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Green Procurement, Production, and Logistics as Drivers of Sustainable Supply Chains: Evidence from Industrial Sectors in Pakistan

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Abstract

This research examines the importance of green procurement, green production and green logistics for the holistic success of green supply chain management. In the context of Pakistan, sustainable business practices are at an infant stage, and many organizations struggle with improving their quality standards. Consequently, it is imperative to recognize existing deficiencies and make the firms want to perfect their strategies and thus improve their nature care while contributing to society's long-term welfare. To understand these relationships, data were gathered through a closed-ended structured questionnaire that was administered in different industrial sectors in Pakistan. The methodology used for the research is quantitative, and a simple random sampling technique has been used to ensure responses from 325 participants. Subsequent statistical analyses, such as reliability testing, exploratory factor analysis and regression analysis, were performed using the statistical software package, Statistical Package and System, to assess the strength of associations between the different variables of interest. The results indicate that the three aspects of green procurement, green production, and green logistics have a positive and statistically significant impact on the overall performance of green supply chain management. These results highlight the need for the incorporation of environmentally responsible practices into organizational practices. The study provides concrete information and recommendations to support the adaptation of sustainable strategies for both large enterprises and small and medium-sized enterprises. By focusing on the benefits of green initiatives, this research is aimed at the continued progression of sustainable development in Pakistan, which eventually creates value for organizations, society, and the environment that endures over time.

Keywords: *Green Procurement, Green Production, Green Logistics, Sustainable Supply Chain Management*

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1. INTRODUCTION

The spurt of population increase in the country has considerably worked on uplifting the pressure of industries to maintain a constant supply of necessary consumer items like packaged foods, beverages, medicines, cosmetics and other items used on a daily basis. Alongside these goods, timely access to those industrial goods which aid production and infrastructure development has also become critical. In this environment, logistics occupies a central position, with the strength of the distribution network becoming one of the most important things defining the success of the organization. A dependable logistics system relies on good warehouses backed by ERP systems, effective transportation arrangements, and an extensive retailer network in the different operating regions of the organization (Jean-Paul Rodrigue et al. 2001). Recent research suggests that with the growing consumption levels, the issue of sustainability of logistics networks is a hot topic, more than ever before (Rahman & Idris, 2021; Gomez & Hiroshi, 2022; Hou & Yuan, 2025). Green purchasing is a future-oriented process of procuring products and services of which purchasing decisions are made with conscious strategies to minimize environmental damage. This concept is applied to raw materials, production processes, packaging, transportation, and waste management throughout the entire supplier value chain. However, there is still growing concern about the depletion of natural resources such as forests and the environmental effects of mining and fossil fuel reliance. Global industries are increasingly moving towards a green procurement framework, but most developing countries are in the transition stages (Malik & Tanveer, 2023; Martin & Camerone, 2025). In Pakistan, some industries have started to

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adopt environmental factors in supply chain strategies, but low adoption comprises more in terms of enforced regulations and mandatory compliance with sustainability (Khan & Sabir, 2022; Tan & Lee, 2025). Establishing structural procedures for green procurement, clean production, and environmentally friendly logistics can contribute substantially to improving supply chain performance in a way that can also support overall environmental objectives.

Historically, logistics systems in many industries have focused on cost and speed but not on environmental sustainability. However, in the contemporary globalized setting, logistics operations are increasingly subject to the sustainability challenges, which are compelling organizations to develop innovative and eco-friendly strategies. Modern-day businesses seek to orchestrate and make end-to-end logistics processes as pollution, carbon emissions and waste minimization as possible (Lee & Ozturk, 2020; Rizwan & Iqbal, 2025). Meanwhile, consumers themselves have grown increasingly environmentally conscious; they demand products from companies that are committed to reducing carbon emissions, efficiently recycling waste and using a sustainable packaging process. This shift is visible throughout industries, such as high-technology manufacturing, that is continuing to grow fast and significantly as a component of global production (Chen & Watanabe, 2021; Bary & Hakim, 2025). Despite all these positive developments, there is much work to be done. Many industries have to cope with constant energy use, emissions of CO2 and less use of green materials. The sustainability of supply chains is particularly important to electronics manufacturers and OEMs, where the cost of procurement is a significant element of overall product cost. Research by Min-Ren Yan et al. (2016), conducted with system dynamics simulations and empirical data based on the Taiwanese high-tech cluster, found that green part procurement leads to cost-efficient and improved shipping performance. But developing nations tend to fall behind. Countries such as Japan, the United States, and Germany have advanced existing green logistics strategies (Xiu and Chen, 2012; Khan et al., 2025), whereas in emerging economies, there is a greater need to work harder to adopt integrated green supply chain models (Green, Whitten and Inman, 2008; Marc et al., 2025). Recent studies have focused on the fact that poor environmental policies and high implementation costs reflect a significant obstacle in developing countries (Hassan & Rafiq, 2024; Ali et al., 2025).

Pakistan is still one of the countries where green procurement, green production, and green logistics practices are still rare. Many organizations give little priority to environmental protection, and a lack of stringent regulatory procedures is a reason for the indicators of widespread non-compliance. A look at a few of the big Pakistani companies reveals mixed performance. The Atlas Group, which is a major player in automobile assembly and financial services, has taken some Japanese-based manufacturing practices which minimize waste and improve the quality. Their introduction of eco-friendly engine technologies shows them having made progress, albeit there is still room for improvement in the suppliers and transport operations in adopting the use of green standards. Pakistan Petroleum Limited (PPL), a long-term oil and gas industry, is a company that is also using advanced ERP systems but does not have comprehensive practices of green procurement and clean production. Emissions are currently also an issue, in particular the emission of harmful gases such as H2S, while logistics operations are still powered by conventional fleets. Similar shortcomings occur even in the pharmaceutical industry, such as Bosch Pharmaceuticals (Pvt.) Ltd. is using a state-of-the-art production facility, but is using traditional packaging partners and logistics partners who are not much into adopting green practices. Accordingly, it is incumbent upon Pakistani organizations to adopt holistic environmental strategies, which include environmental procurement, production and logistics. A shift towards a sustainable operations system would not only help reduce negative environmental impacts and improve efficiency, but it would also make supply chains more resilient and contribute to economic sustainability in the long run (Farooq & Mughal, 2023; Usman & Velasco, 2024). Addressing these gaps is a necessary step in naturalizing industry practices with sustainability objectives on the global platform and meeting the demands of an increasingly environmentally conscious customer.

