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Green supply chain innovation and green innovation: Mediating role of green supply chain learning and specific Investments

Qing Xie

Chronicle	Abstract
Article history Received: May 13, 2021 Received in the revised format: July 26, 2021 Accepted: Sept 21, 2021 Available online: Sept 27, 2021 Qing Xie is currently affiliated with School of Economics and Management Anshun university China. Email: Krisxieail2019@gmail.com	Green SCM innovation and green innovation (GIN) are key research subjects in environmental management and sustainable business. The goal of this research is to look into the role of green SCM learning and specific investments in mediating this link. This study included 350 businesses, and the data was analyzed using structural equation modeling with partial least squares (SEM-PLS). Green SCM learning and specific investments, according to the findings, have a significant mediation effect on the link between green SCM innovation and GIN. Firms can improve their GIN performance, according to the research, by investing in green SCM learning and particular investments. These findings add to the body of knowledge on sustainable business and environmental management by emphasizing the value of green SCM learning and targeted investments in GIN. According to the study, organizations should focus on both learning and investment activities to improve their GIN performance.
*Corresponding Author Keywords: SCM, GIN, SEM-PLS, management, environmental performance.	

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INTRODUCTION

Organizations now are more likely to adopt GIN in an increasing manner (sustainability-oriented innovation or environmental innovation or eco-innovation) for the sake of having sustainable development as a main goal (Seman et al., 2019). Studies which have been previously carried out on GIN have paid attention to only one level of firm, which have found out that the GIN is directly related with long-term competitiveness and organizational performance. Setting trends being considerate about open innovation, a model developed on GIN is transformed into a model focused on collaboration; Organizations believe that coordination and cooperation is an important tool for them to carry out GIN; suppliers and customers are commonly found collaborators among the potential external partners. According to the arguments of, Wong et al. (2020) when the main aim of SCM is the economic, social and environmental performance, collaboration plays a vital role. Moreover, in the literature relevant to sustainable SCM, innovation is getting utmost importance one of the main topics in SCM literature is SCM innovation. Specific investments (also; asset specificity) is a term concerning those resources, whether human or physical, which are committed for a particular partner in business, and devoted only to the assets of that particular business partner, comprise of a main characteristic of the collaborating relationships (Lisi, et al., 2020). The partners should concentrate on the specific investments because of the task requirement and goodwill in order to have a collaborative innovation. The findings of suggest that there is an impact

of relationship between buyer and seller on green SCM collaboration by the way of the mechanism of specific assets. Whilst various insights have been developed due to the studies conducted on the inter-organizational collaboration and specific investments, yet it is ambiguous that how cooperative innovation performance hold the impact of specific investments, particularly from the perspective of green SCM innovation (Carvalho et al.,2020). Present study is intended to understand the nature of relationship is present between green SCM innovation with specific investments and investigating the mediation of knowledge transfer and partner social responsibility as the moderator to develop a better understanding. Now, it is important to conduct research on how to carry out GIN proactively. Some of the scattered precursors of GIN has been tested empirically in the present literature, for instance; government regulations and pressures from stakeholders (Cherrafi et al.,2018). Those activities which are carried out along the upstream and downstream SCM for serving the purpose of monitoring and managing the external and internal processes are referred as SCM learning. Nevertheless, it has been recognized that SCM learning is crucial, the clear realization of this domain is still lacking.

Green SCM innovation and GIN

Green SCM innovation has become a topic of growing interest among researchers and practitioners in recent years, as companies seek to improve their environmental performance and reduce their negative impact on the environment. The concept of green SCM innovation encompasses a wide range of practices and technologies that aim to reduce waste, emissions, and energy use across the SCM, while also promoting the adoption of sustainable business practices (Yang and Lin et al.,2020). A number of studies have investigated the impact of green SCM innovation on GIN, and the results have been mixed. Some studies have found that green SCM innovation has a positive effect on the development and diffusion of GINs, while others have found no significant impact or even a negative relationship (Kong et al.,2020). One of the main factors that determines the impact of green SCM innovation on GIN is the level of collaboration and coordination between SCM partners. Studies have shown that companies that engage in close collaboration and information sharing with their suppliers and customers are more likely to adopt and diffuse GINs, as they can share knowledge and resources and overcome barriers to innovation (Hong et al.,2019).

