International Conference of Advance Research and Innovation (ICARI-2015)

Supply Chain Management in Automotive Industries

Ankit Singh [*], Bharat S Bisht, Deepak Jain, Tarun Arora, Saurabh Agrawal

Department of Mechanical Engineering, Delhi Technological University, Delhi, India

Abstract

With the ever growing demand in automotive industries, a plethora of industries have forayed their way into the industry without even noticing the issues that have come up in the recent past. This has been evident with the plentiful research papers and literary reviews written to tackle and solve these issues. The aim of this paper is to analyze, summarize the environmental and economic problems in this sector. The paper initially studies the previous 41 papers written in this field in the past. Then according to the results, the focus is shifted to the field requiring further study to improve the past results and simultaneously tackle the upcoming issues. This paper concludes that an integrated study of green and sustainable is the need of the hour. The paper also suggest the use and development of an alternative fuel (TPO) which will not only have environmental benefits but also reduces the dependence on conventional fuels.

1. Introduction

Supply Chain Management is a well-known global phenomenon and is widely used in almost every industry in the present scenario. Supply Chain Management is the management of chain of supplies. There are generally 4 major aspects of a Supply chain namely- forward, reverse, closed-loop and green. The "Supply Chain Management" as it sounds manages the supply chain in any industry .Even though the supply Chain Management as a topic sounds easy, but as we go deeper and deeper into it, it makes us realize how interestingly wide and crafty this field is. The simple definition as we see is the management of the flow of goods, flow of cash, and flow of information qinternally and externally of a company or a group of companies that share the same value chain. But however a large part of this topic is yet to be reviled in this paper. It will amaze you to realize how much scope this field has and at the same time the amount of great efforts and skills required to achieve success in this field and give any company an edge over the others. But before proceeding to the crux of the Supply chain management, a few basic definitions should be known to all in order to really comprehend the subject and further find interest in this field that will help you not only in management but also in daily life. Supply chain management is defined as the integration of business processes from customers to suppliers.

2. Supply Chain Flow Diagram

In the above figure, the forward logistics is represented by black arrows and reverse logistics by red arrows. The raw materials are extracted out and send for manufacturing. Here since we have an economical approach as well as environmentalist approach, before we manufacture, the harmful effects of manufacturing to the environment are treated before proceeding to the next stage. The products are then distributed in the market. The next phase represents the more economical approach where defective and returned products are treated accordingly. Their value and state are evaluated and accordingly are discarded as waste or further
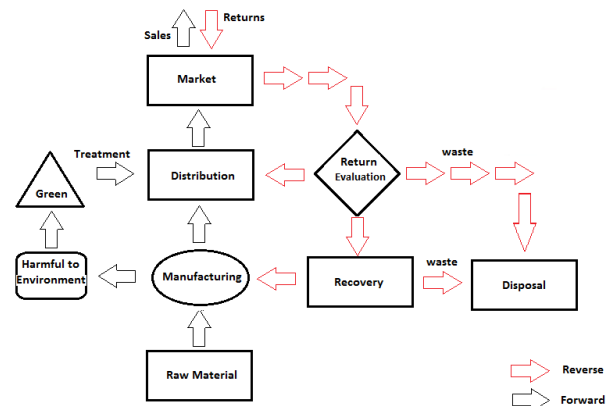
send for recovery.

Fig: 1. Flow Diagram showing a Supply Chain

3. Literature Review
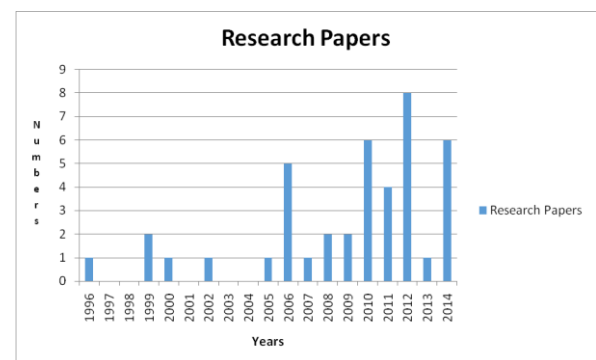
Table: 1. Characteristics of Earlier Review/Partial Review Studies