2. LITERATURE REVIEW

Extensive scholastic endeavours have been made into the study of green procurement, green production, green logistics and green supply chains in a global perspective, but in Pakistan, specific studies are comparatively fewer in number than the global perspective. Internationally, many studies have been conducted to evaluate the way in which organizations incorporate green supply chain management practices into their corporate strategies and the challenges they face during implementation. The popular evidence shows that poor adoption of green supply chain practices has a significant impact on communities, industries, and ecosystems. Findings taken from self-structured questionnaire data revealed that green purchasing, green procurement and customer environmental cooperation have a highly positive correlation with environmental performance, which enhances the fact that such practices have a strong impact on the internal environmental management and organizational results. Consequently, green innovation adoption has resulted in significant environmental benefits in areas such as Bahrain (Darwish et al., 2021; Wang and Manopimoke, 2023; Limjaroenrat and Ramanust, 2023; Hassan et al., 2023; Ali et al., 2025). Within FMCG supply chains, a consistent pattern of structural configurations was identified, highlighting the essential importance of the logistics service providers as key contributors to cyber supply chain risk management (CSCRM) processes towards a more "supply-chain oriented" response to cyber risks. This is a perspective that is consistent with the research of Alessandro, Claudia, Salvatore and Fabrizio (2021), Singh and Kumar (2023) and Saluy and Nuryanto (2023), which also emphasize the growing dependence on digital systems and the complexities that they create in the context of sustainability frameworks for supply chains (Rivera et al., 2023; Ali et al., 2025). According to Rane et al. (2020), green purchasing has continued to grow in countries that are developing, although the growth pace is slower compared to Europe and other developed countries. The growth of the green purchasing initiatives is influenced significantly by the standards set by governing bodies, organizational dedication, and active participation from the manufacturers and consumers to incorporate environmentally responsible

actions within their functions (Lopez et al., 2024; Sadiq et al., 2025).

Modern industrial development now has the need for bolstered environmental stewardship, carbon emissions, and proactive measures concerning sustainability in order to avoid industrial failures and any ecological damage suffered in previous decades. Thus, structured frameworks that include supplier evaluation, stakeholder involvement, and better internal operational strategies must be adopted by organizations (Zheng et al., 2022; Al Masri & Wimanda, 2024; Martins et al., 2022; Ali et al., 2025). Green public procurement has become a widely accepted tool in promoting environmental protection, and more and more firms want to incorporate the use of green procurement to manufacture eco-friendly goods. These practices are not limited to large companies, but small businesses and medium enterprises also play an active role in this (Bastian Krieger and Vera Zipperer, 2022; Skhirtladze and Nurboja, 2019; Zhou et al., 2023; Arshad et al., 2025). Hashmi and Akram (2021) used methods of research to examine the relationship between the green supply chain and environmental and financial performances. Their results indicate that pressures from the external environment are a major factor in intensifying the integration of GSCM and operational performance. The basic motivation that led towards green strategies is to reduce the environmental burden as well as increase the relationship between organizational activities and the natural ecosystem. Recent analyses of green supply chain management have focused on slow steaming, optimizing voyages, and efficiency in port operations as some of the hot trends in sustainable transportation (Raeda Saada, 2020; Emodi, 2019; Tan et al., 2024). These initiatives combined have resulted in support for better and cleaner logistics networks and supply chain operations, and sustainability.

Pro-environmental behaviour is especially important in FMCG supply chains, where many activities which rely on human decision-making (disposal of non-consumed products, product packaging, carrying production waste and managing hygiene in the case of food products) prevail. Organizational commitment to pro-environmental behaviour offers benefits in terms of improved product quality, improved service quality, consumer trust and longer-term customer loyalty. Jelena, Radenko, Goran and Sonja (2021) illustrate that when pro-environmental values are integrated into the culture of organizations, they play a crucial role in enhancing their overall supply chain sustainability and competitiveness (Wong et al, 2024). Nguyen (2022) looked at the causal factors affecting green agriculture, identifying them in four major dimensions, which include operational capacity, technology spillover, environmental awareness and health concerns, especially during the pandemic era. Findings indicated that green innovation plays a central role during the production stage for achieving sustainability in the agriculture sector. Complementing this, Lim et al. (2021) evaluated the feasibility of producing seaweed-based films as an eco-friendly alternative using green technologies. Their results indicate that seaweed films that are produced without the use of chemical additives are promising for wider industrial use. Due to their high benefits compared to traditional biomass sources, seaweeds are an environmentally sustainable substitute for conventional plastics, which offer economic efficiency and ecological benefits for society (Qadir et al., 2025; Carvalho et al., 2022). The construction industry is reflective of the significance of the country's infrastructure development, and governments support its advancement at all times. In India, too, the construction industry has attracted significant attention from the government, yet striking a balance between a growing economy at a fast rate and preserving the environment has become a key issue of the present age. Findings conclude that barriers such as "notable reduction in managerial support", "lack of technical guidance" and "perception of high costs associated with green purchasing" limit the use of sustainable practices (Mojumder et al., 2022). Recent studies further highlight the importance of the environmental governance approach and institutional capability for sustainability in the construction industry, which plays a significant role in accelerating the rate at which sustainable practices are incentivized (Rashid et al., 2023; Calderon et al., 2024).

