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Abstract

Purpose – The objective of the study is to explore the mediatory role of environmental performance of organisations on their economic and social performances. It demonstrates that implementing environmental management techniques should not only be done to comply with environmental regulations, but also as a means of improving social and economic performance.
Design/methodology/approach – Data was gathered from the manufacturing industry of Zimbabwe, and 302 usable responses were received. Data analysis was performed through structural equation modelling using SMART PLS 3.
Findings –Improvement in environmental performance led to improvement in both social and economic performances. Also, environmental performance contributes the greatest total effect hence it deserves attention, not only for compliance, but also economic reasons.
Originality – Our goal is to quantify the extent to which the environmental performance might improve the social and, more importantly, the economic performance of organisations. The study also explores the relative importance and performance of Lean Manufacturing, Green Manufacturing, social performance and environmental performance for purposes of prioritisation of organisational improvement initiatives.

Keywords: Green Manufacturing, Lean Manufacturing, Lean-Green, Sustainable performance
Paper type Research paper

1. Introduction

Organisations around the world have been adopting different methodologies, including Lean Manufacturing (LM) and Green Manufacturing (GM), to improve their sustainable performance, and the integration of these two methodologies tends to improve social, economic, and environmental performance of these firms (Bhattacharya *et al.*, 2019). Initially, organisations strove to enhance environmental performance mostly to comply with regulations. According to Michlak and Schucht (2004), organisations will comply with environmental regulations only if the penalty for environmental breaches outweighs the cost of being compliant. Thus, it seems some organisations weigh their options, either polluting the environment and paying a small fine or implementing environmental management techniques at a cost (Walton *et al.*, 1998). As a result, some prefer paying fines, as they do not realise how environmental performance can help them improve their economic performance, which is of paramount interest to them.

However, it is gradually dawning on many organisations that environmental performance can be key in improving the overall sustainable performance. For instance, Achim and Borlea (2014) observed that for organisations to maximise their economic performance, they should be concerned not only about improving their financial growth but should also focus on non-financial performances, such as the environment. Since the goal of many organisations is to enhance their profit, it is, therefore, important to examine if environmental performance as a mediatory variable can amplify the impacts of LM and GM on economic performance. Once organisations realise the influence of their environmental performance on economic performance, most will opt to improve it, not for the sake of compliance only but also for economic gains.

Previous studies have not quantified the extent to which environmental performance may help in attaining improved economic and social performance. The role of environmental performance in enhancing economic performance needs to be explored further to encourage organisations to improve their environmental performance. Whereas most companies are gradually shifting from the view of environmental management issues as compliance with regulations with less economic gains, it still needs to be backed by figures of merit. Hence, in this research, the authors investigate the extent to which environmental management may boost the social, and eventually, the economic performances or organisation.

There is a realisation today of the need for organisations to measure their performance not only on the economic indices of profitability but also consider the environmental aspect as equally as the economic. This is because the demands from the customers are no longer limited to traditional competitive factors like fast delivery and high-quality products, as the customers are now also interested in sustainability issues (Leme *et al.*, 2018). Also, stakeholders like the government and communities are asking manufacturers to be environmentally conscious and opt for greener services and products (Leme *et al.*, 2018; Baumer-Cardoso *et al.*, 2020). These changes in ecological requirements and customer demand have encouraged organisations to pursue environmental efficiency (Farias *et al.*, 2019), and those companies that are not environmentally compliant may lose some of their customers, which may eventually impact their profitability. Different environmental aspects are now being considered before doing business; for example, the companies' energy consumption, green design, solid waste management, and green materials philosophy (Fercoq *et al.*, 2016). Thus, the environmental aspect needs to be regarded as a competitive tool by organisations desiring to improve customer satisfaction and sales (Leme *et al.*, 2018), and as a result, organisations are considering adopting approaches to enhance environmental performance. The consideration becomes even weightier if the environmental factor could have a more significant role than just on the environment, but also in procuring economic and social capital for the organisation. This may translate to improved sustainable performance in the long run. Therefore, this research shows how improvement in environmental performance can help organisations to attain better sustainable performance. This can make manufacturing organisations to realise the importance of being environmentally compliant and motivate them to focus on environmental performance as equally as economic performance.

It is also important to examine the relative importance of LM and GM as process improvement initiatives within the context of other intervening variables like environmental and social performance. Through the Importance-Performance Map Analysis (IPMA) one can determine the contribution of environmental performance in attaining social and economic performance. By so doing, organisations can determine those factors that they should prioritise for improvement investment, especially in cases of limited resources which is not uncommon in most organisations appropriating budgets. Thus, in this study, the authors seek to investigate how environmental performance impacts sustainable performance by answering the following research question (RQ).

RQ: To what extent does an improvement in environmental performance affect the social, and hence, the economic performance of a manufacturing organisation, and how may this knowledge influence process improvement decisions?

This study's objective is to create a Lean-Green assessment model that can be adopted to evaluate the influence of environmental performance on sustainability using data collected in the manufacturing firms of Zimbabwe. Zimbabwe is an emerging nation that is currently facing many economic challenges, including a high rate of inflation, which impedes the implementation process (World Bank, 2022). In addition, like other countries, Zimbabwe is grappling with the consequences of post Covid-19 pandemic. Since the beginning of Covid-19, the gross domestic product of Zimbabwe has decreased by 8% (World Bank, 2021). Furthermore, it seems there is no standard measurement model that the manufacturing companies currenty use to assess the effect of environmental performance on economic and social performances (Maware and Adetunji, 2019). To the best knowledge of the authors, this is the first study that developed a structural equation model to quantify the leveraging role of environmental performance in enhancing social and economic performances.

2. Literature review and hypothesis development

2.1 Lean manufacturing

Lean pursues continuous improvement by getting rid of non-value-adding activities. The purpose of adopting LM is to reduce waste and enhance the performance of organisations (Anwar *et al.*, 2023). According to Ghobadian *et al.* (2020), waste is using resources for purposes that do not add value. LM is related to the satisfaction of the customers and productivity improvement, leading to improved product quality, cost reduction, and process speed (De *et al.*, 2020).

LM has been adopted by manufacturing companies to improve their organisational performance, and more recently, to enhance their general sustainability performance. For instance, the study done in various countries by Bortolotti *et al.* (2015) noted that LM improves quality, delivery, flexibility and cost performance. Yang *et al*. (2011) conducted research in different international organisations and pointed out that LM positively impacts the market and financial performance. A study in the Italian manufacturing industries showed that LM promotes the growth of organisations by improving their operational performance (Bevilacqua, *et al.,* 2017). A literature review by Naeemah and Wong (2022) noted that Lean has a greater positive impact on economic performance compared to the other dimensions of sustainability.

2.1.1 Lean in emerging nations

Researchers have been conducting studies to examine Lean adoption in emerging nations in the past years. Santos-Bento and Tontini (2018) applied LM in the Brazilian manufacturing sector and found that LM leads to enhanced operational performance. Marodin *et al.* (2019) indicated that Just in Time (JIT) and Total Productive Maintenance (TPM) lead to a reduction in lead time in Brazil's automotive industry. Kamble (2020) integrated Industry 4.0 and LM and noted that such integrations lead to enhanced sustainable organisational performance. A case study in Indian Small and Medium Enterprises (SMEs) highlighted that adopting LM helps attain environmental, social, and economic improvements (De *et al.*, 2020). Arumugam *et al.* (2020) also applied social and technical Lean practices in India and improved financial, employee, and operational performances. In Pakistan, Anwar *et al.* (2023) reported that supplier relationship, product design and customer relationship positively influence sustainable performance.

In Zimbabwe, the impact of implementing LM has also been reported. Kudoma (2014) presented a Total Quality Management (TQM) framework to help SMEs improve quality. Goriwondo *et al.* (2011a) reported improved machine utilisation and overall equipment effectiveness through TPM adoption in the pharmaceutical industry. In the bread manufacturing industry, Goriwondo *et al.* (2011b) utilised value stream mapping and achieved a reduction in defects, inventory, and motion.

Maware and Adetunji, (2019) examined how Lean practices were adopted across industries to improve flexibility, speed, and dependability.

2.2 Green Manufacturing

GM has emerged as a manufacturing methodology that has gained much popularity due to its role in attaining environmental sustainability (Mafini and Loury-Okoumba, 2018). GM is a manufacturing methodology whose objective is to minimise environmental damage by the manufacturing sector (Saxena and Srivastava, 2022). Hence, its adoption is anticipated to improve environmental sustainability by reducing solid waste, air pollution, waste water, and consumption of hazardous materials (Green *et al.*, 2012). Manufacturing organisations become aware of environmental performance role in a competitive market (Mafini and Loury-Okoumba, 2018). Therefore, they are adopting GM to please the customers who are demanding that manufacturers use environmentally friendly processes.

2.2.1 Green Manufacturing in emerging nations

Manufacturing organisations in emerging nations countries have been adopting GM practices to enhance their organisational performances (Afum *et al.*, 2020a). The adoption of GM practices in Brazil improved performance through reduced waste, emissions and material consumption (Soubihia *et al.*, 2015). Research among South Africa's manufacturing SMEs concluded that Green practices cause an improvement in operational performance (Mafini and Loury-Okoumba, 2018). In Malaysia, Hasan and Ali (2015) investigated the effect of implementing Green marketing and realised improvements in organisational performance. A GM framework was developed and validated in the Indian steel industry, which provides ways to achieve environmental sustainability by applying GM practices (Rehman *et al*., 2013). Al-Hakimi *et al.* (2023) concluded that GM has an impact on green innovation, which further enhances sustainable performance in manufacturing SMEs in Saudi Arabia.

