

Applying Structural Equation Modeling for Green Supply Chain in Retail Domain

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Abstract

The purpose of the research was to analyse the impact of Green Supply Chain Management (GSCM) initiatives, currently present in the retail domain in South India, on the economic performance and competitiveness of the retail companies. The GSCM concepts can be implemented in inbound, internal, and outbound stages of the retail supply chain. The research examines each of these functions separately and determines its impact on the overall performance. For this purpose, a conceptual model was developed from literature sources and data collected using a structured questionnaire circulated among mid-size retail firms in Southern India. Thereafter, a confirmatory model was tested using structural equation modeling to validate the conceptual hypothesis. The analysis identified that greening the different phases of the supply chain leads to an integrated green supply chain, which ultimately leads to competitiveness and economic performance. The research findings suggest that if the retail firms green their supply chains not only would they achieve substantial cost savings, but also enhance sales, market share, and exploit new market opportunities which lead to greater profit margins, all of which contribute to the economic performance of the firm.

Keywords: Structural Equation Modelling, Economic Performance, Competitiveness

Introduction to Green Supply Chain

Green Supply Chain Management (GSCM) has grown in popularity in the last few years. The concept is about giving

more concern to the environment and its sustainability while considering the supply chain. GSCM is applying Green principles to the various processes of the supply chain such as usage of environment friendly materials, recycling products, where ever possible, and reducing the usage of certain chemicals which have adverse effects on the environment. Few of the benefits of GSCM are cost reduction, increased efficiency, resource sustainability, public relations benefits, adapting to regulation and risk reduction, and improved quality of products. All the same, the primary objective of GSCM is greening the environment through making all operations of suppliers, distributors, waste handlers, transporters and all other business partners, as environment friendly as possible.

The economic success of some of the biggest firms has been attributed to their efficient supply chain management. Retail chains like Wal-Mart, P&G have been able to drive their profits up significantly by managing their supply chains. Firms have moved from a traditional supply chain model which involves all parties working independently, to a highly integrated system wherein all the involved parties including suppliers and customers work closely with the purchasing, production, and distribution departments.

The supply chain systems which exist in the organised retail sector in India should ideally be like a well woven partnership between the retailer (customer) and the manufacturer (supplier). If this is achieved, it will create supply chains that are efficient with minimum losses. The challenges found in organised retail supply chain in India comprises problems in product sourcing, transparency issues, lack of specialised skills, improper man power management, existence of inefficient kirana stores,

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multiple taxes, inadequate infrastructure, real estate cost, quick response, customer loyalty, high connectivity, operational cost, forecasting etc. (Rajwinder, Bhirmaya, 2011). These may be classified as strategic challenges, environmental challenges, customer challenges, and supply chain (SC) challenges (Rajwinder *et al.*, 2011). The fragmented and un-integrated nature of supply chains in India affect the availability of various essential products needed by consumers. For instance in the organised retail sector in India the availability of fresh produce (vegetables and fruits) is very small. This is so for the nature of supply chain is very unorganised and fragmented. This shows the important role supply chains play in the organised retail sector in India. In the organised retail market in India, the role of supply chain is also very important because the Indian customer demands at affordable prices a variety of product mix. The supply chain ensures to the customer that all the various product offerings are available at reasonable price, in good service condition and in the promptness in responding to ever changing tastes of the customer.

Recently, this integration of the supply chain has taken yet another dimension and the focus of supply chain management is gradually shifting from supplying at minimum cost to supplying materials sustainably. Thus it is important for the integrated supply chain not only to deliver at best prices, best quality and at best possible variety but also in a manner that the products offered are environmentally sustainable. In addition the integrated supply chain which aims to be sustainable must also make sure that in all phases of the supply chain the materials are environment friendly and the production processes are clean and green (Corbett & Kleindorfer, 2003) and operations and sustainability (Kleindorfer *et al.*, 2005). In India, environmentally and socially responsive supply chains are in the early adoption stages. A number of companies are realising the need to 'go green.' Customers are the key drivers, especially if they are large well known multinational companies and they want to know how the products are made, what impact future environmental legislations will have on the products they buy. Practitioners with this knowledge and a vision suggest that there is a need for the business to be environmentally sustainable and to communicate this effort to their customers, partners and the public.

