literature (Gonçalves et al., 2022). These results have traditionally been quantified in terms of a decrease in greenhouse gases, carbon footprint, energy utilization, etc. However, it is still unknown how information sharing affects how much different internal enablers can affect the performance of sustainable freight transportation(Sabat et al., 2022). This subject acquires even more significance when seen from the standpoint of information exchange since certain information-sharing characteristics like quality, asymmetry, distortion, and availability will affect the efficiency of sustainable freight transportation. Sharing information among the parties involved increases the effectiveness of freight operations significantly. This suggests that it may be possible to enhance sustainable freight transportation strategies. Thus, the hypothesis is formed:

H5. Green information system significantly moderates the effect of internal enablers on sustainable freight transportation.

Many 3PL delivery companies transport automotive parts for freight regularly or on a real-time basis exchanging with the company information linked to the manufacturers of such components. However, only big logistics businesses use these techniques (S. A. R. Khan et al., 2022). Furthermore, rather than lowering emission levels, these approaches primarily focus on managing inventories. For instance, quantity dimensions, shipping box specifications, shipment collection details, and so on might affect emission levels and carbon footprint. Some things, including brake hoses, must be watertight (Chatti & Majeed, 2022). There are, at best, a few examples that suggest a relationship between particulate emissions and the existence of information from the product's supplier while it is being transported (Martins et al., 2022). However, some anecdotal evidence suggests that such activities. Hence, the hypothesis is formed.

H6. Green information system significantly moderates the effect of information sharing on sustainable freight transportation.

The number of procedures used to develop novel supply chain solutions is referred to as supply chain explorations. In contrast, the number of processes used to improve and refine the supply chain's present capabilities and resources is known as supply chain ambidexterity. Supply chain exploitation may be accomplished by experimenting and coming up with new solutions and opportunities for supply chain problems. In contrast, supply chain exploration can be accomplished by reducing operational redundancies (Shehzad et al., 2022b). Moreover, various variables have influenced the success of reliable freight transportation at the management level for freight logistical issues and transport operators (Alamsjah & Yunus, 2022). Additionally, public and regulatory pressures, as well as the federal government's enforcement of environmental standards that lead to the application of green practices in the transportation industry besides generally, but mobility professionals explicitly, determine how 3PL logistics providers should record their environmental impact in terms of fleet productivity, energy usage, and certain other criteria (Wairimu et al., 2022). Thus, the hypothesis is formed:

H7. SC ambidexterity significantly moderates the effect of external enablers on sustainable freight transportation.

Researchers have lately looked at the value of Ambidexterity in the context of the supply chain. According to their research, they have found that in ambidextrous supply chains, the supply chain affiliates investigate a new customer demand and adjust the environmental changes in the firm. This might improve the company's operation and reduce supply chain problems (Bag et al., 2023). descriptive frameworks or other particular instance analysis methodologies have shown the significance of shipping and marketing design in lowering carbon footprints (Wairimu et al., 2022). Additionally, commodity variables considerably impact the transportation sector's overall energy footprint (for example, elastomer fibers require a rough transferring system to retain the necessary robotic qualities, including several substances) (Shehzad et al., 2022b). Therefore, the hypothesis is formed:

H8. SC ambidexterity significantly moderates the effect of internal enablers on sustainable freight transportation.

Ambidexterity in Sustainable supply chain management is a crucial idea for businesses to use while facing disruption. According to Shehzad et al. (2022b), Ambidexterity uses organizations' skills and current information flows to enhance their GSCM. Similarly, according to Alamsjah and Yunus (2022), achieving production sustainability necessitates balancing ambidextrous indicators to increase a firm's adaptability in terms of imitation within changing circumstances to deal with unforeseen disruptive events and maintain operational processes, a focus on ambidextrous SSCM strategies is urgently required. Also, a few examples suggest a relationship between emission levels and the existence of information from the component's manufacturer while it is being transported(Wairimu et al., 2022). Thus, the hypothesis is formed:

H9. SC ambidexterity significantly moderates the effect of information sharing on sustainable freight transportation.

Although organizational ambidexterity makes it easier for exploration and exploitation to expand concurrently, SC dynamic qualities keep an organization aligned to a rapidly changing environment, ensuring competitive success. On the other side, SC Ambidexterity is a corporate characteristic that enables a company to simultaneously pursue and balance exploitation and exploration strategies (Shehzad et al., 2022b). On the contrary, adaptation is regarded as a higher-order capacity that entails selecting an adaptation strategy from structural separation, behavioral integration, or sequential alternation to enable the lower-order capabilities of sensing and seizing (exploration and exploitation)(Rehman & Jajja, 2022). Furthermore, some factors have affected how well-managed freight logistical problems and transport operators have implemented responsible freight transportation. Transportation professionals precisely determine how 3PL logistics providers should record their environmental impact in terms of fleet productivity, energy usage, and other criteria, in addition to public and regulatory pressures, as well as the federal government enforcement of environmental standards that lead to the application of green practices on the transportation industry(Jafari et al., 2022). Therefore, the hypothesis has been developed:

H1. SC organization dynamic capability significantly moderates the moderating effect of SC ambidexterity between external enablers and sustainable freight transportation.

SC organization's dynamic capability, which is crucial for developing ambidexterity, considers the company's internal information of its partners and communication. Moreover, relationship skills, partner information, internal communication, and interfirm coordination comprise the four components of the latent construct networking capabilities. Due to the availability of the partners' plans and capabilities, the information of the partners promotes the supply chain's ambidexterity(Shehzad et al., 2022b). To improve their GSCM, ambidexterity takes advantage of organizational capabilities and current information flows. Similarly, (Rehman & Jajja, 2022) claim that to increase a firm's adaptability in terms of imitation within changing circumstances and maintain operational processes, a focus on ambidextrous SSCM strategies is urgently needed. This is because achieving production sustainability necessitates balancing ambidextrous indicators. Additionally, a few instances hint at a connection between emission levels and data availability from the component's maker when transported(Alamsjah & Yunus, 2022). Thus, the hypothesis has been developed:

H2. SC organization dynamic capability significantly moderates the moderating effect of SC ambidexterity between information sharing and sustainable freight transportation.

Despite these slightly divergent explanations, researchers who are currently using the dynamic capability to explain ambidexterity generally agree that dynamic capability results from superior management, leadership, and asset orchestration capabilities, which may help an organization strike an appropriate balance between the mutually exclusive demands of exploitation and exploration (Shehzad et al., 2022b). The capacity of businesses to utilize and organize internal resources is improved by internal enablement. Internal integration is accomplished by knocking down organizational boundaries and promoting internal coordination (Jafari et al., 2022). Commodity variables substantially impact the transportation sector's total energy footprint (for example, elastic elements require a frigid conveyance system to retain the necessary practical qualities of essential elements). Park and Singh (2022) have highlighted the significance of continuing implementation or assessment of actual initiatives to improve ecology in the transportation and logistics business in their work. Thus, the hypothesis has been developed:

SC organization dynamic capability significantly moderates the moderating effect of SC ambidexterity between internal enablers and sustainable freight transportation.

3. METHODOLOGY

3.2 Research design

The quantitative approach enables the systematic measurement of variables and the testing of hypotheses (Watson, 2015). This method can aid in the hypothesis- and theory-testing approach. The current study has been based upon the theory of natural resource-based view (NRBV) theory and dynamic capability theory (DCT). The study used the hypothesis testing approach, which relates to the quantitative approach (Leavy, 2022). The study has collected data in numeric form using a 5-point Likert scale. A high focus is also placed on precise measurements and statistical, mathematical, or numerical analysis of data gathered via questionnaires (Plonsey et al., 2007). The study used statistical techniques to analyze the results; hence, this study used a quantitative approach as a research choice.