Moreover, studies have also been done on the implementation of GM in Zimbabwe. Chikuku *et al.* (2011) highlighted how GM was used as the basis for ISO 14001 implementation in tobacco processing. The application of GM in the oil industry generated savings through pollution prevention and reduced consumption of resources (Madanhire and Mugwindiri, 2012). The case study by Mugwindiri and Mushiri (2016) across various manufacturing industries concluded that GM implementation leads to cost reduction and conservation of resources, such as water. Machingura and Zimwara (2020) presented a GM framework that was implemented in some manufacturing companies in Zimbabwe.

2.3 Lean-Green and sustainable performance

Sustainable performance is based on the three pillars which are economic, social and environmental performance. These pillars are known as the Tripple Bottom Line (3BL). According to Koho *et al.* (2015), economic performance focuses on both short and long-term profitability while social sustainability ensures a safe environment and environmental sustainability aims to reduce pollution and conserve raw materials. The diagrammatic representation of these pillars shows that they have areas of synergies which can be exploited to enhance sustainable performance.

LM and GM have been implemented jointly to enhance the organisational performance of manufacturing organisations, with LM focusing on improved economic performance, and GM for enhancing environmental performance. Machingura *et al.* (2023) reported that Lean-Green improves the environmental and economic performance of Zimbabwean manufacturing organisations. Within the South African manufacturing industry, the study by Thekkoote (2022) found that both LM and GM enhance sustainable performance, particularly economic and environmental performance. Awan *et al.* (2022) investigated the mediation role of Green Supply Chain Management (GSCM) on the relationship between LM and financial, social and environmental performance in the Pakistan industry. The study concluded that a positive relationship exists between LM and sustainable development through GSCM. However, some practices such as manufacturing planning and control were found to have a negative relationship with sustainable performance. In addition, the review by Hassan and Pasha (2022) concluded that Lean-Green has a positive impact on the Tripple Bottom Line (3BL). However, they also noted that some studies reported some negative influence of Lean-Green on sustainable performance, hence, requiring trade-offs. Thus, the impact of Lean-Green on 3BL has not gone entirely one way, hence the need for further research as noted by Machingura *et al.* (2023).

2.4 Hypotheses development

Various studies have indicated that LM and GM are complementary in waste reduction (Dües *et al.*, 2013; Farias *et al.*, 2019). Also, Fercoq *et al.* (2016) highlighted that by reducing waste such as defects and overproduction, organisations are likely to save resources and this supports the Green objective of resource conservation. Consequently, the research by Inman and Green (2018) in US manufacturing companies found that LM positively influences GSCM. Additionally, Green *et al.* (2018) applied JIT and TQM and discovered that they have positive impacts on GSCM. Hence, it can be hypothesised that:

H1: LM has a positive influence on GM

LM's goal of eliminating waste such as defects reduces the damage caused to the environment. LM is a method used to preserve resources and reduce energy use and pollution (Chugani *et al.*, 2017). Consequently, JIT plays an essential role in minimising pollution, waste, and air emissions (Sajan *et al.*, 2017). Studies from the manufacturing industry showed that Lean and environmental performance are positively correlated (Inman and Green, 2018). In addition, Green *et al.* (2018) applied JIT and TQM and realised improvements in environmental sustainability. Sajan *et al.* (2017) applied LM in Indian SMEs and realised a great improvement in environmental sustainability. Thus, it can be hypothesised that,

H2: LM has a positive influence on environmental performance.

LM has an impact on economic performance which is attained through the improvement of performance indicators like cost, quality, productivity and flexibility (Nawanir *et al.*, 2020). In support, Pampanelli *et al.* (2014) pointed out that the primary goal of LM is to increase delivery, enhance quality, and cut costs. Hartini and Ciptomulyono (2015) highlighted that LM is key in attaining improvement in sustainability performance, especially economic performance. The research done by Sajan *et al.* (2017) determined that LM improves economic performance. Also, through Lean adoption, Baumer-Cardoso *et al.* (2020) decreased setup time and energy use and significantly cut expenses. Therefore, we can postulate that,

H3: LM has a positive influence on economic performance.

GM aims to reduce the environmental damage by manufacturing companies through a reduction in gas emissions, solid waste generation, use of hazardous material, and generation of wastewater (Green *et al.*, 2012). Mafini and Muposhi (2017) and Machingura *et al*. (2023) indicated that GM is positively related to environmental performance. The results by Firmansyah and Maemunah (2021) supported the fact that GM improves the environmental performance of organisations. Rehman *et al.* (2013) developed and validated a GM framework that can be used to attain environmental sustainability improvements. GM adoption in Ghana made organisations realise environmental performance improvements (Famiyeh *et al.*, 2018). Consequently, it was hypothesised that:

H4: GM has a positive influence on environmental performance.

Due to the increased awareness of the safety and health of employees and the communities, the social performance dimension is increasingly receiving consideration (Afum *et al.*, 2020a). The adoption of GM reduces environmental pollution such as effluent, emissions and solid waste, thus increasing the health and safety of workers and communities. GM does not focus on improving environmental performance only but also thrives on meeting the expectations of the society (Sezen and Çankaya, 2013). The research conducted by Afum *et al.* (2020a) in Ghana's manufacturing industry concluded that GM led to improved social performance through the reduction of waste, which affects societies. The research by Afum *et al.* (2020b) pointed out that organisations can improve their social performance by adopting GM practices. Thus, we can hypothesise that,

H5: GM has a positive influence on social performance.

The investment in environmental sustainability issues such as reduction in energy, waste, material consumption, and effluent is related to financial improvements (Sajan *et al.*, 2017). Sustainable environmental performance is associated with improved quality, profit, efficiency, and responsiveness (Garza-Reyes, 2015). An improvement in environmental performance by organisations improves the company's image and customer satisfaction, thus impacting market performance (King and Lenox, 2001). In addition, minimisation of waste, emissions, energy and material usage, improves health, comfort and relations with communities and workers (Sajan *et al.*, 2017). Consequently, improvement in workplace safety, employee health, and working conditions increases the motivation and work rate of workers and subsequently, worker's productivity. Additionally, improving working conditions and workplace safety reduces the frequency of accidents, thus, reducing the fines for environmental accidents. Moreover, improved labour relations, community relations and health and safety compliance reduce complaints from workers and communities, which translates to fewer environmental fines. Therefore, it can be postulated that,

H6: Environmental performance is positively associated with economic performance.

H7: Environmental performance is positively associated with social performance.

H8: Social performance has a positive influence on economic performance.

The second-order structural model developed is, therefore, shown in Figure 1.

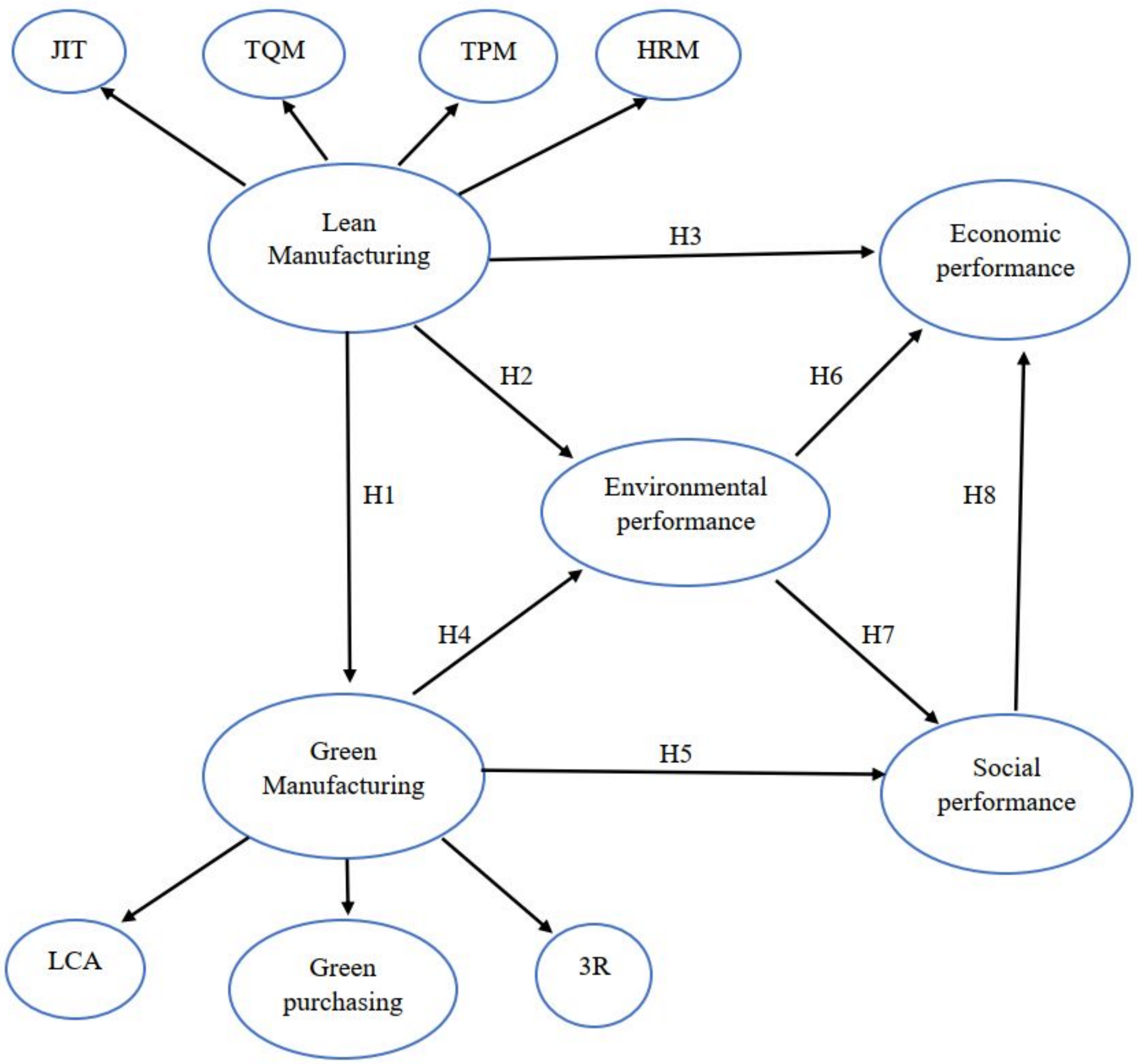

Figure 1: Conceptual model

3. Research design and methodology

3.1 Research philosophy and design

This research made use of pragmatic philosophy. The approach is more positivist in the analysis of the data but makes use of elements of both interpretivism and positivism in the data collection stage. The constructs being measured are abstract, hence needing some measure of personal interpretation of expert opinions of the process improvement techniques and the organisations' performance response to the changes made. However, in order to make the responses as objective as possible, the scale design was carefully constructed to ensure content validity, using established items from previous studies, and cross-validated by industry and academic experts. Also, since Likert scales were used, and the renditions of the qualitative values were based mostly on the changes experienced in items measured, the absolute values are not needed, but the pattern of changes is what is actually important for the correlational analysis.

