Green Supply Chain Management Practices of Indian Manufacturing Firms

C. Ganesh Kumar and G. Mathan Mohan

This study aims to empirically investigate the green supply chain management (GSCM) practices among manufacturing firms. Primary data for the research study were collected from 62 executives of ISO1400 certified manufacturing firms through structured questionnaire and the proposed conceptual model were tested using Structural Equation Modeling. The result shows that internal environmental management, green purchasing and eco-design have higher positive relationship with Green supply chain practices of manufacturing industry.

Keywords: Green Supply Chain Management, Path Modeling, Manufacturing Industry

1. Introduction

Green supply chain management (GSCM) is emerging as an imperative organizational concept to facilitate organizational performance and effectiveness by plummeting environmental risks and bearings by refining their ecological competence. Organizations all over the globe are striving hard to enhance their competitiveness through novel and pioneering means (Srivastava, 2007). Environmental and Supply Chain Management have assumed indispensable proportions in the recent past for competitiveness and success of any organization. Multinational companies have established distribution channels worldwide to avail the economies of operating in specific country-industry and thereby build competitive advantage (Seuring and Muller, 2008).Furthermore, stern legislative protocols and enhanced awareness on the part of consumers and public on environmental issues, industrialists are forced to effectively assimilate environmental apprehensions into their routine businesses and formulation of strategic plans and policies. For instance, In India, Procter & Gamble produces incense sticks while Tata Motors pavement bricks as by-products from the wastes generated from their routine production activities (Sangameshwaran, 2013 & Bajdor and Grabara, 2011). Modern day industrialists have recognized the importance of assimilating environmental concerns and

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Supply Chain management to win and preserve competitive advantage and enhance their organisation's performance. Hence, in addition to business managers, academicians and consultants have started attaching paramount importance to the concept of Green SCM (Sarkis et al, 2011). Similarly, numerous organisations have started recognizing the importance of Green SCM to facilitate building a viable competitive superiority for their products over their rivals in an extensively competitive market environment (Hervani et al, 2005). Hence, this research work aims to study the concept of Green SCM of manufacturing firm. The paper begins with an exploration of prior studies on various aspects relating to GSCM and based on which a theoretical model of GSCM is constructed in section 2. Section 3 throws light on the Methodology used to test the conceptual model using structural equation modeling (SEM).Section 4 highlights the results of this study., Finally, sections 5 and 6 provided the results and discussions by summarizing the findings and highlighting the implications and limitations of the study.

2. LITERATURE REVIEW

Preemptive and principal manufacturing enterprises are utilizing Green SCM as their operational management tool to accomplish their desired goal. GSCM practice operation arrays from green purchasing to reverse logistics. Numerous definitions may be quoted for Green SCM (Zhu et al, 2008 & 15. H s u et al, 2013). Srivastava (2007) talks about various facets to measure GSM practice operation, i.e materials acquisition, preproduction, production, use, distribution, and disposal. Sarkis (2011) established a strategic decision outline for operationalization of GSCM practices to appraise alternatives implemented by enterprises which might have an effect on their exterior associations with suppliers and customers and Zhu and Sarkis (2004) examined the link between GSCM practices operationalisation and performance, focusing on the moderating effects of quality and just-in-time (lean) practices and Zhu et al (2007) conducted a study on some 314 Chinese business enterprises and arrived at clusters of GSCM pressures, practice and performance. Based on previous studies, Zhu et al (2008) formulated and authenticated the GSCM practices and conceptualized five dimensions namely, Internal environmental management, Green purchasing, Cooperation with customers, Eco-design and Investment recovery. These dimensions have been used in this research work. Fig. 1 portrays the Green SCM of manufacturing enterprises framework developed in this research.

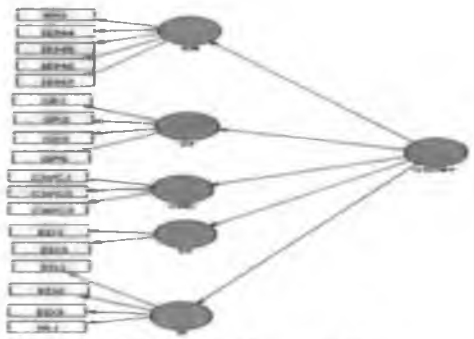

Fig. 1.**Research Framework**

2.1. Research hypotheses

H1: There is positive relationship between Eco-design, Green purchasing, internal environmental management, Cooperation with customers, Investment recovery and green supply chain practices of manufacturing industry.

3. RESEARCH METHODOLOGY

The proposed research is casual in nature; Primary data have been collected by administering personally, a well structured interview schedule to executives of 62 manufacturing enterprises, which were selected at a random from the list of ISO14000 certified manufacturing enterprises obtained from the Department of Industries and Commerce, Government of Tamil Nadu. It was ensured that the executives selected for this study were highly knowledgeable about the operations and supply chain management of their respective enterprises. Content validity is absolutely necessary for any measurement instrument which can be ensured only if the measurement items used in the instrument cover major portion of the constructs proposed to be studied (Hair et al, 2009). The response of the business executives about GSCM practices of their enterprises were collected using a Likert's five point scale and collected data were analysed using the statistical techniques of PLS path analysis using SmartPLS software, which is based on variance rather than covariance base statistical tool. PLS is the suitable analytical tool for this study due to some reasons. First, in PLS, minimum of three items is sufficient to measure a construct, while in covariance-based approaches, a minimum of four variables are required. Secondly, PLS needs no normality assumptions and handles minimum sample size of 30 (Hair et al, 2014)

4. RESULTS FOR THE MEASUREMENT MODEL

First part of the analysis shall test the reliability and validity of the constructs used, while in the second step, the relationship among the dimensions

of green supply chain practices are established by testing the significant value and assessing the overall model fit.

