



Impact of Green Construction Procurement on Achieving Sustainable Economic Growth Influencing Green Logistic Services Management and Innovation Practices

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Green construction procurement is a part of the sustainable development goals (SDGs) that influence economic growth on a strategic level. Adopting green technologies and practices has no longer been an option but a well-worth route for gaining a competitive advantage in the construction sector. The emergent concepts of green procurement and sustainability have raised the need to measure the financial performances in supply chain practices. Green procurement is now gaining importance in the construction industry and supply chain practices for a safer tomorrow. The study aimed to investigate the impact of construction procurement on green logistic services, innovation practices, and their subsequent role in gaining sustainable economic development goals. The population frame for this study was the project teams (engineers and project managers) of construction companies in China. The sampling design followed was convenient random sampling. The study was conducted using self-administered questionnaire surveys to avoid any respondent biases and/or errors. The study's findings show that construction procurement is partially associated with green logistic services management, which thoroughly determines the sustainable economic development goals. Furthermore, construction procurement is found to have a significant impact on green innovation practices that partially predict the SDGs, and the mediation of green logistic services and innovation practices are partially mediated to the construction procurement and sustainable goals. In the future, the study results will help the construction practitioners, contractors, bidders, and engineering community to shape their relationships in a greener way up or down the stream of their supply chains. Additionally, the implication of green procurement and logistic services offers many challenges in the long run for attaining SDGs; however, in the short run, it gives operational efficiency and less hazardous environmental emissions.

Keywords: green construction procurement, green logistic services management, green innovation practices, sustainable economic development goals, procurement policies

INTRODUCTION

Our global environment is continuously deteriorating, which endorses an urgent plea for taking remedial actions to detain further damage, preventive measures to conserve the available resources, and adopting such environmentally friendly practices that minimize the supplementary hurt to the environment (Naseem et al., 2021). In developing countries, the shift to urbanization has changed the paradigm of the construction industry. To fulfill the needs of the increasing populations, massive infrastructural developments have been taking place lately that are contributing to a number of environmental issues such as pollution, emission of hazardous gases that impact the ozone layer depletion, greenhouse effect, climate change, imbalance of the ecosystem, and significant consumption of energy and other natural resources (Mohsin et al., 2021a). According to Tawfik Alqadami et al. (2020), the construction industry has been contributing majorly to environmental pollution. At the global level, activities involved in infrastructure and building developments add 40% of carbon dioxide, 30% of wastes, and 20% of pollutants to the environment (Tawfik Alqadami et al., 2020). This green approach can save future communities from facing horrendous outcomes of our current practices.

Green requirements of the businesses, including green logistic services and innovation practices, can be general or specific, preventive or facilitating, or punitive. These green logistic practices could be used either to elicit or to support the best possible opportunity available to achieve particular sustainable development goals (SDGs), which can help to achieve a climate where productivity, technological output, and innovation are promoted to obtain the desired environment-friendly results (Huo et al., 2020). Given the crucial need to enhance industrial practices, including logistics and innovation, into green, the new competitive advantage of organizations in this active and competitive era has now been diverted to eco-design, eco-production, and ecological-friendly integration through supply chains. Practicing in a safe, greener, cost-effective manner and facilitation of green procurement and logistics services management in infrastructural developments have been major concerns in the construction industry (Nawaz et al., 2019).

SDGs are the compilation of 17 objectives that are interdependent and interconnected strategies to practice sustainable solutions to today's most prevailing issues of society, economy, and environment. These goals were proposed by United Nations in 2015 as an agreement to achieve sustainability at the global level by 2030 (Nawaz et al., 2021). These SDGs consider the broader perspective of sustainability; however, the challenge for implementing those recommended practices remains a challenge. More broadly, these goals strive for the sustainability of the economic, social, and environmental perspectives. Numbers of studies have previously

been carried out in pursuit of solutions to these issues. Porter and van der Linde (1995) suggested that a business's environment-friendly design (green requirements) triggers innovation and enhances business competence. Further validation in understanding green procurement factors contributing to SDGs is needed considering green logistics services and innovation practices. Consequently, the current study has identified the gaps in the green innovation theory associating it with the SDGs adhering to green procurement and logistics services management in China's construction industry. It aims at providing an insightful exploration into some questions as 1) How is green construction procurement associated with green logistic services? 2) How do green construction procurement techniques and policies ensure green innovative practices? 3) What role does green logistic services management play in attaining the SDGs? 4) How can innovative green practices contribute to sustainable economic goals?

Study Rationale

The need for a better tomorrow calls out for the inputs from individuals, organizations, and countries in their capacities, especially the developing countries are recommended to devise their infrastructural needs carefully and urged to ensure the incorporation of sustainable green methods and material in their projects (Awan et al., 2019). This green approach can save future communities from facing horrendous outcomes of our current practices. Therefore, it has been stressed that to incorporate the greener perspective is currently prevailing practices regarding construction procurement, logistic services, and innovation efforts (Wang et al., 2017; Karaman et al., 2020; Lazaroiu et al., 2020) So, the current study has attempted understanding the possible effects of green construction procurements on logistic services management, green innovation practices, and exploring their collective contribution to the attainment of SDGs.

REVIEW OF LITERATURE

Green Construction Procurement With Green Logistic Services Management

Green procurement is the purchases or buying of the products that minimize the negative effects and maximizes the positive impacts on the environment and reduction of waste materials by embedding the concerns of recycling and replacing raw material regarding the environment into purchasing policies and strategies (Song et al., 2015; Wong et al., 2016). Logistics is the delivery of products from their origin to the final destination where they are consumed (Tan et al., 2020). This is important to integrate the process of procurement with preferences regarding the environment while purchasing raw materials, logistics services, and recycling. The use of nonrenewable resources and materials on a large scale, especially in constructing new infrastructures and

buildings, has significantly affected the environment. The activities involved in the construction process, e.g., (manufacturing and transportation) materials that consume energy on a very large scale and emit vast amounts of greenhouse gases, are very harmful to the environment.

Furthermore, it is also necessary for organizations to be involved in procurement and logistics to estimate the financial costs of the products at its lifecycle and to assess the environmental costs, which are equally important to the purchase of raw materials, manufacturing, transporting, handling, storage, and consumption (Wong et al., 2016; Bohari et al., 2017). Green logistics has been gaining importance to improve logistic sustainability (Tan et al., 2020). According to Wong et al. (2016), green procurement considers all these factors of purchase, manufacturing, transporting, handling and storage, consumption, and finally, the disposal of products or recycling. The environmental requirements should be placed in the tenders put forward and the contracts signed to adhere to the green procurement in the construction industry. Based on prior literature, the following hypotheses have been formulated considering green procurement in logistics services management.

