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RESEARCH ARTICLE

Green Innovation, Pressure, Green Training, and Green Manufacturing: Empirical evidence from the Indian apparel export industry

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Abstract

The fact that garment companies contribute to the fast declining environmental conditions in emerging nations and the dearth of sufficient studies that may assist manufacturing companies in reversing this trend, this empirical study of Indian garment manufacturing export units aims to investigate the relationships between Pressure, Green manufacturing, Green Training, and Green Innovation Additionally, it investigates the mediating impacts of green innovation and green training while assessing the impact of Pressure on green manufacturing The research data is collected by preparing questionnaires for garment manufacturing firms in Karnataka Data was acquired by a survey method. Hypotheses were tested using Smart PLS 4.0. The findings indicate that green training, green innovation, and pressures significantly and positively impact green manufacturing. However, green innovation has the most significant impact, followed by green training and Pressure. According to the findings, there is a partial positive significant mediation of Pressure between Green training and GM, a partial positive significant mediation of green innovation between Green training and GM, and a partial positive significant mediation of Pressure between Green innovation and Green Manufacturing. Furthermore, the R2 value of GM is high, exhibiting a 78.2% impact. The investigation results indicate that all the proposed hypotheses have been validated, which adds to the existing literature. The results of this empirical study, which is the first to examine the implications of Pressure, Green Training, and Green Innovation variables on adopting GM practices specifically for the Indian garment manufacturing export industry, will be equally helpful to researchers and practitioners to combat India's environmental problems.

Keywords: Pressure, Green Training, Green Innovation, green manufacturing, apparel, exports.

Introduction

The supply chain of the fashion business is complex, with serious social issues. (Stotz & Kane, 2015).. India, the world's second-largest manufacturer of textiles and clothing, provides 13% to industrial output, 2.3% to GDP, 12% to exports (IBEF, 2022) and employs 45 million people. However, regarding pollution to the planet, the fashion industry is second only to oil (Market Watch 2019) The practices apparel industry has contributed to an array of social and ecological issues, including significant emissions, high consumption of energy and water, and widespread pollution According to Shenet *et al.* (2021), the manufacture of apparel has a significant detrimental impact on the ecosystem, including water and air contamination To save energy and natural resources and lower greenhouse gas emissions, several governments and institutions throughout the world have enacted new ecological legislation The "Fashion Industry Charter for Climate Action (FICCA)" which was created under the supervision of the United Nations Climate Change is one example By 2050, FICCA wants to have eliminated emissions from the fashion sector Famous multinational fashion companies, including H&M (Rahman and Gong, 2016), Patagonia, and Louis Vuitton, have started various sustainable activities along their supply chains to comply with the recently developed legal and environmental restrictions.

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Green Manufacturing: Globally, several academics have evaluated green production procedures for textiles and apparel. (Baskaran, 2014; Caniato, 2015; Saxena, A., Khare, A.K. 2021). Islam *et al.* (2021) investigated environmentally friendly production methods and developed a theoretical framework for the textile and apparel sector Thorisdottir and Johannsdottir (2020) examined how CSR affected the fashion industry's sustainability from 2003 to 2019 Jia *et al.*'s investigation into the circular economy resulted in creating a model for the Textile and Apparel Industry (TAI) that included practices, obstacles, drivers, and measures Asif (2017) aimed to investigate the general condition of sustainability in the garment manufacturing industry, the factors encouraging suppliers from developing countries to embrace sustainable and socially responsible practices, and the obstacles and opportunities to implementation China's garment industries were researched by Choi (2019), and the findings suggest that internal company characteristics, which include cultural innovation and socially responsible mindsets, are related to the adoption of green practices Gardas en. tl (2018) claims that the DEMENTAL technique was used in this study to identify the 14 major obstacles to sustainable textile and apparel production in India. The absence of government efforts and poor infrastructure were the primary roadblocks.

Green training: It helps employees develop the skills to reduce the organization's impact on the environment (Tang *et al.*, 2018) GT is an essential part of research as it covers environmental and social and environmental concerns at different levels. (Masri & Jaaron, 2017). Jabbour (2015) suggests that the ecological development of the firm is positively related to green Training Research indicates that GT is essential for the green industry and it is economy (Jackson *et al.*, 2013) According to Guo, H.(2022), the research study in China lists and prioritize the barriers to GM adoption in the garment industry The findings show that the independent barrier, lack of eco-literacy , a lack of specialized company-level training and monitoring of the progress of GM implementation, and insufficient support from regulatory authorities are the leading causes of all the barriers According to Sagalee, I. L. L. (2021), a study in Sri Lanka apparel industry finds that impact of green performance evaluation and green reward management on employee performance was demonstrated using multiple regression analysis The performance of employees is not significantly impacted by green training The research has yet to discuss the interconnection between green innovation, Pressure and green training The current literature gap also exists in the relationship of green training with green manufacturing in the apparel industry, specific to the Indian apparel export industry.