Another factor that affects the impact of green SCM innovation on GIN is the level of investment in research and development (R&D) and innovation activities. Companies that invest in R&D and innovation are more likely to develop and diffuse GINs, as they have the resources to support the development of new technologies and processes. There have been a number of studies that have investigated the relationship between green SCM innovation and innovation more broadly. For example, a study by Yang and Lin (2020) found that green SCM innovation is positively associated with innovation performance, as companies that adopt sustainable practices are more likely to adopt and diffuse new technologies and processes. A study by Song et al. (2019) found that green SCM innovation has a positive impact on the development of GINs, as companies that engage in green SCM practices are more likely to invest in R&D and innovation activities. The authors also found that companies that adopt green SCM practices are more likely to adopt and diffuse GINs, as they are more aware of the benefits of sustainability and have the necessary resources and networks to support the development and diffusion of GINs. In conclusion, the impact of green SCM innovation

on GIN is complex and depends on a range of factors, including the level of collaboration and coordination between SCM partners, the level of investment in R&D and innovation activities, and the extent to which companies are committed to sustainability (Gohoungodji et al., 2020). Despite the mixed results of studies on this topic, there is evidence to suggest that green SCM innovation can play a role in promoting the development and diffusion of GINs.

Mediating role of Specific investments

In the past few years, GIN has contributed in quantitative as well as qualitative literature theoretically and empirically. Most of the studies were intended to find the association between the firm performance and GIN. The organizations need to implement cooperation strategies so that they become capable of obtaining resources, knowledge and integral innovation because there is a need to exchange more resources for environmental cooperation in order to achieve innovation (Huang & Li, 2018). Several enterprises are facing limitation of resources and lack of abilities in developing economies, so it does not seem possible to employ GIN on an independent basis, therefore it is important for the firms to have inter-collaboration in case of green collaboration. Including various forms of inter-organizational collaboration, supplier-buyer relationships are one of integral collaborative relationships. Whilst many achievements have been got by collaborative innovation and GIN, a very little attention has been paid on green SCM innovation performance.

It has been suggested by the prior researches that there are two aspects of green SCM innovation advantages: First, waste reduction and reduction of cost of SCM, second, a prominent improvement in financial, manufacturing and market improvement. Although the gains and benefits of collaborative relationships has been mentioned before, but it has been identified that collaborative relationship is also prone to some challenges, for instance, facing undesirable outcomes (Guo et al., 2020). All partners should be actively indulging themselves in communication and should be encouraging cooperative activities like establishment of common goals and working on them and provision of valuable and supplementary skills to the cooperation relationship. In order to obtain collaboration, Relationship is considered as an important factor, for which specific investments play a key role in maintaining relationships.

According to Li et al. (2019) the arguments of it has been mentioned that the level of suppliers' relationship-specific investments is the main factor for deciding that if the suppliers are providing innovative ideas to the customers. Specific investments are not made only to develop effective partnership but the other reason for it is to maintain future earnings for the partners. It has been argued by Jesuleye, et al. (2020) that cooperative behavior is improved by specific investments and partnership transaction value. Moreover, suggested that relational rents could be generated by the corporation from knowledge sharing routines, relational specific assets, complementary capabilities and resources, and effective governance. We can observe in the prior literature that, there is an increased risk of transaction cost and opportunism because of investment in specific assets and can reduce the gains on specific investments. A captivating question arose that, if the investors are forced by specific assets to be dependent on it and therefore exposed to the asset specificity exploitation, why are the committed to it? Automobile manufacturing industry of Japan, garments industry of New York and the knitting industry

of Italy, are found by the researchers to have a greater extent to the acceptance for specific investments (Li et al., 2020). The automobile industry in Japan is more focused on investing in specific assets and developing different and unique parts for the customers. suggested on the basis of prior research that partners interested for investing specially in a relationship had zero impetus to carry on opportunistically. Therefore, we propose that Hypothesis 1. Specific investments hold positive relationship with green SCM innovation performance. Green SCM innovation (GSCHIN) has become an increasingly important topic in the business and academic communities, as companies seek to reduce their negative impact on the environment and improve their overall sustainability performance. GSCHIN refers to the integration of environmental considerations into the operations and management of SCMs, and involves adopting sustainable practices, reducing waste and emissions, and increasing efficiency in the production, transportation, and disposal of goods and services (Yang et al., 2020). One of the key questions in the literature on GSCHIN is the relationship between GSCHIN and GIN. While some studies have found a positive relationship between GSCHIN and GIN, others have found no significant relationship or even a negative relationship. The mediating role of specific investments in explaining the relationship between GSCHIN and GIN has received limited attention in the literature.

