Causal Effect of Between Lean and Green Supply Chain Management Practices on Environmental Performance of Manufacturing Firms

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Abstract
Today's changing business environment has posed challenges on organizations' to achieve a balance between cost reduction, profit growth and being environmental conscious. Becoming lean and green is a trend that more manufacturers are beginning to recognize as an important step towards overcoming this challenge and achieving economic austerity and environmental responsibility. Lean supply chain focuses on ways to improve operations and cut wastes from the customer's perspective while green supply chain looks at ways to eliminate waste from the environment's perspective to ensure sustainability. With extensive review of literature, the research proposes a model that demonstrates the relationship between Lean SCM practices, Green SCM practices and Environmental Performance in manufacturing companies. To justify the same data from 122 manufacturing companies was collected through a structured interview. The results show a significant relationship between Lean SCM and GSCM practices. Lean initiatives that improve Green supply chain practices can enable organisations to be responsible citizens and also deliver high profitability and continuous improvement and innovation. The research empirically attempts to bring out the need for lean adoption not only for economic sustainability but also the environmental sustainability of organisations.

Keywords
Lean Adoption, GSCM Practice, Lean SCM, Sustainability, Lean Practices, PLS Modeling

I. Introduction

Supply chain management(SCM)is the vital weapon today in business environment helping organizations' build competency. Some industry segments have recognized the greater role and impact of SCM on their business operations and got adapted to this dynamic entity that changes constantly and evolve in response to changes in technology, competitive actions, and customer demands. This provokes industries to optimize the SCM practices to react to supply uncertainties and demand variability as today the value they provide to their customers is the sum of all the 'value added' along the supply chain. This new challenges and view on SCM has introduced new paradigms in supply chain management practices that guide new management strategies, provide new research agendas, and hence lead to dissemination of new knowledge.

The rapid worldwide industrialization has geared importance to two such paradigms, Green and Lean SCM. In this era of massive environmental destruction, industries have severely damaged and polluted the environment and caused ozone depletion, greenhouse effect and Antarctic icebergs melt. (Hu and Hsu (2010)). The substantial development of these issues has set off the public to demand manufacturers on their industrial production responsibilities in India. These pressures are gaining prominence and affecting the way business is run today. Organizations are taking steps to become environment friendly and going green within the boundaries but initiatives to minimize carbon footprint across the supply chain, is even more significant with increasing cost of operations, shrinking profit margins and extremely competitive price.The focus on sustainability has resulted in a growing need for integrating environmentally sound choices(GSCM) and economically sound practices (LSCM) into supply chain management research and practice.

India has a vision for manufacturing to grow 25% of GDP by 2022. But Indian manufacturing has been slowing down than the GDP in recent years. This is chronically disturbing with the National Manufacturing Policy with a bold vision for manufacturing to grow 2-4% faster than GDP.(CII –BCG report(2012). Though the slowdown can be attributed to the overall Global economy slowdown this proves to be the right time to dissert the domestic industry practices with the dynamic changes happening in the Global supply chain. Being a part of the Global supply chain, Indian manufacturing has a significant impact on the changing paradigms in the SCM practices. The two major paradigms that have made inroads are green and lean. With the promising advantages in various factors for India to become the 'Germany of the East' manufacturing practices should be built on solid foundations towards sustainability with Green and Lean practices.

The country has seen an accelerating implementation of TQM & TQEM with policies, regulations, competition, industry groups and customer requirements driving Indian manufacturing industry towards ISO 9001 QM systems and ISO 14001 EM systems certification that provokes the researcher to study empirically the casual effect and relationship that exists between the Green and Lean SCM practices in Indian manufacturing industry. The investigation in this paper begins with a literature review (Part 2) on Green SCM practices and Lean SCM practices and environmental performance. The research framework and the hypothesis are presented in Part 3. Part 4 discloses the methodology and data analysis. The results with implications are discussed in Part 5 and the paper concludes summarising the results and potentials for future research.

II. Literature Review

A. Green Supply Chain Management

Green Supply Chain Management (GSCM) is one of the recent innovations for the enhancement of capabilities of Supply Chain Management. GSCM finds its definition in the supply chain management. Adding the green component to supply chain management involves addressing the influence and relationships of supply chain management to the natural environment. It considers

the environmental effects of all processes of supply chain from the extraction of raw materials to the final disposal of goods. With this integration, the GSCM practices strive to achieve what any individual organization on its own could not possibly achieve: minimized waste, minimized environmental impact while assuring maximized consumer satisfaction, and healthy profits. This is an effective mechanism for organisations to improve their corporate social responsibility, lower reputational risks, reduce wastes, and improve supply chain response-time to new environmental regulations.