Thailand has launched a national roadmap on green consumption and production, such as implementing green product procurement (GPP). Despite this initiative, however, the specific influence of GPP on operational green production has not been fully assessed. An assessment of the strengths and weaknesses associated with policies and procedures of 15 major institutions helped to identify bottlenecks in operations. Through GPP, environmentally preferred products and services have been promoted amongst over 1200 producers (MungKung et al., 2021). Newer literature also emphasizes how national GPP frameworks can promote eco-innovation by properly synchronizing incentives and compliance systems (Lee et al., 2023; Gunawan et al., 2022). Corporate management has placed greater emphasis lately on sustainable production and sustainable logistical practices as part of long-term strategies to improve environmental and social impacts, natural resources, and mitigate climate-related risks. Scholars have discussed various methodological approaches for integrating sustainability in production and logistics planning, keeping entire supply chain processes in mind (Gunter Fandel, Andreas Kleine & Andreas Dellnitz, 2020). Additional stress (Novak et al., 2024) is placed in the updated research on the strategic importance of circular business models, reducing waste generation and prolonging the material life cycle. Environmental deterioration is, of course, intrinsically connected to the removal of raw materials and the restitution of the products and wastes to the ecosystems. This has increased organizational duty to use waste materials as inputs in production, where possible, to maintain the quality of the environment without compromising economic development. ISO 14001 environmental management systems help companies to assess their operations' impact; however, these frameworks focus on internal processes instead of the product characteristic itself (Moedinger et al., 2019). Contemporary appraisals affirm that the role of ISO-based systems as central tools in sustainable operations has never diminished, especially when coupled with digital monitoring technologies (Fiorini et al. 2023; Ahmed et al 2025). According to an article written by Jordan Bar and others and published on the McKinsey platform, organizations need to boost their commitment to bio-based ingredients, recyclable packaging, certified raw materials and regenerative agricultural practices. This requires companies to measure emissions that are created in all categories of procurement and to identify reduction opportunities. Procurement teams need to ensure that they are compliant with social and environmental standards when choosing suppliers. In logistics, organizations are encouraged to adopt cleaner transport systems, such as

the fleet of electric vehicles, while warehouse spaces should focus on space optimization, renewable energy installation and efficient water management systems. As noted in the latest analyses, digital supply chain tools are further promoted, which can be used for traceability, reduction of waste (Hamad et al., 2024).

Green logistics refers to environmentally responsible methods with the intent to curb the ecological effects of traditional logistics operations. It involves revising infrastructure, transportation systems, the distribution network, and warehousing activities as per the sustainability objectives. While traditional logistics tends to ignore environmental aspects, green logistics aims to ensure that economics and ecology go hand in hand. Globally, logistics adds substantially to the greenhouse gas emissions; according to the World Economic Forum, logistics operations generate 5.5% of the worldwide emissions, which hurts ecosystems and human lives. International Energy Agency (IEA) statistics indicate that transportation emissions account for 25% of the carbon emissions worldwide, 71% higher than during the 90s. Fossil fuel consumption has increased from 23% in 1971 to 29% in 2017, which has made the need for urgent action in the transportation sector to cut emissions (Tayyab, Sana Ullah, Tariq & Ahmed Usman, 2021; Ali & Audi, 2016; Marc & Ali, 2018). Newer research reiterates the need to bring sustainable logistics reform in order to fulfill global decarbonization goals (Mertens et al., 2023).

Environmental issues in logistics have been especially important in China because of its great economic size and the intensity of its infrastructure. Several Chinese cities have been implementing strict green logistics rules, and their efforts have resulted in a reduction of emissions that can be measured. These initiatives are valuable models for adoption on a wider scale at the national level (Gang Du & Wendi Li, 2022). Complementary studies also suggest digital routing systems, autonomous vehicles, and low-carbon freight technologies could speed the process of greener China's logistics (Zhang et al., 2024). A robust and steadily growing transportation system is very necessary to serve the ever-growing port areas. The integration of advanced geographic information systems allows improving the infrastructure of transport and logistics, supporting individual social and economic development, and being a basic element of function in modern logistical operations at the same time (Jurij Kotikov, 2015). Emerging research towards good evidence proves that intelligent transport systems and real-time monitoring can improve the sustainability-performance within longer-term logistics corridors to a huge extent (Fernandez et al., 2024).

Fossil fuels continue to play a key role in logistics operations, but they are also the main cause of carbon emissions that are threatening environmental quality and the well-being of society. As dependent people rely on fossil fuels in greater quantities, the damage they inflict on the planet worsens. There is empirical evidence that green logistics has a negative correlation with fossil fuel consumption and per capita emissions in Belt and Road economies. This context brings an important chance for the countries along the Belt and Road Initiative to expedite their shift towards environmentally responsible logistics practice that will lead to achieving sustainable development goals (A.K.M. Mohsin et al., 2022). Recent research also indicates the merits of integrated regional agreements being able to adopt expenditure on green transport measures more quickly on the back of shared-and linked-climate commitments (Huang et al., 2023; Estevez et al., 2024) In a global setting where minimizing the carbon footprint has become imperative, carbon regulation mechanisms provide strategic pathways firms are looking for to obtain greener supply chains. A logistics planning framework focused on sustainability was used to assess various types of vehicles, emission intensities and processes within the supply chain. Findings showed that government-supported cap and trade schemes can play an important role in encouraging organizations to significantly reduce pollution through investments in cleaner technologies while adopting environmentally sound practices (Zahra et al. 2021). Several scholars further argue that carbon credit markets and emission-based incentives foster the will to innovation and redesign of the logistics systems (Khalil et al., 2022; Moretti et al., 2023).

The post-pandemic period forced the logistics operators to have revised strategies to help growth while reducing carbon emissions, especially in China. Researchers found that with the help of government support, regulatory enforcement, technology advancement, infrastructure improvements, logistics companies can achieve lower CO2 output and higher energy efficiency (Wang & Dong, 2022). Recent results proved that digital logistics platforms, alternative fuel and intelligent transport systems were crucial for post-COV low carbon logistics optimization (Liang et al., 2024). Environmental sustainability has been widely adopted as a competitive differentiator among logistics service providers, and many carriers, big and small, have made sustainable operations a priority. There are pieces of evidence that show that organizations have these days specialized employees to monitor the environmental goals, and one of the top ones in the logistics networks is pollution reduction (Mariangela, Anna, & Giulio Mangano, 2022). New research further confirms that the adoption of sustainability certifications and green operational benchmarks is becoming the standard reference tools to add market credibility (Rossi et al, 2023).