3.3 Sampling design

3.3.1 Population

Manufacturing helps businesses recover their raw materials costs by charging more for finished items. Large-scale manufacturing enables the mass manufacture of goods using assembly line methods and cutting-edge technologies (Rasheed, 2022). The majority of Pakistan's manufacturing sector comprises four sectors: pharmaceuticals, Coke & Petroleum, textiles, and FBT (food, drinks, and tobacco). The three "components" of the manufacturing industry are Large Scale Manufacturing (LSM), Small Scale Manufacturing (SSM), and slaughtering (Matloob et al., 2023). Hence, the data will be collected from the SC professionals of the manufacturing firms of Pakistan.

3.3.2 Sample size

The study used a sample-to-variable ratio of 1:15 (Hair et al., 2018), wherein the study has 21 latent constructs (variables) in the model, and consequently, the analysis needs at least 315 responses. In this instance, the research has gathered 327 responses from the sample population for data analysis.

3.3.3 Sampling technique

The population size is unknown in non-probability sampling (Etikan & Bala, 2017). The total number of SC professionals working in Karachi is still being determined, and there is no open source of information to gauge the total population; therefore, the study has used a non-probability sampling technique.

Purposive sampling, also known as judgmental sampling, is a type of non-probability sampling where researchers narrow down the sample population for the collection of data/to make them participate in surveys (Thomas, 2022). Purposive sampling was also employed in this study because the study chose to collect solely data from the supply chain professionals (managerial staff) of the manufacturing firms of Karachi working in the transportation department (Raifman et al., 2022a). Nonprobability sampling is purposeful and involves a sample to address the research issues (Raifman et al., 2022b). Non-probability purposive sampling was used in this study since it facilitated the collection of relevant and valuable data from the respondents in the targeted sector (Tutz, 2023).

3.4 Data collection instrument

External enablers: External enabler is a 2nd-order reflective latent construct with 11 items with three 1st-order reflective constructs of public and regulatory pressure, green practices, and environmental standards adapted from Goswami et al. (2020) based on a five-point Likert scale.

Internal enablers: Internal enabler is a second-order reflective latent construct with ten items with three 1st order reflective constructs of top management support, transportation planning, distribution network, and commodity consideration adapted from Goswami et al. (2020) based on a five-point Likert scale.

Information sharing: Information sharing is a 2nd-order reflective latent construct having 13 items with four 1st-order reflective constructs of information quality, manufacturer information, customer information, and information sharing support technology adopted from Goswami et al. (2020) based on a five-point Likert scale.

Green information system: The scale has five items based on a five-point Likert rating system adopted by Qu and Liu (2022).

Supply chain ambidexterity: The scale has five items based on a five-point Likert rating system adopted from Alamsjah and Asrol (2022).

Sustainable freight transportation: Sustainable freight transportation is a 2nd-order reflective latent construct having 20 items with five 1st-order reflective constructs of economic dimension, environmental dimension, social dimension, efficiency dimension, and safety dimension adopted from Pathak et al. (2019) based on a five-point Likert scale.

3.5 Data analysis technique

PLS-SEM enables the estimate of complicated models with many constructs, indicator variables, and structural pathways without putting distributional assumptions on the data (Hair, Matthews, et al., 2017; Hair, Sarstedt, Pieper, et al., 2012). Many researchers find the PLS-SEM technique very effective (Hair et al., 2011). The PLS-SEM is typically used to estimate complicated cause-effect relationship models employing latent variables in various domains, including knowledge management (Hair et al., 2019). This method helps the researcher hypothesis test and provide essential and predictive data (Hair et al., 2014). Furthermore, PLS-SEM is advantageous for the study since it uses other statistical approaches, such as cross-loadings, the HTMT ratio, and PLS blindfolding, for predictive relevance (Hair et al., 2013). The PLS-SEM method is also the best choice for small-scale data and aids in detailed assessments of model quality criteria. Additionally, it accurately predicts the results for the variables and evaluates the variables' predictive abilities by considering some variables (Ringle et al., 2012). These advantages led to the PLS-SEM technique used in this study, which also used Smart PLS software for data processing. Hence, the research uses PLS-SEM as a statistical technique using Smart PLS software.

3.6 Ethical considerations

In order to conduct fair and meaningful research, the study has adopted some ethical considerations based on the guidelines of Rani and Sharma (2012). The study ensured that participants were informed of the goal and objective of the research in this regard before recording their responses. No financial or other incentives were used to promote data collection since no respondents were personally, physically, or socially affected throughout the research. The study has safeguarded the confidentiality and privacy of the respondents' personal and other information and has informed them that their responses would only be utilized for academic purposes and that no other interests would be met. These ethical issues were carefully considered during the study, and none of the above research ethics was broken (Gajjar, 2013).

3.7 Definition of the variables

Public and regulatory pressure: Regulatory pressure is described as the authority the government exercises via the adoption of laws and other political rules (Ahmadova & Valenzuela-Ortiz, 2023).

Adoption of green practices: Adopting green practices is choosing resource and environmentally-conscious systems and procedures (Fahad et al., 2022).

Adoption of environmental standards: Adopting the norms usually set by the government might include banning particular activities, requiring monitoring frequency and style, and demanding licenses for land or water usage (Hossain et al., 2022).

External enablers: External enablers (EE) are nontrivial corporate environment changes supporting entrepreneurial endeavors. Examples include new technology, regulatory changes, demographic and sociocultural trends, macroeconomic fluctuations, and changes to the natural environment (Kimjeon & Davidsson, 2022).

Top management support: The involvement in investing in terms of time, money, and resources that support the organization's usage of systems can be characterized as top management support (Chatterjee et al., 2022).

Transportation planning and distribution network: A supply chain's distribution network is a connected system of warehouses and transport hubs that accept stock before sending it to consumers. It links the producer and buyer directly or through a retail network (Unterluggauer et al., 2022).

Commodity consideration: The consideration of products concerning the fact that either it is eco-friendly or energy efficient is known as commodity consideration (Goswami et al., 2020).

Internal enablers: Firm-specific internal drives are referred to as internal enablers (Goswami et al., 2020).

Information quality: The standard of information systems' content is known as information quality (IQ). A standard pragmatic definition is "The fitness for using the information provided" (Zuo & Lin, 2022).

Manufacturer information: Manufacturer information is described as knowledge of the attitudes and conduct of the product's present and former manufacturer (L. Li et al., 2022).

Customer information: Customer information is described as knowledge of the attitudes and conduct of the company's present, former, and prospective customers (Goswami et al., 2020).

Information sharing support technology: The sharing of data among multiple groups of individuals, organizations, and technology (Deng et al., 2023).

Information sharing: Data interchange across multiple companies, individuals, and technology is information sharing (Ha et al., 2022).

Sustainable freight transportation: The overall flow of commodities utilizing inland transit on a specific network without endangering the environment is considered sustainable freight transportation (Mogale et al., 2022).

Economic dimension: The economic component addresses the financial outputs and externalities of the event business and the particular event (Haryanti & Subriadi, 2022).

Environmental dimension: The environmental component concerns how easily ecological and biophysical systems can be harmed or cease to operate in harmful circumstances (Goswami et al., 2020).