Green Innovation: For sustainable development, companies should adopt new technologies and redesign products even if it leads to changes in the SCM business model. (Nidumolu *et al.*, 2009). The crucial part of GSCM is to improve the environment through process and product innovation and using clean and green technologies. (De Brito *et al.*, 2008). Research and development provide the organization with innovative products, product differentiation, quality, and processes, which improve market positioning and increase the firm's value (Shim*et al.*,2016) Some studies focus on diverse methods of introducing sustainability into the business model of the TAI, such as the acquisition of competitive edge, innovation, and model structure (Westerlund, 2013) A sustainable business model is a structure used to explore the creation and acquisition of value by a company, aiming to achieve sustainability objectives by adopting active multi-stakeholder management, innovation, and perennial perspectives (Bocken *et al.*, 2014; Boons & Lüdeke-Freund, 2013) The firms which adopt innovation grow and develop green manufacturing practices, which increase their market share So the hypothesis that green manufacturing is linked to green innovation needs to be confirmed, and its relationship with the other construct, Green Training, and Pressure and green manufacturing needs to be established.

Pressures Several papers investigate the relationship between institutional Pressure, green manufacturing drivers, and green practices of various companies. (Sarkis *et al.*, 2011). According to Alam, S., & Dhamija, P. (2022), in Bangladesh's apparel manufacturing industry, where the fourth industrial revolution is taking place, institutional pressures (coercive, mimetic, and normative) are positively influencing the workforce's technical and managerial skills; these skills are also positively influencing the growth of human resource capabilities As per Sujatha, R., & Karthikeyan, M. S. (2021), the research aims to investigate GSCM practices and understand empirically how Pressure, practices, and performance are related to GSCM The findings showed that GSCM demands force businesses to adopt practices that have a significant impact on the environment and a healthy economy Menguc *et al.* (2010) find that companies' willingness to improve environmental practices is affected by institutional pressure Pressures also impact the resources' efficiency in improving the environment De Clercq *et al.* (2010) find the moderating effect due to institutional pressures between the constructs of supply chain innovation and old business models Many developed countries and developing countries have environmental regulations and certifications Garment manufacturing has several certifications related to green practices like LEED, ISO 14000, REACH, etc Several institutional pressures, such as regulatory Pressure due to government regulations, competitive Pressure, customer pressure, and market pressure, exist and can impact green manufacturing in the fashion industry Customers prefer organizations that implement green manufacturing

practices Therefore, this research assumes that Pressures, Green Training, and Green Manufacturing Innovation impact green manufacturing practices The study considers six pressures in apparel manufacturing: global competitiveness, customer, government policies and regulations, financial factors, external factors, and production and operation factors It uses them at the second level in the model.

The apparent benefits did not motivate people to adopt green practices enough Most previous research has been qualitative, case study-based, or literature-based Additionally, a number of academics have examined green production using case studies from the textile and apparel sectors According to the literature review, several studies are done in the fashion business, while others are done only in the industry of producing garments Many scholars have studied GSCM and green manufacturing practices, with each looking at a particular issue and offering a solution Even if several academics have studied pertinent topics in the industrial sectors, the issue still needs to be studied and analyzed scientifically Regardless of the scale of the clothing industry, there is a substantial environmental effect, and there may be a more extensive studies on green production in the apparel sector In addition, the apparel industry is disorganized and fragmented; to fully understand the situation and formulate policy, a quantitative study on various factors impacting green production is necessary This study employs quantitative approaches to assess and examine the relationship between constructs Pressures, Green Manufacturing, Green Training, and Green Innovation to fill a research gap. In order to set sustainable goals, it is crucial to take the industry and firm size into account Moreover, to assess the mediation results between the constructs mentioned above and green manufacturing The study's conclusions will be incorporated into a repository of knowledge on green manufacturing Additionally, this would assist many Indian and Karnataka garment manufacturing companies in discovering green production techniques.