The key practices worth noting from the previous research work are the concepts of green design, green operations, reverse logistics, waste management and green manufacturing (Guide & Srivastava (1998), Srivastava (2007)). The environmental laws and CSR practices and ISO 14000 certifications have improved the environmental practices in many Indian companies. But the question lies if the same has been extended to the supply chain .It is important to integrate the organizational environmental management practices into the entire supply chain to achieve a sustainable supply chain and maintain competitive advantage (Zhu et al., (2008), Linton et al., (2007)). Critics also argue against that improvements are likely to incur within the organization's operational boundaries rather than being extended throughout the supply chain. The extensive review of literature and some findings of the deductive research undertaken on GSCM practices shows varied approaches as discussed below; Stephan (2007) conceptualized GSCM practices into two environmental collaboration and environmental monitoring. Messelbeck and Whaley (1999) considers the environmental effects of the researching, developing, manufacturing, storing, transporting, using and disposing of the product. Many researchers have identified four kinds of GSCM practices, including internal environmental management, external environmental management, investment recovery and eco-design (Zhu et al., (2007)) and later adopted Ninlawan et al.,(2010). Most of the research works on GSCM practices are fragments of a part of the Porter's value chain model. Emmet and Sood (2010) have classified GSCM practices as Green procurement and supply, Green production, Green packaging, Green marketing, Green Logistics and Supply loop. In this deceptive work a framework of the GSCM practices across four major functions- purchasing (Ninlawan (2010), Sanjeev Kumar (2012), and In-bound logistics (Manish (2011), design and production (Ninlaw (2010), Toke (2010), Sanjeev kumar (2012), Sarbjit Singh(2010), Halme et al(2002), distribution and out-bound logistics(Toke(2010)) and reverse logistics(Toke (2010), Sreevatsa (2007), Tonanont (2008)) is conceptualized for study.

B. Lean Supply Chain Management

Lean is the systematic elimination of waste from all aspects of an organization's operations, where waste is viewed as any use or loss of resources that does not lead directly to creating the product or service a customer wants when they want it. In many industrial processes, such non-value added activity can comprise more than 90 percent of a factory's total activity.Nationwide, numerous companies of varying size across multiple industriesare implementing lean production systems, and experts report that the rate of lean adoption is accelerating. Companies primarily choose to engage in lean manufacturing to boost company profits and competitiveness. To help accomplish these improvements and associated waste reduction, lean involves a fundamental paradigm shift from just being lean within the four walls to involve other links in the supply chain. Leanness implies a holistic perspective of value addition considering developing, delivering and managing products which involves not the individual firm but the integration of the complete business process that create value to the customer. (Jayaram et al.,(2008),Womack and Jones(1996),Mason et al.,(2 000),Farley(1997),Lamming(1996)).

Lean SCM is a strategy based on cost and time reduction to improve the effectiveness. It is focused on optimizing the processes of all the members of the supply chain, searching for simplification, reducing waste and reducing activities that do not add value (Machado and Duarte, 2010). According to Venkat and Wakeland (2006) Lean SCM practices comprises: i) identifying value; ii) determining the best sequence for value-creating steps, eliminating wastes; iii) performing activities without interruption when a customer requests them; and iv) improving processes continually. Shah and Ward (2007) developed a list of lean SCM practices: i) supplier feedback; ii) JIT delivery by suppliers; iii) supplier development; iv) customer involvement; v) pull system; vi) continuous flow; vii) set up time reduction; viii) total preventive maintenance; ix) statistical process control and x) employee involvement. Adopters of lean strategy may implement practices such as mass production, just-in-time, and long-term supplier relationships to eliminate waste and achieve a lower cost cited by Qi et al., (2009). Hence a Lean supply chain enables companies to align themselves with each other and to coordinate their continuous improvement efforts. This synthesis enables even small firms to participate, gain competitive advantage and leadership in the global marketplace. For such a Lean adoption to happen across the entire supply chain it is very important to include the entire chain towards a culture. Lean SCM adoption in or ganizations has been studied by an excellent research by APICS, Oracle, and Supply Chain Vision & Georgia Southern University (2004).It is different attempt not like the case study method that represent any particular company or a cluster of them, which is usually the methodology in Lean based studies; it provides the insight into the Lean supply chain management practices in manufacturing companies. There search also categorizes Lean SCM practices as demand management, process standardization, industry, waste elimination/ value creation, culture and collaboration.(APICS, Supply Chain Visions, Oracle Corp. and Georgia Southern University, (2004)).

