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DRIVERS FOR SUSTAINABLE GREEN SUPPLY CHAIN – CASE OF THE INDIAN AUTOMOBILE INDUSTRY

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ABSTRACT

Purpose*: De-licensing in 1991 put the Indian automobile industry on a new growth trajectory attracting foreign auto giants to set up their production facilities in the country to take advantage of various benefits it offers. The growth in this sector continues to be a threat to the environmental degradation. In light of future environmental challenges posed, this study explores drivers and building strategic framework for Green Supply Chain Management (GrSCM) in automobile sector from the Indian context.*
Design/methodology/approach*: The literature is reviewed by studying articles published in journals during 1990 – 2013, company sustainability reports. Further Expert interviews and survey is used for collection of data from employees working in Original Equipment manufacturers and parent companies.*
Findings*: Raw material dependency, top management commitments, greenhouse gas emissions, reverse logistics, cost of operations, peer influence is the variables which will act as drivers for sustaining Green Supply Chain management. The knowledge penetration level about the subject of Green Supply Chain management among the Engineers and Managers has been found satisfactory.*
Originality/value*: This research project apart from providing valuable insights to managers and top management will also be valuable to new entrant in this sector. The project carried is a first of a kind of project in the country that involves the exhaustive study of literature review followed by Company Sustainability reports and Primary Research for identifying Drivers of Green Supply Chain Sustainability.*

Classifications: Literature review
Keywords: Green Supply Chain Management, strategic framework, Automobile industry, India.

INTRODUCTION

De-licensing in 1991 has put the Indian automobile industry on a new growth trajectory by providing various benefits and attracting foreign auto giants to set up their production facilities in the country. The growing middle class population, greater earning power coupled with strong technological capability has been propelling automobile demand for past few years. Despite economic slowdown, the Indian automobile sector has seen a high growth especially in the passenger cars segment (Indian Automobile Sector Analysis, RNCOS, 2009 [1]). Further, the country has an installed capacity of 24.27 million units with 600 organised players (contributing 77% total production) and 5800 unorganised players (Profile of Automobile Industry in India, SIAM, 2010-11 [2]). In the Indian Automobile Sector, the OEM players have the largest market share followed by replacement and exports. The production stood at 1,79,16,035 units for the year 2010-11 vis-à-vis corresponding

1,55,13,156 units for the domestic sales and 23,39,333 units for export (Indian Automobile Sector Analysis, RNCOS,2009 [1]; Profile of Automobile Industry in India, SIAM, 2010-11 [2]).
In section 2 below we attempt to examine the literature so as to understand the factors critical to the Automobile industry.

LITERATURE REVIEW

1. Definition

Since an attempt is made to understand the evolution of Green Supply Chain through the literatures from SCM. It is important to quote the differing lexicons on SCM and GrSCM. The term 'supply chain' was coined in the mid 70's. Banbury in 1975 used 'supply chain' as a term of passing on electricity towards the ultimate consumer. It was not until the 1980's, however, that the term 'supply chain management' came into context. Stevens in 1989 defined supply chain management as the integration of inbound to outbound ends of the business business functions involving the flow of materials and information (Fortes, [38]).

In the early 1990's, supply chain management evolved dramatically with the increasing importance managing relationship within the organization and with other suppliers (Harland,[36]). Slack (1991) and Christopher (1992) explains that the reason for this was the emergence of a globalised marketplace (Fortes,[38]). Green Supply chain from practitioner's point of view can be defined as integrating the ideas of green purchasing, total quality management, customer focus, continuous improvement and zero waste; life cycle analysis; environmental marketing and so on (Purba Rao,[53], Handfield and Nichols,1999) .The above factors like green purchasing, total quality management, customer focus, continuous improvement, zero waste, life cycle analysis, environmental marketing should be used by companies for empowering its employees (Kumar et al, [42]) .were integrated as The "quality revolution in the late 1980's and the supply chain revolution in the Green supply chain have been further defined as a way in which innovations in supply chain management and industrial purchasing may be considered in the context of the environment (Green et al, 1998[41]). Integrating environmental thinking into a supply chain management, including product design, material resourcing and selection, manufacturing processes, delivery of the final product to the customer as well as end of life management of these product after its useful life (Nimawat, Dheeraj, [64]; (Srivastava, [58]).