Research Methodology

The study looks at the key concepts that were previously covered concerning the green garment manufacturing sector, such as green innovation, green training, and various pressures, and how they relate to and affect green manufacturing. The conceptual research model and the constructs utilized are shown in Figure 1.

Several research hypotheses are formed for testing during the research based on an exhaustive assessment of the literature, gaps observed, and interpretations. The hypothesis that follows illustrates the direct relationship between the constructs (H1): Green Training significantly impacts Green Manufacturing Innovation (H2): Green Training has a significant positive impact on Green Manufacturing (H3): Green Training has a significant

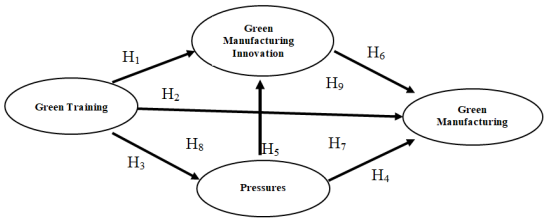

Fig 1: Conceptual framework

positive impact on Pressure (H4): Pressure has a significant positive impact on Green Manufacturing (H5): Pressure has a significant positive impact on Green Manufacturing Innovation (H6): Green Manufacturing Innovation has a significant positive impact on Green Manufacturing.

The following hypotheses help identify the mediation effect between the research constructs (H7): Pressure has partial mediation in finding the impact of Green Training on Green Manufacturing (H8): Green Manufacturing Innovation has partial mediation in finding the impact of Green Training on green manufacturing (H9): Green Manufacturing Innovation has partial mediation in finding the impact of Pressure on green manufacturing.

This exploratory study aims to determine how green innovation, green training, and pressures on green manufacturing relate to Indian clothing manufacturing enterprises in Karnataka. The research study adapts a deductive approach, quantitative analysis, and survey method for data collecting using a questionnaire (Forza, 2002). After establishing that the indicated respondents have implemented green manufacturing and are export-focused units, the questionnaire is distributed to them Utilizing random and snowball sampling techniques, the sample was obtained from export firms that manufacture clothing The sample size for the identified population is 150 (Krejcie & Morgan, 1970), while there are 245 garment manufacturing export firms in Karnataka, according to AEPC.

Variable Measurement and Questionnaire Design

Demographics and constructs are the two components of the questionnaire. The research focuses on pressures, Green Manufacturing, Green Innovation, and Green Training. The scale used to measure the "Green Manufacturing" construct has 15 items, and Shang *et al.* (2010) validated it. The scale for the seven-item construct "Green Training" was verified by Sarkis *et al.* (2010). Daily *et al.* (2012) 18 items make up the scale for the construct "Pressure," which was verified by Henriques and Sadorsky (1996), Hall (2001), and Wang *et al.* (2012). Four items comprised the "Green Managerial Innovation" construct, and Cheng (2014) validated the scale. As explained above, the literature validated all the selected constructs used in the research.

The literature that is currently available indicates that larger businesses are more likely to implement GMP.(Zhu

& Sarkis, 2004; Min & Galle, 2001). International clients exert greater Pressure on export-oriented businesses to implement GMP (Mitra & Datta, 2014). The Pressure on units focused on exports and domestic brands differs in the garment manufacturing industry. The workforce determines the business size, which may be assessed as a variable and divided into four groups: up to 19 in micro-sized organizations, 20–99 in small, 100–499 in medium-sized, and 500 or more in big enterprises.

The studied population consists of export-focused garment manufacturing enterprises in Karnataka in southern India that employ 100 or more people (DCSSL, 2015). The size of the company, EOU business type, and garment manufacturing industry type for the clothing manufacturing sector are the criteria used to decide on the study's population.

There are three stages to the questionnaire's generation. First, a comprehensive and in-depth literature assessment led to the selection of construct items. Second, a committee of academic and industrial experts knowledgeable about green manufacturing examined the selected constructs. Third, a pilot study data analysis was carried out using the information gathered from 35 participants who had a broad understanding of green manufacturing inside the organization.

The final questionnaire was distributed to the firms for the final research after the components' reliability, discriminant validity, and convergent validity were assessed by the preliminary analysis of pilot test data. The pilot study's input was used to improvise the survey items further. The respondents were asked to rate the company's current GMP implementation status on a seven-point Likert scale. The respondents were employed in several divisions of the garment manufacturing company. During the electronic survey, 150 companies sent filled questionnaires.