Consequently, the research design is correlational. A pure empirical research is not adopted here since the researchers do not have control over the input variables, that is the model's manifest variables, but rather, the patterns of movements in these variables for each respondent, and across each item for each respondent can be readily studied to make inferences about the covariances of the items and their latent variables. This suffices for the study, as co-movements of variables offer significant insight into the relationship among the latent variables of interest, and hence, the predictive model of the response variables from the predictors.

The correlational research design is used due to its ability to measure relationships among variables (Curtis *et al*., 2016). It is used to assess whether the change in one variable has an impact on other variables. Also, in correlation design, the research has no option to manipulate the data which suits this research as the latent variables being used are not being observed directly but measured through the observed variables (Seeram, 2019). Based on this we could choose one of the techniques that could fit the research aim, hence our choice of Structural Equation Modelling (SEM) because it is a new generational approach that combines structural modelling, factor analysis and measurement analysis into one model. Also, SEM is best suited for testing multiple relationships between variables (Nunkoo and Ramkissoon, 2012) and estimating the latent variables using the observed variables (Urbano, 2013). Partial Least Square Structural Equation Modelling (PLS-SEM) was used in conducting structural equation modelling because it can process complex models, has little restrictions on sample size (Hair *et al.*, 2017), can work without the traditional data distribution assumptions, and has comprehensive reporting tools (Wong, 2013). Figure 2 shows the research design process.

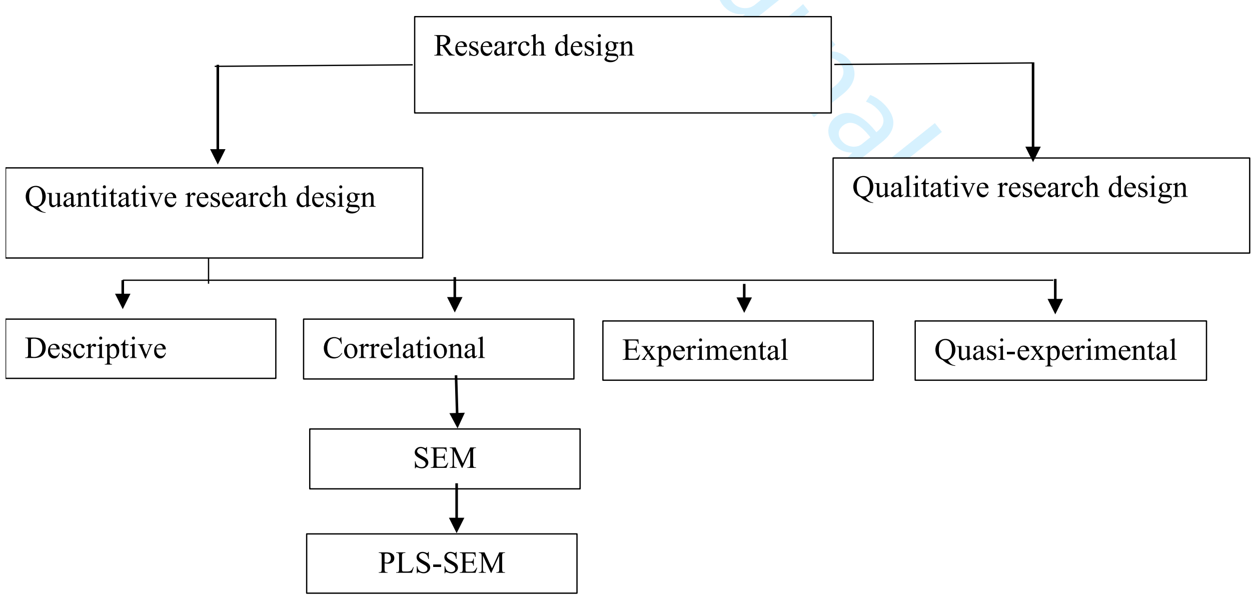

Figure 2: Research design

3.2 Development of the questionnaire

A questionnaire was developed to explore the effect of Lean-Green on sustainable development. The authors adopted the questions that were used by previous studies to increase the validity of the questionnaire, as stated by Murillo-Luna *et al.* (2011); Huo *et al.*(2019) and Shashi *et al.* (2019). There were four sections to this questionnaire. Section 1 covered the company information like number of workers and type of industry, while sections 2 and 3 interrogated the adoption level of LM and GM practices, respectively. Section 4 was concerned with investigating the improvements in social and economic performance that are realised by adopting environmental performance (see Appendix 2). A five-point Likert scale was adopted with ratings varying from 1 to 5, 1 for strongly disagree and 5 for strongly agree. The questionnaire was improved through pretesting by experts from both the manufacturing sector and universities.

3.3 Data collection

Questionnaires were distributed to the Zimbabwean manufacturing firms that are listed by the Confederation of Zimbabwe Industries (CZI) using the drop and pick method. LM and GM have been widely implemented in the manufacturing industry; hence the authors' focus on this industry. The questionnaires were randomly distributed to various companies in this industry to give these companies equal chances to participate (Gbadago *et al.*, 2017) and to collect as much data as possible (Suryoputro *et al.*, 2020). The authors targeted multiple responses from each organisation. Therefore, they dropped two to three questionnaires at each company to counterbalance each other in case of bias, as recommended by Maware and Adetunji (2020) and Machingura *et al.* (2023). People working in management and supervisory positions were invited to complete the questionnaire as they were in a better position to understand the questions being asked (Jabbour *et al.*, 2013). The total number of valid responses was 302. Most respondents (58.9%) were middle managers such as operations managers, Safety, Health and Environment (SHE) managers, and quality managers. Top management, such as the Chief Executive Officers (CEOs) and managing directors, contributed 34.1%, while lower managers, such as production and quality supervisors contributed 7%.

The respondents who participated in the study and their manufacturing sectors are shown in Table 1. Most respondents (29.5%) belong to the food and beverage industry. On the other hand, the automotive and ceramic industries contributed the least number of respondents, 1.7% each.

Table 1: Type of industry

Type of industry	Number of respondents	Sample %
Food and beverage	89	29.5
Chemicals and petrochemicals	24	7.9
Plastic and rubber	33	10.9
Pharmaceutical	6	2.0
Agrochemical	17	5.6
Wood and furniture	19	6.3
Electronics and electrical	27	8.9
Fertilizer	7	2.3
Textiles	15	5.0
Leather	6	2.0
Paper	10	3.3
Ceramic	5	1.7
Steel	13	4.3
Tiles and bricks	11	3.6
Automotive	5	1.7
Battery	7	2.3
Foundry	8	2.6

According to Table 2, 73 respondents specified that their companies have over 350 employees, whereas 37 respondents indicated that their companies have 41-75 employees.

Table 2: Number of employees

Number of employees	Frequency	%
under 41	39	12.9
41-75	37	12.3
76-150	56	18.5
151-250	41	13.6
251-350	56	18.5
over 350	73	24.2

3.4 Non-response bias

Early and late responses method was employed in examining for non-response bias (Kuo and Lin, 2020). The first and last twenty responses were compared using five randomly chosen questions (Maware and Adetunji, 2020; Firmansyah and Maemunah, 2021). The t-tests results indicated that the non-response bias had no significant effect (Chavez *et al.*, 2022).

4. Results and data analysis

4.1 Pre-inferential descriptive summary of data

The first step in Smart PLS is the description of the data to provide the researcher with a comprehensive understanding of the respondent's responses to the survey's questions. Descriptive measures such as median, missing values, mean, minimum, maximum, excess kurtosis, skewness and standard deviation are used (Arijanto and Perkasa, 2020). The indicators had 1 for minimum, 5 for maximum, the biggest value for the missing data is 3, the mean ranged from 3.033 to 4.169, the median ranged from 3 to 4 and the standard deviation ranged from 0.756 to 1.159. Normality test was conducted using skewness and kurtosis. For normally distributed data, the skewness should range from -3 and +3 and kurtosis from -10 to +10 when using SEM (Griffin and Steinbrecher, 2013; Brown, 2015). The skewness and kurtosis were all in the accepted range, hence, while PLS SEM does not really require this, the data was still well within the range required for even other types of analysis or techniques, e.g. Covariance Based (CB) SEM. Appendix 1 shows the values for the descriptive summary of the data.