However, the question remains whether greening the supply chain will be economically profitable for the

business and how much will it affect competitiveness in the market. Literature reviews have shown that adopting techniques to green the supply chain leads to improved efficiency and performance. By re-evaluating a company's supply chain, from purchasing, planning, managing the use of materials to shipping and distributing final products, savings are often identified as a benefit of implementing green policies.

Introduction of GSCM in companies is often expected to increase its performance with several benefits. These could be lowered costs, efficient production system, less wastage, sustainability of resources, positive impact on financial performance, product differentiation & competitive advantages, risk reduction and conforming to local, and international regulation (Cervera & Flores, 2012). This research was targeted at studying the impact of greening the supply chain on a company's economic performance and competitiveness.

Components of Green Supply Chain

Greening the Inbound Function

The inbound phase of supply chain in general comprises various activities or actions required before the production or processing of goods and services begin. These include sourcing and handling of raw materials or merchandise, storage & inventory control, and all activities related to suppliers and procurement of materials. As far as the retail industry is considered, inbound activities are related to the procurement of merchandise goods from the manufacturers and producers. The activities related to implementing green methods in the inbound activities of a supply chain are considered as greening the inbound function. The relationship between the greening of inbound function, along with greening the internal/production and greening the outbound phases is researched through this paper with respect to their impact on competitiveness and economic performance.

The literature reviews shows that green sourcing and encouraging green suppliers leads to internal green product, process and managerial innovations, which in turn enhance competitive advantage (Chiou, Chan, Lettice, & Chung, 2011). The study suggests that the firms should work closely with suppliers both upstream and downstream for a better environmental goals and sustainability. Also it mentions that the companies, in their

effort to green the inbound function, should try to provide adequate technical support, assistance and guidance to suppliers so that they can implement environment friendly systems and processes and to organise environmental awareness seminars or training sessions which will lead to environmental performance which can give the firms a competitive advantage in the global market and hence greater economic performance.

According to Wang, Tian and Hu (2005) suppliers serve to be one of the most important players in the supply chain in maintaining the Green Supply Chain management to remain competitive. The study conducted an empirical analysis and has empirically verified the positive relationship between the competitive advantage of the manufacturer in winning orders and his criteria in selecting suppliers. Even if one of the suppliers fails in conforming to the Green methods, GSCM will not yield required success in competitiveness and economic performance. Su-Lee (2008) study shows that environmental requirements and support of buyers were positively correlated to their suppliers' willingness to participate in GSCM initiatives.

Greening the Internal / Production Function

The internal function, which also refers to production function, relates to the greening activities done as part as the firms initiatives towards the environmental sustainability. It basically includes cleaner production, efficient waste management techniques, cost reduction, eco efficiency etc. which are directly related to the firm. If this function is made environment friendly and sustainable, it is then referred to Green operations as well. When the retail industry is concerned, the internal activities can be green design, internal product delivery system, greening in internal transports, internal packaging (using less packaging materials) & ecolabelling, store management etc.

Green design is defined by Fiksel (1996) as the systematic consideration of product and process design issues associated with environmental safety and health over the full product life cycle. This would encompass the processes during new production and process development. It includes many disciplines, including environmental risk management, occupational health and safety, product safety, pollution prevention, resource conservation, and waste management all of which can ultimately lead to environmental and economic performance.

Green operations therefore, include activities related to product manufacture/remanufacture, usage, handling, logistics, and waste management. These activities are carried out once the design has been finalised (Lund, 1984). There exists research that shows consumers in certain segments are prepared to pay more for environment friendly goods (Thompson, 2007), though many other researchers disagree. Thompson says that by implementing relatively simple steps it is possible to save between 10 and 25 percent of energy costs. This is encouraging because this would be affordable for small retailers. He stresses that retailers should focus on the energy savings by switching over to low energy devices and usage of green energy. He also suggests easy techniques which can be implemented by retailers such as green home delivery by usage of electric cars, online sales which will reduce carbon print and green travel plans etc.