Different perspectives on the definition shows that clear consensus on the definition is yet to be achieved. Further Automotive industrial production growth has caused a significant regional and international ecological burden (Gonza´lez et al, [60]). The growth in this sector comes continues to be a threat to environmental degradation which as alarmed governments and corporate worldwide following fast realization of the deteriorating climatic conditions. Global warming caused by greenhouse gases, ozone layer depletion, haze over Asian countries, fast melting of glaciers, generation of huge amounts of liquid and solid waste, rising air, water and soil pollution levels and irreparable loss of biodiversity are impacts that can be attributed to the coordinated activities of organizations in a supply chain. Much of this arises from manufacturing organizations that continue to produce large amounts of unnecessary waste or emissions rather than investing in better technologies or practices to prevent its generation at the source (Berchicci, [3]).

Green supply chain management (GSCM) has gained momentum in recent years as a potential tool to counter the detrimental impacts of the supply chains and Western countries have adopted

very stringentmeasures to arrest the damage caused by large, global supply chains which are energy and capital inefficient and complex in design.

2. GrSCM Vs Conventional SCM

GrSCM and Conventional SCM differ in various ways. GrSCM takes considerations of ecology as well as economy as an objective, while Conventional SCM is usually concentrated on economy as a single objective. GrSCM are green, integrated and ecologically optimized while Conventional SCM does not take into consideration human toxicological effects (Luthra et al,[45]). Conventional SCM concentrates more on controlling the final product; no matter harmful its effects are to the environment during production and distribution. Ecological requirements are key criteria for products and productions and at the same time the company must assure its economic sustainability by staying competitive and profitable.An attempt to differentiate by (Luthra, Kumar.V, Kumar.S,Haleem,[45]; Ho Johnny, Shalishali, Maurice, Tseng, & Ang, 2009) as in Table 1.

Table 1: "Difference between the Green Supply Chain Management and Conventional Supply Chain Management" [Luthra, Kumar.V, Kumar.S, Haleem, 2011]

S. No	Characteristics	Green Supply Chain Management	Conventional Supply Chain Management	Researcher's
1	Objectives	Ecological and Economic	Economic	Beamon (1999)
2	Ecological Optimization	High Ecological Impacts	Integrated Approach Low ecological impacts	Gilbert (2000)
3	Supplier Selection Criteria	Ecological Aspects Long term relationship	Price Switching suppliers quickly Short term relationship	Ho Johnny et al. (2009)
4	Cost Pressure	High	Low	
5	Flexibility	Low	High	
6	Speed	Low	High	

3. GrSCM Vs Lean manufacturing methods:

Lean manufacturing is closely associated with Green Production as there is an overlap between the goals and drivers for both processes. Various lean manufacturing techniques are JIT, Six sigma, ISO 9000 & 14000. The table below shows comparison between green supply chain versus lean manufacturing techniques. It can be seen that GrSCM has more benefits when compared with lean manufacturing techniques (Table 2).

Table 2: Comparison between Lean manufacturing process vs Green manufacturing process [Bhateja et al, 2011]

Factors	**Lean Manufacturing**			**Green Manufacturing**
	JIT	**SIX Sigma**	**ISO 9000 & ISO 14000**	
Eliminate Defects	*	*		*
Reduction of Cost	*	*		*
Quality Improvement	*	*		*
Quality Standards			*	*
Improve Efficiency	*	*		*
Customers Satisfaction	*	*		*
Reduced Resource Consumption		*		*
Reducing CO2 emissions in manufacturing processes				*
Recycling programs for raw materials				*
Recycling programs for reusable components parts				*
Remanufacturing Programs				*

4. Green Design:

Green Design is the systematic consideration of design issues associated with environmental safety and health over the full product life cycle during new production and process development (Fiksel 1996). The scope of Green Design comprises many disciplines such as environmental risk management, product safety, occupational health and safety, pollution prevention, resource conservation and waste management (Srivastava,[58]). The green design takes care of selection of materials which are environmental friendly. However if the materials are not readily available appropriate composition should be specified to make the new desired material.