Social dimension: The social dimension considers that society must be able to implement laws that ensure respect for human rights, diversity, cultural norms, and community rights in order to reduce the wealth gap and advance social justice (Ramatov & Khasanov, 2022).

Efficiency dimension: Efficiency dimensions are classifications of activities and behaviors determined depending on the demands and expectations of the position (Zhao et al., 2022).

Safety dimension: Organizations may successfully address difficulties with safety performance with the help of Safety dimensions (T. Li et al., 2022).

Green information system: Environmentally friendly information systems are called green information technologies/systems (Esfahbodi et al., 2023).

Supply chain ambidexterity: A manufacturer's attempts to improve/extend its current resources, build new supply chain capabilities, and provide performance gains are referred to as supply chain ambidexterity, especially for significant manufacturing enterprises (Goswami et al., 2020).

4. RESULTS AND DISCUSSIONS

Variable and Factors	Questions	Descriptive Statistics		Confirmatory Factor Analysis		
		Mean	Std. Dev.	Loadings	T-Stats	Prob.
Public and Regulatory Pressure	My firm strongly complies with environmental regulations.	3.54	1.322	0.750	26.526	0.000
	My firm imposes penalties when environmental regulations are not followed.	3.49	1.379	0.847	59.946	0.000
	I think government sets environmental regulations for logistics operations.	3.62	1.262	0.702	19.768	0.000
	I think industrial associations require us to conform to environmental regulations	4.03	0.894	0.639	13.482	0.000
Adoption of Green practices	My firm's key stakeholders provide new ideas for improving green practices.	3.50	1.231	0.781	28.316	0.000
	My firm's key stakeholders participate in identifying green policies, objectives and programs.	3.49	1.124	0.863	46.404	0.000
	I think the key stakeholders convey their perspectives about how to solve the firm's green practices problems successfully.	3.60	1.188	0.848	38.802	0.000
Adoption of Environmental Standards	My firm's supplier undertakes activities to stimulate customers to consume green products.	3.58	1.250	Deleted	Deleted	Deleted
	My firm design product to protect the environment.	3.71	1.293	Deleted	Deleted	Deleted
	My firm produce product in ways that protect the environment	3.69	1.266	0.934	103.608	0.000
	My firm provide staff training on environmental practices for green awareness.	3.59	1.374	0.931	89.798	0.000
Top Management Support	My firm's management encourages the use of technologies for responding to disruptions.	3.44	1.307	0.863	54.268	0.000
	My firm's top management recognizes collaborative efforts.	3.69	1.275	Deleted	Deleted	Deleted
	My firm's top management rewards teamwork and achievements.	3.56	1.290	0.832	31.335	0.000
	My firm's management always encourages us to work in groups for fighting disruptions.	3.76	1.183	0.894	54.184	0.000
Transportation planning and Distribution network	Outbound and inbound logistics planning.	3.78	1.088	Deleted	Deleted	Deleted
	Dispatching schedule.	3.48	1.303	0.916	107.797	0.000
	Stock outs/backorder management.	3.68	1.151	0.912	93.009	0.000
Commodity Consideration	My firm provides environmentally friendly packaging.	3.64	1.158	Deleted	Deleted	Deleted
	Recycling capabilities.	3.59	1.227	0.930	85.865	0.000
	Energy efficiency.	3.61	1.292	0.925	82.718	0.000
Information Quality	My firm's information system capability in information accuracy.	3.71	1.217	0.904	85.324	0.000
	My firm provides real-time information.	3.58	1.124	Deleted	Deleted	Deleted
	My firm update information frequently.	3.83	1.060	0.908	104.242	0.000
Manufacturing Information	My firm electronically provide the major customer with production capacity information.	3.76	1.191	0.786	32.960	0.000
	My firm provide order status information.	3.64	1.093	0.818	43.187	0.000
	My firm provide delivery schedule information to customer.	3.54	1.274	0.776	26.733	0.000
	My firm provide lead time information for products.	3.75	1.233	0.805	35.934	0.000
Information Sharing Support and Technology	My firm use the information system support technologies to advanced planning and scheduling software.	3.80	1.153	0.831	32.850	0.000
	My firm use E-procurement system.	3.64	1.236	0.864	52.345	0.000
	My firm invest in transportation/warehouse management software (WMS)	3.46	1.291	0.877	55.478	0.000
Customer Information	My firm changes in purchase order information.	3.57	1.275	0.672	12.920	0.000
	My firm's major customer electronically provide inventory level information.	3.45	1.302	Deleted	Deleted	Deleted
	My firm's major customer provide production planning information	3.74	1.205	0.925	125.918	0.000
Green Information System	My firm has a formal system regarding environment improvement in operation.	3.68	1.171	0.896	58.769	0.000
	My firm has formal departments that is responsible for environmental affairs.	3.17	1.259	0.809	41.639	0.000
	My firm has a well-developed database to track and monitor environmental issues	3.54	1.240	0.833	34.612	0.000
	My firm regularly track, monitor, and share environmental information.	3.54	1.372	0.826	49.179	0.000
	My firm has a wide range of practices and processes for using green practices.	3.42	1.291	0.851	43.747	0.000
Supply Chain Ambidexterity	My firm focuses on reducing operational redundancies in the existing processes.	3.45	1.319	0.851	45.673	0.000
	My firm focuses on improving the existing technologies.	3.58	1.190	0.880	62.103	0.000
	My firm develops strong competencies in the existing SC processes.	3.67	1.355	Deleted	Deleted	Deleted
	My firm proactively pursues new supply chain solutions.	3.64	1.265	0.855	44.316	0.000
	My firm continually explores new opportunities.	3.55	1.136	0.929	90.669	0.000
Supply Chain Organization Dynamic Capability	My organization has knowledge acquisition and absorptive capacity	3.63	1.327	0.851	54.451	0.000
	My organization has market oriented perception ability.	3.55	1.249	0.844	43.476	0.000
	My organization has innovation ability.	3.83	1.108	0.866	50.831	0.000
	My organization has internal reconstruction ability.	3.67	1.135	0.915	72.986	0.000
	My organization has social network relationship ability.	3.80	1.228	0.864	52.736	0.000
Economic Dimension	I think freight transportation (FT) system strives to provide competitive operating cost.	3.75	1.207	0.854	47.473	0.000
	I think freight transportation system endeavors to enhance economic growth.	3.63	1.075	0.868	45.069	0.000
	I think FT system strives to achieve higher return on investment.	3.88	1.130	0.897	71.101	0.000
	I think FT system conducts personnel training program regularly.	3.70	1.209	0.865	57.170	0.000
Environmental Dimension	I think FT system endeavors to get redesigned vehicles for alleviating noise level.	3.73	1.199	Deleted	Deleted	Deleted
	I think FT system attempts to get redesigned vehicles to curb vibration level.	3.36	1.351	0.933	109.149	0.000
	My firm's strategies to alleviate conventional fossil fuel consumption are followed by FT system.	3.52	1.376	0.927	79.295	0.000
	I think FT system attempts to lessen visual intrusion.	3.42	1.241	Deleted	Deleted	Deleted
Social Dimension	I think FT system attempts to adopt strategies for reducing traffic clogging.	3.50	1.243	0.878	50.882	0.000
	I think FT system takes measures to accommodate all users to enhance equity/fairness.	3.74	1.100	0.924	89.575	0.000