H₁: Green procurement is positively associated with green logistic services

According to Song et al. (2015) and Wong et al. (2016), by involving greener practices in the procurement department, a higher fraction can reduce packaging and transportation costs. Greener resources are consumed at the maximum level to improve costs and environmental damage during the procurement and supply chain processes (Naseem et al., 2020; Mohsin et al., 2021b). Green policies have been found to contribute hugely to the attainment of green development through enhancing green logistics services, their effectiveness, and up-gradation (Zhang et al., 2020). Moreover, it has been suggested in the literature that nonrecyclable material should be used to the lowest degree for the packaging of products (Naseem et al., 2021; Sarfraz et al., 2021). When organizations involved in construction procurement move up the supply chain, the use of recyclable packaging material adds to the improvement of environmental sustainability.

Similarly, suppose the greener practices are declared mandatory in the procurement activities through supply chains. In that case, an improvement in the transportation of raw material or other materials involved can be seen (Song et al., 2015). In the past, Croce et al. (2019) have studied the impact of using an electric vehicle to transport the materials to make a difference to achieve sustainability in shuttling. Green procurement has caused an upsurge in the logistics services industry with the emergence of green logistic technologies that dramatically boosted green efficiency. Procurement policies, when implemented adequately, tend to involve the logistic services that sustain the environmentally friendly factor in transportation (Naseem et al., 2020). The literature mentioned earlier forms the basis for the following sub-hypotheses based on H1 as

H_{1a}: Green construction procurement techniques are positively associated with sustainable packaging of shipping materials

H_{1b}: Green construction procurement techniques are positively associated with sustainable transportation of materials

H_{1c}: Green Procurement policies are positively associated with sustainable packaging of shipping materials

H_{1d}: Green procurement policies are positively associated with sustainable transportation of materials

Green Logistic Services With Sustainable Development Goals

Logistic services management adheres to the green perspective of environmental protection that has been debated as an effective source for sustainable development. According to the United Nations, the basic root of sustainable goals is the improvement of social, environmental, and economic progress, and it tends to the development of future directions accordingly. The fundamental focus of improvement mentioned in this report (General Assembly of the United Nations) was the environmental stability and economic development of the SDGs. The motive of these SDGs is to attain environment-friendly procedures and technologies for innovating new strategies for the different manufacturing industries, which are somewhat similar to the new theory of green practices that is multidisciplinary and meets the modern requirements of the service industries. The sustainable goals that this study includes are SDG7, SDG8, and SDG9. These sustainable goals postulate as:

SDG7: Ensure access to affordable, reliable, sustainable, and modern energy for all

SDG8: Promote sustained, inclusive, and sustainable economic growth, full and productive employment, and decent work for all

SDG9: Build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation

Many SDG achievements have been proposed in the past; certain achievements are brought into lines that support the acceptance and implementation of innovative technologies and practices that are the fundamental contributors in assisting organizations and overall industries in achieving greener supply chains (Centobelli et al., 2020). Furthermore, the changing dynamics of the construction industry, use of new technologies in devising the procurement policies and techniques that help environmental degradation, are offering a wide range of opportunities to organizations. Hence, based on the above literature, the following hypothesis has been formulated:

H₂: Green logistic services management is positively associated with SDGs

These development goals cover all the aspects of economic sustainability. Logistics, transport services, and the shipping

industry have been the highest contributors to environmental degradation (Centobelli et al., 2020; Karaman et al., 2020). Henceforth, there is an increasing trend of green technologies and practices, opening new doors of opportunities for the organizations currently operating in these logistic services management. The exploitation of these opportunities connecting the green organizational and production practices has led to more scalable, affordable, and measurable solutions that minimize the emission of hazardous gases and promote greener climate goals. The main hypothesis has been further broken down into two sub-hypotheses based on the sustainable packaging of shipping materials and sustainable transportation of materials.

H_{2a}: Sustainable packaging of shipping materials is positively associated with SDGs

H_{2b}: Sustainable transportation of materials is positively associated with SDGs

Green Construction Procurement With Green Innovation Practices

Green innovation is finding new ways for doing traditional activities that posit the least environmental harm or negative impacts on people. The possible harms commonly observed are the emission of gasses during extraction of raw materials and pollution during the products' working life and disposal. Procurement and green innovation are taking the products from "cradle to grave" to "cradle to cradle" *via* recyclable strategies. For the last 20 years, green requirements have been the center of attention of many researchers considering different perspectives of its implications in organizational performance; however, green procurement needs attention regarding its role in green innovation practices. Literature has mentioned the two main reasons for green innovation, i.e., whether it is responsive or proactive (Zailani et al., 2011; Bigliardi and Bertolini, 2012; Wong, 2013; Li et al., 2017; Melander, 2017; Abbas and Sağsan, 2019; Fernando et al., 2019). Responsive green innovation is the new feature in a product or process as a solution to a certain environmental problem. In contrast, proactive green innovation may be part of the organizational goal for cost-efficiency or profitability in the long run, in addition to green technology development for indulging in environment-friendly activities (Wong, 2012). Besides, the researchers Björklund and Forslund (2018) and Zailani et al. (2011) have a strong view that when procurement is done by green guidelines, which protect the environment, it leads to the adoption of new practices that contribute to the innovations of products and procedures that are aligned with the international guidelines that guard the environment against currently prevailing hazardous practices. To understand these roles, the following hypothesis has been devised:

H₃: Green procurement is positively associated with green innovation practices

Green innovation creates or adds value to a product and/or process by depicting the green perspective according to the industry, market, organization, or target population. Like conventional innovation, green innovation has also been broadly divided into two main categories, i.e., 1) green product innovation and 2) green process innovation (Zailani et al., 2011; Bigliardi and Bertolini, 2012; Wong, 2012; Wong, 2013; Abbas and Sağsan, 2019; Dantas et al., 2021). Green product innovation has been defined as adding a new feature to a product design or manufacturing or marketing in a new greener perspective that lags behind conventional innovations. Greenness has been described as a relative intangible concept that may evolve over the period considering the requirements and challenges arising according to the changing dynamics of the environment. Different treaties, regulating authorities and agencies, have established guidelines considering the changing standards for product development due to social, cultural, and ecological dynamics. A product is usually considered greener if it adds less harm to the environment at any stage of its life, from raw material to disposal (Song et al., 2015). When the techniques and policies are followed in procurement in any phase of the supply chain in the construction industry, it is supposed to be a determining factor in the innovation of products based on the green theory of innovation (Abbas and Sağsan, 2019; Tseng et al., 2021). Hence, when the techniques and policies adhering to the greener perspective in construction procurement are practiced, it has led to the innovation of green production.