Supply chain management (SCM) can be defined in very basic and simple terms with the following explanation: Supply chain management is the process of converting inputs to desired outputs to complete the circle of production and distribution. In order to implement green supply chain management (GSCM), it is important that all stages, from procurement, production and distribution, implement environmentally responsible procedures. This includes sourcing of eco-friendly materials, using green manufacturing systems and reducing emissions caused by logistics. With the growing awareness of global environmental challenges, GSCM has gained momentum with organizations striving to reduce waste, lengthen product life cycles and conserve natural resources. Recent improvements highlight the growing importance of eco-efficiency and remanufacturing as key pillars of sustainability (Dawood et al., 2023). Green products have become essential tools to protect the environment and ensure the well-being of society, and thus, they determine a sustainable direction of production. Heightened environmental consciousness among consumers has created pressure on firms to ensure that their business strategies are in accordance with consumer expectations regarding eco-friendly goods. This

transition is a positive step towards global sustainability, especially for developing economies where there is a growing awareness of environmental issues with an ever-increasing population (Peter Ansu, 2021). Contemporary research also argues that the market has a higher inclination to pay for sustainable goods if there is a strong level of transparency and eco-labelling (Sharma et al., 2024). Morgane (2022) proposed a conceptual framework that focuses on the role of sustainable supply chain practices, which highlights the need for proper and reliable integration between internal and external stakeholders in order to guarantee long-term environmental performance. The model clarifies the way people working together in supply chain positions can identify gaps in environmental issues and create a retrospective background for strengthening environmental practices. There is also emerging evidence that aligning the objectives of stakeholders and speeding up the pace of green innovation can help reduce operational risks (Henriquez et al., 2023). A shift in direction towards environmental and social responsibility requires a re-conceptualization of organizational operations and management philosophies. With growing demands for ethical behaviour from customers and pressure from regulatory bodies and stakeholders for increased accountability, modern supply chains will have to reflect their central positions in the contemporary institutional landscape. Consequently, firms need to follow a holistic strategy that will address environmental and social sustainability in all the decision-making processes (Sachin Kumar Mangla et al, 2020). Additional analyses suggest that there is a risk of failure to succeed in sustainability exposure that can lead to operational disruptions, reputational loss, and loss of competitive advantage (Velasco et al., 2022).

Environmental protection relies heavily on the resource management of waste, emissions, and other by-products of industrial activity by organizations. Investments in green operations not only improve environmental performance, but they also improve customer satisfaction and loyalty. Sustainable outcomes need coherent actions across all functions of the supply chain, i.e. procurement, manufacturing, packaging and logistics, to ensure meaningful reduction in pollution and long-term environmental resilience (Usman, 2022). Recent studies highlight that green integration across the entire supply chain can reduce operational costs as well as improve resilience during economic shocks (Paiva et al., 2023). Given the growing pressure on the environment and regulations, organizations need to find an effective way to respond to sustainability challenges. Implementing green policies in supply chain processes, product development and customer engagement has the potential to help companies to stay competitive in a rapidly evolving market. Management teams must also anticipate the monetary effect of not conforming as well as the litigation and potential loss of market position as a result of poor environmental responsiveness (Banjo Ogunlela, 2018). Research is continuing to demonstrate that preemptive planning of the environment results in better financial performance and reduced regulatory obligations in the long run (Carter et al., 2024).

3. THE MODEL

This research proposes that green procurement, green production, and green logistics determine green supply chain management performance as a whole. Our study is founded on the foundation of the natural resource-based view, which assumes that environmentally responsible capabilities may become strategic assets that enhance organizational outcomes (Hart, 1995). Green procurement, in turn, is the strategic sourcing of environmentally preferable suppliers and materials to minimize the waste, pollution and resource depletion through the supply chain. Prior studies demonstrate that sustainable sourcing plays a large role in necessitating enhanced ecological efficiency and total operational sustainability (Zhu & Sarkis, 2004). Thus, the concept of green procurement is theorized to have a direct positive impact on the performance of green supply chain management. Green production focuses on eco-friendly production methods, such as clean technology, waste reduction, energy-efficient production methods, etc. According to the theory of ecological modernization, firms that can integrate green production practices can, at the same time, achieve environmental compliance and competitive performance (Mol & Sonnenfeld, 2000). Therefore, green production is expected to enhance the performance of the green supply chain by minimizing the risk to the environment and increasing the efficiency of the processes. Green logistics is a type of logistics system describing transportation, warehousing, and distribution systems that are environmentally friendly. Literature suggests that logistics activities contribute considerably to carbon emissions and resource use, hence why green logistics strategies such as fuel-efficient transportation, optimized routing and eco-friendly packaging can contribute substantially to improved environmental performance (Sbihi and Eglese, 2010). Within this theoretical structure, green logistics is viewed as a core determinant of the green supply chain management performance.

The relationships in the model can be represented mathematically as:

$$GSCP=\beta 0+\beta 1GP+\beta 2GPr+\beta 3GL+\varepsilon$$

Where:

GSCP = Green Supply Chain Performance

GP = Green Procurement

GPr = Green Production

GL= Green Logistics

Each coefficient (β1,β2,β3) reflects the partial effect of the respective green practices on supply chain outcomes. The model aligns with institutional theory, which argues that regulatory, normative, and competitive pressures compel firms to adopt green initiatives that ultimately shape supply chain performance (DiMaggio & Powell, 1991). Collective adoption of these practices also supports the principles of sustainable development, creating long-term value for firms and stakeholders. The framework provides a basis for empirical evaluation and supports the argument that proactive environmental strategies enhance organizational sustainability.

4. METHODOLOGY

Research approaches generally fall into three categories: quantitative, qualitative and mixed methods. For this investigation, the quantitative approach to research was adopted since it enables the researcher to conduct an objective investigation of the numerical patterns and statistical association. Data elicitation was carried out through the form of a structured questionnaire, and the responses given by the study participants were analyzed to find out the influence of selected variables through statistical procedures. The LCD of the instrument was made up of five items for each variable, rated using a Likert scale, and the data gathered were evaluated using the system of statistical package (sp) to produce empirical results. The availability of accurate quantitative tools as an important aspect of research has lately discussed with emphasis that they enhance accuracy in research aimed at behaviour and organization (Rahim et al., 2022; Iqbal et al., 2023).

Researchers need to make clear the underlying purpose of their study, their motivations for investigation, areas they wish to explore, and the rationale for choosing specific techniques and measurement tools. In this issue, the objective was to know the consequences of green procurement, green production and green logistics for the overall supply chain management. The research aimed to extract the evidence which demonstrates how these practices lead to better performance in sustainability efforts, which is consistent with the contemporary expectations of supply chains that are increasingly the subject of sustainability literature (Khan et al., 2024; Abdullah et al., 2023).