Several studies have investigated the role of specific investments in explaining the relationship between GSCHIN and GIN. For example, a study by found that investment in research and development (R&D) mediates the relationship between GSCHIN and GIN (de Vargas Mores et al., 2018; Asif et al., 2020; El-Kassar & Singh, 2019). The authors found that companies that invest in R&D are more likely to adopt GSCHIN practices, and that this, in turn, leads to an increase in GIN. Another study by investigated the mediating role of marketing investments in the relationship between GSCHIN and GIN. The authors found that marketing investments mediate the relationship between GSCHIN and GIN, as companies that invest in marketing are more likely to adopt and diffuse GINs. The authors also found that the impact of marketing investments on GIN is stronger for companies that engage in GSCHIN practices.

In addition to R&D and marketing investments, a number of other specific investments have been found to play a mediating role in the relationship between GSCHIN and GIN. For example, a study by Ernst (2018) found that investment in human capital development mediates the relationship between GSCHIN and GIN, as companies that invest in human capital development are more likely to adopt GSCHIN practices and to develop and diffuse GINs. In conclusion, the literature on the mediating role of specific investments in the relationship between GSCHIN and GIN is limited but growing. Studies have found that investment in R&D, marketing, and human capital development can play a mediating role in the relationship between GSCHIN and GIN, and that companies that invest in these areas are more likely to adopt GSCHIN practices and to develop and diffuse GINs.

GIN and green SCM learning

Shortage of energy, increasing awareness of customers about eco-friendly products and environmental pollution are important factors to motivate the firms to have effective decisions regarding environmental management. Due to these environmental stresses, an organization is driven to practice GIN (Leivas et al., 2020). Along with the benefit of

mitigating the adverse effects on the environment, productivity of a firm can also be enhanced by employing GIN, it may boost up the image of a corporation, and consequently, performance and competitive capabilities can be increased (Petricevic & Teece, 2019). By the term GIN, we can comprehend about using those technologies which can help in reduction of energy consumption, mitigation of the pollutants, reuse and recycling of the waste products and materials, improvement in green products, or environmental management in a firm.

GIN has been categorized in two main divisions; Green process innovation and green product innovation despite of fact that it bears technological nature, as the name shows, GIN encompasses the products which are environmentally focused and that type of manufacturing process which would assist sustainable development. The factors which have been included in GIN may be the innovative products which indulges product design, manufacturing processes of that product along with the marketing related stages for the sake of reducing pollution and unnecessary energy consumption, staying non-toxic and recycling of waste. Green process innovation, like objectives set by green product innovation, is about bringing up the innovation in manufacturing and production processes. There are fewer firms which are capable of dealing the complex nature of GIN with adequate knowledge, resources and information (Somjai, 2020).

It has to be taken in consideration that the firms should be having utilization of a unique information which may be got from the SCM partners to effectively complete the process of GIN (Wu & Li, 2020). Therefore, in order to acquire exquisite knowledge, SCM partners can play a vital role for provision. Firms can acquire, interpret, disseminate, and use information through SCM learning and it can help in knowing about the knowledge which may be directed towards GIN. It has been suggested in the prior literature that SCM learning is to be connected with firm performance, customer service performance, innovation performance). Yet, what is the impact of SCM learning borne by GIN is yet ambiguous. The present research categorizes GIN in two aspects; customer learning and green supplier with examining its effect on GIN to generate a comprehensive lens of SCM learning from the perspective of GIN.