On the other hand, green process innovation is the application of new and innovative ideas that are ecologically friendly, causing lesser harm than the present activities for the completion of products or delivering the services to consumers (Wong et al., 2016; Abbas and Sağsan, 2019). Furthermore, the innovation in the green process is usually characterized by the fulfillment of environmental criteria of maximum utilization of the natural resources, no or less ecological harm, following the sustainability issues in economic, social, and environmental aspects (Teng et al., 2018; Wang et al., 2018; Centobelli et al., 2020; Moșteanu et al., 2020; Tawfik Alqadami et al., 2020). However, it has also been mentioned that if the procurement techniques and policies have been incorporated considering the less harmful environmental perspectives, it will lead to the new ideas and implementation of such new processes and activities that meet the requirements of greener and sustainable economic activities (Wong, 2012; Wong et al., 2016). The products and processes with respect to innovation are interdependent and inseparable. Hence, the innovation in one of these factors contributes to the other, consequently, though a little. This helps in breaking down the H₃ into four sub-hypotheses as

H_{3a}: Green construction procurement techniques are positively associated with green product innovation

H_{3b}: Green construction Procurement policies are positively associated with green product innovation

H_{3c}: Green construction procurement techniques are positively associated with green process innovation

H_{3d}: Green construction procurement policies are positively associated with green process innovation

Green Innovation Practices With Sustainable Development Goals

Green practices are currently the hot topic for supply chain researchers, attaining sustainable goals, and improving global environmental concerns. Green innovation has been defined as finding new methods for practicing and experimenting the new products and processes that help environmental degradation (Fernando et al., 2019). New procedures and methods are constantly emerging, finding new practices, processes, and methods that make the environment the safest ground for all these human activities (Zailani et al., 2011; Björklund and Forslund, 2018). It is about inventing new processes, products, management structures, and environmentally friendly technologies and protecting them from hazards around with minimum use of resources and taking waste and pollution under control (Li et al., 2017; Abbas and Sağsan, 2019). Green innovation is related to both the products and processes, including the administrative tasks. New products and procedures are devised through these innovation strategies, and the old tasks could be done efficiently using new technologies. This leads to the formation of the following hypothesis:

H₄: Green innovation practices are positively associated with the attainment of SDGs

A wide range of green production guidelines is being followed to acquire sustainable development by efficient energy, resources management, advancement of smart technologies, novel policy developments, supply chains, and construction sectors (Giannetti et al., 2020). Based on the literature available on green production and other green practices, the need for such interdisciplinary research has been emphasized that addresses the effective ways of intervening green production with innovations that help in connecting with the attainment of SDGs (Huang et al., 2016; Li et al., 2017). According to Abbas and Sağsan (2019), the incorporation of green innovation of technology and procedures in organizational activities is positively contributing to environmental and economic sustainability.

Furthermore, policies that support innovative technologies and practices play a major role in helping the supply chain process of organization and logistics services in achieving the SDGs.

H_{4a}: Green product innovation is positively associated with the attainment of SDGs

H_{4b}: Green process innovation is positively associated with the attainment of SDGs

Mediating Roles of Green Logistic Services and Green Innovation Practices

Moreover, sustainable procurements and logistic services are needed more than ever since transportation and freight forwarding contribution toward the highest side of environmental degradation *via* the emission of harmful gasses

(mainly Chlorofluorocarbons and Carbon dioxide) (Mohsin et al., 2021a; Mohsin et al., 2021b; Sarfraz et al., 2021). In the current scenarios of stress on green practices, the impact of green technologies and practices on business activities is exponentially growing and opening new opportunities for freight forwarders and the logistic services industry (Centobelli et al., 2020). Therefore, the logistic services and the innovative practices that follow the green guidelines can be the triggering factors for attaining the sustainable economic development goals that hold the construction procurement. When organizations invest in obtaining green industrial and business operations by stressing the development of green technology and innovations, it ultimately helps in economic sustainability. Therefore, the mediating role of green logistic services management and innovation practices has been proposed based on the literature reviewed. Considering the relationship of green logistic services and green innovation practices with green procurement and SDGs, the following hypotheses for the mediation have been devised.

H₅: Green logistic services mediate the relationship of green construction procurement and SDGs

H_{5a}: Sustainable packaging of shipping material mediates the relationship of green procurement techniques and SDGs

H_{5b}: Sustainable packaging of shipping material mediates the relationship of green procurement policies and SDGs

H_{5c}: Sustainable transportation of materials mediates the relationship of green procurement techniques and SDGs

H_{5d}: Sustainable transportation of materials mediates the relationship of green procurement policies and SDGs

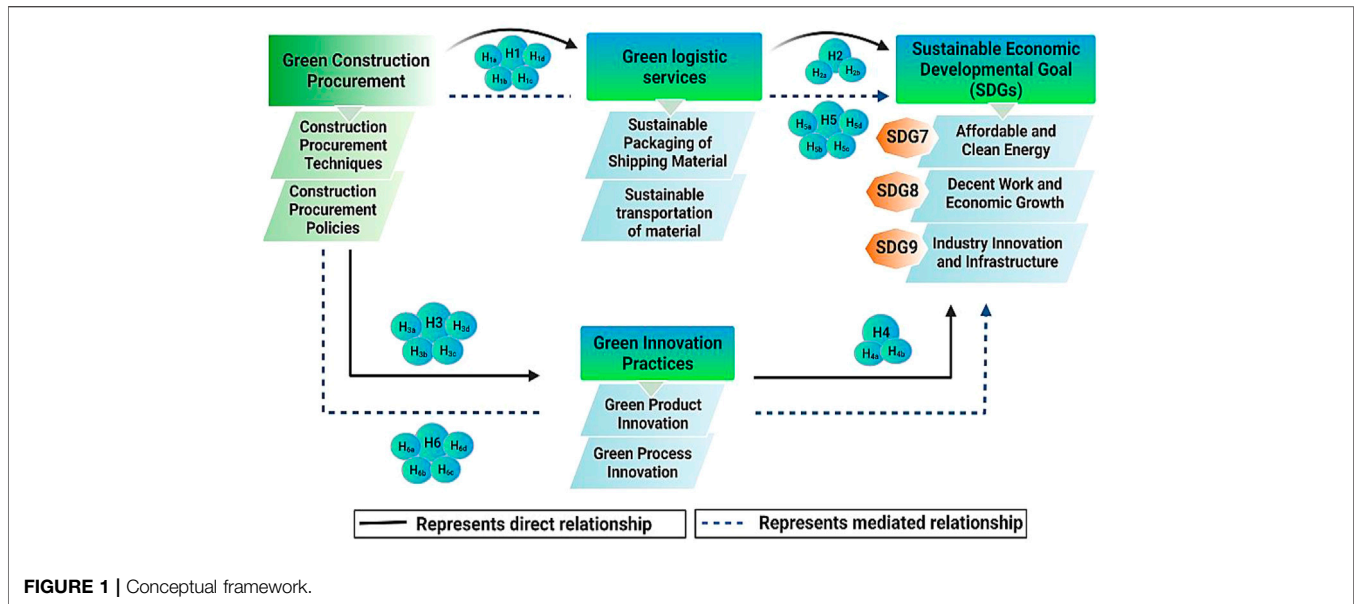
Green innovation practices have been previously used as mediators for sustainable development (Abbas and Sağsan, 2019). Green innovations aim to introduce the new features in the products or activities necessary to convert the raw material obtained through procurement to the final product or service delivery aligned with the sustainable goals and less deterioration for the environment (Song et al., 2015). Such innovations usually aim to improve the quality aligned with sustainability, maximum utilization of natural resources, and minimization of their waste. Previously, the impact of green procurement has been checked in the manufacturing industry in China that found a significantly improved impact on their performance. The countries under infrastructural development need to contain the environmental hazards caused by the construction procurements and logistic services. Hence, on the basis of the literature support, the following hypotheses have been devised for the mediation:

H₆: Green innovation practices mediate the relationship of green construction procurement and SDGs

H_{6a}: Green product innovation mediates the relationship of green procurement techniques and SDGs

H_{6b}: Green product innovation mediates the relationship of green procurement policies and SDGs

H_{6c}: Green process innovation mediates the relationship of green procurement techniques and SDGs



H_{6d}: Green process innovation mediates the relationship of green procurement policies and SDGs

FRAMEWORK OF THE STUDY

Based on the literature and hypothesis discussed earlier, the conceptual framework discussed later has been proposed in the study (see **Figure 1**).

The conceptual framework mentioned earlier operates on the green innovation theory that Hemmelskamp proposed in 1997, stating that there is a need for innovation that declines, lessens, or prevents the environmental deterioration, relates to the cleanup of wastes, addresses the problems of the environment, and contributes to the environmental sustainability and development through the ecological improvements (Bigliardi and Bertolini, 2012). Furthermore, the organizations and corporations involved in the construction procurement and logistics services are obliged to legal, economic, social, philanthropic, and ethical obligations for better surroundings and environment-friendly growth. The construction industry, being the major contributor to environmental hazards, proposes that if organizations work on the procurement mentioned earlier, sustainable energy and economic growth can be obtained through green logistic and innovation practices. Further validation of the proposed conceptual framework is presented in the forthcoming section of the results.

RESEARCH METHODS

According to one of the pioneer researchers, Woody (1924), good research should necessarily address the identification of a problem, form hypotheses, and suggest a clearer picture toward the solutions. Creswell et al. (2016) have termed

research as a gathering of data and systematically analyzing it to get some patterns; however, some researchers have mentioned that research has to what, when, why, and how related questions to a certain problem, which are further investigated with a broader understanding of techniques and procedures for data analysis. This study follows a post-positivist approach of research methods because certain variables cause an effect on some other related variables. In this study, those effects will be measured. A quantitative study design has been selected with the deductive approach for reasoning with minimum bias and the use of the results from different perspectives. Generally, in quantitative studies, data are collected through surveys, questionnaires, closed-ended interviews, and certain rating scales. For the present study, self-administered surveys have been adopted for data collection. The population frame used in this study will be the managerial level staff of construction firms (project managers) and the civil engineers of the construction industry in China. The data in this study were collected with a simple random sampling technique of sample selection. Because the population is known for the registered companies in China stock exchanges, it is accessible for data collection. The sample size was obtained from the method of sample size selection described by Bhalerao and Kadam (2010), Adam (2020), and Archer et al., 2021. In addition, a sample size of 200 is considered as an adequate sample size. However, this study has taken a sample size of more than 300 to avoid any biases in the results. The unit of analysis in this study was individual (project managers of construction companies and civil engineers).

Instrument Development

The instrument used for data collection in this study was a questionnaire in which questions related to each respective variable are asked from the respondents through surveys. There is a total of four variables in this study. One is an independent variable, i.e., green procurement, which is further

TABLE 1 | Demographic summary.

Age	Frequency	Percentage
<20	84	16.71
21–29	225	44.73
30–39	184	36.58
40–49	10	1.98
Sex		
Male	221	43.94
Female	282	56.06
Profession		
Project manager	251	49.90
Engineer	252	50.10
Education		
Bachelor	180	35.78
Masters	289	57.45
Doctorate	34	6.77
Length of service		
<10	304	60.44
11–20	56	11.14
20>	143	28.42

Note: $N = 503$.

divided into green procurement techniques and green procurement policies; two mediating variables, i.e., green logistic services (which is subdivided into two sub-variables, i.e., sustainable packaging of shipping materials and sustainable transportation of material) and green innovation practices (which is further divided into two sub-variables, i.e., green product innovation and green process innovation); and one dependent variable of sustainable economic development goals (SGDs-SDG7, SDG8, and SDG9). The scales that were used for the variable green procurement were adapted from Wong et al. (2016), green logistic services from Ali et al. (2021), green innovation scale from Abbas and Sağsan (2019), and sustainable economic development goals from Dantas et al. (2021). As adapted from the previous studies, the current study will also follow the five-point Likert scale for documenting the respondents' responses ranging from "strongly disagree = 1" being the lowest degree of disagreement and "strongly agree = 5" being the highest degree of agreement. This study has used primary data because the data from the respondents are collected directly. In such cases, the primary data are either collected through interviews or questionnaire surveys; however, this study has used the survey method for the collection of data. To improve the quality of responses, the surveys were self-administered. The current study has used the latest version available of Smart-PLS for the data analysis of the study.

The demographic profile of the respondents has been analyzed with frequencies and percentages. Of the total respondents, 16.71% were below 20 years of age, whereas the highest percentage was between 21 and 29 years. Regarding sex, 43.94% were men, whereas the remaining 56.06% were women among the 503 total respondents. Furthermore, half of the respondents were project managers, and the other half were engineers, thus taking the proportionate respondents of the population frame. More detail is mentioned in **Table 1**.