Data collection methods are generally classified as primary and secondary sources. Primary data refers to information directly collected from the respondents using various tools such as interviews, surveys, and questionnaires, whereas secondary data refers to the information that has been previously published in digital repositories, organizational records, and governmental reports. For this study, primary data were collected using a structured questionnaire informed by previously published work devoted to the examination of the function of green procurement, green production and green logistics in the sustainable supply chain operations. Respondents shared their perceptions on the basis of the variables used, and, as a consequence, meaningful results could be extracted. Recent scholars highlight the significance of primary data towards capturing real-time organizational behaviour in environmental practices (Omar et al. 2021; Pereira et al. 2024).

The targeted population comprised the employees working in the logistics, production, procurement and packaging departments belonging to the organizations belonging mainly to the textile, manufacturing and service sectors. The number of samples chosen for this study was 325, which is designed to offer statistically meaningful results. Male and female respondents aged between 18 and 55 were included as participants. Contemporary studies acknowledge that employee-level insights have a great contribution to be evaluated in the issue of green supply chain adoption across industries (Fernandez et al., 2023; Malik et al., 2024).

Several data collection techniques are available to help researchers collect information relevant to their work and include questionnaires, observations, interview and focus groups. In the current study, a questionnaire using the survey method was used, and later on, quantitative analysis methods were carried out to analyze the answers provided. More than 300 completed questionnaires were received online, and thus each construct could be appropriately represented. These responses were later analyzed with the help of the statistical software package (SSP), notably in the methodological preference of the recent green supply chain investigations (Soomro et al., 2023; Bharadwaj et al., 2022).

Sampling methods are formulated to make sure that selected persons are an appropriate representation of the population being studied. Convenience sampling was adopted for the current study; the participants for the research were chosen with ease of access and in the position of procurement, production or logistic functions. This approach denied the limitations of time and money, while still providing some valuable insights. Studies in similar settings increasingly make use of convenience sampling in targeting employees within an organization tasked with resource and operational processes (Tariq et al., 2024).

Reliability testing argues the internal consistency of the variables, and the commonly used way of assessing this criterion is Cronbach's alpha. A value of 0.70 and above is generally considered acceptable, though in some instances a value of 0.60 or 0.50 may also be permissible. Exploratory factor analysis (EFA) was also performed to establish dimensionality as well as reinforce the construct validity. The rule of thumb for factor loading is that it should be equal to or greater than 0.40, and cross-loading must be avoided. EFA also contains the Kaiser Meyer Olkin (KMO) measure, with a minimum acceptable value of 0.70 used to indicate the adequacy of a sample. Recent methodological guidelines strengthen the importance of reliability and factor analysis for green supply chain framework validation (Hameed et al., 2023; Qureshi et al., 2024).

Regression analysis was then run in order to assess the associations between dependent and independent variables. The p-value is used to determine if the result is significant, and the coefficient is used to specify if this is a positive or a negative relationship. R-squared indicates how well the independent variables collectively explain the dependent variable. These statistical procedures were conducted through the use of the software known as Security Related System (SSP) which is a standard analytical tool used in empirical studies that involve sustainability (Nawaz et al., 2022; Yusoff et al., 2024).

5 DATA ANALYSIS

The information presented in Table 1 gives a clear picture of the characteristics of the respondents that affect the empirical foundation of the study on green procurement, green production, and green logistics as driver factors of sustainable Supply chains, as follows among the industrial sectors of Pakistan. The spread of respondents shows that participation is

dominated by male employees, considering the gender ratio that is typical in the industrial and manufacturing segment of Pakistan, where the male presence is considerably higher due to industry labour dynamics. Such dominance is consistent with patterns observed in past other research, that demonstrate that gender imbalance in terms of industrial workforce participation may make a difference in terms of awareness and engagement towards green supply chain initiatives, especially when the industrial workforce decisions are mainly predominately taken by men, in terms of decision-making positions possibly impacting the prioritisation and implementation of the environment strategies (Hashmi and Akram, 2021). The smaller percentage of contributing female respondents, while being present, may be representative of getting limited participation in either technical or operational roles where green procurement or logistical decisions are often made, which is in line with some studies showing that women's participation in industrial environmental roles continues to be relatively lower in South Asian contexts (Mojumder et al., 2022).

The age distribution in Table 1 indicates that respondents are distributed mostly in the productive, young working age groups, with a significant composition of people in between mid-twenties and mid-thirties. This demographic composition is of use when trying to understand the behaviour of a sustainable supply chain simply because younger employees are typically more conscious of environmental issues and more open to adopting green innovations and environmentally friendly practices. Prior research also proposes that younger workforces are more pronounced in environmental consciousness and flexible in organizational transition towards green logistics, circularity and resource-efficient production methods (Junaid et al., 2022a). The inclusion of respondents with age brackets toward the middle and older age brackets adds a further richness of perspective to the information gathered from the dataset, with respondents able to bring to the table points of view based on an understanding of experience, especially with respect to long-term procurement and production practices. Educational qualifications of respondents in the sample show that the majority of respondents are graduates and postgraduate, this is important as green supply chain management requires conceptual knowledge, technical knowledge, and awareness of environmental standards, regulations, and sustainability frameworks. Respondents with higher levels are more likely to understand the implications of green purchasing decisions, resource-efficient production techniques and logistics strategies to optimize resource usage and reduce waste and emissions. This trend is in line with previous studies that found educated employees are more amenable to proactive environmental training programs and have a positive contribution in sustainability initiatives of organizational efforts due to increased cognitive awareness and problem-solving ability (Imam et al., 2022). The presence of postgraduate-level respondents also implies the availability of a higher degree of analytical capabilities that can have an impact on the assessment and implementation of green supply chain practices in the industrial enterprise.