Paper	Area	Scope	Year
Sunil Luthra & Vinod Kumar (2010)	Green	Qualitative and Quantitative study of GSCM barriers in Indian automobile	2010

Corresponding Author,
E-mail address: ankit10sevs@gmail.com

		industry	
Qinghua Zhu (2012)	Green	Relationships between the external and internal practices of GSCM	2012
Jorn- Henrik Thun Daniel Hoenig Oct (2009)	Risk Management	Understanding of risk management via analysing German automobile industry	2009
Chee Yew Wong (2011)	Supply Chain Integration	Theory to explain complex relationship between Supply Chain Integration and Operational performance	2011
Kuan Yew Wong (2012)	CLSC	Case Studies	2012
Aysegul Sarac (2013)	Reverse Logistics	Case Studies	2013
Craig R. Carter (2011)	Sustainable	Review Paper	2011

In the light of Table 1, no comprehensive review study in the automobile sector relating sustainable and green, which analyzes state-of- the-art recently published papers, is found in the literature.

Fig: 3. Showing Country Wise Distribution of Research Papers

4. Research Methodology

Content analysis and description of research methodology should include four steps: material collection, descriptive analysis, category selection, and material evaluation. This paper utilizes the steps to discuss and clarify the research methodology of the paper.

The material for this research paper has been collected from 1997 to 2014 to include voluminous and disparate research work in order to draw comprehensive results. Initially around 40 papers were reviewed from google scholar. But the google scholar helped to determine other websites too which gave a set of 30 papers more. Hence finally the websites that were referred includes "www.googlescholar.com", "www.wiley.com", "www.emeraldinsight.com", and www.elsevier.com".

Firstly the time period is mentioned in the search engine followed by keywords like "supply chain management" and "automotive industry". The papers are then sorted by relevance. The first 5-10 search pages are analyzed and then according to need and importance, the papers are collected. After collection, papers are initially cross checked for repetition and relevance.

4.1 Category Selection

We have categorized the papers on the followings lines and their apparent meaning has been explained afterwards:

Table: 2. Showing Category Selection in Classifying the Research Papers

TIME PERIOD	PURPOSE/OBJECTIVE	PROBLEM TYPE	FIELD OF RESEARCH	REGARDING UNCERTAINTY	DECISION VARIABLE
Short	Single	Quantitative	Green	Deterministic	Strategic
Medium	Multi-Purpose	Qualitative	Sustainable	Non Deterministic	Operational
Long		Case study	Reverse Logistic	Fuzzy Hierarchy	Planning
		Survey	Closed Loop Supply Chain		
		Hypothetical study	Lean		
			Supply Chain		
			Risk		

Quantitative Research options have been predetermined and a large number of respondents are involved.

By definition, measurement must be objective, quantitative and statistically valid. Simply put, it's about numbers, objective hard data. The sample size for a survey is calculated by statisticians using formulas todetermine how large a sample size will be needed from a given population in order to achieve findings with an acceptable degree of accuracy. Generally, researchers seek sample sizes which yield findings withat least a 95% confidence interval (which means that if you repeat the survey 100 times, 95 times out ofa hundred, you would get the same response), plus/minus a margin error of 5 percentage points. Many surveys are designed to produce a smaller margin of error.

Qualitative Research is collecting, analysing, and interpreting data by observing what people do and say. Whereas, quantitative research refers to counts and measures of things, qualitative research refers to the meanings, concepts, definitions, characteristics, metaphors, symbols, and descriptions of things.

Qualitative research is much more subjective than quantitative research and uses very different methods of collecting information, mainly individual, in-depth interviews and focus groups. The nature of this type of research is exploratory and open-ended. Small numbers of people are interviewed in-depth and/or a relatively small number of focus groups are conducted. Participants are asked to respond to general questions and the interviewer or group moderator Deterministic functions always return the same result any time they are called with a specific set of input values and given the same state of the database.