There are several other techniques which can be used in retail sector like green lease as described by Sinreich (2009). He describes green lease as one that provides for the sustainable construction, operation and renovation of a property and allocates the costs, benefits and responsibilities for sustainability in a manner that facilitates achievement of the desired green results.

The paper explores if (a) inbound function directly and positively impacts internal function

Greening the Outbound Function

Outbound logistics consists of activities involving distribution of finished product, material handling after production, order fulfilment, packaging, transportation, warehousing, and retailing of finished products to the ultimate consumer. (Davison, 2008)

Currently, most products in the market come in a form of packaging that prevents the product from damage and makes the product easy to handle. The use of packaging whether, it is made of glass, metal, paper or plastic, contributes heavily to the solid waste stream (Rao & Holt, 2005). Few of the areas where greening can be introduced in outbound logistics are environment friendly packaging, taking back packaging, wherever possible, environment friendly transportation, and environment friendly waste management.

The benefits of Green Supply Chain approach to industrial packaging are significant. In addition to environmental

benefits, these also include savings in packaging, waste disposal as well as other efficiencies (Verghese & Lewis, 2007). Eco-friendly packaging offers a vast potential for the Indian manufacturing companies in terms of cost reduction and resource conservation. With a growing consumer demand, limited resource availability and high wastage rate (40%), manufacturing companies will have to focus on sustainable as well as lean & green packaging alternatives. While some progressive steps have been taken by companies in this direction, the sector is still at a very nascent stage in India. The packaging companies in India have the potential to innovate and develop sustainable practices (Dharmadhikari, 2012).

The design of a logistics network and its planning are two of the more strategic issues facing logistics managers in this function. Some of the design and management criteria that support environmental planning in this area include fewer shipments, less handling, shorter movements, more direct routes, and better space utilisation. But, each of these issues includes trade-offs among delivery time, responsiveness, quality and cost, as well as environmental performance. Warehousing and delivery packaging design are two important issues in outbound (and inbound) logistics and distribution (Wu & Dunn, 1995). Standardised reusable containers, good warehouse layouts, easy information access all cut storage and retrieval movements and save on operating costs and are environmentally sounder (Toke, Gupta & Dandekar, 2012)

The paper explores if (b) inbound function directly and positively impacts outbound function.

- (c) Internal function directly and positively impacts outbound function.

Competitive Advantage

Competitive advantage is a phenomenon under which companies occupy some niche positions where their competitors cannot imitate their business strategies and they can gain significant market benefits (Porter, 1980; Porter & van der Linde, 1995). In the context of green supply chain it is expected that companies that have high environmental ethics and standards can not only avoid the troubles that come with environmental protection protests, but also improve their corporate images leading to competitive advantage (Chen *et al.*, 2006). Greening

of supply chain brings about significant cost savings and resource conservation. These lead to competitive advantage in terms of cost. Also companies can acquire a competitive edge with respect to competition with the support of green initiatives which will change the perception of customers towards the firm and its products. Environmental sustainability image of the company can be treated as an intangible asset which will improve the goodwill of the company. The empirical results demonstrate that corporate environmental ethics positively affects corporate competitive advantage (Chang, 2011). Also competitiveness is expected to be directly related to the economic performance of the company in the future.

Greening effects of the inbound, internal, and outbound segments of the retail supply chain can be evaluated through the increase in the competitive advantage given to the company. The correlation between the competitive advantage and the economic performance can also be revealed as part of this study.

The paper also explores if

- (d) Greening inbound function directly and positively impacts competitive advantage.
- (e) Greening internal/production function directly and positively impacts competitive advantage.
- (f) Greening outbound function directly and positively impacts competitive advantage.

Economic Performance

For an organisation the industry perception of its economic performance and benchmarking is very essential for positioning and also identifying the 'best practices' for an organisation in an industry. Thus it becomes critical to measure the various processes in Green Supply Chain in terms of economic performance.