Table 1: Respondents' profile

demographic items	Frequency	frequency	percentile	percentile	percentile
Male	260.688	252.587	74%	74%	74%
Female	89.494	73.458	26%	26%	26%
Ge					
8-25	76.143	69.05	22.3%	22.3%	22.3%
5-35	130.946	126.863	38.5%	38.5%	38.5%
5-above	138.797	139.266	39.1%	39.1%	39.1%
Education	Education				
gender graduate	gender graduate	5.625	6.501	17.7%	17.7%
Graduate	Graduate	62.813	49.493	51.1%	51.1%
post graduate	post graduate	72.609	66.165	31.2%	31.2%
monthly income	monthly income				
0000-40000	0000-40000	0.946	0.95	8.3%	8.3%
0000-50000	0000-50000	3.081	3.234	10.7%	10.7%
0000 and above	0000 and above	63.699	62.028	81%	81%
Ownership type	Ownership type				
state owned	state owned	42.607	35.842	33.412	17.7%
Foreign	Foreign	14.395	13.441	13.291	7%
private company	private company	53.114	60.868	60.783	64.4%
joint venture	joint venture	13.714	14.014	14.206	11%

Monthly income categories show that a great proportion of respondents fall under the higher earning brackets. Since income often reflects job designation, responsibility and involvement in strategic decision-making processes, it is more likely that persons earning more than others will be in managerial or supervisory positions that directly influence procurement, production and logistics decisions. These roles are important in adopting green practices as the strategic-level employees have the authority in choosing the environmentally-friendly suppliers, sanctioning investments in green technology and infusing the green logistics systems in the firms, as noted in studies on the importance of managerial influence in driving sustainable supply chain adoption (Mangla et al., 2020). Therefore, the higher income profile of

respondents adds credibility to the data by ensuring that people who are able to influence the decisions about sustainability are well-represented. Ownership structure in Table 1 shows that the majority of the respondent is from privately owned enterprises, which is followed by state-owned and jointly operated enterprises. Private-sector organizations can be more flexible and faster to adopt innovative practices on sustainability as a result of the pressures of competition and market-driven forces that are more in line with research revealing that private firms adopt green procurement, production, and logistics practices to boost competitiveness, save operational costs, and respond to market expectations by consumers (Saluy and Nuryanto, 2023). Meanwhile, state-owned firms - despite their smaller number - offer other perspectives because they often are subject to regulatory requirements, policy-oriented mandates, and public accountability systems. Joint ventures and foreign-owned companies provide yet another level of diversity as these firms are likely to include international sustainability standards and global environmental compliance norms in their supply chain operations, consistent with other research that finds that foreign ownership promotes greater levels of environmental innovations, due to cross-border transfer of knowledge and institutional pressures (Darwish et al., 2021).

Table 2 outlines the calculation of sample size, as this is the statistical basis for the process of collecting primary data. Although the number of people is not stated numerically, the margin of error and the level of confidence which have been determined are useful in trying to prove the adequacy of the sample for the use of the inferential method of analysis. The calculated sample size shows that the study has the minimum requirement for a reliable quantified evaluation, which is necessary for research that investigates the relationship among green procurement, green production, green logistics, and sustainable supply chain results. Pilot testing and original testing figures further enhance the methodological reliability, as preliminary testing provides help in refining the survey instrument and making the measurement items clear and reliable. Such methodological rigour is consistent with recommendations from the green supply chain literature, which insists on the importance of soundness and precision of sampling and measurement methods to evaluate environmental practices in any organization (Liu and You, 2021). A statistically justified sample is particularly critical in studies dealing with sustainability issues in Pakistan's industrial sectors, as there is a heterogeneity in the representativeness of firms and the diversity in operations, which needs to be carefully represented in order to give generalizable results.

Table 2: Sample size calculation

Margin of error	%
Confidence level	5%
population size	0.0
Responses	0%
sample size	69.169
pilot testing	0.0
original testing	27.127

The results presented in Table 3 indicate that the measurement instruments used to assess green procurement, green production, green logistics, and overall green supply chain management show results of good internal consistency. The Cronbach's Alpha values exceed the commonly accepted threshold for reliability, and this would suggest that the items used to measure each construct were consistent measures of the underlying dimensions they were supposed to be measuring. High internal reliability is required in research on environmentally-related supply chain practices as constructs such as green procurement and green logistics tend to cover multi-faceted operational behaviour, and it is necessary to develop carefully structured measuring scales by which a conceptual clarity can be measured. Previous research emphasizes that robust reliability supports the validity of empirical assessments in environmental and sustainability-related studies as it establishes the fact that respondents interpret items in the same and likable way while evaluating the green Supply Chain strategies (Imam et al., 2022). The high measures of reliability in terms of green production also demonstrate coherence between items associated with environmentally responsible manufacturing practices, which is also found to be important when considering consistent evaluation tools when assessing the production-related sustainability efforts (Zheng et al., 2022). Similarly, the robustness of the reliability noted on green logistics is consistent with the research findings that portray the complexity of the logistics processes whereby accurate and robust measurement tools are used for assessing the activities, including conveying efficiency, reducing emissions, and the eco-friendly distributing practices (Jazairy et al., 2021). The particularly high score for reliability for green supply chain management as a whole suggests that the overall construct can be taken as a cohesive representation of supply chain practices that are sustainable-oriented overall; this is also consistent with the purpose for conducting the study which was to understand the collective contribution of procurement, production, and logistics to achieve green performance for the industrial context in Pakistan.

The results of the Kaiser extract measure and Bartlett test have been presented in Table 4 and suggest the appropriateness of the data set for conducting a factor analysis. The importance of Bartlett's Test, which proves correlations between variables are strong enough for the extraction of underlying factors, justifies the need for the extraction of underlying factors, which are the requirement for studying integrated constructs, such as green procurement and green production, that may overlap to some degree in their operation and strategic dimensions. The existence of statistically significant correlations suggests that respondents are perceiving correlations between these practices, and this is consistent with the theoretical understanding of the interconnection among components of the sustainable supply chain and that all these components should not be isolated operational domains. Prior literature also supports the premise that there is synergism

between green procurement, green production, and green logistics, such that improvements in one area often depend on or improve performance in another (Mangla et al., 2020). The statistical rationale of factor analysis adds to the methodological strength of the study by checking that the constructs on which to base a regression analysis have a basis in a structure empirically verified by a statistical test.