This leads to the development of a more complex and developing strategy in recent years, 'eco-efficiency' or 'lean-and-green' approach to SCM. This type of strategy drives environmental performance benefits for the supply chain beyond mere regulatory compliance through the requirement for suppliers to meet operations-based efficiency targets. The major issue in GSCM practices and the controversy that commonly arises is the use of just-in-time (JIT) practice common in today's manufacturing industries. This practice is meant to reduce inventory, eliminating costs and waste, which in turn reduces the necessary overhead and resource consumption needed to manage inventory. Thus, JIT is an environmentally sound practice. But it also raises a controversy that less amount of inventory also means more number of delivery and small batches production. Thus raising fuel consumption and traffic congestion (McIntyre et al., (1998), Penman(1994), Sarkis (1995), Wu and Dunn(1995).This evokes the debate and need for an empirical research to connect and conceptualize these two controversies but related strategies in SCM as the compatibility between lean and green paradigms

represents a new way of thinking in the context of SCM. Cost efficiency and environmental responsibility are not mutually exclusive, they are mutually enforcing as described by Duarte et al.,(2010). King and Lenox (2001) conducted a study and have established that organisations that adopt the quality management standard ISO 9000 are more likely to adopt the environmental management standard ISO 14000. They also find strong evidence that lean production is as measured by ISO 9000 adoption and low chemicals inventories is complementary to waste reduction and pollution reduction. Ravikumar and Marimuthu (2011) have demonstrated how environmental performances are improved by eliminating the wastes with Lean practices. The study was an attempt to demonstrate that lean is associated with greater source reduction (pollution prevention) and lean is associated with lower emissions. It explicitly concludes that Lean is green.

C. Environmental Performance

It is the measure of reduction of substances, emissions and environmental improvement in a business organization. Zhu et al(2004), Wu et al.,(2010), Ninlawan et al.,(2010), Sanjeev kumar et al.,(2012), Bhateja et al.,(2011), Sarkis (2003), Chein & Shih (2007). It also helps to improve efficiency and synergy among business partners and helps to enhance environmental presence, minimize waste and achieve cost saving (Rao and Holt, 2005) and good will.(Cervera and Flores(2012)). Environmental performance is measured in many research works. Researchers have proved that GSCM practices enhance environmental performance in organisations. (Chanetal., citedenLou, 2011; Huand Hsu, 2010; Efron, 2009). Cervera and Flores (2012), Ninlawan et al(2009), Zhu et al.,(2007). Vario Corderio & Sarkis (1997), Walley & Whitehead (1994). Zhu et al., (2007)Zhu et al.,(2010), Montabon et al. (2007), Wagner et al., (2001) and Zhu et al., (2008) have found significant and positive relationships between GSCM practices and environmental performance.

III. The Research Model

The conceptual framework used in this research is shown in Figure 1. The causal relationship between Lean SCM practices, Green SCM practices and Environmental performance has been much debated in literature (King and Lenox, 2001), Rothenberg et al. (2001).Academic research by Hines (2010) found that the most compelling reason for organizations adopting lean practices is for economic benefits and green practices for the environmental benefits. Sustainability has become one of the big themes in SCM and lean is looked particularly for economic and green from an environmental perspective. These paradigms lean and green may be combined to enable highly competitive supply chains and can help Indian manufactures become capable of winning in a volatile and cost-conscious environment. (Ravet, 2011).

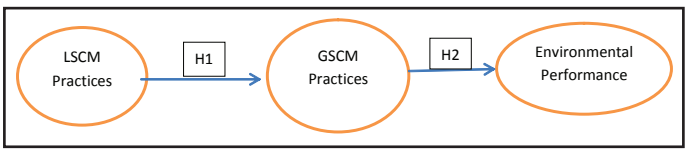

Fig. 1: Proposed Model

A. Green SCM practices and Lean SCM Practices

Practices adopted by organisations across the supply chain from green inbound, green operational,green outbound and reverse logistics to work with suppliers to improve products or processes and increase the environmental performance of the supply chain is termed as the Green supply chain management practices. (Srivastava (2007), Svensson(2007), Zhu et al.,(2007), Ninlawan et al.,(2010), Sanjeev kumar et al.,(2012), Shang et al(2010), Zhu et al.,(2008), Toke et al(2010), Chung Hsiao (2008), Florida et al (2001), Bhateja et al(2011), Chein & Shih(2007)).