Non deterministic functions may return different results each time they are called with a specific set of input values even if the database state that they access remains the same. A Case Study (or case report) is a descriptive,

International Conference of Advance Research and Innovation (ICARI-2015)

exploratory or explanatory analysis of a person, group or event. An explanatory case study is used to explore causation in order to find underlying principles. Case studies may be prospective (in which criteria are established and cases fitting the criteria are included as they become available) or retrospective (in which criteria are established for selecting cases from historical records forinclusion in the study). Survey: A field of applied statistics, survey methodology studies the sampling of individual units from a population and the associated survey data collection techniques, such as questionnaire construction and methods for improving the number and accuracy of responses tosurveys. Generally, there are three types of Decision Variables: strategic decision variables (locations, capacities, etc), tactical decision variables (allocations, planning, etc.), and operational decision variables (lot sizing, inventory, etc.). Finally, in terms of period, product, and objective function (if applicable), a paper can be single-type or multiple-type. As mentioned, these categorizations are based on analysis of the characteristics/ of the selected papers.

5. Review in Supply Chain Management

Gopal P.R.C and Thakkar Jitesh [1] (2014) appointed both qualitative and quantitative approaches to present an integrated method for the development of composite sustainable supply chain (SC) performance index. They computed the index by applying an integration of fuzzy analytical hierarchy process, Liberatore score and signal-to-noise ratio. This methodology demonstrates how quantitative statistical inputs can be combined with expert opinion to construct an overall index of sustainability. They also stated an application of the index as to how it can be applied to automobile supply chain and used by SC managers to measure their organization's contribution towards SC sustainability.

Chanchaichujit Janya, Quaddus Mohammed, West Martin, Saavedra-Rosas Jose [2] (2012) developed a decision support model based on optimization for the Thai rubber industry by incorporating the distribution, production and transportation of rubber products in a manner to minimize the total costs. The model helped in the analysis of rubber supply network flows, the factory locations, the outbound distribution of transportation mode and route choices.

Behrouzi Farzad and Yew Wong Kuan [3] (2011)used principal component analysis to identify the lean supply chain performance components and related measures with a special focus on small and medium enterprises in Iran's automotive industry. They chose a total of 28 performance measures essential to monitor the leanness of a supply chain. They identified four components (quality, cost, flexibility, and delivery and reliability) and the 28 related measures were subsequently grouped under these performance components. They also stated that by identifying and validating a multidimensional list of lean supply chain performance components and related measures for small and medium enterprises, the research can be useful for practitioners or academics that are going to evaluate the leanness of a supply chain.

Joshi Deepika, Nepal Bimal, Pal Singh Rathore Ajay, Sharma Dipti [4] (2012)examined the determinants of competitiveness for Indian automotive component (IAC) manufacturing industry, in special context to its supply chain (SC) performance indicators. They used a longitudinal case study of a large scale automotive component manufacturer in India to examine the SC competitiveness of IAC. They collected the real world data on 24 competitiveness drivers from the case study company. They employed analytical network process to prioritize the competitiveness determinants by considering their mutual dependence. Management strategies to improve the competitiveness drivers and their effects on overall supply chain competitiveness of the firm in question were discussed. This case study showed that the business environmental factors such as workers' skills, globalization, and government regulations contributed the most to the overall supply chain competitiveness of the IAC. However, the competitiveness factors are mutually dependent; therefore, making managerial decisions by considering individual weights only can lead to a wrong conclusion.

Lin and Chen [5] (2011) studied the implementation of GSCM in developing countries in general and automobile manufacturing firms. Green Supply chain management not only provides environmental issue but also bring various economic benefits to its manufacturers. Their study explored the criteria that influence the performance of the automobile manufacturing industry. They used fuzzy set theory and Decision Making Trial and Evaluation Laboratory. Their study concluded that the increase of cost for purchasing environmentally friendly material is the most important criterion, while the pollution control initiatives is the most effective criterion.