Measuring performance and utilising metrics have an important role to play in setting objectives, evaluating performance, and determining future courses of actions. All the same performance measurement and metrics pertaining to supply chain practices have not received adequate attention from researchers or practitioners (Gunasekaran, Patel & McGaughey, 2004). Of the few existing research pertaining to the topic one may mention the work on environmental indicators across a green supply chain which have been found to lead to

environmental performance (Rao, 2014).

To meet efficiency and market demand objectives, the output of the processes enabled by the supply chain must be measured and compared with a set of standards. In order to be properly executable, the process indicator values need to be kept within a pre-assigned limit which remains relatively constant. This will allow comparison of planned and actual indicator values, and once done, the parameter values can be influenced through certain reactive measures in order to improve the performance or re-align the monitored value to the specified value (Gunasekaran *et al.*, 2004).

Research and studies have shown that greening the various phases of supply chain contributes to improved economic and environmental performance. But greening all the phases need not necessarily impact financial performance. The extents to which the various functions in the supply chain affect the economic and financial performance need to be measured (Rao & Holt, 2005).

The paper explores whether

- (g) Inbound function directly and positively impacts economic performance.
- (h) Internal function directly and positively impacts economic performance.
- (i) Outbound function directly and positively impacts economic performance.
- (j) Competitive advantage directly and positively

impacts economic performance.

The Conceptual Model and Research Question

Based on literature review as given above the conceptual framework used for the research may be depicted as follows.

Research Methodology

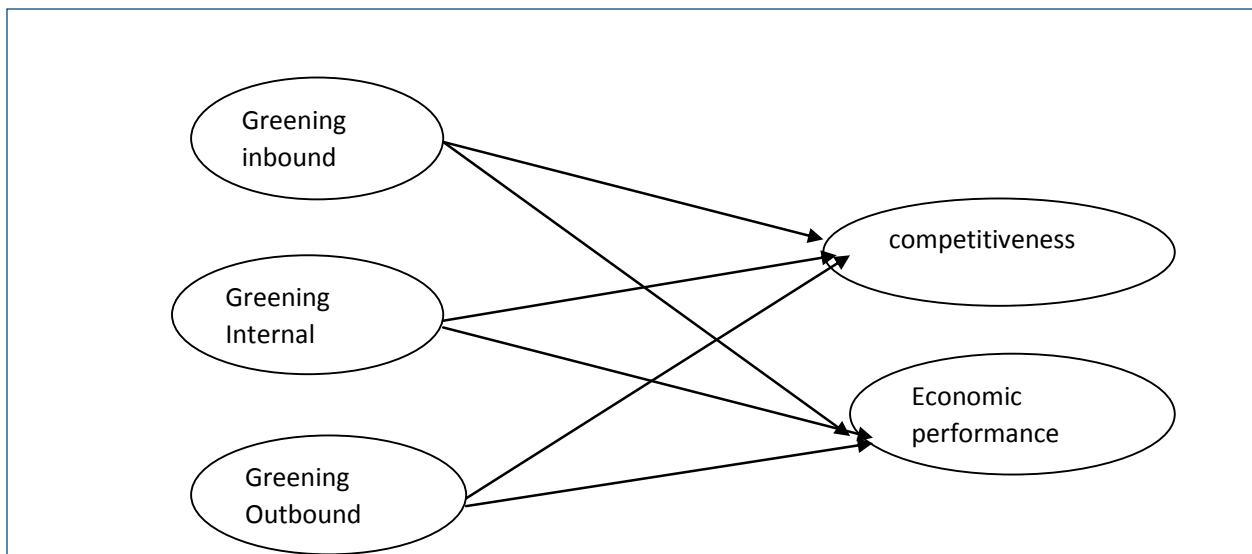
Data Sources

The data for this study are collected through primary sources. Since we don't have much empirical evidence on measuring the impact of incorporating green initiatives in supply chain, on a firm's competitiveness and economic performance in the retail sector, our reliance on secondary data is limited. Although similar studies have been conducted before, though not particularly focussing on the retail sector, we referred to those sources (research papers from EBSCO etc.) and got a fair idea of the relationship between greening and economic performance.