	I think FT system encourages to uphold quality of life.	3.71	1.091	Deleted	Deleted	Deleted
	I think FT system conducts injury prevention program regularly.	3.64	1.172	0.898	77.623	0.000
Efficiency Dimension	I think FT system utilizes energy efficient freight vehicles.	3.47	1.248	0.940	110.099	0.000
	I think FT system implements quality management practices.	3.61	1.108	0.938	96.264	0.000
	I think FT system attempts to implement strategies for improving logistics efficiency.	3.62	1.174	Deleted	Deleted	Deleted
	I think FT system attempts to implement the best distribution planning strategies.	3.54	1.222	Deleted	Deleted	Deleted
Safety Dimension	My firm's management is committed to mitigate accident rate.	3.64	1.296	Deleted	Deleted	Deleted
	I think FT system takes measures to lessen injury severity level.	3.72	1.280	0.897	82.439	0.000
	I think FT system endeavors to enhance customer satisfaction.	3.63	1.280	0.928	99.585	0.000
	I think FT system implements required safety rules and regulations.	3.70	1.204	0.852	29.555	0.000

4.1 Measurement model

Table 4.1 shows the result of measurement model for assessing construct and convergent validities using PLS algorithm technique (Hair, Hult, et al., 2017).

Table 4.1: Measurement Model

	loadings	Prob.	Alpha	CR	AVE
AOES3 <- AES	0.934	0.000	0.850	0.930	0.870
AOES4 <- AES	0.931	0.000			
AOGP1 <- AGP	0.781	0.000			
AOGP2 <- AGP	0.863	0.000			
AOGP3 <- AGP	0.848	0.000	0.776	0.870	0.691
CC2 <- CC	0.930	0.000			
CC3 <- CC	0.925	0.000			
CI2 <- CI	0.925	0.000			
CI3 <- CI	0.896	0.000	0.795	0.907	0.829
ED1 <- ED	0.868	0.000			
ED2 <- ED	0.897	0.000			
ED3 <- ED	0.865	0.000			
EFFD1 <- EFF	0.940	0.000	0.866	0.937	0.882
EFFD2 <- EFF	0.938	0.000			
ENVD1 <- EnD	0.933	0.000			
ENVD2 <- EnD	0.927	0.000			
GIS1 <- GIS	0.809	0.000	0.845	0.928	0.866
GIS2 <- GIS	0.833	0.000			
GIS3 <- GIS	0.826	0.000			
GIS4 <- GIS	0.851	0.000			
GIS5 <- GIS	0.851	0.000	0.891	0.920	0.696
IQ1 <- IQ	0.904	0.000			
IQ3 <- IQ	0.908	0.000			
ISST1 <- ISST	0.831	0.000			
ISST2 <- ISST	0.864	0.000	0.782	0.902	0.821
ISST3 <- ISST	0.877	0.000			
ISST4 <- ISST	0.672	0.000			
MI1 <- MI	0.786	0.000			
MI2 <- MI	0.818	0.000	0.828	0.887	0.664
MI3 <- MI	0.776	0.000			
MI4 <- MI	0.805	0.000			
PARP2 <- PRP	0.847	0.000			
PARP4 <- PRP	0.639	0.000	0.808	0.874	0.634
PARP1 <- PRP	0.750	0.000			
SCA1 <- SCA	0.880	0.000			
SCA3 <- SCA	0.855	0.000			
SCA4 <- SCA	0.929	0.000	0.723	0.826	0.545
SCA5 <- SCA	0.851	0.000			
SD1 <- SD	0.878	0.000			
SD2 <- SD	0.924	0.000			
SD4 <- SD	0.898	0.000	0.902	0.932	0.773
SFD2 <- SFD	0.897	0.000			
SFD3 <- SFD	0.928	0.000			
SFD4 <- SFD	0.852	0.000			
SSODC1 <- SSODC	0.844	0.000	0.882	0.927	0.810
SSODC2 <- SSODC	0.866	0.000			
			0.872	0.922	0.797
			0.919	0.939	0.755

SSODC3 <- SSODC	0.915	0.000			
SSODC4 <- SSODC	0.864	0.000			
SSODC5 <- SSODC	0.854	0.000			
TMS1 <- TMS	0.863	0.000			
TMS3 <- TMS	0.832	0.000	0.829	0.898	0.745
TMS4 <- TMS	0.894	0.000			
TPADN2 <- TPDN	0.916	0.000			
TPADN3 <- TPDN	0.912	0.000	0.802	0.910	0.835

Above table has shown that indicator reliability are found higher than the recommended threshold of 0.70 with statistical significance below 5 percent (Hair et al., 2011). Therefore, construct validity has been achieved for all latent constructs. Moreover, alpha and CR coefficients are found higher than the recommended thresholds of 0.70 and 0.80, respectively (Hair et al., 2013; Hair, Sarstedt, Ringle, et al., 2012). Therefore, convergent validity has also been achieved for all latent constructs in the structural model.

