A Framework for the Analysis of Sustainable Supply Chain Management: an Insight from Indian Rubber Industry

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Abstract

Industrial operations could emit harmful pollutants and degrade natural environment, thereby posing a threat to human beings and wildlife (polar bears, panda, penguins, turtles, whales, walrus etc.). Globally manufacturers must ensure that the operations be done as safely and responsibly as possible keeping in line with the three dimensions of triple bottom line. We develop a model which analyses the various complex relationships involved in a sustainable supply chain with the aid of interpretive structural modeling. The key factors influencing sustainable supply chain were identified based on a thorough literature review and in consultation with rubber industry experts. Further MICMAC analysis was applied to identify the autonomous, linkage, dependent and independent factors.

Keywords: Sustainable Supply Chain Management (SSCM), Indian Rubber Industry, Interpretative Structural Modeling, MICMAC.

1. Introduction

India's economy has grown very rapidly in recent years. Since 1991 it has been among the top 10% of the world's countries in terms of economic growth. Before the liberalization of its economy began in 1991, India had been one of the most over-regulated and closed economies in the world. But with the fast pace growth of Indian economy has led to infinite damages in the environment due to industrial operations. Successful environmental policies can contribute to efficiency by encouraging, rather than inhibiting, technological innovation. However, little research to date has focused on the design and implementation of sustainable supply chains that ensure productivity improvements in the face of increasing stringency of environmental regulations.

Reducing and mitigating carbon emissions, the culprit of global warming and climate change, is an increasingly important concern for both industry and government (IPCC, 2007). The United Nations, the European Union, and many countries have enacted legislations or designed mechanisms, such as carbon taxes, carbon offset, clean development, cap and trade, carbon caps, and made joint implementation to curb the total amount of carbon emissions. Firms worldwide, in response to such mechanisms and legislations or to concerns raised by their own customers, are undertaking initiatives to reduce their carbon footprints.

However, these initiatives have largely focused on investment in new technology, developing energy-efficient equipment and facilities, finding less polluting sources of energy, and implementing energy-saving programmes. While such efforts are valuable, they tend to ignore a potentially more significant source of emissions - one driven by business practices, production economics, operational policies, interaction, and coordination, where the flow of products to consumers engages multiple firms in long and complex supply chains (NSF, 2010). It is therefore necessary to address the problem of carbon emissions reduction from a supply chain and logistics perspective.

The Indian rubber products manufacturing sector draws its strength and stability from the rapidly growing demand for the products in both domestic and overseas market. The exports are well over 85 countries including US, Russia, UK, Bangladesh, Afghanistan, Italy, Germany, France, Saudi Arabia, UAE, Canada and the African countries. The chemicals and the allied products export promotion council co-ordinates activities connected with the export of rubber products.

Indian rubber goods manufacturing sector faces major challenge from environmental degradation resulting from its various operations. Workers are exposed to these hazards through inhalation and skin absorption during rubber processing and product manufacturing. Risk of cancer and other adverse health effects are high among rubber products workers, DHHS (NIOSH), 93(106), Sept 1993.CPCB has categorized this sector in the high polluting RED category due to GHG emission and solid waste generation and throughout the supply chain this sector is trying hard to reduce their carbon emissions.

We have presented statistics of natural rubber and synthetic rubber production, consumption, import and exportin Fig. 1 and 2. In Fig. 3 we have presented the statistics of rubber goods exports.

2. Literature Review

The purpose of conducting literature review is to understand whatsoever work has been carried out by past researchers in the area of sustainable supply chain management in the last decade.

Various secondary sources were considered to extract the information and seminal papers from leading journals such as IJPE, IJPR, Transportation Research, EJOR, DSS, EJPSM, JOM and JPSM were referred to prepare the groundwork for further research.

The summary of the literature on SSCM has been tabulated in Table 1.

3. Research Gap

The review reveals various insights and gaps in the existing GSCM literature.

1. Existing literature is not capable to explain the underlying relationships among key variables influencing SSCM practices in Indian Rubber Industry.
2. Lack of SSCM model for Indian Rubber Industry.