4.2 Assessment of the measurement model

SEM was conducted using SMART PLS 3. Before the structural relationships could be evaluated, it was imperative to explore data reliability and validity. Thus, the reliability and internal consistency were analysed using composite reliability and Cronbach's alpha, where values > 0.7 indicate that the data is reliable and has a high internal consistency (Nunnally, 1978). All the values for composite reliability and Cronbach's alpha were > 0.7; hence, they were acceptable. Moreover, the Average Variance Extracted (AVE) was employed to examine the convergence validity. Fornell and Larcker (1981) indicated that the AVE values should be > 0.5. Accordingly, the values obtained were all > 0.5; therefore, they are considered acceptable. The reliability and validity results are highlighted in Table 3.

Table 3: Reliability and validity values

	Cronbach's alpha	Composite reliability	AVE
3R	0.852	0.865	0.578
Economic performance	0.857	0.860	0.540
Environmental performance	0.874	0.882	0.611
Green Manufacturing	0.920	0.927	0.508
Green purchasing	0.903	0.907	0.598
HRM	0.787	0.794	0.550
JIT	0.830	0.831	0.543
LCA	0.848	0.853	0.623
Lean Manufacturing	0.929	0.932	0.518
Social performance	0.907	0.910	0.644
TPM	0.837	0.840	0.563
TQM	0.860	0.861	0.507

The discriminant validity of a construct indicates how absolutely unique it is from the other constructs (Hair *et al.*, 2017). The Fornell-Larcker criteria, which compares the square roots of

AVE to the correlations of the latent variables, was used to evaluate the discriminant validity (Fornell and Larcker, 1981). Table 4 indicates that discriminant validity was established as the AVE square roots were greater than their correlations with other constructs (Famiyeh *et al.*, 2018).

Table 4: Fornell-Larcker criterion-discriminant validity

	3R	EP	EVP	GM	GP	HRM	JIT	LCA	LM	SP	TPM	TQM
3R	**0.760**											
EP	0.472	**0.735**										
EP	0.446	0.630	**0.782**									
GM	0.633	0.508	0.496	**0.713**								
GP	0.461	0.362	0.341	0.509	**0.774**							
HRM	0.413	0.413	0.321	0.434	0.334	**0.742**						
JIT	0.439	0.465	0.373	0.582	0.509	0.521	**0.737**					
LCA	0.470	0.383	0.306	0.564	0.660	0.357	0.523	**0.790**				
KM	0.497	0.567	0.486	0.635	0.546	0.573	0.645	0.538	**0.720**			
SP	0.477	0.668	0.585	0.497	0.334	0.401	0.480	0.380	0.551	**0.802**		
TPM	0.387	0.403	0.342	0.465	0.394	0.662	0.648	0.375	0.566	0.383	**0.750**	
TQM	0.339	0.452	0.306	0.531	0.501	0.512	0.648	0.479	0.436	0.402	0.606	**0.712**

EP-Economic Performance, EVP – Environmental Performance, SP – Social Performance

4.3 Structural model assessment

The Variance Inflation Factor (VIF) was used in determining collinearity among the factors. VIF values between 0.2 and 5 suggest there is no collinearity problem (Hair *et al.*, 2017). Consequently, the VIF ranged from 1.293 to 3.548, which were considered satisfactory. R^2 demonstrates how much of the endogenous variable variance is explained by the model (Famiyeh *et al.*, 2018). An R^2 value of 26% is regarded as a large effect, 13% as an average effect, and 2% as a small effect (Cohen, 1988). Figure 3 shows that the model's R^2 values indicated large effects in all its variables.

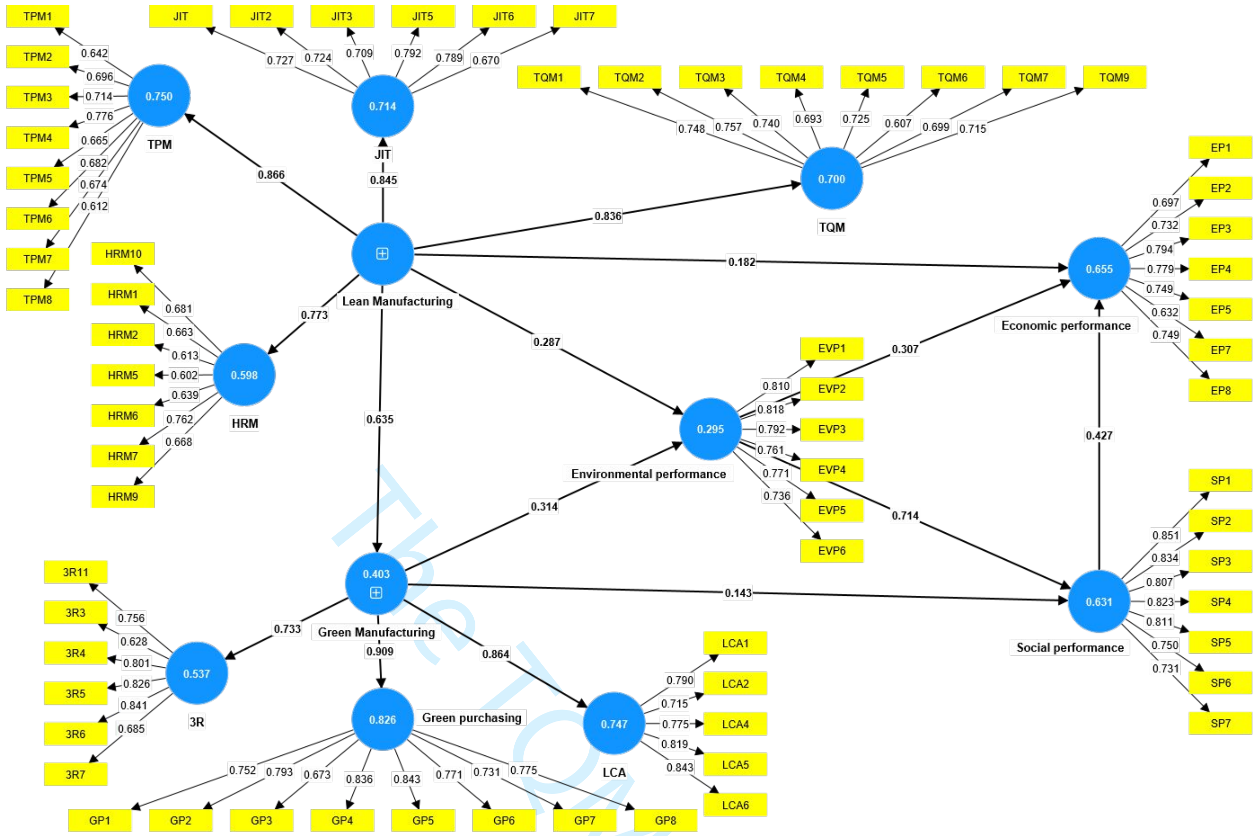

Figure 3: Structural model

The effect size (f^2) and Stone-Geisser (Q^2) values were employed to evaluate the model. The f^2 represents the change in R^2 due to the omission of a specific exogenous variable (Cohen, 1988). The f^2 equal to 0.02 denotes a low effect, 0.15 an average effect, and 0.35 a big effect (Cohen, 1988; Famiyeh *et al.*, 2018). The relationship between LM and environmental performance, between LM and economic performance, between GM and social performance and between environmental performance and economic performance showed medium effects whilst all the other relationships showed a big effect.

The prediction power of the model was assessed using Q^2 (Famiyeh *et al.*, 2018). The Q^2 values were determined through the blindfolding procedure in SMART PLS 3 where values above 0 indicate good predictive relevance (Maware and Adetunji, 2020). As shown in Table 5, the Q^2 values were all > 0, hence the model's predictive significance was high.

Table 5: Q^2 and f^2 values

	f^2				Q^2
	EP	EVP	GM	SP	
Social performance	0.385				0.293
Lean Manufacturing	0.154	0.164	0.676		
Green Manufacturing		0.356		0.151	0.139
Environmental performance	0.337			1.043	0.216

Using the bootstrapping method, the significance of the path coefficients was evaluated by adopting 5000 subsamples (Hair *et al.*, 2017). A t-statistic > 1.96 and a p-value < 0.05 are regarded as significant. Table 6 shows that all the p-values and t-statistics were satisfactory; hence, the hypotheses were supported. Therefore, both LM and GM have positive relationships with environmental performance. On the same note, environmental performance positively influences social and economic performance.

Table 6: Hypothesis decision

	t-statistic	p-values	Hypothesis	Decision
EVP → EP	5.933	0.000	H6	Accepted
EVP → SP	22.533	0.000	H7	Accepted
GM → EVP	3.616	0.000	H4	Accepted
LM → EVP	3.663	0.000	H2	Accepted
LM → GM	12.954	0.000	H1	Accepted
SP → EP	7.671	0.000	H8	Accepted
LM → EP	3.877	0.000	H3	Accepted
GM → SP	3.397	0.001	H5	Accepted

4.4 Importance-Performance Map Analysis (IPMA)

IPMA was employed to assess the importance and performance of the predecessor latent variables with economic performance as the target construct. LM, GM, social performance and economic performance have fairly equal performance as shown in Figure 4. However, environmental performance has the greatest importance of 61.1%. This shows that environmental performance has the greatest impact towards improvement in economic performance. An increase in one unit in the performance of environmental performance will increase economic performance by 61.1%. For social performance, LM and GM, an increase in one unit will increase economic performance by 42.7%, 51.8% and 25.3%, respectively. Thus, the greatest improvement in economic performance is realised by improving the environmental performance.