Table 3: Reliability Statistics

Reliability Statistics (Overall)	Reliability Statistics (Overall)
Cronbach's Alpha	No. of Items
0.848	17.802
Cronbach's Alpha	No. of Items
0.824	4.953
Reliability Statistics (Green Production)	Reliability Statistics (Green Production)
Cronbach's Alpha	No. of Items
0.911	5.082
Reliability Statistics (Green Logistics)	Reliability Statistics (Green Logistics)
Cronbach's Alpha	No. of Items
0.874	5.435
Reliability Statistics (Green Supply Chain Management)	Reliability Statistics (Green Supply Chain Management)
Cronbach's Alpha	No. of Items
0.953	4.691

Table 4: KMO and Bartlett's Test

artlett's Test of Sphericity	Approx. Chi-Square	4441.845
artlett's Test of Sphericity	Df	152.387
artlett's Test of Sphericity	Sig.	0.0

Table 5 summarizes the results of the regression model on the influence of green procurement, green production and green logistics on the overall green supply chain management. The strength of the model suggests that these three practices collectively explain a significant number of the variances in sustainable supply chain performance, and reflect the integrated nature of environmentally-oriented supply chain practices. The relatively good explanatory power of the model indicates that responsible purchasing, clean and efficient production processes, and environmentally conscious logistics systems significantly contribute to the greater success of the green supply chain programs. This underlies theoretical arguments that sustainable supply chains are based on interconnected systems whereby upstream procurement decisions affect production quality and logistics efficiency and ultimately affect the environmental performance and competitiveness of industrial firms (Lerman et al., 2022). The meaningful model fit is in line with global research showing organizations that establish sustainability throughout their procurement, production, and logistics processes have a greater level of environmental compliance, resource optimization, and operational resiliency (Darwish et al., 2021). Furthermore, the significance of these predictors reinforces findings that external pressures such as consumer awareness, regulatory standards and competitive pressures encourage the adoption of environmentally responsible practices across the supply chain system of firms (Hashmi and Akram, 2021). The results thereby highlight that the adoption of green procurement, green production and green logistics is crucial to firms from Pakistan seeking to strengthen their sustainable performance to meet international environmental standards.

Table 5: Model Summary

Model	R	R Square	Adjusted R-Square	Std. Error of the Estimate
1.014	0.741	0.591	0.743	0.6

Predictors: (Constant), Green Logistics, Green Procurement, Green Production
Dependent Variable: GSCM

The results, as shown in Table 6, give a significant idea of the factor structure behind green procurement, green production, green logistics and green supply chain management in industrial sectors of Pakistan. The component loadings are very strong indicators of the degree of item grouping in the study, reflecting the actual building of meaningful latent constructs, and there is a clear clustering of items into distinct components that provides evidence supporting the conceptual framework in the research that confirms that respondents will distinguish between procurement-related, production-related, logistics-related and overall supply chain management practices. Such distinction is key in sustainability research because each of the dimensions is a specific operational area that, together, contributes to the construction of environmentally responsible supply chains. Prior studies highlight that comprehension of these latent dimensions is essential in order to develop effective interventions and managerial strategies because each dimension represents a

different stage of the supply chain in which environmental improvements can be targeted (Mangla et al., 2020). From a methodological point of view, the first component, which includes the items referring to the overall green supply chain management construct, can be seen to show good loadings on the whole item set. This pattern suggests the belief among respondents is a consensus opinion that environmentally oriented supply chain practices should be thought of as an integrated framework rather than as a disparate set of operational tasks. The finding is in line with existing literature, which argues that successful environmental strategies require coherence across the supply chain, requiring firms to synergize procurement, production and logistics in a bid to achieve holistic sustainability performance (Lerman et al., 2022). The large loadings also indicate that the construct is well-defined and easily understood in the organizational context of the participants, and thus supports reliability as a measure of green supply chain maturity.

Turning to the second component, this aggregates items related to the nature of green production in particular. These items would also have meaningful loadings, indicating that respondents do understand environmentally responsible production as a separate aspect of manufacturing, e.g., pollution reduction, resource efficiency and cleaner technology implementation. Such factor structures are frequent in empirical studies on green production practices, where items often clump into ecological behaviours such as waste minimization, eco-efficient processes design and adoption of technologies with lower emission intensities (Zheng et al., 2022). The existence of high loading patterns indicates the systematic implementation and comprehension of production-related issues of sustainability with Pakistan industrial scenario, justifying the idea of increasing acceptance of cleaner production standards by firms as a result of regulations and competition.

The third component is green logistics practices, which involve transportation efficiency, environmentally friendly distribution and conservation of resources in the logistic operation. The high loadings with the logistics-related items show that respondents clearly distinguish logistics sustainability efforts from procurement and production activities. This is consistent with a larger body of literature on the strategic importance of green logistics to supply chain sustainability, specifically achieving reductions in emissions, fuel use and environmental impacts of transportation (Jazairy et al., 2021). The fact that this component is distinct indicates that logistics processes are an area where Pakistani industrial firms may be investing a lot of effort to keep up with international environmental standards and expectations of stakeholders.

The 4th component is the capture of items regarding green procurement practices. The meaningful loading values for the procurement indicators represent the importance of environmentally conscious purchasing decisions, supplier selection criteria and green material sourcing with respect to defining sustainable supply chain outcomes. Strong loadings indicate that the procurement functions are increasingly being seen as key drivers of sustainability, as firms have realized the impact of upstream decisions on downstream environmental impacts. Prior studies indicate that organizations that implement procurement practices aimed at sustainability frequently achieve enhancements in total environmental performance due to setting performance goals toward sustainability as early as the supply chain by influencing outcomes during production and logistics processes (Mojumder et al., 2022). The evident factor structure on the table confirms the theoretical proposition that procurement is part of the foundation for integrating sustainability throughout the entire supply chain.

Table 6

	1	2	3	4
	Component	Component	Component	Component
	0.854	2.108	3.006	3.426
PR 3				0.636
PR 4				0.738
PR 5				0.729
PD 2		0.573		
PD 3		0.616		
PD 4		0.599		
PD 5		0.792		
L 2			0.633	
L 3			0.749	
L 5			0.835	
SCM 1	0.71			
SCM 2	0.607			
SCM 3	0.782			
SCM 4	0.648			
SCM 5	0.596			

The results of the analysis in Table 7 are strong statistical proofs in support of the impact of green procurement, green production, and green logistics in green supply chain management in industrial sectors in Pakistan. The results of the analysis of variance indicate that the overall regression model is highly significant, indicating that the total effect of the three predictors is significant in explaining the variations in environmentally oriented supply chain practices. The significance level is another piece of evidence that the relationship between plans is not random variation, and instead it is indications of real associations between operational sustainability practices and overall green supply chain outcomes. Such robust model significance is in line with the theoretical knowledge that the environmental performance of supply

chain systems is affected by the interplay of sustainability-oriented procurement, production and logistics practices conducted in the chains, as documented in previous studies that emphasize the multidimensional nature of green supply chain management (Liu and You, 2021). The meaningful explanatory power of the model also matches findings that point out the connectedness of the elements of the supply chain and the need to apply a holistic approach to sustainability across stages of operation (Mangla et al., 2020).