5. Green Manufacturing:

Green manufacturing needs to meet evolving definitions of "clean", "greener" products demanded by customers, developing recycling schemes, minimizing materials in packaging and choosing materials that have less environmental impact (Richards, [57]).Other definition of Green manufacturing given by (Chien et al., [20]) says its a manufacturing mode designed to minimize the environmental impact in the manufacturing processes of products, and the adoption of green manufacturing helps to reduce waste and pollution.Green manufacturing is also sometimes referred to initiatives for efficient use of energy, materials with an aim for eliminating pollution and waste, hence Green Manufacturing can be also referred to as "clean technologies" (Baines etall, [64]; Chiang & Tseng, 2005; Mohanty & Deshmukh, 1998; Porter & van der Linde, 1995; Rusinko, 2007; Sangwan, 2006; Sarkis & Cordeiro, 2001; Seliger & Zettl, 2008; Vachon, 2007). Reduction or elimination of hazardous substances (Cd, Pb, PBBE etc), reduction in consumption of energy (standby and in operation), recyclability (disassembly, mono-

materials, pressfit, glue, welding), packaging mass (elimination of PVC, PU, EPS) are some of the techniques which can be employed for green manufacturing (Ramakrishnan, [56]).

6. Reverse logistics:

Beamon (1999) defined Reverse Logistics (RL) as the opposite of traditional or forward logistics (Krishna et al, [52]). Dowlatshahi (2000) and Carter and Ellram (1998) define reverse logistics as a process where a manufacturer accepts previously shipped products from the point for consumption for possible recycling and re-manufacturing. Heavy industries that have complex supply chains should take into consideration the benefits of reverse logistics (RL). Collection is the first stage in the recovery process. Products are selected, collected and transported to facilities for remanufacturing (Srivastava, [60]). Thierry (1995) explained that products came from different sources and should be brought to product recovery facility to begin the converging process. Further in a highly competitive industry reverse Logistics provides firm with cost and strategic advantage (Fortes, [39]). The effective use of reverse logistics can help a firm to compete in its industry especially when confronted with intense competition and low profit margins (Dowlatshahi, [27]).

7. Waste Management:

(Bellmann and Khare, 1999) explained waste management as means of best utilization of waste material in a profitable way. In process industries there will be some wastage of production along with actual production. Different waste management issues come into context particularly around recycling and remanufacturing. Green Manufacturing in automobile ancillary industry is not only keeping control greenhouse gases emissions across the entire producing value chain. Keeping a tab on carbon emissions in house helps to standardize and improve processes, provide single platform to manage environmental compliance, consistently supply emission data for carbon credits trading, and strategically contribute towards greener manufacturing. Recycling is one of the critical activity that finds its application in automobiles. The economic and regulatory factors are main factors that drive recycling. It is mainly performed to retrieve the material content of used and non-functioning products economically (Srivastava et al [42]). Other way company can handle waste is by employing Integrated Waste Management which can be defined as selection of suitable techniques, technologies and management programs to achieve waste management goals and objectives (Nemerow and Agardy, [51]).

Green operations relates to all aspects related to product manufacturing /remanufacturing, usage, handling, logistics and waste management once the design has been finalized (Srivastava,[60]). So it can be safely said the above explained aspects of Green Manufacturing, Reverse logistics, Waste management forms the part of Green Operations.

8. Relationship between EMS and Environmental Performance

EMS in the automotive industry maybe due to regulatory policy pressure, supply chain pressures. ISO 14001 is a well known EMS certification. Inspite of certifications like ISO 14001 there exist other investment costs and barriers (P. Gonza´lez et al, [62], Watson et al, 2004). Employing ISO 14001 is not a sure shot gurantee to get improved environmental performance. Some also describe it as “ceremonial” activity (Cary Coglianese[19]). Others have stated that some organizations implement ISO 14001 for the purpose of signaling to the market that they are

environmentally responsible organizations, even though the proof of actual improvements in environmental performance is tenuous (P. Gonza´lez et al [62]).

The above discussion in the literature review can be summed up with the help of a theoretical framework (Figure 1). The proposed framework is based on the similar lines of the SCOR Model (Supply Chain Operations Reference). Since the SCOR model version 10.0 does not take into consideration research and technology development, product development the need is felt to propose a new model. Table 3 lists the variables that are derived from the literature review.