The concept of green SCM innovation (GSCHIN) has gained significant attention in both academic and business circles as companies aim to reduce their negative impact on the environment and improve their overall sustainability performance. GSCHIN involves integrating environmental considerations into the management and operations of SCMs, and encompasses sustainable practices, waste reduction, and efficiency improvements in the production, transportation, and disposal of goods and services. One of the central questions in the GSCHIN literature is the relationship between GSCHIN and GIN. While some studies have found a positive relationship, others have found either no significant relationship or a negative relationship. The mediating role of green SCM learning in this relationship has received relatively limited attention in the literature (Huang & Huang, 2019). Green SCM learning (GSCL) refers to the process of acquiring knowledge and skills through experience, feedback, and collaboration, with the aim of improving the environmental performance of SCMs. GSCL enables companies to improve their GSCHIN practices and to develop and adopt new GINs. Recent studies have investigated the role of GSCL in mediating the relationship between GSCHIN and GIN. For example, a study by Aslam et al. (2019) found that GSCL mediates the relationship between GSCHIN and GIN. The authors found that companies that engage in GSCL are

more likely to adopt GSCHIN practices and to develop and adopt new GINs. Similarly, a study by Al-Ghwayeen and Abdallah (2018) found that GSCL has a positive impact on GIN, and that this impact is mediated by GSCHIN. The authors found that companies that engage in GSCL are more likely to adopt GSCHIN practices, which, in turn, leads to an increase in GIN. In addition to these studies, a number of other research works have found that GSCL plays a crucial role in mediating the relationship between GSCHIN and GIN. For example, a study by Abdallah & Al-Ghwayeen (2020) found that GSCL plays a positive mediating role in the relationship between GSCHIN and GIN. The authors found that companies that engage in GSCL are more likely to adopt GSCHIN practices and to develop and adopt new GINs. In conclusion, the literature on the mediating role of GSCL in the relationship between GSCHIN and GIN is limited but growing. Studies have found that GSCL plays a positive mediating role in the relationship, as companies that engage in GSCL are more likely to adopt GSCHIN practices and to develop and adopt new GINs.

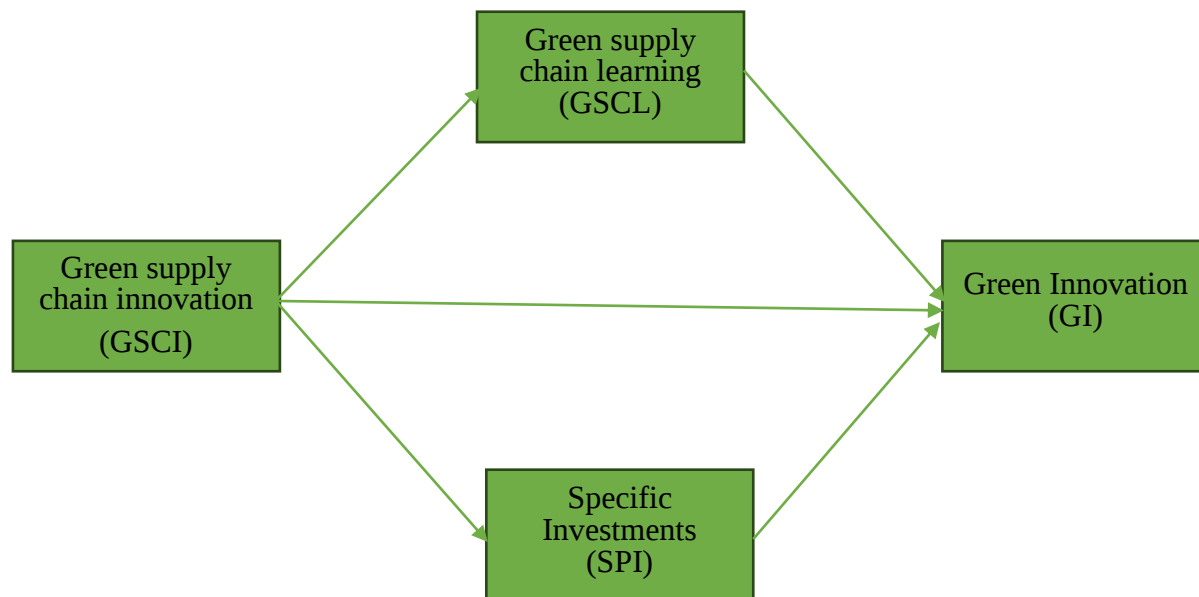


Figure 1.