Data Analysis

PLS-SEM, which is often used in social science, marketing, and business strategy research, is used for data analysis (Hair *et al.*, 2016). The present study uses Smart PLS 4.1 version software for data analysis. It is a valuable tool that offers significant flexibility in the interactions between the data and the theories (Vanalle *et al.*, 2017).

Common Method Bias It is a measurement source error which can result in inappropriate relationships between the measurement items and, in the end, faulty study findings. A one-factor test by Harman (Harman, 1976) and variance inflation factors (VIF) to measure collinearity are two tests that may be used to assess CMS. The total variation for a single component was lower than the advised 50% (Podsakoff *et al.*, 2003) VIF was within the recommended level of 3.4 (Kock, 2015) CMB is therefore not present in the data.

Measurement Model The measurement model investigates the constructs' reliability and validity (Hair *et al.*, 2016) (Table 1). The reliability of the data was examined using Cronbach's alpha (CA) and composite reliability (CR) scores The resulting measurement model has CR values between 0.837 and 0.958 and CA values between 0.811 and 0.953. All of the data used in the measurement model are reliable and may be utilized for additional study without modification because the values of CA and CR are higher than 0.7 (Hair *et al.*, 2014).

Second, the average variance extracted (AVE) values were utilized to determine convergent validity (Fornell & Larcker, 1981) and range between 0.568 to 0.858, confirming acceptable convergent validity Hair and colleagues (2016). A discriminant validity measure is used to confirm a substantial difference in the constructs utilized in the model Cross-loading, the Fornell-larger criteria, and the Heterotrait - Monotrait ratio (HTMT) are used to assess discriminant validity.

The Fornell-Larcker criteria are verified in this study by the square root of AVE, and its off-diagonal values are less than the diagonal constructs (Fornell & Larcker, 1981) (Table 2) The outer loading values can be used to determine cross-loading, which should be greater than the loadings of the associated constructs The data analysis demonstrates that the values in the cross-loading matrix are greater than the intended constructs (Table 3) The HTMT is less than 0.9, suggesting adequate HTMT (Table 4). As a consequence, the discriminant validity of the variables used in the investigation is achieved.

Figure 2 depicts the measurement model and a path diagram constructed with constructs to test the constructs' reliability and validity. Moreover, the path coefficient values and Cronbach's alpha values of all the constructs are connected in the measurement model. Table 5 shows the demographic characteristics of 150 respondents whose data was used in the research.

Table 1: Construct Reliability

Constructs	*Cronbach's alpha*	*Composite reliability (rho_a)*	*Average variance extracted (AVE)*
GM	0.953	0.958	0.610
GMI	0.945	0.945	0.858
GT	0.944	0.949	0.747
P	0.811	0.837	0.568

Table 2: Fornell–Larcker criterion

	GM	*GMI*	*GT*	*P*
GM	0.781			
GMI	0.823	0.926		
GT	0.641	0.512	0.864	
P	0.688	0.623	0.362	0.753

Table 3: Outer Loading

	GM	*GMI*	*GT*	*P*
GM1	0.853			
GM10	0.797			
GM11	0.782			
GM12	0.793			
GM13	0.746			
GM14	0.834			
GM15	0.833			
GM2	0.557			
GM3	0.757			
GM4	0.731			
GM5	0.832			
GM6	0.835			
GM7	0.778			
GM8	0.817			
GM9	0.718			
GMI1		0.929		
GMI2		0.937		
GMI3		0.916		
GMI4		0.924		
GT1			0.908	
GT2			0.842	
GT3			0.839	
GT4			0.875	
GT5			0.840	
GT6			0.861	
GT7			0.883	
PE				0.807
PF				0.638
PG				0.721
PGC				0.822
PP				0.765

Later, a structural equation model was created by bootstrapping with 5000 subsamples to examine the statistical significance of the constructs and test all hypotheses developed during the research (as shown in Figure 3).

Results

The structural equational model is used to evaluate the data received from respondents in accordance with the research objectives and hypothesis specified in the study. In smart PLS, the direct path coefficient value is calculated via bootstrapping with 5000 samples The effects of mediation between the constructs are then studied The R2 value achieved by the structural model is good and significant. (Cohen,1992) The structural model (figure 3) shows that R2

Table 4: Heterotrait–monotrait ratio (HTMT)