DATA ANALYSIS

Smart-PLS 3.3 was the software used for the data analysis obtained from the main study. The data of the main study were collected using the finalized questionnaire with deletion of two items, each from sustainable transportation of material and green process innovation, because both items showed the discriminant validities of less than 0.5, which is the cutoff value (Sarstedt et al., 2019; Josephy and Marko, 2021). The data were tested in two stages: 1) measurement model algorithm and 2) structural model. Then, the data were tested for further validity and reliability with the results obtained from the measurement model algorithm. The measurement model algorithm can be seen in **Figure 2**.

The tests that the current study used for checking the discriminant validities were the heterotrait–monotrait (HTMT) ratio and the Fornell and Larcker criterion of validity (Franke and Sarstedt, 2019). The results obtained from these two tests are given in **Tables 2** and **3**. For the data to be valid, it is said that the values at the top of each should exceed and the rest of the values underneath (Franke and Sarstedt, 2019). Hence, this requirement has been met in this study, considering the highest value in each column lies at the top. The results of the Fornell and Larcker criterion can be seen in **Table 2**.

To further validate the data, an HTMT ratio was obtained to find the convergent validity of the scales used in this study. For the HTMT ratio to be acceptable, these should not exceed 0.9 (Franke and Sarstedt, 2019). **Table 4** gives the results for HTMT ratios, which are all well under the cutoff value reported in the literature, hence meeting the requirements of the convergent and discriminant validities for this study.

The data were further checked for reliability. This study used two types of reliabilities: Cronbach alpha (?) reliability and composite reliability. The results are given in **Table 4**. Literature has believed that the higher the reliability of the scale, the better it is; however, the threshold for reliability has been set to be more than 0.7 (Hair et al., 2017; Sarstedt et al., 2019). All the values in this study for alpha reliabilities have been reported between 0.79 for sustainable transportation of materials and 0.93 for SDGs. Similar is the case for composite reliability; all the values are above 0.80. Furthermore, the average variance extracted for a valid measurement scale should be more than 0.5 (Franke and Sarstedt, 2019), thus meeting the criteria of acceptable AVE.

The second stage of Smart-PLS gives the structural model algorithm that estimates t-statistic significance values for the direct and indirect paths of the model to test the hypotheses formulated from the gaps in the literature review. Structural equation modeling is a multivariate analytical approach to measure the path effects (Sarstedt et al., 2019). The measurement model simultaneously measures the direct effects (direct relationships) and indirect effects (mediating) of independent variables on the dependent variables through a structural model algorithm obtained *via* consistent bootstrapping of 5,000 or more sub-sampling (Moqbel et al., 2020; Amora, 2021). The structural model of the study can be seen in **Figure 3**.

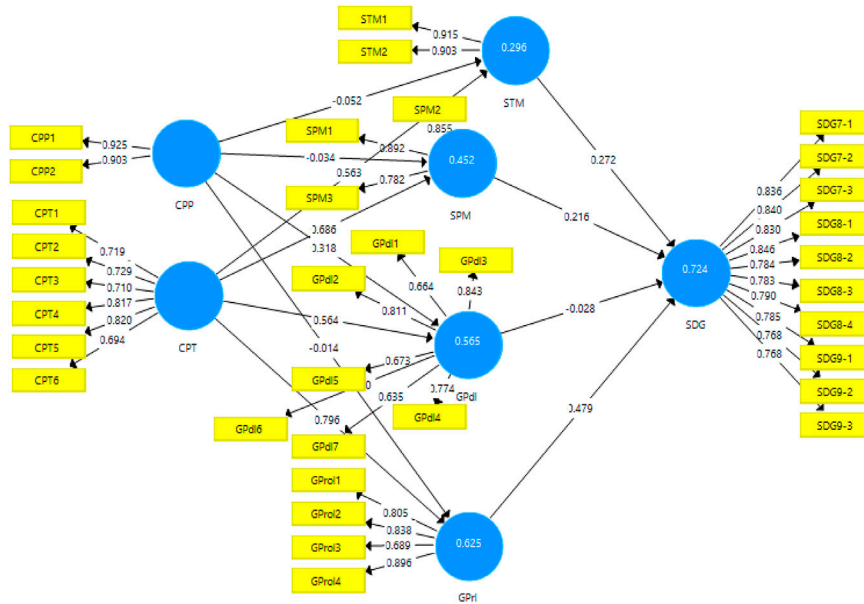


FIGURE 2 | Measurement model algorithm.

TABLE 2 | Fornell and Larcker criterion.

	CPP	CPT	GPdI	GPpI	SDG	SPM	STM
CPP	0.914						
CPT	0.408	0.750					
GPdI	0.548	0.693	0.725				
GPpI	0.311	0.790	0.575	0.810			
SDG	0.145	0.690	0.465	0.785	0.804		
SPM	0.246	0.672	0.478	0.686	0.744	0.845	
STM	0.178	0.542	0.417	0.638	0.735	0.780	0.909

N = 503; CPP, construction procurement policies; CPT, construction procurement techniques; GPdI, green product innovation; GPpI, green process innovation; SDG, sustainable economic development goals; SPM, sustainable packaging of material; STM, sustainable transportation of material. Its shows the significance of each construct in particular table.

TABLE 3 | HTMT ratio.

	CPP	CPT	GPdI	GPpI	SDG	SPM	STM
CPP							
CPT	0.519						
GPdI	0.667	0.806					
GPpI	0.386	0.864	0.682				
SDG	0.167	0.651	0.504	0.876			
SPM	0.320	0.748	0.574	0.836	0.845		
STM	0.223	0.572	0.495	0.780	0.847	0.909	

N = 503; CPP, construction procurement policies; CPT, construction procurement techniques; GPdI, green product innovation; GPpI, green process innovation; SDG, sustainable economic development goals; SPM, sustainable packaging of material; STM, sustainable transportation of material.

The hypotheses were checked for their significance, with the results obtained at a 5% level of significance (Sekaran and Bougie, 2003; Sarstedt et al., 2019). The results obtained have been used for deciding the acceptance or rejection of the proposed hypotheses. Generally, the values obtained from the estimation of statistical tests of *t*-test, their respective *p*-values, R-squared values, and beta-values will be used. The study results can be seen in Tables 5 and 6 for the acceptance and rejection of hypotheses.