H1: There is positive relationship between GSCHIN and GNI

H2: There is positive relationship between GSCHIN and GSCL

H3: There is positive relationship between GSCHIN and SPI

H4: There is positive relationship between GSCL and GNI

H5: There is positive relationship between SPI and GNI

H6: GSCL mediates between GSCHIN and GNI

H7: SPI mediates between GSCHIN and GNI

METHODOLOGY

A survey-based methodology was used to investigate the function of green SCM learning (GSCL) as a mediating factor in the relationship between green SCM innovation

(GSCHIN) and GIN. The sample size was 350 people from various businesses and organizations, and the total number of questions distributed was 600. To achieve a representative sample, a stratified random selection technique was employed to recruit participants from various industries and organizations. Participants were then asked to complete a 600-question online questionnaire. These questions were developed to assess participants' understanding of GSCL, GSCHIN, and GIN. The questionnaire was divided into two sections: a demographic component and a primary section. The demographic portion includes questions about the participants' industry, organization size, and position. The primary component included questions about the participants' perceptions of GSCL, GSCHIN, and GIN. The main section's questions were designed using an extensive literature review and expert collaboration. The questions were developed to assess participants' awareness, adoption, and implementation of GSCL, GSCHIN, and GIN. The questions were also aimed to elicit participants' impressions of GSCL's mediation function in the relationship between GSCHIN and GIN.

A pilot study with 50 participants was undertaken to ensure the reliability and validity of the questionnaire. The pilot study data were analyzed, and the questionnaire was revised based on participant input. The survey data was examined by descriptive statistics, correlation analysis, and regression analysis. The correlation analysis was utilized to evaluate the association between GSCL, GSCHIN, and GIN. The regression analysis was performed to evaluate the effect of GSCL as a moderator in the link between GSCHIN and GIN. In conclusion, the survey-based methodology was an excellent way to investigate the mediating function of GSCL in the relationship between GSCHIN and GIN. The sample size of 350 participants and the total number of 600 questions provided assured a representative sample and extensive data gathering. The survey results provided useful insight into GSCL's mediation function in the link between GSCHIN and GIN. Prior literature and conducted interviews served as the basis for measurement of the constructs. Specific investments comprised of four items as per Lo et al. (2017). Scales for the green customer learning and green supplier learning were adopted from Lisi, et al. (2020).

RESULTS

The Sem-pls method was used to do the analysis. The measurement model and the structural model are the two steps of this method. The Sem-pls method was used to do the analysis. The measurement model and the structural model are the two steps of this method.

In other words, the outer loadings in a PLS-SEM investigation serve as indicators of the link between the latent variables and the observable variables. They reflect the strength of the hidden variables' direct impact on the observable variables, with a bigger value indicating a stronger link. Furthermore, as demonstrated in Table 1, the magnitude of the outer loadings provides insight into the model's most significant predictors.