Instrument for Data Collection

The research instrument was a survey questionnaire to collect data for study. The questionnaire comprised

Fig 1: Conceptual Framework/Research Question for Green Supply Chain, Competitiveness and Economic Performance (Adapted from Rao & Holt, 2005)



multiple constructs, each construct having multiple questions, indicator variables within it that will measure the latent construct. The various constructs that exist in the questionnaire include inbound, internal, outbound functions of a supply chain and also questions directly measuring the economic performance and competitiveness.

Sample

The research target segment is retail outlets across South India. Excluding hypermarkets and super chains, mid-segment retail outlets were focussed. To bring diversity in the research the data collection focussed on different kinds of retail outlets like apparels, foot wears, bags, baby's products, branded stores etc.

Methodology

For data collection the researchers visited stores in Chennai and questioned people managing the supply chain i.e., the supervisors & managers of supply chain, store managers, logistics head etc. to get a perspective of the techniques being adopted by them. Once this was done, we got the questionnaires filled and used the data to perform further analysis.

The final sample size was 104, margin of error 9 %.

Structural Equation Modeling to be used for Validating Research question.

In Structural Equation Modeling approach one considers latent constructs which are looked upon as unobserved variables. These unobserved variables are constituted and measured by observed variables or indicator variables. The model comprising the linkages between unobserved variables and indicator variables associated with it is called measurement model. The model comprising linkages between unobserved variables is called structural model.

To carry out structural equation modelling one uses a conceptual model proposed by the research. This is validated or not validated by checking if the data collected supports the model or not. In the current research the proposed conceptual model was considered and evaluated by using AMOS Graphics for Windows Version 3.6 (Arbuckle , 1997) estimating the regression weight of

each link (arrow) and the associated significance. This significance was evaluated with the statistic called "critical ratio" associated with the regression weight which helped to test the null hypothesis.

Ho: regression coefficient , $\beta = 0$

If critical ratio > 1.96 , one rejected the null hypothesis and considered the link to be significant. If critical ratio < 1.96 , it implied that there was no statistical evidence to say that there was a cause and effect relationship between the two latent constructs concerned.

Upon running the algorithm provided a Chi square value, the degrees of freedom and the associated probability level, the p-value. The model was considered acceptable at 5% level of significance if the p-value $> .05$.

In addition to p - value, chi square/degrees of freedom, which is needed to be < 2 .

GFI, AGFI were additional indicators to evaluate the validity of the model.

The latent constructs which were used in the model and the associated indicator variables were the same as given in the conceptual framework section. Several sets of analyses were conducted with the input being the descriptive statistics of the indicator variables and the correlation matrix for all of them. Also several sets of structural equation models were run to test variations of the model with alternate paths deleted to assess the importance of model aspects. The proposed model which would be validated have five latent constructs, each being measured by the indicator variables as given below:

Latent Construct: Greening the Inbound Function

Indicator Variables

Conducting awareness seminars for suppliers and contractors, bringing together suppliers in the same industry to share their know-how and problems, choosing suppliers based on environmental criteria, guiding suppliers to set up their own environmental programmes, urging/pressuring suppliers to take environmental actions, informing suppliers about the benefits of cleaner production and technologies etc.

Latent Construct: Greening the Internal Function

Indicator Variables

Optimisation of process to reduce solid waste and emissions, internal recycling of materials within the production phase, substitution of environmentally questionable materials, use of environment friendly raw materials, use of cleaner technology processes to save energy, water, and waste, etc.

Latent Construct: Greening the Outbound Function

Indicator Variables

Environmental improvement of packaging, taking back packaging, environment friendly waste management, use of environment friendly transportation, recovery of company’s end-of-life products, etc.

Latent Construct: Economic Performance

Indicator Variables

Improved profit margin, sales enhancement, improvement in market share, new market opportunities, product price increase, etc.