Fig. 1: Production, consumption, import and export of natural rubber

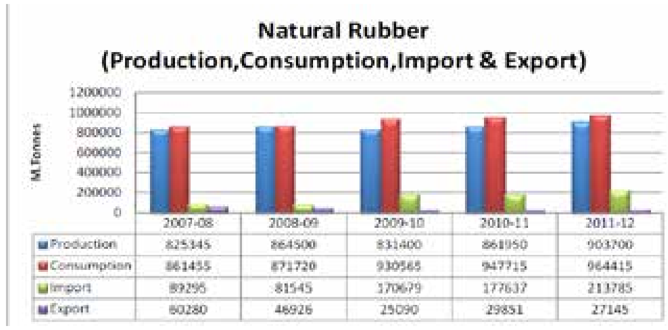


Fig. 2: Production, consumption, import and export of synthetic rubber

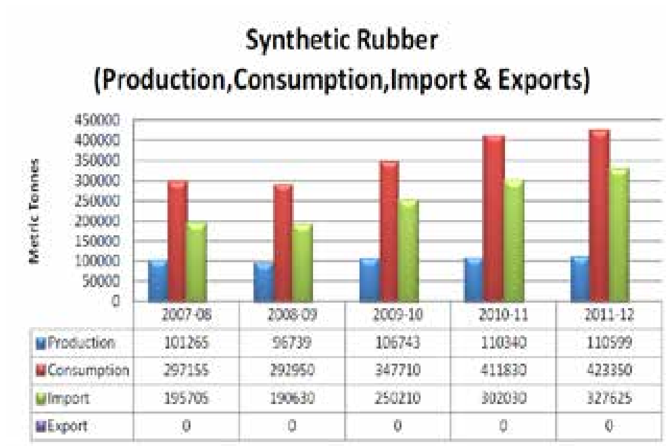
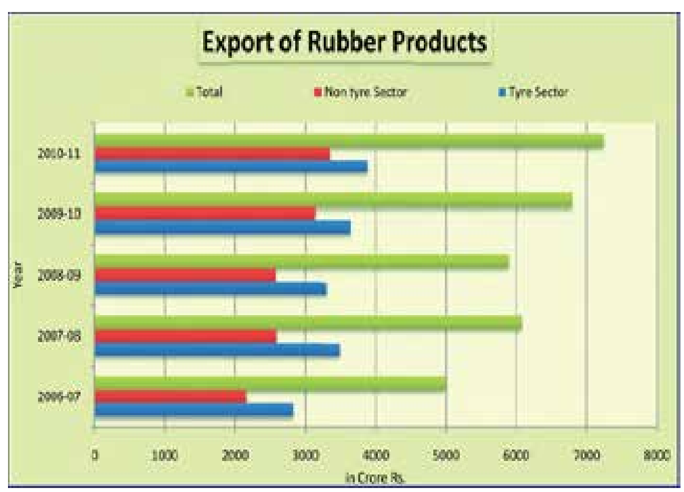


Fig. 3: Export of Rubber products



Source: Rubber Board

Table 1: Literature Review

AUTHOR(S), YEAR	OBJECTIVE OF STUDY	KEY FINDINGS	METHODOLOGY APPLIED	VARIABLES IDENTIFIED
Brandenburg *et al*., (2014)	To understand and review mathematical models focusing on environmental/social factors in the forward supply chains.	Major publications and models were found in a limited set of six journals (JCLP, IJPR, IJPE, TRE, EJOR & DSS). AHP, ANP and LCA were commonly used tool for developing the models.	Review	Environmental, Social and Economic dimensions.
Mirhedayatian *et al*., (2014)	To propose a novel network DEA model for evaluating the GSCM in the presence of dual role factors, undesirable outputs and fuzzy data.	The proposed model can be easily computerized so as to serve as a decision making tool in decision making.	Quantitative modeling	Cost of quality, Supplier flexibility, Carbon dioxide emission, Satisfaction, Facility technology level
Suering, S., (2013)	To review research on quantitative models for green or sustainable supply chains.	Different kinds of models are applied in this area but the social dimension is not taken into consideration. On the modeling side there are three popular methods: Equilibrium models, MCDM & AHP.	Review	Environmental, Social and Economic dimensions
Zhu and Lai. (2013)	To develop and empirically test a theoretical model.	The research contributes to the literature on institutional theory in corporate environmental practices.	Empirical	Institution pressure: Coercive, Normative, Competitive
Reefke and Trocchi (2013)	To develop a framework to facilitate a balanced approach to performance measurement for SSCM.	A scorecard design customized for sustainable supply chain is proposed along with the development and implementation process	Theoretical	Cost savings, Profit, customer satisfaction, quality management
Liu *et al*. (2012)	To integrate green marketing and SSCM.	Development of a new hub and spoke integration model. Drivers: Improve company's sustainable supply chain capabilities; reach green customers before competitors; government regulations; green customers demand; community expectation	Empirical	Products, Promotion, Planning, Process, People and Project
Hoejmose *et al.* (2012)	To understand the general engagement with GSCM in both B2B and B2C supply chains.	Firms in B2B market is generally less engaged with green practices compared to firms in B2C markets. Developing Trust with supply chain partners and top management commitment is a crucial GSCM driver among firms in B2B markets.	Empirical	Trust, Top management commitment
Ageron *et al*. (2012)	To develop a Sustainable Supply Management framework.	External pressures have positive impact on the development of SSM; Waste reduction programmes have greater impact on greening supply chains; MNC and SMEs' have differential impact on SSM; Financial barriers have more impact on SSM; Top management support is a critical success factor in SSM; Key benefits such as customer satisfaction, supplier innovation, quality and capacity have greater positive impact on SSM.	Empirical	Top Management Commitment, Govt. regulatory requirements, Quality, Flexibility, Waste Reduction, Clean Programs, Reducing carbon footprint, Financial costs, ROI, Green Investments, Customer Satisfaction, Innovativeness