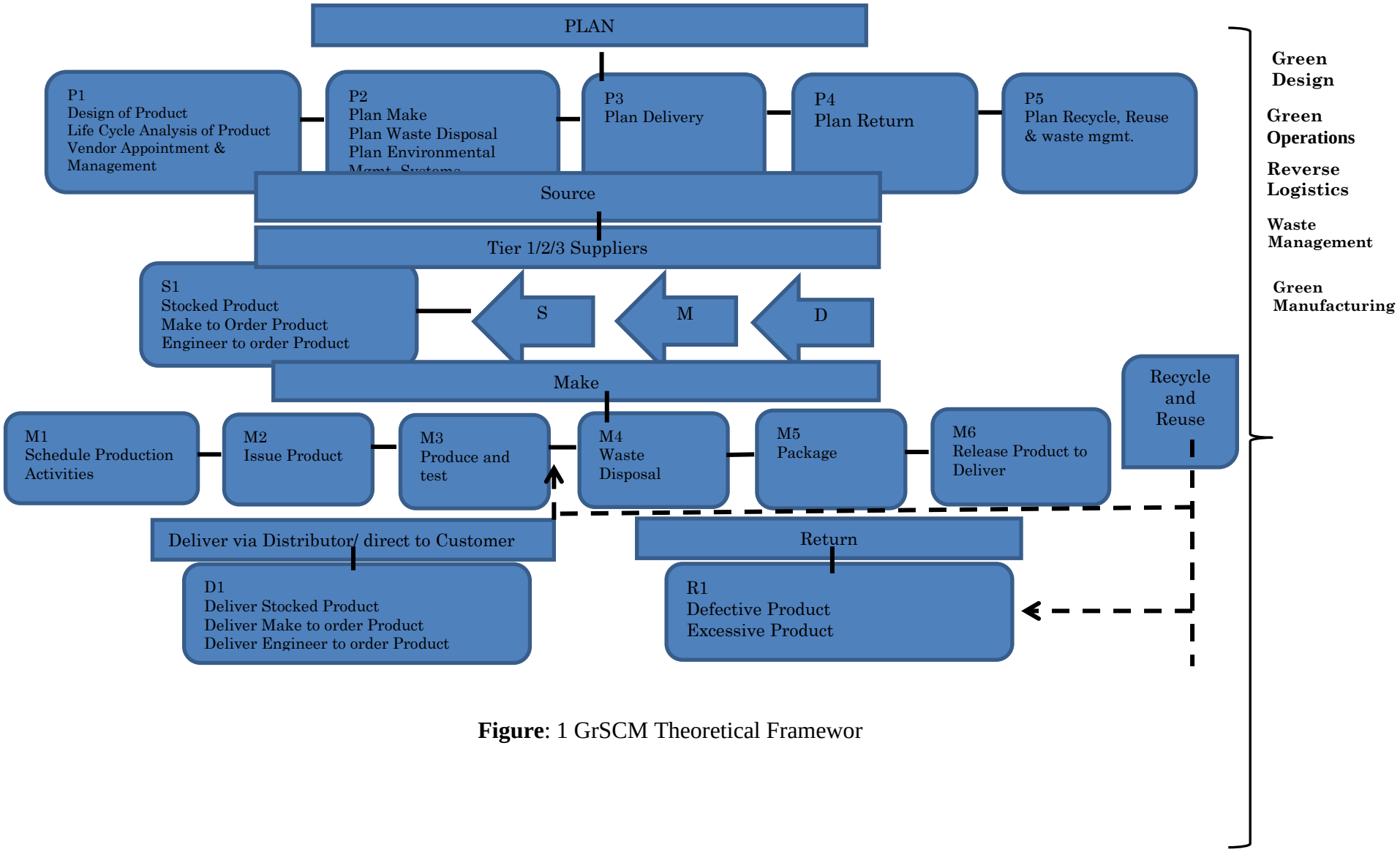

Figure: 1 GrSCM Theoretical Framewor

Table 3: Variable derived from the Literature Review

S.No	Author	Variables	Automobile related variables
1	Apratul Chandra Shukla, S.G. Deshmukh and Arun Kanda (2009);	1) Inbound Supply Chain Activities, 2) Outbound Supply Chain Activities, 3) Reverse Supply Chain Activities	All factors considered
2	Manish Choudhary, Nitin Seth (2011); Chien et al., (2007) Tan, et al., (2002); Hui, et al., (2001); Baines etall, (2012); Chiang & Tseng, (2005); Mohanty & Deshmukh, (1998); Porter & van der Linde, (1995); Rusinko, (2007); Sangwan, (2006); Sarkis & Cordeiro, (2001); Seliger & Zettl, (2008); Vachon, (2007)	1) Awareness seminars for suppliers and contractors; 2) Guiding suppliers to set up their own environmental programs; 3) Bringing together suppliers in the same industry to share their know-how and problems 4) Informing suppliers about the benefits of cleaner production and technologies; 5) Urging/pressuring suppliers to take environmental actions; 6) Selection of suppliers by environmental criteria	All factors considered
		1)Environmentally-friendly raw materials; 2) Substitution of environmentally questionable materials; 3) Taking environmental criteria into consideration; 4) Environmental design considerations; 5) Optimization of process to reduce solid waste and emissions; 6) Use of cleaner technology processes to make savings in energy, water, and waste; 7) Internal recycling of materials within the production phase; and 8) Incorporating environmental total quality management	All factors considered
		1) Environment-friendly waste management; 2) Environmental improvement of packaging; 3) Taking back packaging; 4) Eco-labelling; 5) Recovery of company's endof-life products; 6) Providing consumers with information on environmental friendly products and/or production methods	Factors listed at 4), 5), and 6 listed.