4.1. Reliability and Validity of constructs

To begin with, the internal consistency reliability is checked using the traditional criterion of Cronbach's alpha, which provides an estimate for the reliability based on the indicator intercorrelations. The PLS path model uses composite reliability. Composite reliability takes into account that indicators have different loadings and can be interpreted in the same way as Cronbach's alpha. Irrespective of usage of different reliability coefficient, an internal consistency reliability value above 0.6 is satisfactory (Hair et al, 2009)Table 1 displays the values of Cronbach's alpha and composite reliability, which seems to exceed the minimum requisite of around 0.6, which establishes the internal consistency and reliability of the proposed measurement model. Furthermore, validity of the model can be assessed using convergent validity and discriminant validity. The former certifies that the variables used (known as observed variables) represent the construct (known as Latent variable) adequately. Hair et al (2012) suggested that the average variance extracted (AVE) and the factor loadings in respect of the items should be around the 0.5, indicating that the observed variables are able to explain at least 50% of the Latent variable, signifying there is sufficient convergent validity. Table 1 portrays the factor loadings and AVE measurements of each constructs. It can be seen that there is a strong convergent validity as all the values exceed the threshold limit of 0.5. The next step is to test the discriminant validity, for which the square roots of AVE for individual constructs exceed the correlation between a construct and any other construct. Table 2 displays the correlation between constructs with square root of the AVE on the diagonal. Since all the diagonal values exceed the inter-construct correlation, discriminant validity is proved and it can be inferred from the two tables that the constructs possess both discriminant and convergent validity, and hence it can be concluded that adequate construct validity exists in respect of the data collected.

Table 1. **Factor Loadings, Reliability and AVE and of Constructs**

Constructs	Factor Loadings Range	AVE	Composite Reliability	R Square	Cronbachs Alpha
Cooperation with customers(CWC)	0.76-0.80	0.61	0.82	0.86	0.68
Eco-design(ED)	0.50-0.92	0.58	0.79	0.85	0.60
Green purchasing(GP)	0.62-0.80	0.48	0.82	0.91	0.72
Internal environmental management (IEM)	0.60-0.76	0.53	0.88	0.91	0.85
Investment recovery (IR)	0.72-0.94	0.70	0.81	0.62	0.59

Table 2. **Results of Discriminate Validity**

Constructs	AVE	Square AVE	CWC	ED	GP	IEM	IR
Cooperation with customers(CWC)	0.61	0.57	0	0	0	0	0
Eco-design (ED)	0.58	0.62	0.5	0.6	0	0	0
Green purchasing (GP)	0.48	0.53	0.4	0.5	0.6	0.6	0
Internal environmental management (IEM)	0.53	0.52	0.3	0.5	0.6	0.6	0.5
Investment recovery (IR)	0.7	0.43	0.3	0.5	0.6	0.5	0.5

The individual path coefficients of the PLS structural model can be interpreted as standardized ? coefficients of ordinary least squares regressions. The result of the structural model analysis is portrayed in Figures 2 while Table 3 depicts the relationship between constructs of GSCM practices and the results of path model using PLS structural equation modeling has been portrayed in the following part.

4.2. Results for the structural model

The theoretical framework illustrated in Figure 2 has hypothesized relationships among the constructs of Green SCM Practices of the manufacturing enterprises. The results exhibit that all the measurements have significant loadings to their corresponding construct. It may be noted that even though all the t-values of the measurements are significant at 0.05 level, their loadings (r-value) to the corresponding construct are different.

Figure 2 **Results of Research Framework**

Results of path analysis relating to the testing of the hypotheses are displayed in Table 3.

Table 3. **Path analysis results**

Path between Constructs	Path coefficients	T Statistics	Results
GSCMP -> CWC	0.93	75.1	Supported
GSCMP -> ED	0.92	74.62	Supported
GSCMP -> GP	0.96	90.02	Supported
GSCMP -> IEM	0.96	86.13	Supported
GSCMP -> IR	0.79	35.21	Supported

**p <0 .01, **p <0.05*

Fig.2 portrays the five relationships of among GSCM practices and the relationships have been represented in tabular form in Table 3. The beta value and t-value displayed by the table in respect of the five relationships establish that GSCM has positive relationship with Eco-design, Green purchasing, internal environmental management, Cooperation with customers and Investment recovery of manufacturing industry.

5. CONCLUSION AND IMPLICATIONS OF THE STUDY

Many organizations have understood the importance of implementing GSCM practices. However, they have been incapacitated to implement such practices due to lack of understanding of the inclusive components of such GSCM practices. This study will be of immense utility to business managers to tide over this delicate situation. Furthermore, this study has clarified that dimension of eco-design, green purchasing, internal environmental management, Cooperation with customers and Investment recovery are positively related to the green supply chain practices of manufacturing industry and this research paper provides empirical justification for a framework that identifies five key dimensions of Green SCM practices, and describes the relationship among their five dimensions of manufacturing enterprises. The results indicate that if manufacturing wants to improve their Green supply chain practices, they should give more emphasis on these factors, internal environmental management, green purchasing, and eco-design practices in manufacturing industry to improve their green supply chain performance.

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