AUTHOR(S), YEAR	OBJECTIVE OF STUDY	KEY FINDINGS	METHODOLOGY APPLIED	VARIABLES IDENTIFIED
Bose and Pal (2012)	To investigate the influence of GSCM initiatives on stock prices of firms.	Firms observe greater positive change in stock price by undertaking green initiatives. Firms with high R&D expenses show strong positive impact. Early adopters of GSCM show greater positive impact.	Event Study	R&D, Size of firm, Stock prices
Dekker *et al.* (2012)	To review research on green logistics.	The review highlighted the contribution of operations research to green logistics	Review	Mode choice, Intermodal transport, Equipment choice and efficiency, fuel choice and carbon intensity
Chaabane *et al.* (2012)	To present a generic mathematical model to assist decision makers in designing sustainable supply chains over their entire life cycle.	The model can serve as a tool that facilitates the understanding of optimal SC strategies under different environmental policies.	Quantitative modeling	Economic: Cost, revenue, taxes, transfer Environmental variables: Carbon footprint, Raw material use, Energy use, Social variables: Noise, pollution
Dubey and Bag (2013)	To explore sustainable manufacturing practices that improves environmental and business performance.	Green Purchasing, SRM, Green logistics and regulatory norms are positive determinants of firms business performance and Environmental performance.	Empirical	Green Purchasing, SRM, Green logistics and Regulatory norms
Gunasekaran and Spalanzani (2012)	To bring important issues related to sustainable business development in both manufacturing and services sector.	Developed a framework for sustainable development along with strategies, techniques and tools.	Conceptual	Sustainable Product and process design, sustainability in supply operations, sustainability in production operations, sustainability in distribution operations, sustainability through reverse logistics
Gimenez *et al.* (2012)	To analyse the impact of environmental programmes on each dimension of the triple line.	Internal environmental programmes have a positive impact on the three components of the triple bottom line. Social initiatives have a positive impact only on two components: social and environmental performance .	Empirical	Environmental,Social and Economic performance, Internal and external action programs
Hassisni *et al*. (2012)	To review literature on sustainable supply chains from 2000-2010.	Based on the findings authors have developed a framework for sustainable supply chain metrics.	Review and Case	Market Forces, Policyand Regulations, Scienceand Technology, Product Development, Process Capability, Sourcingand Operations, Logistics, Marketing andPR, Social issues
Barari *et al*. (2012)	To provide integrated and holistic conceptual framework that combines the practical aspects of green supply chain with the objective of profit maximization.	With the help of evolutionary game theory it has been possible to derive the strategy set that not only promises maximum economic benefit and presents a win-win situation.	Quantitative modeling	Green tax, green burden

AUTHOR(S), YEAR	OBJECTIVE OF STUDY	KEY FINDINGS	METHODOLOGY APPLIED	VARIABLES IDENTIFIED
Kang *et al.* (2012)	To establish the framework for strategy development to construct the sustainable supply chain.	Identified the factors.	Theoretical	Leadership for knowledge sharing, Innovation of product and process
Wang*et al.* (2011)	To provide a multi objective mixed integerformulation for the supply chain network design with environmental concerns.	The model can be effectively used in the strategic planning for green supply chain.	Quantitative modeling	Demand and Supply of Product, Carbon dioxide emission, capacity of facility, environmental investment cost, environmental protection, Transportation cost, Handling cost for products
Wu and Pagell (2011)	To understand how organisations balance short term profitability and long term environmental sustainability when making supply chain decisions under uncertainty.	Factors contributing to the uncertain decision environment are as under:- Uncertainty about environmental outcomes and future regulation, the saliency of each environmental issue to multiple stakeholders, lack of visibility and influence in one's supply chain.	Theoretical	Operating principles, Technical standard
Gupta and Desai (2011)	To review the current state of academic research in sustainable supply chain management.	Authors developed an integrative framework summarizing the existing literature under four broad categories: strategic considerations, decisions at functional interfaces, regulation and government policies, integrative models and decision support tools.	Review	Product design and product life cycle,Regulation and government policies
Azevedo *et al.* (2011)	To investigate the relationships between green practices and supply chain performance.	A conceptual model of the relationships between green practices and SC performance was developed.	Case Study	Environmental friendly practices in purchasing, Environmental collaboration with suppliers, Minimizing waste, Environmental collaboration with customers, Reverse logistics
Pereira (2009)	To understand how IT can foster information management and help sort out supply chain problems.	IT must be used to develop SC strategies to make supply chains more robust and resilient.	Conceptual	Information Technology
Longo and Mirabelli (2008)	To present an advance modeling approach and a simulation model and provide a decision making tool for supply chains.	An advance model is proposed based on programming code, tables and event generators and provides the user with a simulator capable of high efficiency for executing simulation runs.	Quantitative modeling	Inventory Control, Lead Time, Demand Intensity, Demand variability
Linton *et al.* (2007)	To prepare a background to better understand current trends in the area of sustainable supply chains.	Research on Sustainable supply chain is still at a infant stage.It is strong links with government policy.	Review	Product life extension, Product design, Recovery process at end of life.

AUTHOR(S), YEAR	OBJECTIVE OF STUDY	KEY FINDINGS	METHODOLOGY APPLIED	VARIABLES IDENTIFIED
Zhu and Sarkis (2004)	To determine the economic and environmental relationships of GSCM practices among Chinese firms.	Significant win-win opportunities exist for Chinese firms practicing GSCM. Strong relationship exists between GSCM practice and positive economic performance.	Empirical	Commitment of GSCM from senior managers, Total quality environmental management, Environmental compliance and auditing programs, Supplier relationship, green design
Croom *et al.* (2000)	To conduct literature review.	Lack of theoretical work in the field as compared to empirical based studies	Review	Sourcing strategy, attitude and commitment to collaborative improvement programmes

4. Research Questions

1. What are the key variables influencing SSCM practices and the nature of relationship existing between the variables in context to Indian Rubber Industry?
2. Can a SSCM model be developed for Indian Rubber Industry?