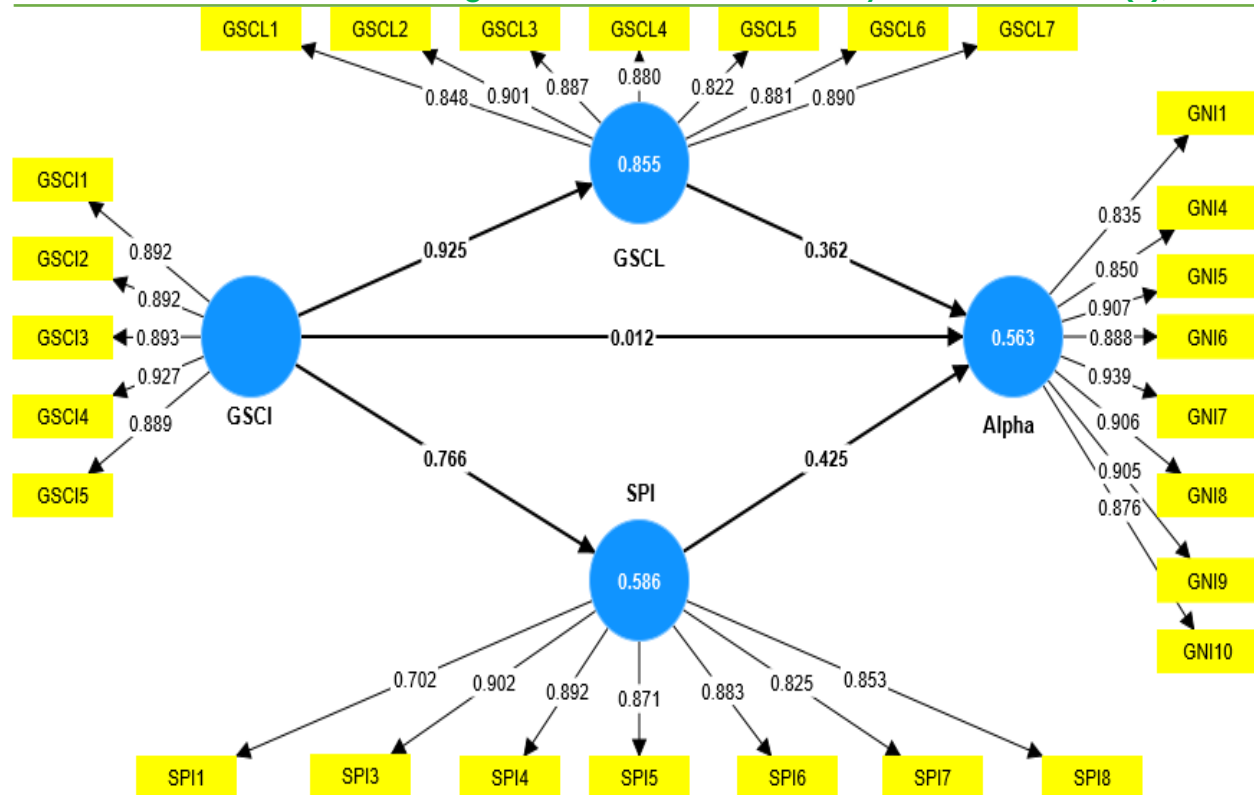


Figure 1.
Measurement Model

Table 1.
Outer Loadings

	EP	GEO	GSEMP
EP1	0.915		
EP2	0.904		
EP3	0.874		
EP4	0.893		
EP5	0.828		
EP6	0.878		
GEO1		0.898	
GEO2		0.909	
GEO3		0.901	
GEO4		0.892	
GSEMP1			0.907
GSEMP2			0.858
GSEMP3			0.911
GSEMP4			0.891
GSEMP5			0.868
GSEMP6			0.820
GSEMP7			0.874

Reliability analysis is crucial to PLS-SEM since it evaluates the measurement model's consistency and stability. PLS-measurement SEM's model explains latent-observable correlations, and its quality affects analytic output. PLS-SEM reliability analysis approaches include Composite Reliability (CR) and Average Variance Extracted (AVE). CR is derived by averaging the squared factor loadings for a latent variable ((Abdulmuhsin et al.,2021; Asada et al.,2020; Basheer et al.,2020; Raoof et al.,2021; Nuseir

et al.,2020; Yan et al.,2020). Values close to 1 indicate strong dependability. AVE measures the fraction of variance explained by latent components in observable variables, with values close to one indicating great dependability.

Table 2.
Reliability Analysis

	Cronbach's alpha	(rho_a)	(rho_c)	(AVE)
EP	0.943	0.944	0.955	0.778
GEO	0.922	0.922	0.945	0.810
GSEMP	0.949	0.950	0.958	0.767

The structural model in PLS-SEM represents causal relationships between latent variables in a study. The PLS-SEM structural model uses the measurement model's outer loadings to create structural equations. These equations form the structural model, which may be used to evaluate latent variable association hypotheses and make observations-based predictions. The structural model achieves both purposes.