Latent Construct: Competitiveness

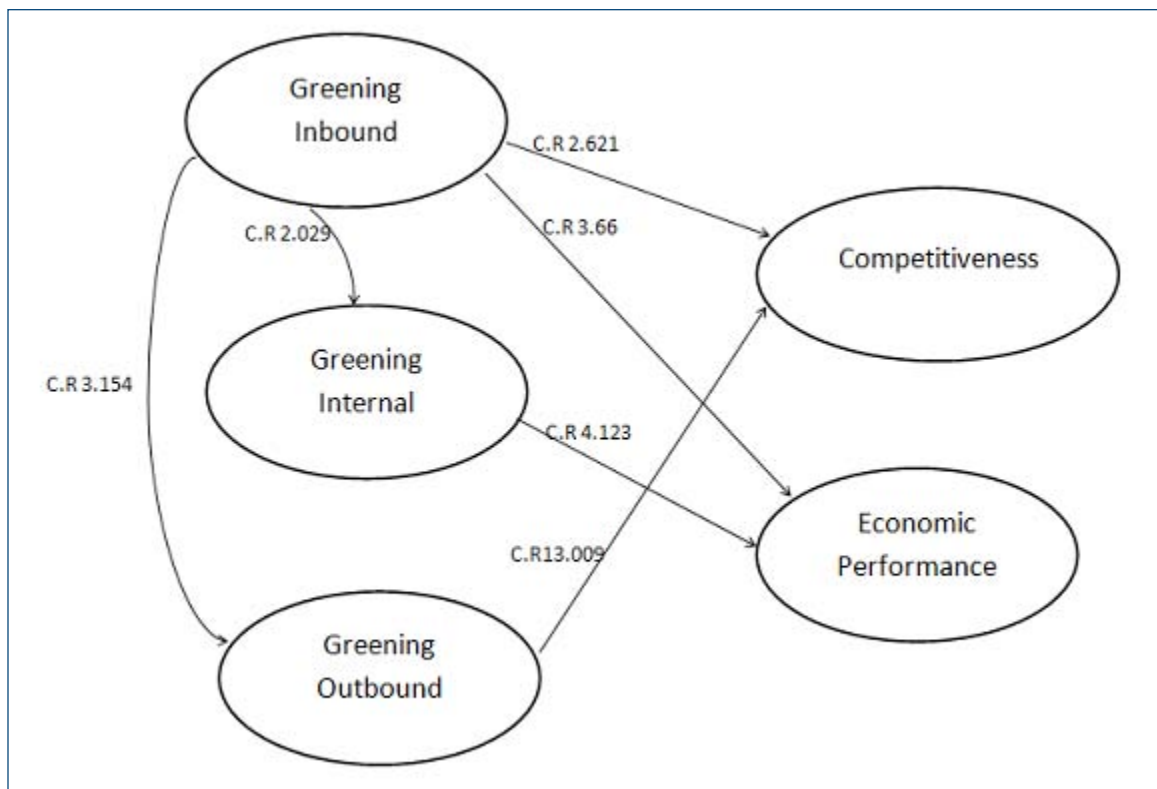
Indicator Variables

Cost savings, improved efficiency, productivity improvement, quality improvement, etc.

Results and Data Analysis

The Structural Equation Model was run with AMOS graphics software. Several runs were carried out until the overall model p-value became > .05 in fact much higher than.05. The other model indicators, GFI, AGFI, CFI etc. were all not very good but they indicated reasonably acceptable fit.

Fig. 2: Finalised Model with the Associated Statistics



Thus the overall convergence of the SEM model was considered significant, as indicated by the statistics detailed in Table 1.

Table 1: Convergence of the SEM Model

Model	GFI	AGFI	CFI	P	CMIN/DF
Default model	0.869	0.775	0.985	0.193	1.135
Saturated model	1		1		
Independence model	0.324	0.234	0	0	6.777

The chi-square values and associated p-value are highly acceptable indicating a good fit for the model. However, GFI and AGFI, both of which are measures that represent overall degree of fit (squared residuals from prediction compared to the actual data) are on the low side. For both of these, higher values would indicate better fit but no absolute threshold levels have been established for GFI (Rao, 2013, Hair *et al.*, 1992).