5. Research Objectives

Literature review has given a direction to identify the research gaps and to develop the below two specific research objectives for the present study are as follows:-

1. To identify the key factors influencing SSCM practices and understand the relationships in context to Indian rubber goods manufacturing sector.
2. To develop a SSCM model for Indian rubber goods manufacturing sector.

6. Research Methodology

Phase I:

- Based on the synthesis of literature review and experts opinion from rubber industry; the key variables influencing SSCM practices have been identified.

Phase II:

- GSCM model has been developed by using ISM technique which was further refined using MICMAC analysis.

The research variables have been derived from the above literature review. To reduce the redundancy and check their relevancy in present Indian context the pretesting has been carried out among ten selected experts who are having more than 20 years of work experience. The final shortlisted variables are as under:-

1. Supplier Relationship Management (SRM)
2. Customer Relationship (CR)
3. Top Management Commitment (TMC)
4. Regulatory Pressures (RP)
5. Market Pressures (MP)
6. Green Technology Adoption (GTA)
7. Total Quality Management (TQM)
8. Flexible operations (FO)
9. Technology Innovativeness (TI)
10. Cleaner Production (CP)
11. Environmental and Social Responsibility (ESR)
12. Carbon Emissions Reduction (CER)
13. Export Sales (ES)
14. Market Share (MS)
15. Profit (PR)

7. Theoretical Framework

ISM is a proven and popular methodology for understanding relationships among specific items that define a problem. ISM is useful to achieve the objective in presence of large number of directly and indirectly related elements and complex interactions among them

Table 2: Review on ISM application

Author and Year	ISM Application
Hawthrone and Sage(1975)	Higher education program planning
Sage (1977)	Modeling complex situations
Jedlica and Meyer (1980)	Exploring factors involved in a cross cultural context
Saxena *et al.* (1992)	Determining the hierarchy and class of elements in cement industry
Mandal and Desmukh (1993)	Vendor selection
Kanungo *et al.* (1999)	Developing an IS effectiveness framework
Ravi and Shankar (2004)	Explore reverse logistics barriers
Jharkaria and Shankar (2005)	Enablers of IT implementation in SC
Ravi *et al.* (2005)	Indentify key reverse logistics variables
Faisal *et al.* (2006)	Modeling the enablers for supply chain risk mitigation
Thakkar *et al.* (2006)	Integrated approach with ISM and ANP to develop a balanced scorecard

Source: Diabat *et al.* 2013

which may or may not be expressed in a proper manner. ISM plays a vital role in this kind of situation and helps in understanding a structure within a system. The ISM model depicts the structure of a complex problem in a carefully designed pattern.

ISM has been used in the past by several researchers due to multiple benefits. It guides and records the results of group response on complex issues in an efficient and systematic manner, (Source: Attri *et al.*, 2013; Warfield 1994, 1974).ISM has been applied in different areas of the supply chain starting from purchasing to production and logistics management. Dubey *et al.*, (2013) have applied ISM to understand the contextual relationship among antecedents of truck freight.Sushil (2012) hascontributed in the ISM literature by providing directions to interpret the links in ISM using the tool of interpretive matrix.

ISM steps are as follows:

7.1. Interpretative Structural Modeling

1. Developing the structural self interaction matrix (SSIM)

For developing SSIM, the below symbols have been used to denote the direction of relationships between variables (i and j):

V: i leads to j but j does not lead to i

A: i does not lead to j but j leads to i

X: i leads to j and j leads to i

O: i and j are unrelated to each other

2. Develop Reachability Matrix

The SSIM has been converted into a binary matrix i.e., the reachability matrix (Table 4) by substituting V, A, X and O by 1 and 0. The substitutions of ‘1’ and ‘0’ have been done as below:

i. If the (i, j) entry in the SSIM is V, then the (i.j) entry in the reachability matrix becomes ‘1’ and (j,i) entry becomes ‘0’
ii. If the (i, j) entry in the SSIM is A, then the (i.j) entry in the reachability matrix becomes ‘0’ and (j,i) entry becomes ‘1’
iii. If the (i, j) entry in the SSIM is X, then the (i.j) entry in the reachability matrix becomes ‘1’ and (j,i) entry also becomes ‘1’
iv. If the (i, j) entry in the SSIM is O, then the (i.j) entry in the reachability matrix becomes ‘0’ and (j,i) entry also becomes ‘0’

7.2. Micmac Analysis

Matrice d’ Impacts croises multiplication appliqué an classment (cross-impact matrix multiplication applied to classification) is abbreviated as MICMAC. The objective of MICMAC analysis is to analyze the drive power and dependence power of factors. Based on the drive power and dependence power the factors have been classified into four factors: autonomous factors, linkage factors, dependent and independent factors.