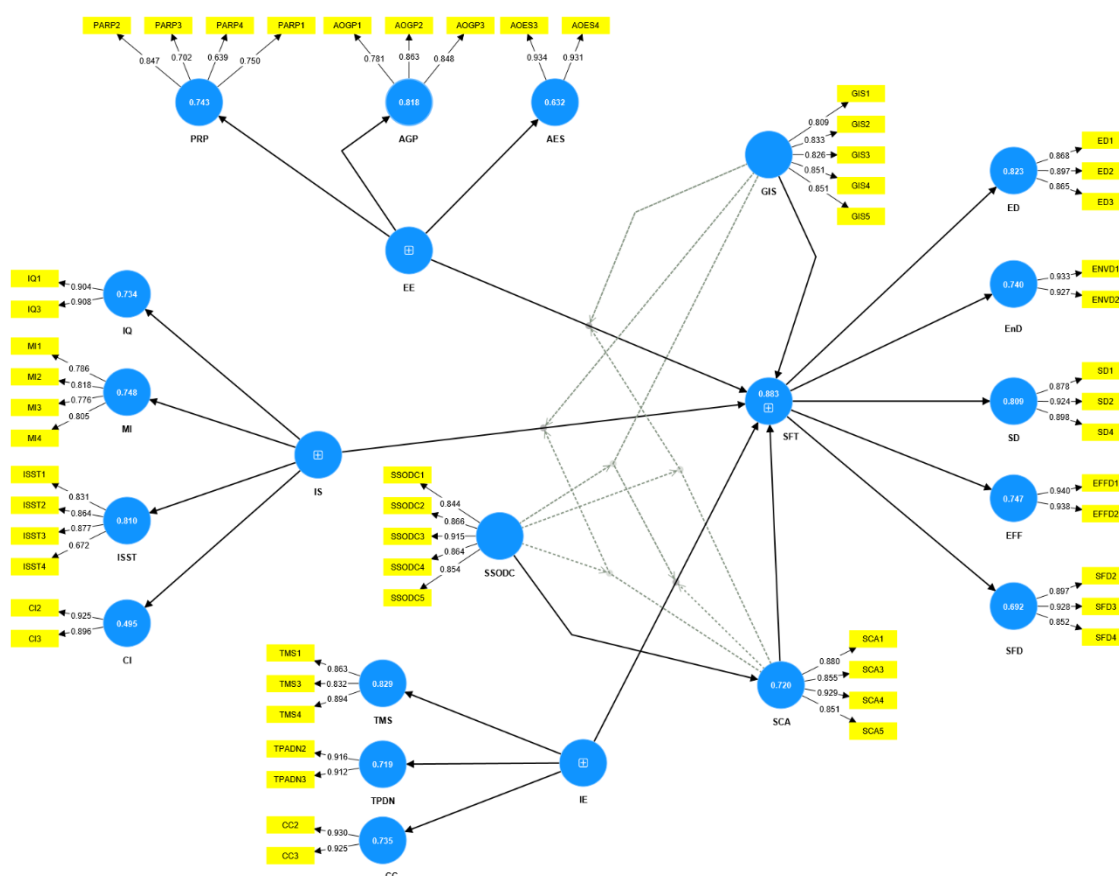


Figure 4.1: Measurement Model using PLS Algorithm

4.2 Discriminant validity using Fornell and Larcker (1981) criterion (FLC)

Table 4.2 shows the result of FLC for discriminant validity assessment and it has been found that all constructs have square-root of AVE (diagonally bold values) higher than their respective correlation with other constructs (Cheung & Wang, 2017; Rönkkö & Cho, 2022). Therefore, constructs have manifested dissimilarity between them and hence, discriminant validity using FLC has been achieved.

4.3 Discriminant validity using HTMT ratio

Table 4.3 shows that constructs have HTMT ratio below the recommended threshold of 0.95 providing that constructs are considerably different from one another in the structural model (Henseler et al., 2016; Henseler et al., 2015). Therefore, discriminant validity has been achieved using HTMT ratio.

Table 4.2: Fornell-Larcker Criterion

	AES	AGP	CC	CI	ED	EFF	EnD	GIS	IQ	ISST	MI	PRP	SCA	SD	SFD	SSODC	TMS	TPDN
AES	0.933																	
AGP	0.619	0.831																
CC	0.773	0.598	0.928															
CI	0.456	0.509	0.505	0.911														
ED	0.603	0.597	0.527	0.568	0.877													
EFF	0.528	0.556	0.609	0.709	0.726	0.939												
EnD	0.502	0.580	0.560	0.509	0.674	0.734	0.930											
GIS	0.729	0.713	0.702	0.661	0.732	0.714	0.708	0.834										
IQ	0.685	0.627	0.707	0.480	0.685	0.675	0.700	0.727	0.906									
ISST	0.606	0.621	0.597	0.583	0.686	0.624	0.678	0.772	0.704	0.815								
MI	0.582	0.687	0.560	0.464	0.699	0.569	0.608	0.675	0.700	0.646	0.796							
PRP	0.498	0.672	0.448	0.437	0.543	0.523	0.611	0.613	0.511	0.516	0.595	0.738						
SCA	0.638	0.619	0.574	0.493	0.809	0.681	0.692	0.751	0.686	0.753	0.631	0.560	0.879					
SD	0.500	0.534	0.611	0.497	0.768	0.769	0.761	0.716	0.738	0.794	0.664	0.474	0.713	0.900				
SFD	0.625	0.659	0.659	0.394	0.747	0.600	0.651	0.614	0.688	0.631	0.719	0.581	0.706	0.605	0.893			
SSODC	0.652	0.569	0.633	0.561	0.788	0.744	0.710	0.713	0.675	0.683	0.693	0.614	0.848	0.676	0.752	0.869		
TMS	0.738	0.649	0.663	0.463	0.703	0.556	0.498	0.787	0.656	0.730	0.679	0.514	0.816	0.622	0.615	0.696	0.863	
TPDN	0.433	0.500	0.613	0.413	0.503	0.592	0.571	0.541	0.626	0.632	0.600	0.399	0.596	0.586	0.543	0.598	0.656	0.914

Table 4.3: HTMT Ratio

	AES	AGP	CC	CI	ED	EFF	EnD	GIS	IQ	ISST	MI	PRP	SCA	SD	SFD	SSODC	TMS	TPDN
AES																		
AGP	0.761																	
CC	0.917	0.744																
CI	0.555	0.643	0.619															
ED	0.710	0.734	0.625	0.689														
EFF	0.616	0.677	0.714	0.858	0.846													
EnD	0.593	0.710	0.665	0.624	0.794	0.858												
GIS	0.835	0.853	0.811	0.785	0.842	0.814	0.815											
IQ	0.842	0.801	0.876	0.611	0.840	0.823	0.862	0.871										
ISST	0.718	0.777	0.707	0.710	0.827	0.740	0.801	0.890	0.864									
MI	0.698	0.861	0.678	0.575	0.848	0.681	0.734	0.791	0.879	0.780								
PRP	0.596	0.883	0.539	0.576	0.676	0.651	0.754	0.765	0.668	0.651	0.778							
SCA	0.726	0.736	0.660	0.579	0.924	0.768	0.780	0.834	0.813	0.866	0.737	0.672						
SD	0.578	0.645	0.709	0.586	0.887	0.878	0.881	0.806	0.890	0.928	0.786	0.595	0.792					
SFD	0.725	0.803	0.771	0.478	0.865	0.690	0.759	0.693	0.833	0.733	0.861	0.713	0.790	0.692				
SSODC	0.735	0.669	0.719	0.661	0.890	0.836	0.804	0.785	0.796	0.778	0.806	0.724	0.924	0.749	0.837			
TMS	0.878	0.807	0.795	0.563	0.841	0.656	0.595	0.917	0.815	0.877	0.829	0.633	0.948	0.731	0.722	0.794		
TPDN	0.525	0.633	0.746	0.515	0.611	0.711	0.694	0.639	0.793	0.767	0.747	0.490	0.698	0.699	0.648	0.696	0.805	

4.4 Structural model

Higher-order constructs

Table 4.4 shows the development of higher-order reflective construct of external enablers.

Table 4.4: External Enablers

	Estimate	S. D.	t-Stats	Prob.
EE -> AES	0.795	0.025	32.246	0.000
EE -> AGP	0.904	0.012	74.436	0.000
EE -> PRP	0.862	0.016	53.394	0.000

Above table has shown that external enablers (EE) has been statistically developed by the first-order constructs of adoption of environmental standards (AES; $\beta = 0.795$; $p < 0.05$), adoption

of green practices (AGP; $\beta = 0.904$; $p < 0.05$), and public and regulatory pressure (PRP; $\beta = 0.862$; $p < 0.05$).

Table 4.5: Internal Enablers

	Estimate	S. D.	t-Stats	Prob.
IE -> CC	0.857	0.018	46.786	0.000
IE -> TMS	0.910	0.011	80.499	0.000
IE -> TPDN	0.848	0.020	42.444	0.000

Above table has shown that internal enablers (IE) has been statistically developed by the first-order constructs of commodity consideration (CC; $\beta = 0.857$; $p < 0.05$), top management support (TMS; $\beta = 0.910$; $p < 0.05$) and transportation planning and distribution network (TPDN; $\beta = 0.848$; $p < 0.05$).

Table 4.6 shows the development of higher-order reflective construct of information sharing.