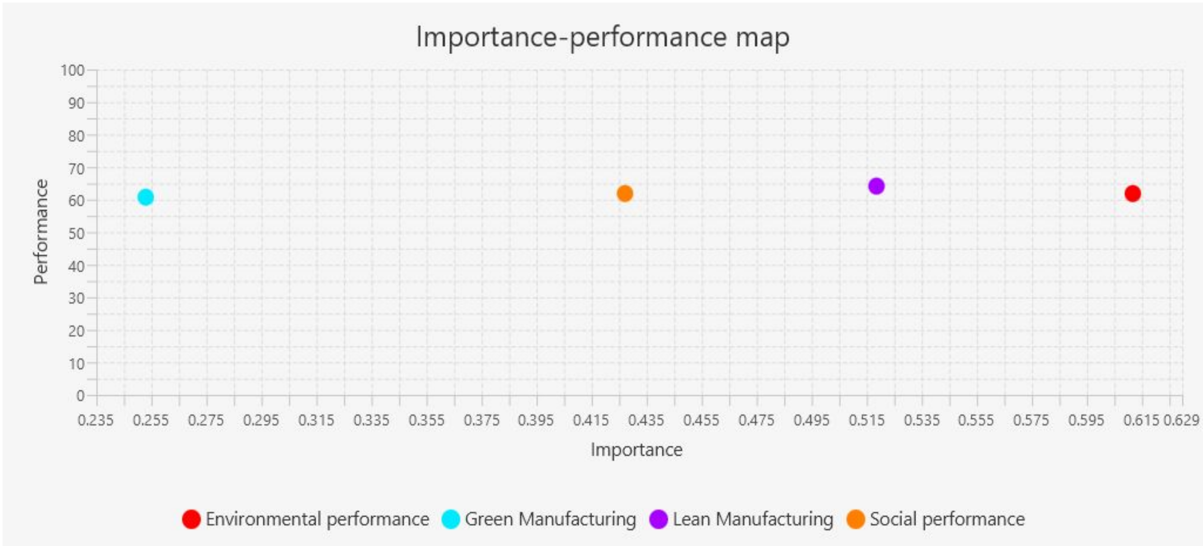

Figure 4: Importance-performance map

4.5 Mediatory impacts

To further understand the importance of environmental performance on economic and social performance, the mediatory effects were analysed. The findings in Table 7 suggest that LM and GM have significant indirect impact on economic and social performance via environmental performance. Thus, environmental performance mediates the relationship between Lean-Green and socio-economic performance. This shows that organisations seeking ways to improve their economic performance should consider improving their environmental performance.

Table 7: Indirect impact results

	t-statistic	p-Values	Decision
LM ⟶ EVP ⟶ EP	3.222	0.001	Significant
LM ⟶ EVP ⟶ SP	6.477	0.000	Significant
GM ⟶ EVP ⟶ EP	2.996	0.003	Significant
GM ⟶ EVP ⟶ SP	8.139	0.000	Significant

Furthermore, analysis was done to expatiate on the contribution of environmental performance towards improved economic performance. This was done by comparing the direct, indirect and total effects of LM, GM, environmental performance and social performance on economic performance. The indirect contribution of environmental performance is almost twice the direct impact of LM implementation. Thus, the environmental performance effect is much more than the direct impact of LM alone. Moreover, the total effect on economic performance is doubled, showing that environmental performance has the potential to double the economic benefit. In fact, the indirect effect of all variables via the environmental factor strongly increases the overall impact of each of the variables, like the LM factor that almost doubles. All this indicates that environmental performance is key in achieving enhanced economic performance.

Table 8: Total effects

	Direct effect	Indirect effect	Total effect
Environmental performance	0.307	0.305	0.611
Social performance	0.427	-	0.427
GM	-	0.253	0.253
LM	0.182	0.336	0.518

5. Discussion

5.1 Strength of the environmental impact

Organisations are beginning to understand the role of environmental performance in improving sustainable performance. However, much work has not been done in quantifying the extent to which it enhances social and economic performance. The results indicated that environmental performance can double the return in economic terms and it also amplifies Lean and Green on economic performance. Thus, the importance of environmental performance on profitability seems to have been understated in many reports as most studies were interested in exploring the direct relationship between environmental and economic performance without exploring further the extent of its indirect impact. Findings from this study suggests that environmental performance is the most important factor significantly impacting both social and economic performances. Therefore, any organisations interested in improving their socio-economic performance have to give proper consideration to their treatment of the environmental factor. When organisations do not have adequate resources, they should channel the available resources prioritising environmental performance to properly leverage their returns. While LM, GM, social and economic performance are at the same level of performance, the level of importance of each of these factors is completely different, with the environmental factor having the greatest importance. The results are consistent with the study by Elshaer *et al.* (2023) which indicated that environmental performance significantly improves economic performance.

5.2 Process improvement

Though organisations are usually more interested in their economic performance, they should know that this can be improved through improvements in environmental performance. In particular, the findings showed that environmental sustainability is key to attaining improved social and economic performances, therefore, sustainable performance can be achieved through good investment in environmentally friendly initiatives. Some companies tend to favour implementing LM more than GM practices in hope that such leads to profitability and economic performance improvement. However, this research demonstrated that organisations could improve their economic performance significantly through improvement in environmental performance due to structured implementation of LM and GM. The findings indicated that improving environmental performance results in better economic and social performance of manufacturing organisations. This agrees with the results obtained by Sajan *et al.* (2017) on the LM model in Indian SMEs and Afum *et al*. (2020a) on the GM model in Ghana's manufacturing industry.

Furthermore, the study demonstrated the positive influence of social performance on economic performance, which agrees with results obtained by Afum *et al.* (2020b) and Afum *et al.* (2020a).

Although the relationship between social performance and economic performance contradicts the Sajan *et al.* (2017) findings, achieving social improvement means workers are healthy and available for work, their safety is guaranteed and conflicts are reduced; thus, they are motivated and encouraged to perform better.

These findings agree with several studies that have reported on the influence of Lean-Green on enhanced environmental performance (Green *et al.*, 2018; Inman and Green, 2018). However, Chen *et al.* (2019) discovered that the association between LM and environmental performance is not supported as the positive effects only apply to specific environmental performance metrics, not to environmental performance as a whole. Furthermore, Hartini and Ciptomulyono (2015) pointed out that issues of social performance have not been widely examined. Hence, this study's findings are more crucial as, in addition to economic and environmental performances, it outlines how social performance is improved by implementing Lean-Green. Thus, it has an impact on the people (social) impact, in addition to profit (economic) and the planet (environmental) impacts.

6. Conclusion

The research investigated how improvements in environmental performance affect economic and social performance. The data was collected in the Zimbabwean manufacturing industry and analysed using SMART PLS 3. The results demonstrated that environmental performance is crucial for enhancing social, and particularly, economic performance. This mediatory role is probably why authors are beginning to realise that joint implementation of LM and GM tends to produce greater impact as a collective, than implementing them individually. Environmental performance has a greater leveraging effect in improving economic performance compared to LM, GM and social performance. Its total effect is greater than other variables, showing that much improvement in economic performance is attained by improving environmental performance through Lean-Green implementation. Although adopting Lean and Green manufacturing practices has implementation costs, there are many benefits associated with the implementation, including improved sustainable and sustained performance. Thus, it is not sufficient for organisations to view environmental management techniques as a mere compliance issue, but rather as a necessity to gain social capital, which also feeds back to their economic gains, and consequently drives up their bottom line.

6.1 Research implications

The research has demonstrated that improvements in environmental performance positively impact social and economic performances. This furnishes managers with knowledge of the leveraging effect of environmentally friendly production. Those hesitant managers, who thought environmental management is only about compliance with regulations and see it only as a cost contributor may realise its impact on their profit goals and desires. IPMA has shown that an increase in one unit of environmental performance will increase economic performance by 61.1% whereas social performance increase by 42.7%, LM by 51.8% and GM by 25.3%. Thus, managers should understand that environmental performance plays a big role in improving economic performance. Hence, the necessary priority should be given to environmental performance, when planning their improvement initiatives. This is important, especially in developing countries such as Zimbabwe that suffer from resource constraints as they are guided on where to channel more resources, and may tend to ignore factors that seem not to have had direct connection to revenue and profit. While implementing environmental friendly policies may have associated costs, the return may still be well worth it.

In Zimbabwe, there are a lot of economic challenges forcing companies to favour adopting those approaches that have a direct influence on profitability. As some companies are scaling down whilst others are shutting down, it is important to exploit all avenues that can improve their profitability. It is therefore important for these organisations not to focus on the approaches that seem to have direct impacts on profits only, but also those having indirect impacts. The study also indicates that researchers should always consider a full analysis of all impacts (total, indirect and direct effects) of all SEM models of factor relationships, rather than simply reporting the direct path weight implications only.

6.2 Limitations and future research opportunities

The study looked at how Lean-Green affected sustainable performance using the data obtained in Zimbabwe, a developing country. A comparison can be made between SMEs and large enterprises, as SMEs seem to lag due to several reasons such as financial constraints. The research can investigate if the size of the organisations can play a moderating role on the effect of Lean-Green on sustainable performance, and in particular, if the environmental impact changes with the nature and size of the organisation. Integration of LM and GM has numerous obstacles, including a lack of resources. Hence, it is helpful to examine the challenges faced in adopting these methodologies and provide viable solutions. This can be done at the country level, as the socio-economic situation is different among countries. The results obtained in this study may not readily generalise to other countries, hence, further research may be required in other country contexts, and the results compared to this.