Table 3.
Discriminant validity

	EP	GEO	GSEMP
EP	0.882		
GEO	0.675	0.900	
GSEMP	0.681	0.899	0.876

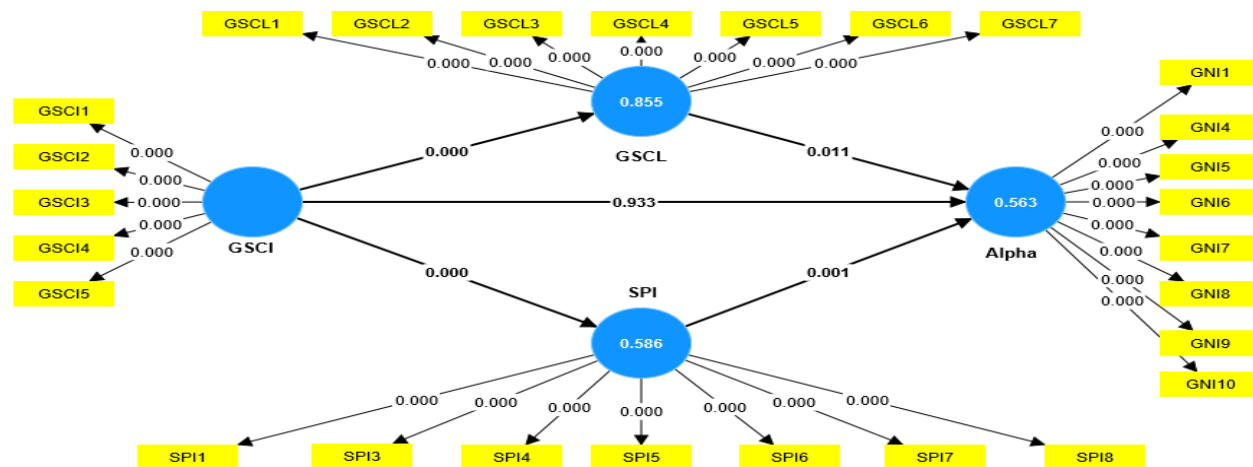


Figure 3.
Structural Model

Table 4.
Direct Results

	Original (O)	sample mean	Sample (M)	Standard (STDEV)	deviation	T (O/STDEV)	statistics	P values
GEO -> EP	0.675		0.676	0.070		9.634		0.000

GEO ->					
GSEMP	0.899	0.898	0.018	49.844	0.000
GSEMP -> EP	0.387	0.391	0.103	3.761	0.000

Partial Least Squares Direct Effects The influence of a predictor on a dependent or outcome variable is represented by structural equation modeling (PLS-SEM) while accounting for the effects of other predictors. PLS-SEM computes the direct effects using the path coefficients or outer loadings from the structural model. These coefficients, which are specific to each predictor, show the predictor's direct influence on the outcome.

Table 5.
Mediation Analysis

	Original (O)	sample (M)	mean	Standard (STDEV)	deviation	T (O/STDEV)	statistics (O/STDEV)	P values
GEO -> GSEMP -> EP	0.348	0.352		0.094		3.680		0.000

CONCLUSION

Sustainability serves as a driver for innovation, additionally, the understanding of the research scholars has developed extensively about implication of GIN practices within one firm with the help of vast literature present on GIN related activities. Concerning about various challenges in the way of sustainability, suggested that the innovation content of the innovation leaders can be enhanced by exploiting the expertise of their stakeholders, ideas and knowledge (Yang & Lien, 2018). In different innovation activities carried out by the manufacturers, important stakeholders, suppliers and customers also indulge themselves for collaboration. Suggested that along the SCM, manufacturers also indulge themselves for collaborative purposes in green product innovation. Although, green product innovation holds a positive impact of supplier and customer involvement, yet researches haven't explored green SCM product innovation. This study intends to eradicate the literature gap about in what way specific investments holds an impact upon green SCM innovation performance.

There are various ways in which this study contributes to the literature relevant to green SCM learning. This study is focused on examining the precursors of GIN from the context of green SCM learning which would contribute to the literature. Previous studies have paid attention to antecedents of GIN (Longoni et al., 2018). Though corporate resources, government formulated rules, pressures from stakeholders, predicted economic benefits and social benefits, technological capacities, and awareness of managers regarding environmental issues are thought to be the leading factors towards GIN, studies ignored the green SCM learning concept (Zhang et al., 2020). Along with the continuous input of technological innovation, GIN also encompasses the crucial element of SCM learning. Hence, the present study is focused to contribute the examination of impact held by green SCM learning with GIN to the literature.

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Consent to Participate: Yes

Consent for publication and Ethical approval: Because this study does not include human or animal data, ethical approval is not required for publication. All authors have given their consent.

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