Lean SCM practices create value for the customer by eliminating inefficiencies and make the supply chain customer-driven. (Womack(1991)). Lean supply chains strategies focus on waste reduction, helping firms eliminate non-value adding activities related to excess time, labor, equipment, space and inventories across the supply chain (Corbett and Klassen (2006). Such strategies enable firms to improve quality, reduce costs, and improve service to customers (Larson and Greenwood, (2004). A Lean supply chain enables companies to align themselves with each other and to coordinate their continuous improvement efforts. The U.S. Environmental Protection Agency presents a table of environmental positive impacts associated with wastes targeted by Lean. Hence organizations can improve their Lean SCM practices implementation to improve environmental performance, so that environmental wastes can be identified explicitly during Lean activity (U.S.EPA, (2007), Slack et al., (2004)). Since more and more manufacturers are implementing Lean practices beyond their shop floor to meet green commitments it becomes imperative to check the association of Lean SCM practices and Green SCM practices with Environmental performance. Thus the following hypothesis is framed to test the relationship of GSCM practices, LSCM practices and environmental performance in manufacturing industries.

H1: The link between Lean SCM practices and Green SCM practices is positively associated.
H2: The link between Green SCM practices and environmental performance is positively associated.

IV. Methodology

The study focused on the Green SCM and Lean SCM practices in Indian manufacturing industries. Based on the literature review the instrument was developed to measure Lean SCM practices, Green SCM practices and Environmental performance with some changes. The instrument was tested for reliability and validity. Fourvariables where identified to define Green SCM practices((Zhu et al., (2007), Ninlawan et al., (2010), Sanjeev kumar et al.,(2012)) and six variablesfor Lean SCM practices was identified.(APICS,Supply ChainVisions,OracleCorp.and Georgia Southern University, (2004)).Environmental performance was ascertained using six variables with expert intervention. (Zhu et al., (2007), Ninlawan et al., (2010))

The instrument used for the study consists of three parts, Part 1: The company profile that documented the demographics of the industry type, organization size, turnover, products manufactured. Part 2: The Green profile that analysed the critical practices in GSCM implemented in the organization on a five point scale to indicate the extent in which each item was practiced in the organization. Part 3: The Lean profile captured the level of implementation of the Lean SCM practices in the organization and its extension outside the walls of the company in a five point scale.

The list of member companies from CII (Confederations of Indian Industries), Tamilnadu chapter which comprised a list of 1182 companies was filtered to remove organisations having <100 employees, educational institutes, service companies and

individuals. Using G-power a sample with alpha of 5%,beta of 20% and the no. of largest predictors of 27 with a large effect sixe (f^2 = 0.35) measured to 90 samples. The study was conducted for a total number of 122 firms with an effective sample size of 9.5%). The data collected was administered with Senior / Top management executives over a period of 9 months in the state of Tamil Nadu, India. The respondents of the survey are key informants who are knowledge able in the field of Green and Lean practices in each firm. Path modeling using Smart PLS2.0 (beta) is used to test the path. The analysis of interdependent variables is done together. For e.g. consider the dependencies X-->Y--->Z. This solved together gives the solution different than when analysed as X-->Y and Y-->Z. This combined analysis is done using path analysis. This technique for path analysis doesn't make any assumptions about the distribution of the data and is non-parametric. (Wold (1989), Fornell (1982)). The Reliability is tested by the Cronbach alpha and the Convergent validity of each construct is examined by the AVE value. Constructs with an alpha score greater than 0.7 are accepted for accuracy (Nunnally, (1978)) and constructs with AVE value greater than 0.5 are said to have convergent validity and unidimentionality. (Chin (1995), Barclay et al.,(1995), Chin et al.,(2003)). The main purpose of the theory is to examine the inter relationships between the constructs. Each relationship is a hypothesis to be tested. As a non-parametric method, the hypothesis cannot be directly tested. Testing is done by means of re-sampling method of bootstrap. The accepted value for t-coefficients depends on the assumed significance level. A commonly assumed significance level of two tailed 5% significance level has a t-value =1.96. If the computed value of t-statistic happens to be higher than the this it implies that the path being considered is significant.