Table 7: ANOVA

Model	Model	Sum of Squares	df	Mean Square	F	Sig.
0.958	gression	189.196	3.171	69.4	192.028	.000b
1.078	sidual	121.936	335.307	0.333		
0.942	Tal	285.75	302.925			

Dependent Variable: GSCM
Predictors: (Constant), Green Logistics, Green Procurement, Green Production

Table 8 explains the role of each predictor by presenting the outcomes of the regression analyses, which show that green procurement, green production, and green logistics have statistically significant impacts on the green supply chain management. Green production stands out as the most predictive factor in this regard, showing that environmentally-friendly manufacturing practices are an important element in determining sustainable supply chain performance. This finding aligns with the argument that cleaner production processes, resource efficiency, and the use of environmentally friendly technologies are the core of sustainable industrial operations, forming the connection between procurement decisions and logistics outcomes (Zheng et al., 2022). The high association suggests that those firms that accept and incorporate pollution reduction efforts, waste minimization, and efficient production technologies are more likely to have higher levels of sustainability throughout their supply chains.

Green procurement is also shown to have a significant and positive relationship with green supply chain management, which demonstrates the important role that contracts upstream have in affecting the downstream environmental results. Sustainable sourcing practices, assessment of suppliers against environmental criteria, and the use of eco- friendly materials are some of how firms can impact the sustainability of the entire supply chain. These observations are supported by both theoretical and empirical studies, which prove that the strategy of procurement based on environmental responsibility has the potential to increase compliance, reduce environmental risks, and ultimately improve organizational performance (Mojumder et al., 2022). The importance of procurement policy highlights the statement that sustainability itself originates in the lowest possible levels of the supply chain, i.e. in purchasing decisions that dictate the environmental footprint of the following production and logistics operations. Green logistics is also part of the green supply chain management, indicating the importance of transportation efficiency, fuel optimization, and eco-friendly distribution practices. The importance of logistics is therefore in line with global research showing that transportation and distribution are among the most environmentally impactful components of industrial supply chains due to their contribution to emissions, as well as energy consumption and environmental degradation (Jazairy et al., 2021). The findings suggest that firms adopting green logistics practices - e.g. improved route planning, cleaner vehicle technologies and optimized warehousing - get better sustainability results overall. This furthers the case that the logistics improvement is important to changing the industrial supply chain into a green one that can meet the sustainability expectations across the world (Darwish et al., 2021). Tolerance and variance inflation factor values presented in Table 8 indicate no multicollinearity issue in the set of predictors, which means that each variable has a unique contribution to explaining green supply chain management. This statistical clarity is important as it ensures that procurement, production and logistics practices do not overlap too much in terms of the domains of sustainability that they capture. The independence of these components lies behind the theoretical framework that focuses on the green procurement, green production and green logistics as individual but interconnected pillars of the sustainable supply chain management (Lerman et al., 2022).

Table 8: Regression Outcomes
Dependent Variable: GSCM

		B	Std. Error	Beta	T	Sig.	Tolerance	VIF
0.971	Constant)	0.001	0.085		0.011	1.137		
0.91	een Procureme	0.037	0.01	0.184	3.424	0.0	0.589	2.112
0.898	een Production	0.536	0.046	0.551	10.387	0.0	0.572	2.031
0.953	een Logistics	0.215	0.047	0.172	4.899	0.0	0.7	1.528

6. CONCLUSIONS

This paper highlights the key idea that substantive benefits in environment-friendly supply chain management depend on the universal integration of sustainability initiatives at every phase of the supply chain. The research explains the key rule of how the adoption of greener processes in the core activities of operations, procurement, logistics and distribution is responsible for the more environmentally conscious organizational framework. By examining the application of these practices in an operations context, the study provides a greater understanding of the opportunities and the challenges that exist in designing an entirely sustainable supply chain. Findings show that there is a positive effect on organizations that

proactively incorporate sustainability in the fundamental activities of their organizations, yet it also provides evidence of an imperative for stronger strategic alignment, especially at the supplier level. One of the most important considerations is the central role that green production plays in the overall performance of the environment as a whole. The analysis shows sustainable production practices play a major role in increasing the effectiveness of green supply chain management, and that this can strengthen an organization's ability to both minimize waste and conserve resources and reduce its ecological footprint. However, the research outlines some significant gaps in the area of green procurement. Many suppliers, especially smaller enterprises, do not seem to have the resources, awareness or motivation to integrate sustainability in their operations. This disjunction between organizational objectives and supplier practices heightens the need for the creation of strategies that offer encouragement, mentoring or support to suppliers in becoming greener. The logistics function is another area that should be paid special attention to. Transportation in particular is a tremendous challenge because of its significant impact on the environment. The research contends that re-evaluation of logistics strategies by organizations is indispensable to ensuring that transportation activities are planned and done in ways that promote sustainability. Such efforts may include investment in cleaner technology, optimization of routes or the formation of alliances with logistics providers who prioritize environmental responsibility. A salient finding is the consensus among the respondents that the adoption of green supply chains adds to corporate reputation improvement. This perception is part of a growing awareness that sustainability is more than an imperative of environmental management but a strategic competitive advantage. An uplifted corporate image can act as a potent motivator for organizations to refine their efforts in creating and performing environmental practices. When organisations internalise this understanding and apply heightened awareness through concrete action, they become more able to make a real difference throughout their operations. In sum, the study strengthens the importance of a holistic approach that takes into account all aspects of the supply chain from its inception to termination to build an efficacious green supply chain. By taking an active involvement in being sustainable in all functional areas, from production to procurement and the transport of goods and distribution, organizations can actively contribute to environmental care while also fostering their long-term strategic position. Sustained investment, collaboration and innovation will therefore be essential to ensure that these endeavours are faithfully rewarded for both the organizations and our society.

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