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Appendix 1

Description of the Data

Name	Missings	Mean	Median	Scale min	Scale max	Observed min	Observed max	Standard deviation	Excess kurtosis	Skewness
HRM1	0	3.549	4.000	1.000	5.000	1.000	5.000	1.014	-0.133	-0.620
HRM2	0	3.695	4.000	1.000	5.000	1.000	5.000	0.873	0.089	-0.387

HRM5	2	3.973	4.000	1.000	5.000	1.000	5.000	0.973	-0.045	-0.777
HRM6	1	3.894	4.000	1.000	5.000	1.000	5.000	0.901	0.802	-0.883
HRM7	2	3.587	4.000	1.000	5.000	1.000	5.000	1.024	-0.067	-0.581
HRM9	2	3.700	4.000	1.000	5.000	1.000	5.000	1.012	-0.434	-0.516
HRM10	0	4.169	4.000	1.000	5.000	1.000	5.000	0.756	2.112	-1.079
TPM1	1	3.618	4.000	1.000	5.000	1.000	5.000	1.116	-0.256	-0.731
TPM2	0	3.470	3.000	1.000	5.000	1.000	5.000	0.989	-0.465	-0.206
TPM3	0	3.983	4.000	1.000	5.000	1.000	5.000	0.926	1.155	-1.074
TPM4	2	3.870	4.000	1.000	5.000	1.000	5.000	0.966	0.238	-0.807
TPM5	2	3.420	3.000	1.000	5.000	1.000	5.000	1.076	-0.573	-0.268
TPM6	1	3.033	3.000	1.000	5.000	1.000	5.000	1.138	-0.910	-0.079
TPM7	1	3.571	4.000	1.000	5.000	1.000	5.000	0.991	-0.417	-0.456
TPM8	0	3.791	4.000	1.000	5.000	1.000	5.000	0.931	-0.127	-0.661
JIT1	2	3.440	4.000	1.000	5.000	1.000	5.000	1.036	-0.470	-0.327
JIT2	1	3.103	3.000	1.000	5.000	1.000	5.000	1.015	-0.665	-0.035
JIT3	2	3.403	4.000	1.000	5.000	1.000	5.000	1.014	-0.364	-0.411
JIT5	0	3.172	3.000	1.000	5.000	1.000	5.000	0.978	-0.528	-0.074
JIT6	2	3.263	3.000	1.000	5.000	1.000	5.000	0.997	-0.505	-0.162
JIT7	1	3.359	3.000	1.000	5.000	1.000	5.000	0.973	-0.508	-0.141
TQM1	0	3.579	4.000	1.000	5.000	1.000	5.000	1.016	-0.344	-0.551
TQM2	0	3.488	4.000	1.000	5.000	1.000	5.000	1.036	-0.470	-0.468
TQM3	1	3.525	4.000	1.000	5.000	1.000	5.000	1.083	-0.398	-0.541
TQM4	0	3.298	3.000	1.000	5.000	1.000	5.000	0.972	-0.393	-0.319
TQM5	2	3.860	4.000	2.000	5.000	2.000	5.000	0.906	-0.427	-0.531
TQM6	0	4.020	4.000	1.000	5.000	1.000	5.000	0.941	0.633	-0.980
TQM7	1	4.017	4.000	1.000	5.000	1.000	5.000	0.917	0.487	-0.943
TQM9	0	3.944	4.000	1.000	5.000	1.000	5.000	0.903	0.767	-0.920
3R3	1	3.678	4.000	1.000	5.000	1.000	5.000	0.964	0.584	-0.837
3R4	2	3.633	4.000	1.000	5.000	1.000	5.000	0.993	0.428	-0.815
3R5	1	3.694	4.000	1.000	5.000	1.000	5.000	0.922	0.909	-0.889
3R6	2	3.647	4.000	1.000	5.000	1.000	5.000	0.987	0.300	-0.768
3R7	1	3.698	4.000	1.000	5.000	1.000	5.000	0.907	0.678	-0.735
3R11	1	3.555	4.000	1.000	5.000	1.000	5.000	0.944	0.257	-0.623
GP1	1	3.458	4.000	1.000	5.000	1.000	5.000	1.055	-0.302	-0.454
GP2	3	3.358	3.000	1.000	5.000	1.000	5.000	1.061	-0.646	-0.231
GP3	1	3.465	4.000	1.000	5.000	1.000	5.000	1.039	-0.382	-0.344
GP4	2	3.063	3.000	1.000	5.000	1.000	5.000	1.125	-0.715	-0.139
GP5	1	3.199	3.000	1.000	5.000	1.000	5.000	1.081	-0.536	-0.242
GP6	1	3.389	4.000	1.000	5.000	1.000	5.000	1.071	-0.688	-0.319
GP7	0	3.163	3.000	1.000	5.000	1.000	5.000	1.159	-0.856	-0.103
GP8	0	3.173	3.000	1.000	5.000	1.000	5.000	1.085	-0.670	-0.113
LCA1	0	3.309	3.000	1.000	5.000	1.000	5.000	1.052	-0.651	-0.174
LCA2	1	3.249	3.000	1.000	5.000	1.000	5.000	1.022	-0.480	-0.102

LCA4	0	3.303	3.000	1.000	5.000	1.000	5.000	1.110	-0.794	-0.254
LCA5	0	3.633	4.000	1.000	5.000	1.000	5.000	0.989	0.021	-0.644
LCA6	1	3.578	4.000	1.000	5.000	1.000	5.000	1.056	-0.371	-0.471
EVP1	1	3.687	4.000	1.000	5.000	1.000	5.000	0.907	0.481	-0.661
EVP2	0	3.838	4.000	1.000	5.000	1.000	5.000	0.840	1.103	-0.798
EVP3	0	3.719	4.000	1.000	5.000	1.000	5.000	0.912	0.471	-0.651
EVP4	1	3.897	4.000	1.000	5.000	1.000	5.000	0.885	0.557	-0.750
EVP5	1	3.870	4.000	1.000	5.000	1.000	5.000	0.855	0.381	-0.614
EVP6	1	3.658	4.000	1.000	5.000	1.000	5.000	0.925	0.260	-0.608
EP1	0	3.907	4.000	1.000	5.000	1.000	5.000	0.817	0.506	-0.634
EP2	1	3.734	4.000	1.000	5.000	1.000	5.000	0.924	0.071	-0.541
EP3	0	3.748	4.000	1.000	5.000	1.000	5.000	0.882	0.403	-0.591
EP4	1	3.724	4.000	1.000	5.000	1.000	5.000	0.904	-0.197	-0.402
EP5	0	3.530	4.000	1.000	5.000	1.000	5.000	0.916	0.546	-0.642
EP7	2	3.733	4.000	1.000	5.000	1.000	5.000	0.854	1.342	-0.847
EP8	2	3.660	4.000	1.000	5.000	1.000	5.000	0.847	0.539	-0.576
SP1	1	3.664	4.000	1.000	5.000	1.000	5.000	0.966	0.615	-0.816
SP2	1	3.857	4.000	1.000	5.000	1.000	5.000	0.860	1.601	-1.009
SP3	0	3.742	4.000	1.000	5.000	1.000	5.000	0.935	0.711	-0.808
SP4	0	3.536	4.000	1.000	5.000	1.000	5.000	1.021	0.302	-0.624
SP5	0	3.368	3.000	1.000	5.000	1.000	5.000	1.049	-0.103	-0.364
SP6	0	3.295	3.000	1.000	5.000	1.000	5.000	1.008	-0.218	-0.383
SP7	0	3.623	4.000	1.000	5.000	1.000	5.000	0.901	0.340	-0.548

Appendix 2

Measurement scale

Construct	Item	Authors
HRM	Our workers undergo cross-functional training.	Iranmanesh et al. (2019); Yadav et al. (2018)
	The opinion and suggestions of the team members are considered before making decisions.	Iranmanesh et al. (2019)
	My firm has multifunctional (multiskilled) workers.	Iranmanesh et al. (2019)
	My firm gives workers a broader range of tasks.	Iranmanesh et al. (2019)
	At our firm, we have an expansion of autonomy and responsibility.	Iranmanesh et al. (2019)
	In our company, the management takes all improvement suggestions seriously.	Abdallah and Phan (2007); Wickramasinghe and Wickramasinghe (2017)

	The employees are encouraged to work together to achieve common goals, rather than competition.	Abdallah and Phan (2007); Dal Pont et al. (2008)
TPM	Our operators are trained to maintain their own machines.	Bortolotti et al. (2014); Yadav et al. (2018)
	Our equipment is always in a high state of readiness.	Yadav et al. (2018); Nawanir et al. (2012)
	We keep the records of routine maintenance.	Yadav et al. (2018); Filho et al. (2016); Kamble et al. (2020); Nawanir et al. (2012)
	We maintain all our equipment regularly.	Bortolotti et al. (2014); Filho et al. (2016); Kamble et al., (2020)
	We dedicate a portion of everyday to planned equipment maintenance related activities.	Filho et al. (2016), Kamble et al., (2020) Nawanir et al. (2012)
	The equipment maintenance records are shared with all the shop floor employees.	Kamble et al., (2020)
	Our operators understand the cause and effect of equipment deterioration.	Bortolotti et al., (2014)
	Our operators inspect and monitor the performance of their own equipment.	Bortolotti et al. (2014)
JIT	Our customers receive just-in-time deliveries from us.	Maware and Adetunji (2019)
	Our suppliers deliver to us on a just-in-time basis.	Kamble et al. (2020); Maware and Adetunji (2019)
	Our company involves all the key suppliers in the process.	Kamble et al. (2020)
	The daily production schedule is met every day.	Maware and Adetunji (2019)
	The daily production schedule is completed on time.	Maware and Adetunji (2019)
	The layout of our shop floor facilitates low inventories and fast throughput.	Maware and Adetunji (2019)
TQM	Our equipment or processes are under statistical quality control.	Maware and Adetunji (2019)
	We use statistical techniques to reduce variance.	Maware and Adetunji (2019)
	The control charts are used to determine whether the manufacturing processes is in control.	Maware and Adetunji (2019) Nawanir et al. (2012)
	The processes in the plant are designed to be “foolproof.”	Maware and Adetunji (2019)
	The process ensures that all parts, materials, information, and resources meet the specifications before use.	Bento and Tontini (2018)