		1) Use of environmentallyfriendly transportation; 2) Taking back packaging	All factors considered
		1) Reduce waste and pollution; 2) Reduction or elimination of hazardous substances;	All factors considered

S.No	Author	Variables	Automobile related variables
		3) Reduction in consumption of energy; 4) Recyclability	
3	Claudia Colicchia, Marco Melacini and Sara Perotti (2011),Florida and Davison (2001),Hilliard (2006), King and Lenox (2001) and Veleva and Ellenbecker (2001), McKinnon et al. (2010),Rothenberg et al. (2005) and Turner and Houston (2009)	1) Eco-labelled product purchase adoption of environmental criteria into the supplier assessment system; 2) Environmental collaboration with suppliers	All factors considered
		1) Introduction of an energy manager; 2) Energy: choice of green electric power suppliers; 3) Energy: use of cogeneration plants; 4) Energy: energy efficiency improvement; 5) Energy: adoption of cleaner technology; 6) Fuel: district heating system; 7) Water: increase water system efficiency; 8) Water: waste water treatment; 9) Water: process optimization; 10) Material: reuse of materials; 11) Material: process optimization	All factors considered
		1) CO2 capture and storage; 2) Reduction of hydrofluorocarbons (HFC) and perfluorocarbons (PFC); 3) Use of CO2 refrigeration systems; 4) Treatment and control of postcombustion emissions; 5) Use of alternative fuels (e.g. cleaner fuels); 6) Treatment and recycle of hazardous wastes; 7) Process optimization; 8) Implementation of waste-to-energy process Waste reduction, reuse and recycling approaches	Factors from 2 to 8 considered

Figure 2 identifies the unique variables which as part of the framework as derived from Table 3 could be used as a framework in sustaining GrSCM.