	GM	*GMI*	*GT*	*P*
GM				
GMI	0.862			
GT	0.668	0.536		
P	0.744	0.678	0.381	

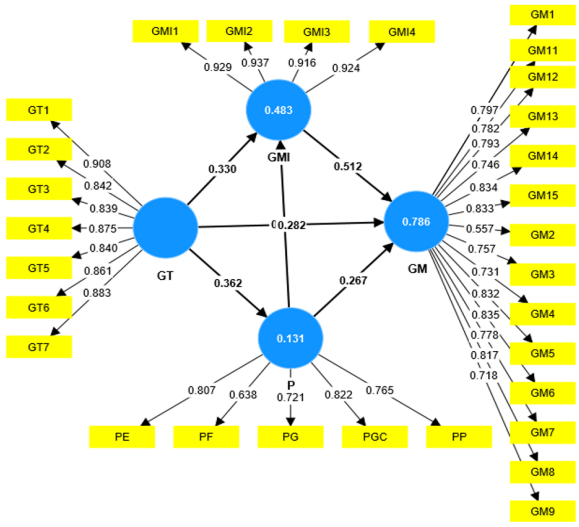

Figure 2: Measurement model from smart PLS

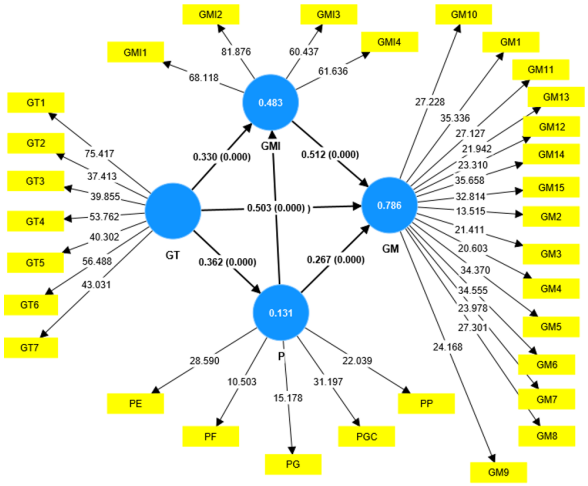

Figure 3: Structural model from smart PLS

value explains for 48.3% of the variation in Green managerial Innovation, 13.1% of the variance in Pressure, and 78.6% of the variance in green manufacturing, confirming predictive validity (Hair *et al.*, 2016) R2 is considered less if it is less than 0.25, medium if it is less than 0.50, and large if it is less than 0.70, according to Latan and Ghozali (2012) The P values, path coefficient (β), and t-statistics are used in the research study to investigate the relationship between the constructs As shown in Table 6, the relationship between GMI on GM (t = 9.983,β= 0.512,p< 0.001), GT on GM (t = 5.646,β= 0.282,p< 0.001), GT on GMI (t = 5.19,β= 0.330,p< 0.001) GT on P (t =

Table 5: Demographic characteristics of the companies

Demographics of the samples	
Present Job Function	
Corporate Executive	23
Manufacturing Production	82
Merchandising	32
Quality Assurance/ Product Design/ R&D	5
Sales/ Marketing	8
LEED certification status	
LEED-certified	4
LEED Silver certified	2
LEED gold certification	1
LEED platinum certification	1
No	142
Implementation of Green manufacturing practices	
0 ~ 2 years ago	19
2 ~ 4 years ago	43
4 ~ 6 years ago	59
6 ~ 8 years ago	8
8 ~ 10 years ago	9
more than 10 years ago	12
Number of employees	
Between 100 and 499	90
Between 500 and 999	44
Over 1000	16

5.038,β= 0.362,p< 0.001), P on GM (t = 6.080,β= 0.267,p< 0.001), P on GMI (t = 9.459,β= 0.503,p< 0.001) successively As a result, hypotheses H1, H2, H3, H4, H5, and H6 are supported, which indicates a direct and significant impact on the dependent variable.

The mediating effect of the constructs is tested by bootstrapping with 5000 samples, according to Preacher (2008). The study of p-values, path coefficients (β), and t-statistics in indirect specific effects (Table 7) tests the significance of the impact of mediation of the constructs The test results show that Pressure has a partial positive significant mediation on GT and GM (t =3.952, β = 0.097,p 0.001), and GMI has a partial positive significant mediation on GT and GM (t =4.329, β = 0.169,p 0.001) Pressure on GM has a partial positive significant mediation due to GMI mediation (t =6.786, β = 0.258,p 0.001).

The mediation tested in H7, H8, and H9 research hypotheses is partially positive significant, as both the direct effect values (path coefficient (β) and t-statistics and P values) and the indirect, specific effect values (path coefficient (β) and t-statistics and P values) are significant Finally, the model fit is checked to determine the statistical adequacy of the model; the SRMR value is close to .8, indicating that the model is valid. (Latan and Ghozali, 2012).