	Our customers give us feedback on our quality and delivery performance.	Bortolotti et al. (2014)
	We undertake programs for quality improvement and control.	Yang et al. (2010)
	Quality problems can be traced to their source and solved without reworking too many units.	Nawanir et al. (2012)
3R	We optimize the processes to reduce solid wastes.	Rao and Holt (2005)
	We optimize the processes to reduce water use.	Rao and Holt (2005)
	We optimize the processes to reduce air emissions.	Rao and Holt (2005)
	We optimize the processes to reduce energy use.	Machingura et al. (2023)
	We optimize the processes to reduce raw material use.	Machingura et al. (2023)
	We design the products for reduced consumption of energy.	Ninlawan et al. (2010); Green et al. (2012)
Green purchasing	We coordinate with the suppliers for environmental objectives.	Ninlawan et al. (2010); Green et al. (2012)
	We perform the environmental audit for suppliers' internal management.	Ninlawan et al. (2010); Green et al. (2012)
	Our suppliers are ISO14000 certified.	Ninlawan et al. (2010); Green et al. (2012); Mafini and Muposhi (2017)
	We choose our suppliers by environmental criteria.	Green et al. (2018).
	We urge/ pressure our supplier(s) to take environmental actions.	Green et al. (2018).
	We provide the design specification to suppliers that include environmental requirements for purchased items.	Green et al. (2012)
	Our products are eco-labelled.	Green et al. (2012)
	Our firm has an environmental purchasing policy in practice.	Hussain et al. (2018)
LCA	We systematically consider customer feedback for eco-design.	Belhadi et al. (2019)
	Our company considers its discharges as a wealth.	Belhadi et al. (2019)
	We recover the company's end-of-life products.	Belhadi et al. (2019)
	We consider the impact of products in their entire lifetime.	Machingura et al. (2023)
	We monitor the environmental impact of the products at all stages.	Machingura et al. (2023)

Environmental Performance	We reduced the air emissions.	Huo et al. (2019); Inman and Green (2018); Kamble et al. (2020); Kenneth et al. (2012); Ninlawan et al. (2010)
	We reduced the solid waste.	Ninlawan et al. (2010)
	We reduced the waste water.	Ninlawan et al. (2010)
	We decreased the consumption of hazardous/harmful/ toxic materials.	Inman and Green (2018); Huo et al. (2019); Hussain et al. (2019); Iranmash et al. (2019); Kamble et al. (2020); Kenneth et al. (2012); Shashi et al. (2019)
	We decreased the frequency of environmental accidents.	Inman and Green (2018); Huo et al., (2019); Kenneth et al., (2012)
	We decreased the energy consumption.	Huo et al. (2019); Hussain et al. (2019); Kamble et al. (2020) Ninlawan et al. (2010); Shashi et al. (2019)
Social Performance	The working conditions improved.	Kamble et al. (2020)
	The workplace safety improved.	Kamble et al. (2020)
	The employee health improved.	Kamble et al. (2020)
	The labour relations improved.	Kamble et al. (2020)
	The workers' morale improved.	Kamble et al. (2020)
	The work pressure decreased.	Kamble et al. (2020)
	The community health and safety improved.	Huo et al., (2019)
Economic Performance	Our profits increased.	Kamble et al. (2020)
	The product development costs decreased.	Kamble et al. (2020)
	The energy costs decreased.	Kamble et al. (2020); Ninlawan et al. (2010)
	The inventory costs decreased.	Kamble et al. (2020)
	The rejection and reworking costs decreased.	Kamble et al. (2020)
	The waste treatment costs decreased.	Kamble et al. (2020); Ninlawan et al. (2010)
	The fine for environmental accidents decreased.	Ninlawan et al. (2010).