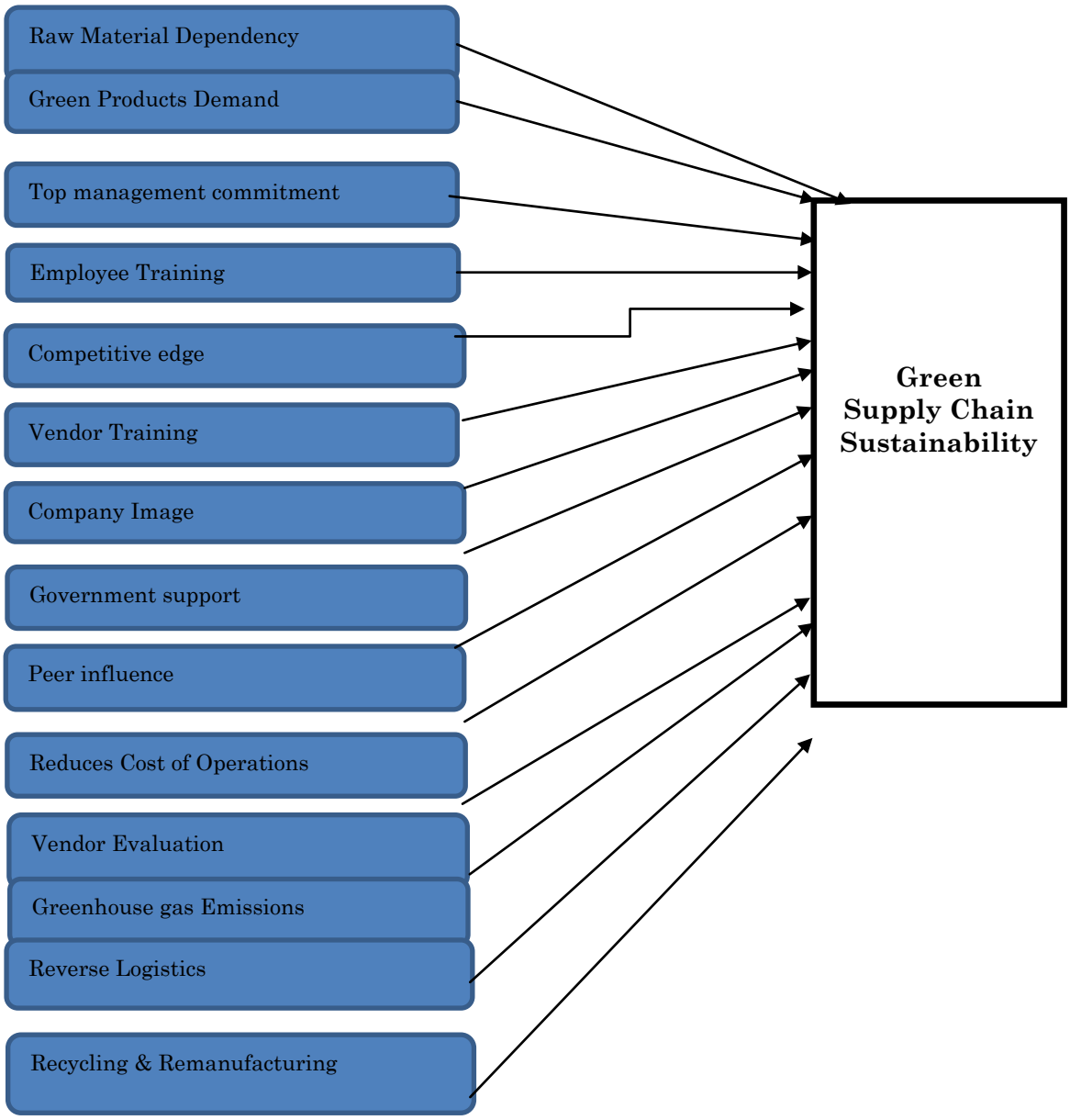

Figure 2: Unique variables for sustaining GrSCM.

CONCLUSIONS

The investigation 'What drivers are involved to sustain GrSCM for Automobile Companies in India?' has been carried out by a systematic review of GrSCM articles published in journals during 1990 – 2013. Eleven unique variables are identified for sustaining GrSCM. This include 1) GrSCM Awareness, 2) Raw material Dependency, 3) Green Products demand 4) Top management attitude towards initiate, appoint, train its employees and vendors 5) Impact on Competitive edge and Company Image, 6) Government support 7) Reduced Cost of Operation, 7) Peer influence, 8) Vendor Evaluation, 9) Greenhouse gas Emissions 10) Reverse Logistics, and 11) Recycling & Remanufacturing. From the Table 3, it can be concluded that these variables help build a

strategic framework for the drivers for implementing GrSCM in the Automobile industry. In the Indian context, to identify its validity and usability of all these variables is in progress by a survey questionnaire. The analysis of the result shall be updated by mid-April. 13.

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