There were six hypotheses in the study, which were further divided depending on the constructs of each variable. The first hypothesis was about the association of green construction procurement to green logistic services H₁: Green procurement is positively associated with green logistic services. It was partially accepted, as its sub-hypotheses had been partially accepted, such as H_{1a}: Green procurement techniques are positively associated with sustainable packaging of shipping materials *t* – statistic = 22.615: *p* – value = 0.000 as it is accepted, whereas H_{1b}: Green procurement techniques are positively associated with sustainable transportation of materials, as it is also accepted at *t* – statistic = 15.462: *p* – value = 0.000. However, H_{1c}: Green procurement policies are positively associated with sustainable packaging of shipping materials *t* – statistic = 0.863: *p* – value = 0.389, and H_{1d}: Green procurement policies are positively associated with sustainable transportation of materials *t* – statistic = 1.165: *p* – value = 0.245 is not accepted, showing significant levels of more than 5%. For H₂: Green logistic services management is positively associated with SDGs that have been accepted, as its sub-hypotheses are also accepted, i.e., H_{2a}: Sustainable packaging of shipping materials is positively associated with SDGs *t* – statistic = 4.772: *p* – value = 0.000 H_{2b}: Sustainable transportation of materials is positively associated with SDGs *t* – statistic = 6.462: *p* – value = 0.000. As long as H₃ is

TABLE 4 | Constructs reliabilities and AVE.

Constructs	Code	FD	α	CR	AVE
Construction procurement policies	CPP1	0.925	0.805	0.911	0.836
	CPP2	0.903			
Construction procurement techniques	CPT1	0.719	0.853	0.885	0.563
	CPT2	0.729			
	CPT3	0.710			
	CPT4	0.817			
	CPT5	0.820			
	CPT6	0.694			
Sustainable packaging of materials	SPM1	0.892	0.798	0.882	0.713
	SPM2	0.855			
	SPM3	0.782			
Sustainable transportation of material	STM1	0.915	0.790	0.905	0.827
	STM2	0.903			
Green product innovation	GPd1	0.664	0.846	0.884	0.525
	GPd2	0.811			
	GPd3	0.843			
	GPd4	0.774			
	GPd5	0.673			
	GPd6	0.640			
	GPd7	0.635			
Green process innovation	GPro1	0.805	0.823	0.884	0.657
	GPro2	0.838			
	GPro3	0.689			
	GPro4	0.896			
Sustainable economic development goals	SDG7-1	0.836	0.939	0.948	0.646
	SDG7-2	0.840			
	SDG7-3	0.830			
	SDG8-1	0.846			
	SDG8-2	0.784			
	SDG8-3	0.783			
	SDG8-4	0.790			
	SDG9-1	0.785			
	SDG9-2	0.768			
SDG9-3	0.768				

Note: $N = 503$; FD, factor loading; AVE, average variance extracted; CR, composite reliability. Its shows the significance of each construct in particular table.

concerned, H_3 : Green procurement is positively associated with green innovation practices; it is also accepted because all its sub-hypotheses are accepted, i.e., H_{3a} : Green procurement techniques are positively associated with green product innovation $t - statistic = 15.556$; $p - value = 0.000$, H_{3b} : Green procurement techniques are positively associated with green process innovation $t - statistic = 31.199$; $p - value = 0.000$, and H_{3c} : Green Procurement policies are positively associated green product innovation $t - statistic = 7.217$; $p - value = 0.000$ except for H_{3d} : Green procurement policies are positively associated with green process innovation $t - statistic = 0.447$; $p - value = 0.655$. For the fourth hypothesis, H_4 : Green innovation practices are positively associated with the attainment of SDGs; it is also partially accepted, as one of the two hypotheses are accepted, and others were rejected; H_{4a} : Green product innovation is

positively associated with the attainment of SDGs $t - statistic = 0.716$; $p - value = 0.474$ is rejected, whereas H_{4b} : Green process innovation is positively associated with the attainment of SDGs $t - statistic = 9.081$; $p - value = 0.000$ is accepted. As for the mediations of the green logistic services, two of the four hypotheses were accepted. Details of each mediating hypothesis are as H_{5a} : Sustainable packaging of shipping material mediates the relationship of green procurement techniques and SDGs, $t - statistic = 4.532$; $p - value = 0.000$, is accepted at 5% level of significance. The second and third hypotheses of mediation, H_{5b} : Sustainable packaging of shipping material mediates the relationship of green procurement policies and SDGs was accepted with $t - statistic = 5.637$; $p - value = 0.000$. However, H_{5c} : Sustainable transportation of materials mediates the relationship of green procurement techniques and SDGs with $t - statistic = 0.836$; $p - value = 0.404$ and H_{5d} : Sustainable

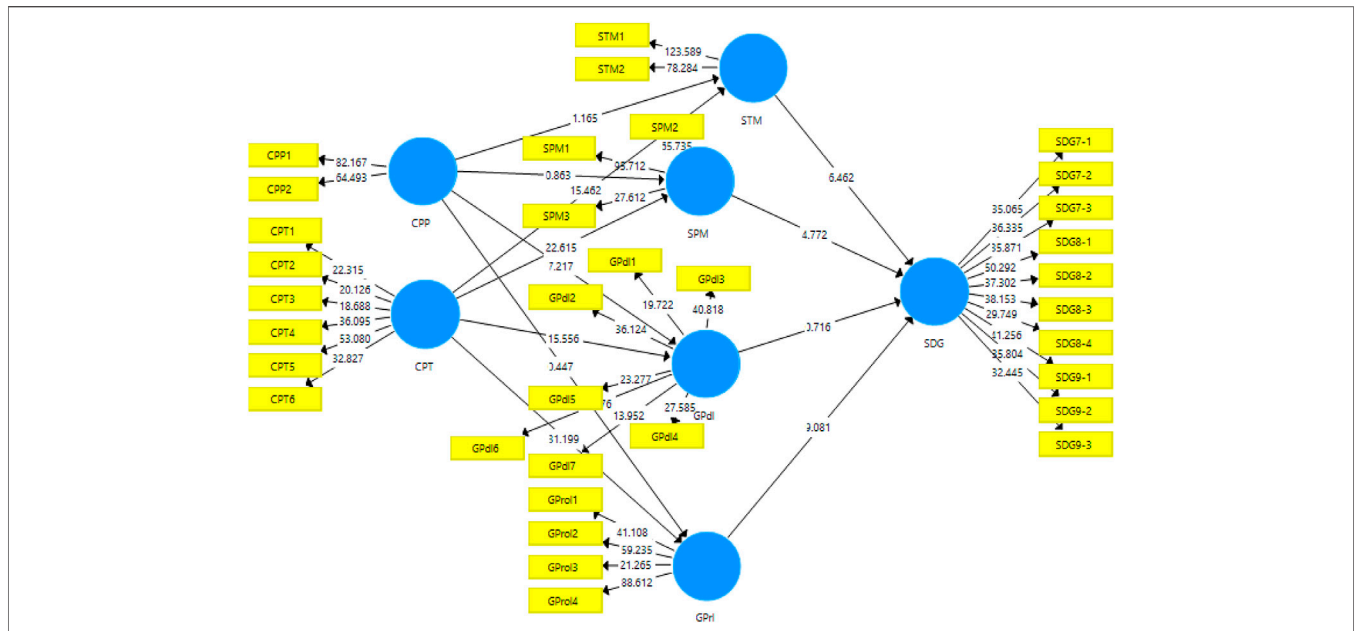


FIGURE 3 | Structural model.