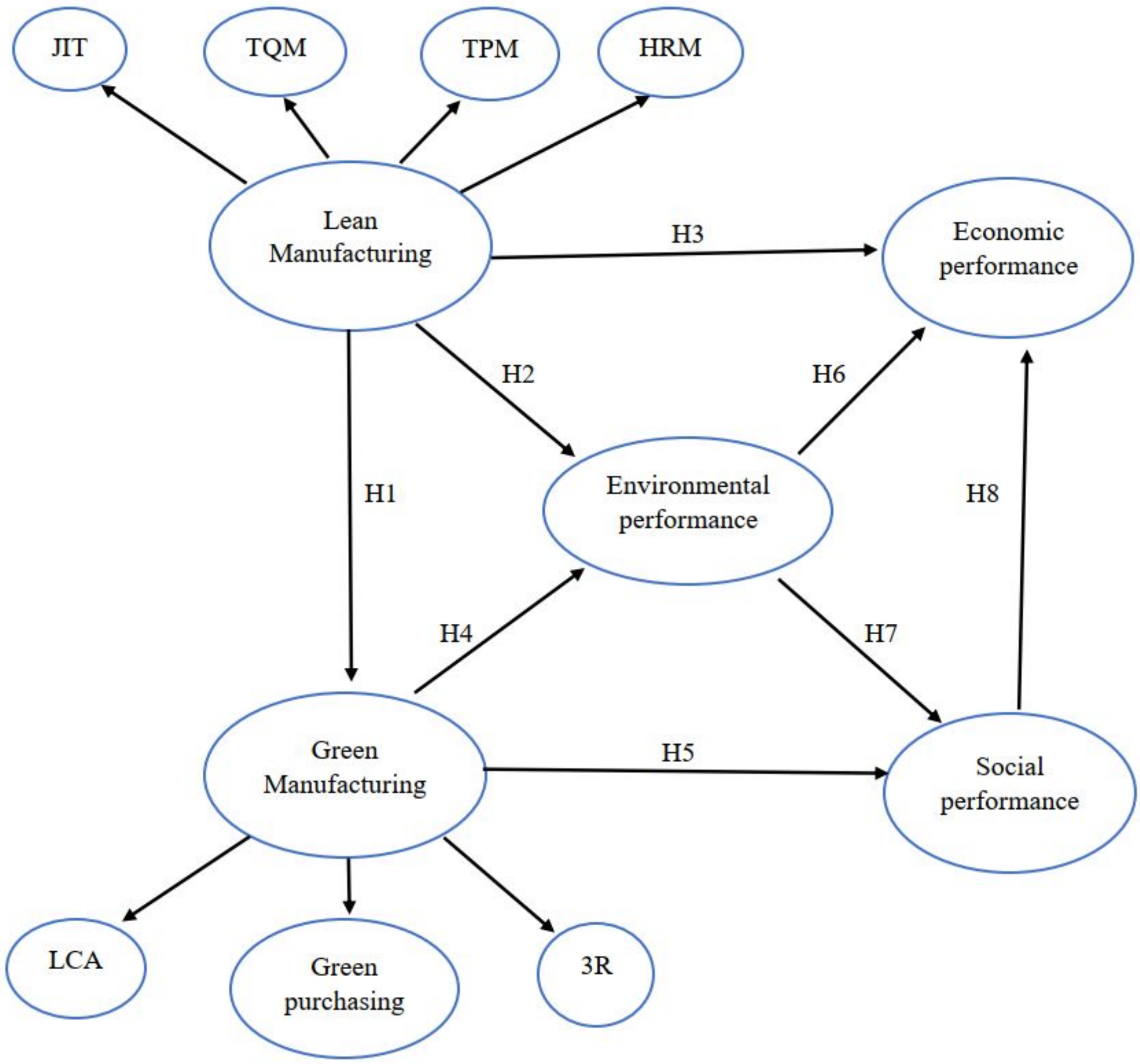

Figure 1: Conceptual model

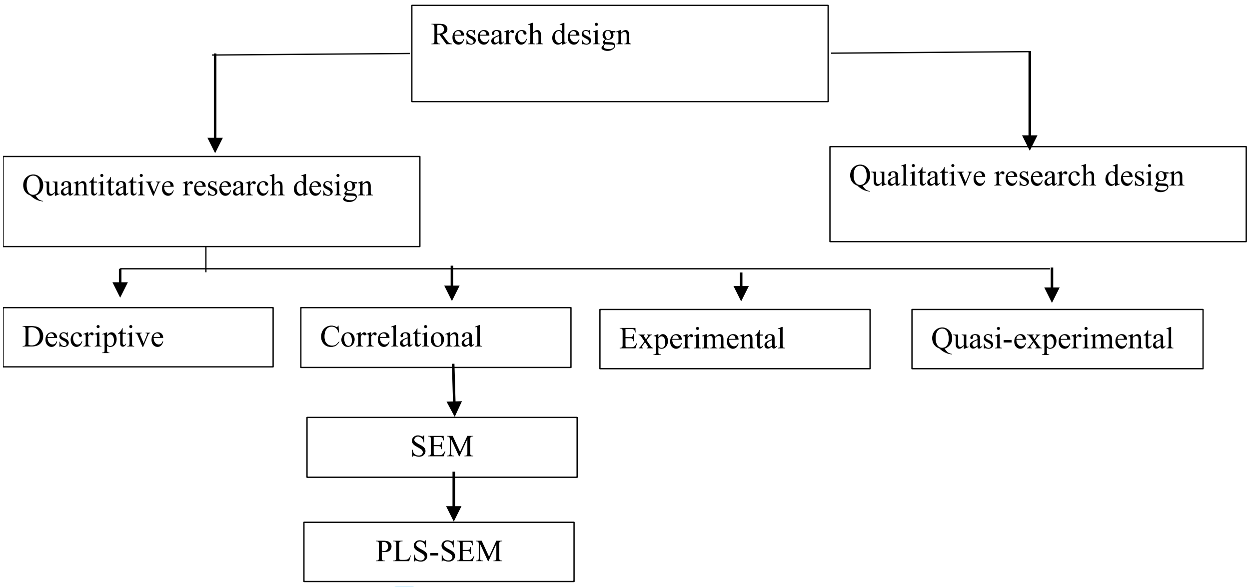

Figure 2: Research design

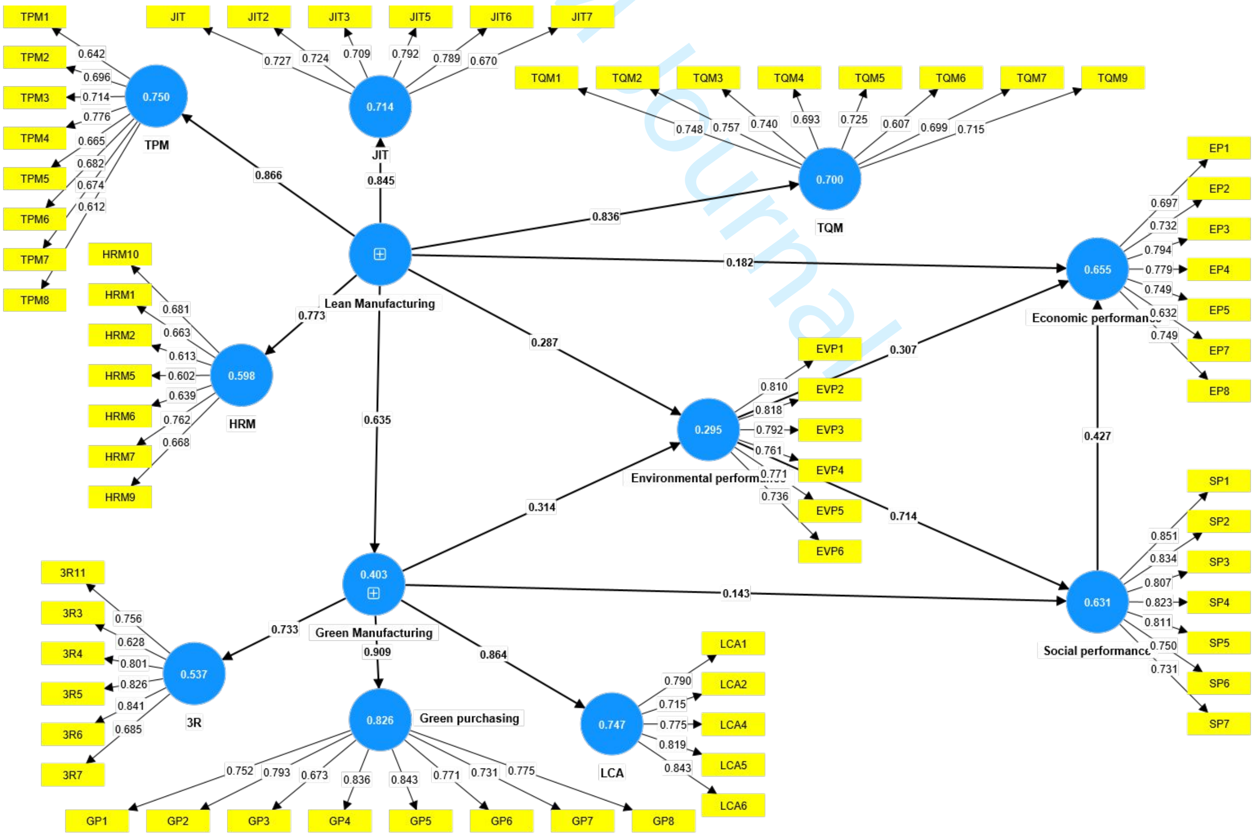

Figure 3: Structural model

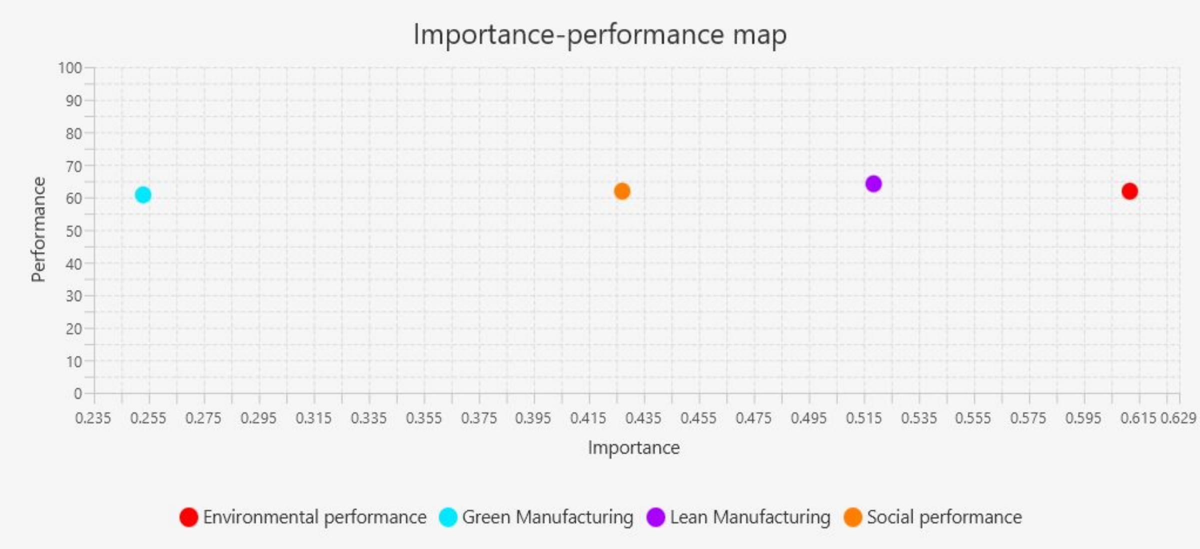

Figure 4: Importance-performance map

Table 1: Type of industry

Type of industry	Number of respondents	Sample %
Food and beverage	89	29.5
Chemicals and petrochemicals	24	7.9
Plastic and rubber	33	10.9
Pharmaceutical	6	2.0
Agrochemical	17	5.6
Wood and furniture	19	6.3
Electronics and electrical	27	8.9
Fertilizer	7	2.3
Textiles	15	5.0
Leather	6	2.0
Paper	10	3.3
Ceramic	5	1.7
Steel	13	4.3
Tiles and bricks	11	3.6
Automotive	5	1.7
Battery	7	2.3
Foundry	8	2.6

Table 2: Number of employees

Number of employees	Frequency	%
under 41	39	12.9
41-75	37	12.3
76-150	56	18.5
151-250	41	13.6
251-350	56	18.5
over 350	73	24.2

Table 3: Reliability and validity values

	Cronbach's alpha	Composite reliability	AVE
3R	0.852	0.865	0.578
Economic performance	0.857	0.860	0.540
Environmental performance	0.874	0.882	0.611
Green Manufacturing	0.920	0.927	0.508
Green purchasing	0.903	0.907	0.598
HRM	0.787	0.794	0.550
JIT	0.830	0.831	0.543
LCA	0.848	0.853	0.623
Lean Manufacturing	0.929	0.932	0.518
Social performance	0.907	0.910	0.644
TPM	0.837	0.840	0.563
TQM	0.860	0.861	0.507

Table 4: Fornell-Larcker criterion-discriminant validity

	3R	EP	EVP	GM	GP	HRM	JIT	LCA	LM	SP	TPM	TQM
3R	**0.760**											
EP	0.472	**0.735**										
EP	0.446	0.630	**0.782**									
GM	0.633	0.508	0.496	**0.713**								
GP	0.461	0.362	0.341	0.509	**0.774**							
HRM	0.413	0.413	0.321	0.434	0.334	**0.742**						
JIT	0.439	0.465	0.373	0.582	0.509	0.521	**0.737**					
LCA	0.470	0.383	0.306	0.564	0.660	0.357	0.523	**0.790**				
KM	0.497	0.567	0.486	0.635	0.546	0.573	0.645	0.538	**0.720**			
SP	0.477	0.668	0.585	0.497	0.334	0.401	0.480	0.380	0.551	**0.802**		
TPM	0.387	0.403	0.342	0.465	0.394	0.662	0.648	0.375	0.866	0.383	**0.750**	
TQM	0.339	0.452	0.306	0.531	0.501	0.512	0.648	0.479	0.836	0.402	0.606	**0.712**

EP-Economic Performance, EVP – Environmental Performance, SP – Social Performance

Table 5: Q^2 and f^2 values

	f^2				Q^2
	EP	EVP	GM	SP	
Social performance	0.385				0.293
Lean Manufacturing	0.154	0.164	0.676		
Green Manufacturing		0.356		0.151	0.139
Environmental performance	0.337			1.043	0.216

Table 6: Hypothesis decision

	t-statistic	p-values	Hypothesis	Decision
EVP → EP	5.933	0.000	H6	Accepted
EVP → SP	22.533	0.000	H7	Accepted
GM → EVP	3.616	0.000	H4	Accepted
LM → EVP	3.663	0.000	H2	Accepted
LM → GM	12.954	0.000	H1	Accepted
SP → EP	7.671	0.000	H8	Accepted
LM → EP	3.877	0.000	H3	Accepted
GM → SP	3.397	0.001	H5	Accepted

Table 7: Indirect impact results

	t-statistic	p-Values	Decision
LM → EVP → EP	3.222	0.001	Significant
LM → EVP → SP	6.477	0.000	Significant
GM → EVP → EP	2.996	0.003	Significant
GM → EVP → SP	8.139	0.000	Significant

Table 8: Total effects

	Direct effect	Indirect effect	Total effect
Environmental performance	0.307	0.305	0.611
Social performance	0.427	-	0.427
GM	-	0.253	0.253
LM	0.182	0.336	0.518