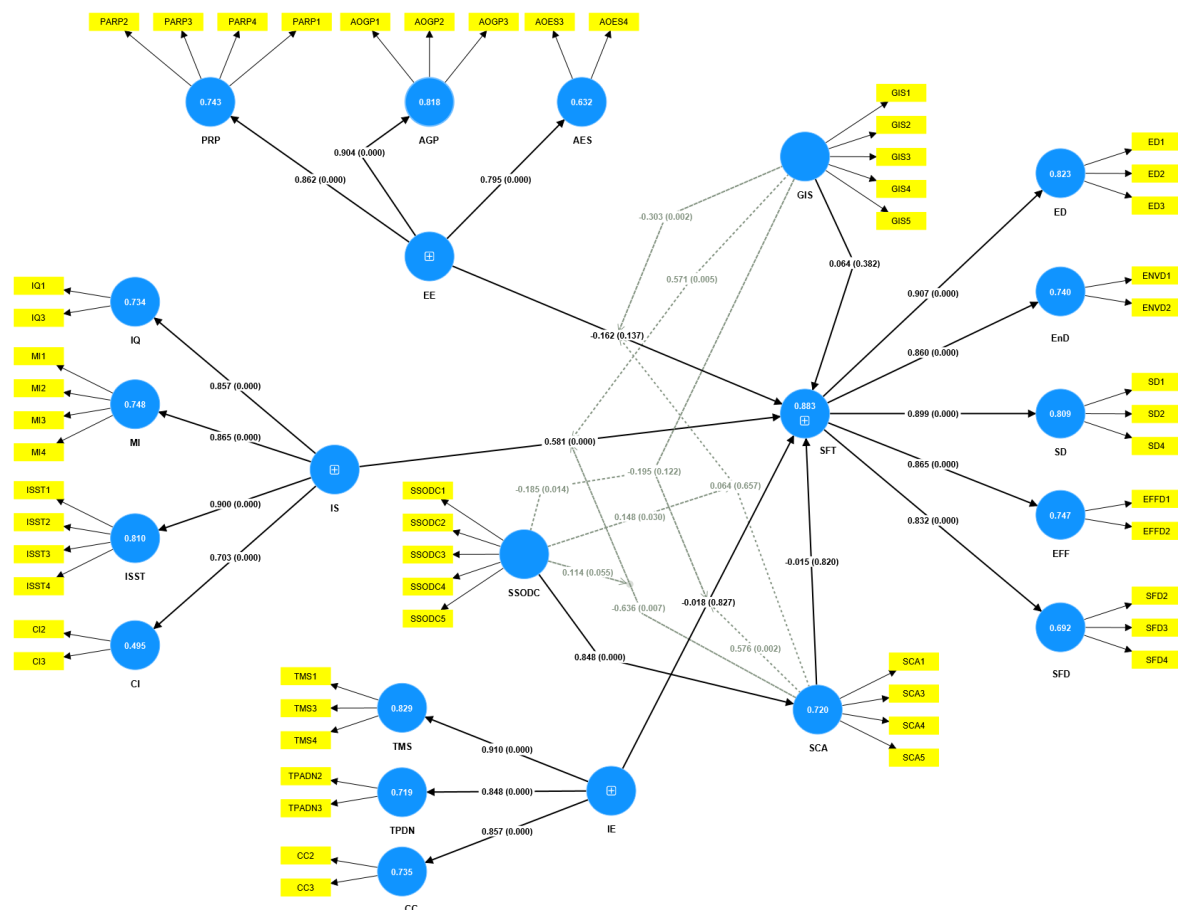


Figure 4.2: Structural Model using PLS Bootstrapping

Table 4.6: Information Sharing

	Estimate	S. D.	t-Stats	Prob.
IS -> CI	0.703	0.029	23.940	0.000
IS -> IQ	0.857	0.016	53.474	0.000
IS -> ISST	0.900	0.010	93.753	0.000
IS -> MI	0.865	0.022	40.157	0.000

Above table has shown that information sharing (IS) has been statistically developed by the first-order constructs of customer information (CI; $\beta = 0.703$; $p < 0.05$), information quality

(IQ; $\beta = 0.857$; $p < 0.05$), information sharing support technology (ISST; $\beta = 0.900$; $p < 0.05$), and manufacturer information (MI; $\beta = 0.865$; $p < 0.05$).

Table 4.7 shows the development of higher-order reflective construct of sustainable freight transportation.

Table 4.7: Sustainable Freight Transportation

	Estimate	S. D.	t-Stats	Prob.
SFT -> ED	0.907	0.011	79.364	0.000
SFT -> EFF	0.865	0.013	66.544	0.000
SFT -> EnD	0.860	0.014	59.348	0.000
SFT -> SD	0.899	0.017	52.349	0.000
SFT -> SFD	0.832	0.031	26.971	0.000

Above table has shown that sustainable freight transportation (SFT) has been statistically developed by the first-order constructs of economic dimension (ED; $\beta = 0.907$; $p < 0.05$), efficiency dimension (EFF; $\beta = 0.865$; $p < 0.05$), environmental dimension (EnD; $\beta = 0.860$; $p < 0.05$), social dimension (SD; $\beta = 0.899$; $p < 0.05$) and safety dimension (SFD; $\beta = 0.832$; $p < 0.05$).

Direct-effect analysis

Table 4.8 shows the result of direct-effect analysis using PLS path modeling analysis.

Table 4.8: Direct-Effect Analysis

	Estimate	S. D.	t-Stats	Prob.	Decision
EE -> SFT	-0.162	0.109	1.488	0.137	Rejected
IE -> SFT	-0.018	0.081	0.218	0.827	Rejected
IS -> SFT	0.581	0.120	4.862	0.000	Accepted

Above table has shown that external enablers ($\beta = -0.162$; $p > 0.05$) have a negatively insignificant effect on sustainable freight transportation while internal enablers ($\beta = -0.018$; $p > 0.05$) also have a negatively insignificant effect on sustainable freight transportation. Lastly, information sharing ($\beta = 0.581$; $p < 0.05$) has a positively significant effect on sustainable freight transportation.

Moderation analysis

Table 4.9 shows the result of moderation analysis using PLS path modeling analysis.

Table 4.9: Moderation Analysis

	Estimate	S. D.	t-Stats	Prob.	Decision
GIS x EE -> SFT	-0.303	0.098	3.085	0.002	Accepted
GIS x IE -> SFT	-0.195	0.126	1.547	0.122	Rejected
GIS x IS -> SFT	0.571	0.203	2.811	0.005	Accepted
SCA x IE -> SFT	0.576	0.189	3.052	0.002	Accepted
SCA x EE -> SFT	0.064	0.144	0.445	0.657	Rejected
SCA x IS -> SFT	-0.636	0.234	2.721	0.007	Accepted
SSODC x SCA x IE -> SFT	0.064	0.069	0.924	0.355	Rejected
SSODC x SCA x EE -> SFT	0.148	0.069	2.166	0.030	Accepted
SSODC x SCA x IS -> SFT	0.114	0.060	1.920	0.055	Accepted

Above table has shown that green information system ($\beta = -0.303$; $p < 0.05$) negatively moderate the effect of external enablers on sustainable freight transportation; whereas green information system ($\beta = -0.195$; $p > 0.05$) does not moderate the effect of internal enablers on

sustainable freight transportation and lastly, green information system ($\beta = 0.571$; $p < 0.05$) positively moderate the effect of information sharing on sustainable freight transportation. Moreover, SC ambidexterity ($\beta = 0.576$; $p < 0.05$) positively moderate the effect of external enablers on sustainable freight transportation while SC ambidexterity ($\beta = 0.064$; $p > 0.05$) does not moderate the effect of internal enablers on sustainable freight transportation; however, SC ambidexterity ($\beta = -0.636$; $p < 0.05$) negatively moderate the effect of information sharing on sustainable freight transportation.