Table 3: Structural self -interaction matrix (SSIM)

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
1	V	O	V	V	A	V	V	V	V	V	A	A	A	O	
2	V	V	V	A	A	A	A	X	V	A	O	O	A		
3	V	V	V	V	V	V	V	V	V	V	A	A			
4	O	O	O	V	V	V	V	O	O	V	X				
5	O	O	O	V	V	V	V	V	V	V					
6	V	V	V	V	X	V	A	A	A						
7	V	V	V	V	X	V	V	V							
8	V	O	O	O	O	A	A								
9	V	O	O	V	A	V									
10	V	O	V	V	A										
11	O	V	V	V											
12	V	V	V												
13	V	V													
14	V														
15															

Table 4: Reachability Matrix

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	DRIVING POWER (Y)
1	1	0	0	0	0	1	1	1	1	1	0	1	1	0	1	9
2	0	1	0	0	0	0	1	1	0	0	0	0	1	1	1	6
3	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1	13
4	1	0	1	1	1	1	0	0	1	1	1	1	0	0	0	9
5	1	0	1	1	1	1	1	1	1	1	1	1	0	0	0	11
6	0	1	0	0	0	1	0	0	0	1	1	1	1	1	1	8
7	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	10
8	0	1	0	0	0	1	0	1	0	0	0	0	0	0	1	4
9	0	1	0	0	0	1	0	1	1	1	0	1	0	0	1	7
10	0	1	0	0	0	0	0	1	0	1	0	1	1	0	1	6
11	1	1	0	0	0	1	1	0	1	1	1	1	1	1	0	10
12	0	1	0	0	0	0	0	0	0	0	0	1	1	1	1	5
13	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	3
14	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
DEPENDENCE POWER (X)	5	8	3	2	2	9	6	8	7	9	6	10	8	8	12	

Cluster 1: Autonomous variables

These factors have a weak drive power and weak dependence power. In this cluster we do not have any variable.

Cluster 2: Dependence variables

These factors have a weak drive power but strong dependence power. In this cluster we have seven variables, i.e, 2 (Customer Relationship),8 (Flexible operations),10 (Cleaner Production),12 (Carbon Emissions Reduction),13 (Export Sales), 14 (Market Share) and 15(Profit)

Cluster 3: Linkage variables

Table 5: Transivity

TRANSIVITY	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***9***	***10***	***11***	***12***	***13***	***14***	***15***	***D R I V I N G POWER (Y)***
1	1	1*	0	0	0	1	1	1	1	1	1*	1	1	1*	1	
2	0	1	0	0	0	1*	1	1	1*	1*	1*	1*	1	1	1	
3	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1	
4	1	1*	1	1	1	1	1*	1*	1	1	1	1	1*	1*	1*	
5	1	1*	1	1	1	1	1	1	1	1	1	1	1*	1*	1*	
6	1*	1	0	0	0	1	1*	1*	1*	1	1	1	1	1	1	
7	1*	1*	0	0	0	1	1	1	1	1	1	1	1	1	1	
8	0	1	0	0	0	1	1*	1	0	1*	1*	1*	1*	1*	1	
9	0	1	0	0	0	1	1*	1	1	1	1*	1	1*	1*	1	
10	0	1	0	0	0	1*	1*	1	0	1	0	1	1	1*	1	
11	1	1	0	0	0	1	1	1*	1	1	1	1	1	1	1*	
12	0	1	0	0	0	0	1*	1*	0	0	0	1	1	1	1	
13	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	
14	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
DEPENDENCE POWER (X)																

Table 6: Level Partitioning (Iteration 1)

VARIABLES	***RS***	***AS***	***IS***	***LEVEL***
1	1,2,6,7,8,9,10,11,12,13,14,15	1,3,4,5,6,7,11	1,6,7,11	
2	2,6,7,8,9,10,11,12,13,14,15	1,2,3,4,5,6,7,8,9,10,11,12	2,6,7,8,9,10,11,12	
3	1,2,3,6,7,8,9,10,11,12,13,14,15	3,4,5	3	
4	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15	4,5	4,5	
5	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15	4,5	4,5	
6	1,2,6,7,8,9,10,11,12,13,14,15	1,2,3,4,5,6,7,8,9,10,11	1,2,6,7,8,9,10,11	
7	1,2,6,7,8,9,10,11,12,13,14,15	1,2,3,4,5,6,7,8,9,10,11,12	1,2,6,7,8,9,10,11,12	
8	2,6,7,8,10,11,12,13,14,15	1,2,3,4,5,6,7,8,9,10,11,12	2,6,7,8,10,11,12	
9	2,6,7,8,9,10,11,12,13,14,15	1,2,3,4,5,6,7,9,11	2,6,7,9,11	
10	2,6,7,8,10,12,13,14,15	1,2,3,4,5,6,7,8,9,10,11	2,6,7,8,10	
11	1,2,6,7,8,9,10,11,12,13,14,15	1,2,3,4,5,6,7,8,9,11	1,2,6,7,8,9,11	
12	2,7,8,12,13,14,15	1,2,3,4,5,6,7,8,9,10,11,12	2,7,8,12	
13	13,14,15	1,2,3,4,5,6,7,8,9,10,11,12,13	13	
14	14,15	1,2,3,4,5,6,7,8,9,10,11,12,13,14	14	
15	15	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15	**15**	**1**

Table 7: Level Partitioning (Iteration 2)