This might be expected given the sample size, which makes estimation of maximum likelihood parameters not significant. Conversely, the measure of chi-square/degrees of freedom is 1.135; which falls within the recommended levels of 1.0-2.0, and indicates a significant model. One should also consider the value of CFI equal to 0.985, which is acceptable. Thus, given the limitation of a small sample size, we accept the validity of the model.

Fig. 2 gives the finalised model with the associated statistics as presented in Table 2. From the statistics as shown in Table 2, the evidence suggests that greening the different phases of the supply chain does lead to an integrated green supply chain where the green inbound function leads to a green outbound function of supply chain.

From the values of critical ratios and p values given in the table, we can conclude that greening the inbound and outbound functions leads to increased competitiveness as the critical ratios are above 1.96 (95% confidence) and p values are less than 0.05 indicating significance. However, nothing much can be said about the impact of internal function on competitiveness.

Similarly, economic performance can be improved by focusing on greening the internal and inbound functions of supply chain. We can see from the table, they have critical ratio of as high as 3.66 and 4.12 and almost negligible p values. This signifies a very strong linkage between them.

The environmental initiatives form the indicator variables and hence in order to improve the economic performance and competitiveness, the firms should focus on having integrated green supply chain functions.

- Inbound function green initiatives such as having a sustainable purchasing policy in place, choosing the right suppliers, taking initiatives to educate them on various environmental programs and have them implement systems like EMS, etc. will lead to a definite positive impact on our dependent variables and on the outbound function of supply chain.
- Internal function green initiatives such as having an environment friendly retail store design, using alternative sources of energy, clean fuel, organic packaging materials etc. can improve the economic performance of the retailer.
- Outbound function green initiatives such as using eco-friendly transportation, making reverse logistics efficient etc. aid in improving firm's competitiveness in the industry.

Table 2: Statistics of the Finalised Model

Regression Weights		Estimate	S.E.	C.R.	P	
InternalFunction	<---	InboundFunction	0.376	0.185	2.029	0.042
Outbound	<---	InboundFunction	0.512	0.162	3.154	0.002
Competitiveness	<---	Outbound	0.919	0.071	13.009	***
Competitiveness	<---	InboundFunction	0.166	0.063	2.621	0.009
Competitiveness	<---	InternalFunction	-0.061	0.035	-1.751	0.08
EconomicPerformance	<---	InboundFunction	0.632	0.173	3.66	***
EconomicPerformance	<---	InternalFunction	0.422	0.102	4.123	***
Economic Performance	<---	Outbound	0.224	0.633	0.354	0.723

Discussion

This research concludes that greening the supply chain also has the same potential to lead to competitiveness and economic performance. The first contribution of the study is that it considers the green supply chain not in sections but in its entirety. Here we consider the distinct environmental initiatives in each phase as different indicator variables. The second contribution is that it establishes with empirical analysis that the green supply chain does lead to increased competitiveness and better economic performance. The third contribution is that this research has a theoretical basis and an empirical analysis where the model converged statistically with acceptable chi-square and p-values using Structural Equation Modelling.

From previous research by Klassen and McLaughlin (1996) environmental management is identified as a potential factor in the enhancement of financial performance and competitiveness of the firm.

The results obtained from the research demonstrates that the greening of inbound function and production significantly lead to greening outbound, which results in better competitiveness and economic performance of the firm.

From an industry perspective, firms are continuously striving to achieve competitiveness in their business activities in both the domestic and the global arena. These research findings suggest that if they green their supply chains not only would firms achieve substantial cost savings, but they would also enhance sales, market share, and exploit new market opportunities to lead to greater profit margins, all of which contribute to the economic performance of the firm.

The main limitation of this research is that the study was confined to the retail supply chain in South India, but the lack of empirical research in this region is also one of the main strengths of the paper. This paper will contribute to various retail firms which are planning to establish their footprint in South Indian region in terms of supply chain especially in the greening function. Future research should empirically test the relationships suggested in this paper to different parts of the country to enable comparative studies.

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