Furthermore, SC organization dynamic capability (SSODC; $\beta = 0.064$; $p > 0.05$) does not moderates the moderating effect of SC ambidexterity on the relationship between internal enablers and sustainable freight transportation. However, SC organization dynamic capability (SSODC; $\beta = 0.148$; $p < 0.05$) positively moderates the moderating effect of SC ambidexterity on the relationship between external enablers and sustainable freight transportation and SC organization dynamic capability (SSODC; $\beta = 0.114$; $p < 0.05$) positively moderates the moderating effect of SC ambidexterity on the relationship between xxx and sustainable freight transportation.

Predictive power and relevance

Table 4.10 provides the outcome of predictive power and relevance for all endogenous constructs in the model.

Table 4.10: Predictive Power and Relevance		
	R-Square	Q-Square
Sustainable Freight Transportation	0.883	0.820

Above table showed that sustainable freight transportation has been strongly predicted up to 88.3 percent (Hair et al., 2011) with a strong relevance of 82 percent (Hair et al., 2013) in the structural model.

4.5 Discussion

The result showed that EE has an insignificant effect on SFT. The outcome is consistent with Karuppiyah et al. (2022), who explained that Systems for moving freight have several difficulties. Other obstacles are context-specific (national/international, rural/urban, advanced/emerging/frontier markets, etc.), while some are mode-specific (rail, road, air, or water). The main difficulties are often related to governance.(For example, internal freight management procedures and external policy, regulation, enforcement, and compliance, economy financing, fuel pricing, and tariff levels, environment emission, air pollution, noise, health, safety, and security, technology innovation, safety, infrastructure, and services quality, capacity; legal issues, and labor markets/working conditions, among others. Also, Kumar and Anbanandam (2022)supported this result. They stated that public and regulatory pressures, as well as the federal government’s enforcement of environmental standards that lead to the utilization of green practices in the transportation industry in general but transportation professionals in particular, have repercussions on how the environmental impact of 3PL delivery companies are disclosed in terms of energy usage and fleet optimization, as well as other factors.

Secondly, the study found that IE has an insignificant effect on SFT. This result is supported by Karupiah et al. (2022), who identified that Proper transport planning and distribution network architecture is essential for third-party logistics (3PL) organizations to ensure lower fuel consumption, shorter fleet wait times, and shorter delivery distances. Also, Jamkhaneh et al. (2022) supported this result. They stated that the value of continued implementation or evaluation of practical measures to advance ecology in the transportation and logistics sector, particularly from a commodities and transport planning standpoint.

Similarly, the finding showed that IS positively and significantly affects SFT. The outcome is consistent with Hader et al. (2022), who concluded that most places lack awareness and understanding of transportation's significant role in society. Improving this information is crucial for communication within these cities' practical transportation value chains. Moreover, Kumar and Anbanandam (2022) also bear this result and demonstrate that in the modern era, "smart transportation" (IOT) refers to a wide variety of information as well as hundreds of various systems that use data to make decisions about smart transportation.

Further, the result showed that GIS has positively and significantly moderated the effect of EE on SFT. This result is supported by Esfahbodi et al. (2023), who explained that information-sharing characteristics could impact how well external enablers fulfill their role in helping the 3PL firms considered in the research study sustainably. Also, Shoaib et al. (2022) brace this result and stated that In this scenario, consumer information transmission at the individual 3PL enterprises would likely moderate the adoption of green practices, with favorable effects on greenhouse gas reduction (measured in terms of a smaller energy footprint) or slower productivity.

Moreover, the finding showed that GIS has positively and significantly moderated the effect of IS on SFT. This outcome is consistent with Esfahbodi et al. (2023), who concluded that internet technologies generate economic benefits because they enable chain members to communicate practical information and make more informed decisions that reduce travel-related costs, time, and environmental impact. Similarly, Qu and Liu (2022) also hold this result and demonstrated that many 3PL delivery providers communicate information with the business connected to the makers of these components regularly or in real-time while shipping automobile parts. However, only substantial logistics companies employ these methods.

Additionally, the finding showed that GIS has an insignificantly moderated effect of IE on SFT. This outcome is consistent with Esfahbodi et al. (2023) and clearly stated that historically, these effects have been measured as a reduction in greenhouse gases, carbon footprint, energy usage, etc. Nevertheless, it is still being determined how information sharing impacts how much various internal enablers might impact the effectiveness of sustainable freight transportation. Further, AL-Dosari et al. (2023) supported this result. They stated that when seen from the perspective of information exchange, this topic has even greater relevance since the effectiveness of sustainable freight transportation will be impacted by information-sharing characteristics, including quality, asymmetry, distortion, and availability. The efficacy of freight operations is significantly increased when the parties involved share information.

In addition, the study found that SCA positively and significantly moderates the effect of EE on SFT. This result is supported by Shehzad et al. (2022b), who explained that transportation specialists specifically decide how 3PL logistics providers should track their environmental impact in terms of fleet productivity, energy usage, and specific other criteria. Public and regulatory pressures, as well as the federal government's enforcement of environmental

standards that lead to applying green practices in the transportation industry, in addition to general, determine these factors. Further, Alamsjah and Yunus (2022) also hold this result and identified that While supply chain exploration may be performed by eliminating operational redundancy, supply chain exploitation can be accomplished by experimenting, coming up with new solutions, and opportunities for supply chain challenges.

Furthermore, the result showed that SCA positively and significantly moderates the effect of IS on SFT. This outcome is consistent with Shehzad et al. (2022b), who concluded that in order to improve their GSCM, ambidexterity takes advantage of organizational expertise and current information flows. Moreover, Alamsjah and Yunus (2022) bore this result and explain that focusing on ambidextrous SSCM methods is vitally needed to achieve production sustainability, which demands balancing ambidextrous indicators to boost a firm's adaptability in terms of imitation within shifting conditions.

Likewise, the study found that SCA insignificantly moderates the effect of IE on SFT. This result is supported by Wairimu et al. (2022), who demonstrated that in ambidextrous supply chains, the affiliates look into new client demands and adapt to firm-wide environmental changes. This can enhance business operations and minimize supply chain issues. The importance of shipping and marketing design in reducing carbon footprints has been demonstrated using descriptive frameworks, or other specific instance analysis approaches. Also, Bag et al. (2023) supported this result and stated that ambidexterity's importance in the supply chain context has recently received research attention.

In addition, the findings showed that SCODC has significantly moderated the moderating effect of SCA between EE and SFT. This outcome is supported by Rehman and Jajja (2022), who stated that Organizational ambidexterity facilitates the expansion of both exploration and exploitation simultaneously, while SC dynamic traits maintain a company oriented to a fast-changing environment, assuring competitive success. Various variables have influenced how well-managed freight logistical issues and transport operators have implemented responsible freight transportation. External enabler also facilitates early supplier engagement in new product development processes. Further, Jafari et al. (2022) also hold this result and state that external integration often entails information exchange, cooperation between suppliers and customers, and strategic alignment of business operations.

Consequently, the study found that SCODC positively and significantly moderates the moderating effect of SCA between IS and SFT. This result is supported by Alamsjah and Yunus (2022), who explained that the parts of the latent construct networking capabilities are connection skills, partner information, internal communication, and interference coordination. The partners' information encourages the supply chain's ambidexterity since it makes plans and capabilities of the partners available. Also, E. A. Khan et al. (2022) hold this result and identified that due to the complicated processes in transportation networks and the occasionally conflicting demands made on investors, clever ways to improve freight flow in major cities are being considered. In the modern era, "smart transportation" refers to a wide variety of data and hundreds of systems that use data to make decisions about smart transportation.