VARIABLES	*RS*	*AS*	*IS*	*LEVEL*
1	1,2,6,7,8,9,10,11,12,13,14	1,3,4,5,6,7,11	1,6,7,11	
2	2,6,7,8,9,10,11,12,13,14	1,2,3,4,5,6,7,8,9,10,11,12	2,6,7,8,9,10,11,12	
3	1,2,3,6,7,8,9,10,11,12,13,14	3,4,5	3	
4	1,2,3,4,5,6,7,8,9,10,11,12,13,14	4,5	4,5	
5	1,2,3,4,5,6,7,8,9,10,11,12,13,14	4,5	4,5	
6	1,2,6,7,8,9,10,11,12,13,14	1,2,3,4,5,6,7,8,9,10,11	1,2,6,7,8,9,10,11	
7	1,2,6,7,8,9,10,11,12,13,14	1,2,3,4,5,6,7,8,9,10,11,12	1,2,6,7,8,9,10,11,12	
8	2,6,7,8,10,11,12,13,14	1,2,3,4,5,6,7,8,9,10,11,12	2,6,7,8,10,11,12	
9	2,6,7,8,9,10,11,12,13,14	1,2,3,4,5,6,7,9,11	2,6,7,9,11	
10	2,6,7,8,10,12,13,14	1,2,3,4,5,6,7,8,9,10,11	2,6,7,8,10	
11	1,2,6,7,8,9,10,11,12,13,14	1,2,3,4,5,6,7,8,9,11	1,2,6,7,8,9,11	
12	2,7,8,12,13,14	1,2,3,4,5,6,7,8,9,10,11,12	2,7,8,12	
13	13,14	1,2,3,4,5,6,7,8,9,10,11,12,13	13	
14	14	1,2,3,4,5,6,7,8,9,10,11,12,13,14	**14**	**2**

Table 8: Level Partitioning (Iteration 3)

VARIABLES	*RS*	*AS*	*IS*	*LEVEL*
1	1,2,6,7,8,9,10,11,12,13	1,3,4,5,6,7,11	1,6,7,11	
2	2,6,7,8,9,10,11,12,13	1,2,3,4,5,6,7,8,9,10,11,12	2,6,7,8,9,10,11,12	
3	1,2,3,6,7,8,9,10,11,12,13	3,4,5	3	
4	1,2,3,4,5,6,7,8,9,10,11,12,13	4,5	4,5	
5	1,2,3,4,5,6,7,8,9,10,11,12,13	4,5	4,5	
6	1,2,6,7,8,9,10,11,12,13	1,2,3,4,5,6,7,8,9,10,11	1,2,6,7,8,9,10,11	
7	1,2,6,7,8,9,10,11,12,13	1,2,3,4,5,6,7,8,9,10,11,12	1,2,6,7,8,9,10,11,12	
8	2,6,7,8,10,11,12,13	1,2,3,4,5,6,7,8,9,10,11,12	2,6,7,8,10,11,12	
9	2,6,7,8,9,10,11,12,13	1,2,3,4,5,6,7,9,11	2,6,7,9,11	
10	2,6,7,8,10,12,13	1,2,3,4,5,6,7,8,9,10,11	2,6,7,8,10	
11	1,2,6,7,8,9,10,11,12,13	1,2,3,4,5,6,7,8,9,11	1,2,6,7,8,9,11	
12	2,7,8,12,13	1,2,3,4,5,6,7,8,9,10,11,12	2,7,8,12	
13	13	1,2,3,4,5,6,7,8,9,10,11,12,13	**13**	**3**

Table 9: Level Partitioning (Iteration 4)

VARIABLES	*RS*	*AS*	*IS*	*LEVEL*
1	1,2,6,7,8,9,10,11,12	1,3,4,5,6,7,11	1,6,7,11	
2	2,6,7,8,9,10,11,12	1,2,3,4,5,6,7,8,9,10,11,12	2,6,7,8,9,10,11,12	
3	1,2,3,6,7,8,9,10,11,12	3,4,5	3	
4	1,2,3,4,5,6,7,8,9,10,11,12	4,5	4,5	
5	1,2,3,4,5,6,7,8,9,10,11,12	4,5	4,5	
6	1,2,6,7,8,9,10,11,12	1,2,3,4,5,6,7,8,9,10,11	**1,2,6,7,8,9,10,11**	**4**
7	1,2,6,7,8,9,10,11,12	1,2,3,4,5,6,7,8,9,10,11,12	**1,2,6,7,8,9,10,11,12**	**4**

VARIABLES	*RS*	*AS*	*IS*	*LEVEL*
8	2,6,7,8,10,11,12	1,2,3,4,5,6,7,8,9,10,11,12	**2,6,7,8,10,11,12**	**4**
9	2,6,7,8,9,10,11,12	1,2,3,4,5,6,7,9,11	2,6,7,9,11	
10	2,6,7,8,10,12	1,2,3,4,5,6,7,8,9,10,11	2,6,7,8,10	
11	1,2,6,7,8,9,10,11,12	1,2,3,4,5,6,7,8,9,11	1,2,6,7,8,9,11	
12	2,7,8,12	1,2,3,4,5,6,7,8,9,10,11,12	**2,7,8,12**	**4**

Table 10: Level Partitioning (Iteration 5)

VARIABLES	*RS*	*AS*	*IS*	*LEVEL*
1	1,2,9,10,11	1,3,4,5,11	1,11	
2	2,9,10,11	1,2,3,4,5,9,10,11	2,9,10,11	**5**
3	1,2,3,9,10,11	3,4,5	3	
4	1,2,3,4,5,9,10,11	4,5	4,5	
5	1,2,3,4,5,9,10,11	4,5	4,5	
9	2,9,10,11	1,2,3,4,5,9,11	2,9,11	
10	2,10	1,2,3,4,5,9,10,11	2,10	**5**
11	1,2,9,10,11	1,2,3,4,5,9,11	1,2,9,11	