TABLE 5 | Statistical results for structural model.

Paths	H	O	M	SD
GP → GLS	H ₁			
CPT → SPM	H _{1a}	0.686	0.686	0.030
CPT → STM	H _{1b}	0.563	0.565	0.036
CPP → SPM	H _{1c}	-0.034	-0.034	0.040
CPP → STM	H _{1d}	-0.052	-0.052	0.044
GLS → SDG	H ₂			
SPM → SDG	H _{2a}	0.216	0.215	0.045
STM → SDG	H _{2b}	0.272	0.272	0.042
GP → GIP	H ₃			
CPT → GPdl	H _{3a}	0.564	0.566	0.036
CPT → GPrl	H _{3b}	0.796	0.796	0.026
CPP → GPdl	H _{3c}	0.318	0.317	0.044
CPP → GPrl	H _{3d}	-0.014	-0.013	0.032
GIP → SDG	H ₄			
GPdl → SDG	H _{4a}	-0.028	-0.027	0.039
GPrl → SDG	H _{4b}	0.479	0.481	0.053
GP → GLS → SDG	H ₅			
CPT → SPM → SDG	H _{5a}	0.148	0.148	0.033
CPT → STM → SDG	H _{5b}	0.153	0.154	0.027
CPP → SPM → SDG	H _{5c}	-0.007	-0.007	0.009
CPP → STM → SDG				
GP → GIP → SDG	H _{5d}	-0.014	-0.015	0.013
	H ₆			
CPT → GPdl → SDG	H _{6a}	-0.016	-0.015	0.022
CPT → GPrl → SDG	H _{6b}	0.381	0.384	0.050
CPP → GPdl → SDG	H _{6c}	-0.009	-0.009	0.013
CPP → GPrl → SDG	H _{6d}	-0.007	-0.006	0.015

Note: N = 503; H, hypotheses; O, original sample; M, sample mean; SD, standard deviation; GP, green procurement; GLS, green logistic services; CPP, construction procurement policies; CPT, construction procurement techniques; GIP, green innovation practices; GPdl, green product innovation; GPrl, green process innovation; SDG, sustainable economic development goals; SPM, sustainable packaging of material; STM, sustainable transportation of material.

transportation of materials mediates the relationship of green procurement policies and SDGs with *t* – statistic = 1.102 : *p* – value = 0.271 are rejected. As for the mediation of green innovation practices, one of four hypotheses is accepted. The hypothesis H_{6a}: Green product innovation mediates the relationship of green procurement techniques and SDGs *t* – statistic = 0.712 : *p* – value = 0.477; H_{6b}: Green product innovation mediates the relationship of green procurement policies and SDGs is accepted with *t* – statistic = 7.687 : *p* – value = 0.000, whereas others are rejected based on their respective t-values. H_{6c}: Green process innovation mediates the relationship of green procurement techniques and SDGs *t* – statistic = 0.692 : *p* – value = 0.483 and H_{6d}: Green process innovation mediates the relationship of green procurement policies and SDGs *t* – statistic = 0.660 : *p* – value = 0.440.

DISCUSSIONS

The current study is based on six hypotheses measuring the role of construction procurement in achieving SDGs with the mediating roles of green logistics services and green innovation practices. Each hypothesis is divided into further sub-hypotheses based on their subsequent constructs. In this rapidly growing infrastructure era, green construction practices offer wide opportunities to explore the environmental benefits. First of all, the demographic information of the respondents is analyzed using frequencies and percentages. This study used two types of reliabilities: the Cronbach alpha (?) reliability and the composite reliability. The results are given in Table 4. Literature has witnessed that the higher the reliability of the scale, the better it is; however, the threshold for reliability has been set to be more

TABLE 6 | Hypotheses result from a structural model.

Paths	H	f-square	Adjusted R ²	T-stats	p-Value	Results
GP → GLS	H ₁					<i>Partially Accepted</i>
CPT → SPM	H _{1a}	0.716	0.452	22.615	0.000***	<i>Accepted</i>
CPT → STM	H _{1b}	0.375	0.296	15.462	0.000***	<i>Accepted</i>
CPP → SPM	H _{1c}	0.002		0.863	0.389	<i>Rejected</i>
CPP → STM	H _{1d}	0.003		1.165	0.245	<i>Rejected</i>
GLS → SDG	H ₂					<i>Accepted</i>
SPM → SDG	H _{2a}	0.055	0.724	4.772	0.000***	<i>Accepted</i>
STM → SDG	H _{2b}	0.100		6.462	0.000***	<i>Accepted</i>
GP → GIP	H ₃					<i>Accepted</i>
CPT → GPdI	H _{3a}	0.609	0.565	15.556	0.000***	<i>Accepted</i>
CPT → GPpI	H _{3b}	1.409	0.625	31.199	0.000***	<i>Accepted</i>
CPP → GPdI	H _{3c}	0.194		7.217	0.000***	<i>Accepted</i>
CPP → GPpI	H _{3d}	0.000		0.447	0.655	<i>Rejected</i>
GIP → SDG	H ₄					<i>Partially Accepted</i>
GPdI → SDG	H _{4a}	0.002		0.716	0.474	<i>Rejected</i>
GPpI → SDG	H _{4b}	0.358		9.081	0.000***	<i>Accepted</i>
CPT → SPM → SDG	H _{5a}			4.532	0.000***	<i>Accepted</i>
CPT → STM → SDG	H _{5b}			5.637	0.000***	<i>Accepted</i>
CPP → SPM → SDG	H _{5c}			0.836	0.404	<i>Rejected</i>
CPP → STM → SDG	H _{5d}			1.102	0.271	<i>Rejected</i>
CPT → GPdI → SDG	H _{6a}			0.712	0.477	<i>Rejected</i>
CPT → GPpI → SDG	H _{6b}			7.687	0.000***	<i>Accepted</i>
CPP → GPdI → SDG	H _{6c}			0.692	0.489	<i>Rejected</i>
CPP → GPpI → SDG	H _{6d}			0.440	0.660	<i>Rejected</i>