Discussions

The research study has constructed a conceptual research model from the constructs identified in the research gap, during the literature review, focusing on green training, green innovation, Pressure, and green manufacturing. Later, the constructs' link was assessed and analyzed regarding the direct impact and moderating effect. The findings indicate that green training, innovation, and green pressures significantly and positively impact green manufacturing. The impact of pressures, however, is smaller than that of green innovation and green training. The findings back the previous studies on the pressures in the apparel industry, which led to GSCM practices adoption (Darnall *et al.*, 2008b).

It demonstrates that GT is significant for implementing advanced environmental practices in the study done for organizations in Spain, which is also compatible with Sarkiset's (2010) findings Green training, for green management companies is positively associated, according to Jabbour (2015), while Jackson *et al.* (2013) emphasized the need of green training in green firms. This study adds to existing research in green manufacturing by revealing a strong partial mediating effect.

Theoretical Implication

The study adds to the growing knowledge about green manufacturing in the apparel industry. The study will be beneficial to both academics and researchers.

According to the study, garment manufacturing units involved in exports should prioritize green training and green innovation when implementing green manufacturing practices in the organization. According to the study, Pressure also causes garment export units to adopt green practices.

Table 6: Path coefficient

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
GMI -> GM	0.512	0.512	0.051	9.983	0.000
GT -> GM	0.282	0.282	0.050	5.646	0.000
GT -> GMI	0.330	0.329	0.064	5.190	0.000
GT -> P	0.362	0.365	0.072	5.038	0.000
P -> GM	0.267	0.268	0.044	6.080	0.000
P -> GMI	0.503	0.505	0.053	9.459	0.000

Table 7: Specific Indirect effect

Sample (O)	*Original*	*Sample mean (M)*	*Standard deviation (STDEV)*	*Tstatistics (|O/STDEV|)*	*p-values*
P -> GMI -> GM	0.258	0.258	0.038	6.786	0.000
GT -> P -> GM	0.097	0.098	0.024	3.952	0.000
GT -> GMI -> GM	0.169	0.169	0.039	4.329	0.000
GT -> P -> GMI -> GM	0.093	0.095	0.026	3.579	0.000
GT -> P -> GMI	0.182	0.185	0.047	3.919	0.000

Second, the study contributes significantly to the literature on green manufacturing by assessing the mediating impacts of the constructs. Third, the study adds to the current body of knowledge by demonstrating that Pressure alone is insufficient to drive green manufacturing; the mediation effect of green training and green innovation is also substantial. Finally, the research assists management in developing essential skills for green manufacturing in a competitive, challenging environment.

Managerial Implication

First, the research assists garment industry experts in understanding the significance of several constructs, such as green training and green innovation, in green manufacturing implementation at the firm level and, as a result, in restoring environmental resources. Second, decision-makers of garment export houses competing for orders from other nations may utilize green innovation and training to adopt green manufacturing and plan business strategies in their organizations. Third, the findings will assist garment exporters in obtaining certifications such as LEED and ISO 14000 upon implementing green manufacturing to increase their apparel export business. Finally, the knowledge will benefit the apparel manufacturing industry in other countries.

Conclusions

The effect of pressures, green training, and green innovation on the application of GM practices in garment manufacturing enterprises are investigated in this study. This study provides empirical evidence implementation of GM, as well as examines the positive partial mediation among the constructs Green manufacturing lowers the negative environmental impact of apparel production practices GMI has a direct and considerable positive impact on GM, GT on GM, GT on GMI, GT on P, P on GM, and P on GMI. As a result, H1, H2, H3, H4, H5, and H6 are supported. The findings reveal that Pressure has a partial positive significant mediation on GT and GM, GMI has a partial positive significant mediation on GT and GM, and Pressure has a partial positive significant mediation on GM and GMI As a result, hypotheses H7–H9 are supported The research will establish the groundwork for the organization's management, practitioners, managers, and environmental management to comprehend GM practices and develop strategic plans to apply sustainability in operations.

One of the study's shortcomings is that it was done in Karnataka's clothing manufacturing export-oriented businesses. Second, the data is gathered at the firm level, either from top or middle management, limiting the study's generalizability. Third, the study investigates the influence and interrelation of the constructs as direct and mediating effects. Future researchers may investigate the moderating effect of constructs in the textile and garment sector business.

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