Table 11: Level Partitioning (Iteration 6)

VARIABLES	*RS*	*AS*	*IS*	*LEVEL*
1	1,9,11	1,3,4,5,11	1,11	
3	1,3,9,11	3,4,5	3	
4	1,3,4,5,9,11	4,5	4,5	
5	1,3,4,5,9,11	4,5	4,5	
9	9,11	1,2,3,4,5,9,11	**9,11**	**6**
11	1,9,11	1,2,3,4,5,9,11	**1,9,11**	**6**

Table 12: Level Partitioning (Iteration 7)

VARIABLES	RS	AS	IS	LEVEL
1	1	1,3,4,5	**1**	**7**
3	1,3	3,4,5	3	
4	1,3,4,5	4,5	4,5	
5	1,3,4,5	4,5	4,5	

Table 13: Level Partitioning (Iteration 8)

VARIABLES	RS	AS	IS	LEVEL
3	3	3,4,5	**3**	**8**
4	3,4,5	4,5	4,5	
5	3,4,5	4,5	4,5	

Table 14: Level Partitioning (Iteration 9)

VARIABLES	*RS*	*AS*	*IS*	*LEVEL*
4	4,5	4,5	**4,5**	**9**
5	4,5	4,5	**4,5**	**9**

Table 15: Position coordinates of identified variables

Variables	*Dependence Power (X)*	*Driving Power(Y)*
1	5	9
2	8	6
3	3	13
4	2	9
5	2	11
6	9	8
7	6	10
8	8	4
9	7	7
10	9	6
11	6	10
12	10	5
13	8	3
14	8	2
15	12	1

Fig. 3: ISM Model

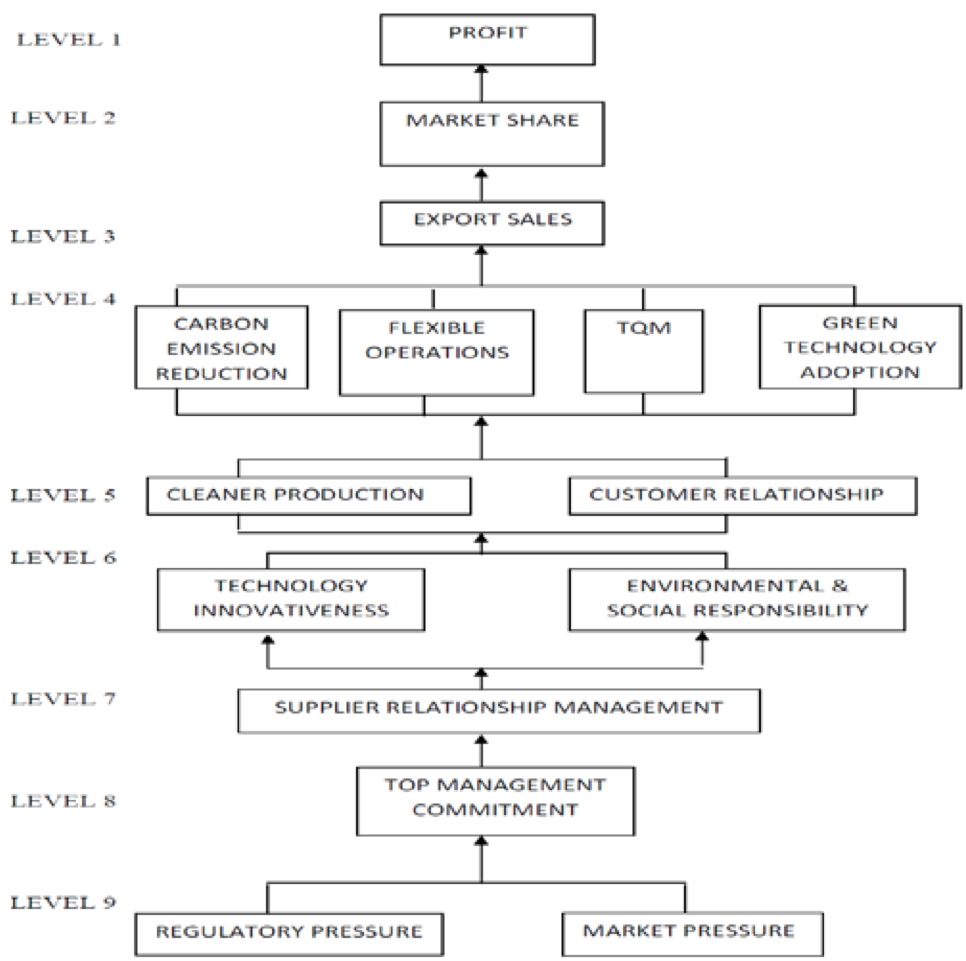
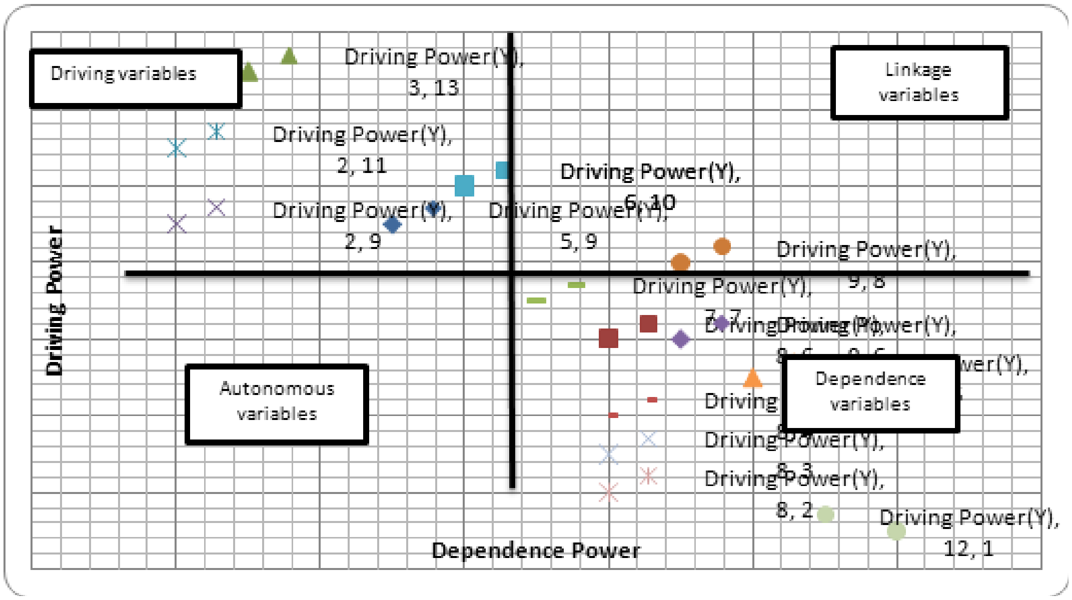