Note: N = 503; H, hypotheses; O, original sample; M, sample mean; SD, standard deviation; ***p < 0.0005, **p < 0.005, *p < 0.05; GP, green procurement; GLS, green logistic services; CPP, construction procurement policies; CPT, construction procurement techniques; GIP, green innovation practices; GPdI, green product innovation; GPpI, green process innovation; SDG, sustainable economic development goals; SPM, sustainable packaging of material; STM, sustainable transportation of material. Its shows the significance of each construct in particular table.

than 0.7 (Hair et al., 2017; Sarstedt et al., 2019; Hair and Sarstedt, 2021). All the values in this study for alpha (?) reliabilities have been reported between 0.79 for sustainable transportation of materials and 0.93 for sustainable development goals. Similar is the case for composite reliability; all the values are above 0.8.

Furthermore, the average variance extracted for a valid measurement scale should be more than 0.5 (Franke and Sarstedt, 2019), thus meeting the criteria of acceptable AVE. The second stage of Smart-PLS gives the structural model that estimates t-statistic significance values for the direct and indirect paths of the model to test the hypotheses formulated from the gaps in the literature review. The current study's tests were used for checking the discriminant validities, HTMT ratio and the Fronell and Larcker criterion of validity (Franke and Sarstedt, 2019). Hence, this requirement has been met in this study, considering the highest value in each column lies at the top. Structural equation modeling is a multivariate analytical approach to measure the path effects (Sarstedt et al., 2019). The measurement model simultaneously measures the direct effects (direct relationships) and indirect effects (mediating) of independent variables on the dependent variables through a structural model algorithm obtained via consistent bootstrapping of 5,000 or more sub-sampling (Moqbel et al., 2020; Amora, 2021). The first hypothesis, H₁, about the association of green construction procurement with green logistic services, was partially accepted because a change in policies does not contribute to green logistic practices unless construction procurement techniques in accordance with green

practices altogether are not in practice, which changes the logistic services approach that is less hazardous to the environment (Centobelli et al., 2020). H₂, regarding the positive role of green logistic services in achieving SDGs was accepted as environment-friendly logistic services, has been found previously as the key factor for achieving sustainable goals (Tawfik Alqadami et al., 2020; Dantas et al., 2021).

Regarding H₃, construction procurement aligned with the green environmental guidelines has been found to be a major determinant in green innovation practices. This is because a change in the construction procurement regarding policies and techniques leads to the innovation of new practices that are greener than before and contribute to the positive impact on the environment (Zailani et al., 2011; Wong, 2012; Björklund and Forslund, 2018). In H₄, the results also showed the partial acceptance of the hypothesis. In this study, the innovation of green processes was found to be a significant triggering contributor to the attainment of SDGs than the product innovation, which is so much in accordance with the previous studies (Wong, 2012; Abbas and Sağsan, 2019). This is because when the innovative practices in the organizations are done considering lest of environmental degradation, this leads to the achievement of SDGs given by the United Nations.

As for the mediation of green logistic services and green innovation practices, these hypotheses (H₅, H₆) were partially accepted (see Table 6). The relationship of construction procurement techniques and SDGs was significantly mediated by green logistic services management (i.e., sustainable packaging

of shipping materials and sustainable transportation of materials) because the logistic services are a fundamental component of supply chains in the construction industry; however, the innovation practices are not mandatory for the attainment of successful project performance. The context-based analysis has indicated the insignificant mediation of green product innovation among the construction procurement and SDGs because the supply chain is a service based in the construction industry, hence, not signifying the mediation of product innovation. Among the green product and green process innovations, green process innovation has been found to be a catalyst to enhance the role of construction procurement in the SDGs (Abbas and Sağsan, 2019). The current model focuses on the service industry of construction; hence, process innovation has been found to be a significant mediator for this particular relationship.

CONCLUSION AND MANAGERIAL IMPLICATIONS

Based on the green innovation theory, a conceptual framework was devised to understand the underlying mechanism of green construction procurement and its relationship with green logistic services, innovation practices, and their role in attaining SDGs sustainability. The findings of the current study show that green procurement partially contributes to the green logistic services, which determines the attainment of SDGs. On the other hand, green procurement has significantly predicted green innovation practices, which partially determine its role in economic sustainability. As long as the moderating roles of green logistic services management and green innovation practices are concerned, they have partially mediated the relationship of green construction procurement and SDGs. Moreover, this study has highlighted the importance of green procurement in achieving SDGs and the importance of green logistic services management and green innovation practices throughout the supply chain in building infrastructure. Organizations should be promoted for strategizing their procurement and logistic services in a greener way for substantial contribution to the environmental up-gradation and economic developments at the mass level. These factors are suggestive to see the broader beneficial outcomes for indulging in green practices through construction supply chains. The results obtained can be objectively proposed to recommend effective and efficient adoption of green procurement in the construction industry. Construction organizations have to be aware of the green

aspect in the procurement of raw materials and intriguing green logistic services management. These green product and process innovations are considered a big determinant of sustainable economic development, although it is a time-consuming process; however, it can improve organizational efficiency in the short term by upgrading the procurement, logistic, and innovation practices. Currently, practicing green construction procurement, logistic services, and innovation is challenging, as “turning into green” often differs in its requirements. Therefore, construction companies should indulge in such green practices that tend to balance all stakeholders’ benefits to get aligned with their policies and agreements.

LIMITATION OF STUDY

Certain limitations of the study have been embedded in the current study, which can be covered in future studies for getting more generalized and applicable results. First of all, it is a cross-sectional study, which can be validated further by taking data from another point of time and comparing the performance and achievement of organizations in achieving green practices in supply chains in the construction industry. Secondly, more variables related to construction procurement and logistic services can be incorporated in the theoretical framework for getting more factual results, which can suggest further modifications in the practical implications. The current study is conducted in China; it should be replicated in other parts of Europe and the Gulf to validate the generalizability of the results.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/Supplementary Material; further inquiries can be directed to the corresponding author.

AUTHOR CONTRIBUTIONS

TS and YC conceived and designed the concept literature review and data collection and wrote the paper. AR and ZH helped to provide technical support and contributed to analysis tools. AN has reviewed the work to improve the outcomes. All authors have read and agreed to the published version of the article.

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