V. Findings and Implications

The sample obtained belonged to the cross section of 8 sectors namelyAutomobile and Auto components (51), Textiles and Garments (45),Engineering and Electronics (26).Reliability and validity of the constructs are depicted in Table 1 which shows that Cronbach's alpha and the AVE value are higher than the required standards defined.

Table 1: Reliability & Validity

	AVE	Composite Reliability	Cronbachs Alpha
Environmental Performance(envperf)	0.608249	0.884708	0.841281
Green SCM Practices (gscmprac)	0.569470	0.835026	0.729137
Lean SCM Practices (lscmprac)	0.666383	0.922762	0.899775

The Cronbach's alpha and AVE value for the three constructs Environmental performance (envperf), Green SCM practices and Lean SCM practices (lscmprac) is above the defined standards and hence the constructs used in the study have proved to have Construct Reliability and Convergent Validity or Unidimentionality.

A bivariate correlation was done to check the preliminary association between variable and the significance of the association. The table below demonstrates the correlation between variables tested in the hypothesis.

Table 2: Correlation Coefficient

Variable	Correlation coefficient	Significance (p<0.01)
lscmprac- gscmprac	0.452	0.00
gscmprac-envperf	0.462	0.00

The above table shows that the correlation between variables is significant but the path has to be verified when the variables are put together in the model. Smart PLS was used and the bootstrap was conducted for 122 samples across 500 cases and the results are depicted in Table 3.

Table 3: Bootstrap Overview

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	Standard Error (STERR)	T Stat	R square	Result
gscmprac ->envperf	0.46	0.46	0.039	0.039	11.63	0.2086	Significant
lscmprac ->gscmprac	0.48	0.48	0.035	0.035	13.78	0.2303	Significant

H1: The link between Lean SCM practices and Green SCM practices would be positively associated.
The relation was found to be significant (beta=0.48, t=13.78). The R Square value is also 0.23 which shows a positive relationship. This rein forces the theory that an organization that adopt lean supply chain practices also contribute to the green SCM practices of the company.
H2: The link between Green SCM practices and environmental performance would be positively associated.
The relation Green SCM practices and Environmental performance was found to be significant (beta=0.46, t=11.63). The R Square value is also 0.21 which shows a positive relationship.
Hence the research hypothesis was generally proven and the results show significance and the estimated model is depicted in Fig. 2.

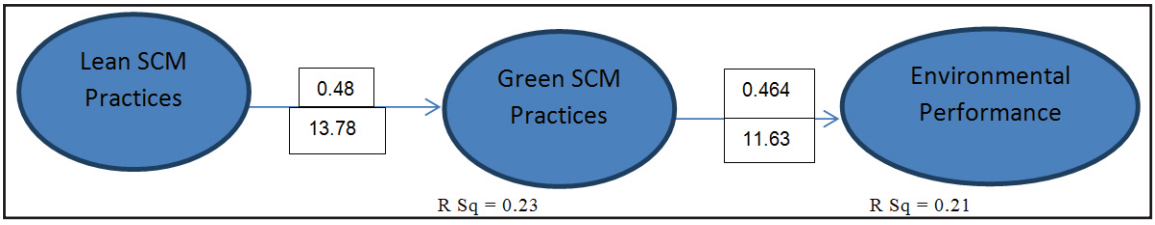

Fig. 2: Estimated Model

Although the strength of the relationship is not very strong it still implies that there exists a positive relationship between GSCM practices and LSCM practices and the casual effect on the environmental performance. These practices though looked up as two different strategies may require further research to map the practices, the field and its progress in India.

VI. Conclusion

The concern for environment and organizational sustainability are increasing but there are not much empirical analysis on the strategies and practices. Sustainability only on the environmental front is not a primary goal in SCM strategies in today's organizations', hence it requires a cost cutting, efficiency driving strategy like Lean SCM to be hooked with the Green SCM strategy to foster environmental sustainability. This study mainly projects the relationship between Lean and Green supply chain management practices and Environmental performance of manufacturing industries. A theoretical model that explained the casual effect relationships through the primary data collected through the survey with the manufacturing industries in Tamilnadu, India.

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