Fig. 4: MICMAC analysis



These factors have a strong drive power as well as strong dependence power. In this cluster we have three variables, i.e., 6 (Green Technology Adoption), 7 (Total Quality Management), 9 (Technology Innovativeness)and 11(Environmental and Social Responsibility).

Cluster 4: Driving variables

These factors have a strong drive power but weak dependence power. In this cluster we have four variables, i.e., 1 (Supplier Relationship Management), 3 (Top Management Commitment), 4 (Regulatory Pressures) and 5 (Market Pressures)

8. Conclusions

- Earlier works and reviews have a limited focus and narrow perspective. They do not cover adequately all the aspects and facets of SSCM. Although rubber industry is of national important for the growth of Indian economy but lack of previous SSCM empirical studies related to this sector is the main reason for lack of SSCM knowledge. Rubber board of India is putting emphasis in enhancing export sales and showing interest in GSCM practices. Literature show that without SSCM practices it is impossible to develop competitiveness in the global market. The model developed by us clearly explains the complex relationships among key variables and also show the direct and indirect relationships in a better fashion so that managers can easily understand the links and devise GSCM strategies successfully.
- SSCM practices in Indian rubber industry are mainly influenced by Market Pressures, Carbon Emission Reduction, Market Share and Profit. Rubber industry feel motivated in SSCM practices due to increase in market share and profit. Also there would be reduction in carbon emission and hence less market pressure on the sector. This will increase the brand image of the firm.
- Secondly Supplier relationship management and Green technology adoption are the linkage variables with respect to SSCM practices in Indian rubber industry.
- Thirdly Supplier Relationship Management, Top Management Commitment, Regulatory Pressures and Market Pressures are the key drivers of SSCM practices in Indian rubber industry.

9. Recommendations

- Reducing emissions in the rubber industry requires a sustained and focused effort.
- Maximize energy efficiency potential by replacing obsolete, inefficient equipments and adopting best available technologies and best practices.
- Switching to low carbon energy sources.

- Alter product design and waste disposal protocol to facilitate reuse and recycle in order to close the supply chain loop.
- Improve benchmarking through standardized measurement and data capturing protocols.
- Formation of a cross functional team and prepare the action plan for implementing GSCM in a holistic way.
- Preparation of the GSCM/environmental policy and create awareness among all employees.
- Approving the budget from top management for investment in clean technologies/best practices.
- Emphasis on supplier relationship management.
- Train and educate suppliers so as to implement ISO 14001.
- Emphasis on TQM practices.
- Monitor progress on a periodic basis is important.

Limitations

We understand that every management research has its own limitations; the present study also suffers from certain limitations. Present study is confined to a single sector and need to be validated in other sector and industry.

Unique Contributions

There are three important components of 'Unique Contributions' i.e., What, How and Why (Whetten, 1989). In the present study we have put effort to answer the three vital questions in terms of variables which we have identified from the synthesis of literature and experts opinion. We have developed a contextual relationships using ISM approach and further refined using MICMAC analysis.

Given the nature of this study, researcher makes three contributions:-

- First researcher provides one of the most comprehensive analyses of SSCM in Indian context.
- Second the study furthers existing research in the field of SSCM, which suggests that SRM is an important factor for its successful implementation. Researcher therefore contributes to an emergent literature, which suggests that the implementation of SSCM is sensitive to the characteristics of buyer-supplier relationships.
- Third SSCM has been explored on a more in-depth and theoretical level, by integrating NRBV and institutional theories, and addressing both internal and external perspectives of the firm.

Further research directions

To eradicate the limitations of present research we propose to validate the model empirically in other sectors by using Exploratory factor analysis and further test using linear multiple regression analysis using SEM packages such as AMOS/LISREL.

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