Lastly, the finding showed that SCODC has positively and significantly moderated SCA's moderating effect between IE and SFT. This outcome is consistent with Shehzad et al. (2022b), who concluded that internal enablement increases a company's ability to manage and utilize internal resources. By tearing down organizational barriers and fostering internal cooperation, internal integration can be done. Also, Jafari et al. (2022) bear this result and explain that the

overall energy footprint of the transportation industry is significantly influenced by commodity factors (for example, elastic elements require a frigid conveyance system to retain the necessary practical qualities of essential elements).

CHAPTER 5 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The study examined the effect of information sharing, external enablers, and internal enablers on sustainable freight transportation with the moderating role of green information systems and SC ambidexterity in the manufacturing sector of Pakistan. The study used a quantitative deductive methodology, investigating a selected study topic using explanatory research, with some significant adjustments made to account for the unknown aspects. The researcher used a research paradigm in this study to successfully select different methods and create a proper research design. The target population of the current study would be the SC professionals of the manufacturing firms of Pakistan. The data is collected using a non-probability purposive sampling technique, and the data is analyzed with PLS-SEM. Also, the current study's survey technique may be carried out using a questionnaire to collect data. Further, the study used NRBV theory and dynamic capability theory for the theoretical framework.

The study concluded that EE insignificantly affects SFT. Similarly, IE also insignificantly affects SFT. Whereas IS significantly effect SFT. The finding showed that GIS significantly moderates the effect of EE on SFT, or GIS also significantly moderates the effect of IS on SFT. However, GIS insignificantly moderates the effect of IE on SFT.

Moreover, the study found that SCA insignificantly moderates the effect of EE on SFT. Also, SCA significantly moderates the effect of IS and IE on SFT. Likewise, SSODC significantly moderates the moderating effect of SCA between EE and SFT. In a similar vein, SSODC also significantly moderates the moderating effect of GIS between IE and SFT. Lastly, findings showed that SSODC insignificantly moderates the moderating effect of SCA between IS and SFT.

In addition, instead of only aiming to lessen the SC ecological implications, GSCM focuses on encouraging value creation inside supply chain enterprises to lessen the total ecological effect. Similarly, the effectiveness of GSCM, however, depended on how each stakeholder interacted with their incoming and outgoing SC partners. More openness, cooperation, and integration of supply chain systems and procedures are necessary for the programmer to be effective.

5.2 Managerial recommendation

The findings of this study could be used to enhance management practices and offer guidance for GSCM techniques. Therefore, innovation-based GSCM strategies differ from efficiency-based approaches due to their emphasis on the environment and their focus on specific supply chain performance goals. Organizations are now taking into account the aspects of the life span of products or considering the entire cycle's stability to consumers' accounts with increased standards for protecting the environment, resource scarcity, and general environmental awareness. This development has pushed the company to set up a way of dealing, state-of-the-

art tools, and strict quality standards for suppliers, all of which have boosted collaborations, expenditures, and knowledge exchange throughout the supply chain.

Additionally, Relocating toward innovation-based techniques requires the dedication of dedicated substances but instead specialized personnel throughout to enhance the implementation of environmental performance into distribution networks and manufacturing technology, ensure compliance with relevant legislation changes, and inform suppliers of environmental performance upgrades. Companies acquire the capacities and competencies necessary to integrate creative, sustainable business practices in specific manufacturing techniques, features, functionalities, or evolution processes (such as maintenance, disposal, or operation). Companies could even create method skills to create ecologically sound production and distribution and use techniques and systems because most SC begins using resources that have been brought to the maker. They ought to adopt a circular supply chain. After that, the finished items would go through fulfillment centers until being transported to their ultimate destination. After use, objects typically end up in the trash.

Furthermore, companies should reduce transportation emissions since doing so can lead to obtaining supplies from suppliers in the area, reducing pollution from logistics and fulfillment. Many people may benefit from using healthier green technologies but more efficient modes of transportation, so companies slash emissions. Also, by demanding specific credentials, businesses may refrain from working with suppliers who use illegal items or resources. A manufacturer could elect, for example, to only employ parts from vendors that have already obtained the Certification. Also, transparency is crucial for creating a trustworthy GSCM strategy. A thorough site that describes SC targets describes the group's supply chain rules of behavior or norms (whether using accreditations, exterior standards, as well as institutional standards but rather guidelines), contains data on the advancement of goal-meetings, but also divulges the organization's adherence procedure is mainly responsible for ensuring transparency. Consumers, suppliers, employees, and others should fully understand the firm's GSCM plan.

Similar to this, the most straightforward GSCM strategy is risk mitigation. Companies use this method mostly in reaction to demands from stakeholders. Organizations with limited tools for sustainable development or those who have just implemented an SC sustainability strategy can benefit from this tactic. It is predicated on limited engagement between organizations. Suppliers may be required to meet some primary conditions in procurement contracts to comply with all applicable regulatory standards. The majority of the time, this strategy uses well-recognized international norms like (Environmental Management) to direct operational procedures. With this technique, risk can be reduced, and even reputation can be improved. So, now that most companies or institutions are increasingly conscious of the hazards of expanding past evolution's capacity to support its occupants, there has been an increase in interest in achieving sustainability. This objective has resulted in many eco-friendly innovations in the latest days, notably in the field of supply chains.

5.3 Limitations of the study

There were certain limitations to this study. Overcoming these constraints might provide some new opportunities for further research. First, all the data was acquired in Karachi because the sample size for data gathering was so small. Due to the need for a comprehensive examination,

more than the results from a single city is needed. Moreover, even if the study technique assures that the results are generalizable, changes in national features, such as organizational and cultural components, may lead to variations in the correlations analyzed. The study's conclusions cannot be applied to the entire population.

Additionally, the target demographics need to be expanded. Furthermore, as the study was carried out in Pakistan, its conclusions and suggestions are exclusive to Pakistan and do not apply to other nations. Also, other factors may be taken into account. The survey methodology was used, although this inflexibility can be viewed as a weakness of the survey method; however, the research adopted a quantitative deductive approach which concentrates primarily on predetermined concepts and difficulties and limitations. Similarly, a non probability purposive sampling technique was used to make it impossible for the researcher to determine whether the population was adequately represented. The study also used dynamic capacity theory (DCT) and resource-based view theory (RBV) as theoretical foundations because the study's framework needs to be adequately articulated using ideas relevant to the environment.

5.4 Future research

A few recommendations are made for further research in this study. As a result, given the sustainability viewpoint of supply chain research, the resource-based theory will be more thoroughly validated. Future studies may also consider these relationships to explain how GSCM procedures impact the organization's image. Various data collection techniques, like interviews, should be investigated in the future. Future studies could be done from the standpoint of additional supply chain participants. Comparison of the outcomes from the manufacturing firm and the supplier firm may have further benefits. The study employs a tiny sample. Thus it should be repeated with a bigger sample size.

Moreover, a bigger sample size better suited to SEM may also be advantageous for future studies. The researcher also suggests using qualitative analysis to obtain more specific research results that reflect the study population in future studies. This study might be expanded to include new kinds of businesses, making the results less comprehensive. The last point is that every nation has its own culture, economic principles, etc. This study was carried out in Pakistan, a country with distinct characteristics. Future studies could compare the results of testing the research model in different countries.

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