Choi and Narasimhan [6] (2012) studied the "postponement" strategy in the context of a global production–distribution system of an automobile manufacturer. Their study proposed a model that integrates multiple considerations to global supply chains. Postponement took into consideration the international transfers and tariffs and their consideration is important for the impact of postponement on total costs. Variables such as customs, tariff and cost differences are essential to derive full benefits in a global supply chain model. Their paper developed insights regarding postponement strategy in global supply chains via a system dynamics simulation model. The results of the system dynamics simulations show that the choice of optimal shipping point and the right level of postponement under the "decoupling points" strategy in global operations has a significant effect on overall cost efficiency, when decoupling point and postponement timing are considered simultaneously. The results also show that there are key differences in executing the postponement there are key differences in executing the postponement strategy when shipping to a developing country as opposed to a developed country.

Sarac and Absi [7] (2010) reviewed the impact of RFID technologies on supply chain management. They used a state-of-the-art on RFID technology deployments in supply chains is given to analyze the impact on the supply chain performance. They briefly surveyed the potential benefits, particularly against inventory inaccuracy problems, the bullwhip effect and replenishment policies. Various works addressing analytic modelling, simulations, case

studies and experiments as well as ROI analyses were reviewed.

Matsuo [8] (2014) studied the implications of the Tohoku earthquake for Toyota's coordination mechanism. The paper specifically focused on a case of supply disruption of the automotive microcontroller units, which were produced by Renesas Electronics and supplied to Toyota via its first tier vendors like Denso. Their paper analyzed the events of the case from a supply chain point of view and closely observes the action Toyota tool to recover to the pre-earthquake level production from the perspective of execution, design, strategy and sustainability. The paper also identifies the missing function from the Toyota Production System where the coordination is propagating from Toyota to upstream suppliers through the close interaction between the successive layers of its multi-layered supplier network. The missing function which is direct control functions need to be added to alleviate the disruption risk and secure the supply of key parts and materials.

Luthra Sunil, Kumar Vinod, Kumar Sanjay and Haleem Abid [9] (2011) surveyed the Indian market especially automobile one and developed a structural model of the barriers to implement GSCM in Indian automobile industry. Eleven numbers of relevant barriers were identified from literature and subsequent discussions with experts from academia and industry. Out of which, five numbers of barriers were identified as dependent variables; three number of barriers were identified as the driver variables and three number of barriers were identified as the linkage variables.. Four barriers were identified as top level barriers and one bottom level barrier. Removal of these barriers was also discussed.

Thun Jorn-Henrik and Hoenig Daniel [10] (2009) did an empirical analysis of supply chain risk management in the German automobile industry. They identified supply chain risk and their potential impact.

Jörn-Henrik Thun[*] and Andrea Müller [11] (2009) did research on green supply chain management in the German automotive industry from a practitioner's point of view. Several aspects of green supply chain management, such as the point of time of implementation, the driving forces, the relevance of intended goals and their particular realization and the adoption of eco-programs with suppliers and customers as well as internal and external barriers were discussed at length.

Saad Mohammed and Patel Bhaskar [12] (2006) researched on supply chain practices in the Indian automobile sector. They identified the main motives and determinants for the adoption and implementation of supply chain management concepts

Sharma Satyendra Kumar and Bhat Anil [13] (2013) made a significant impact in supply chain management risk strategies. Firstly they divide these firms in 2 categories as low and High SCRM risks. By including as wide as 7 factors for risk management, namely avoidance, supplier development, flexibility, risk pooling, redundancy, integration and control strategies, a vital and detailed study has been made. The study highlights implementation of SC risk mitigation strategies is higher in companies in focal position. Also this can be illustrated by the fact that these strategies are implemented by the firm itself. PCA derived seven factors, namely: avoidance, supplier development, flexibility, risk pooling, redundancy, integration and control strategies. The surveyed firms were classified into two clusters as low and high SCRM level.

Qrunfleh Sufian and Tarafdar Monideepa [14] (2013) carried forward the fact that strategic supplier partnership mediates the relation between a lean supply chain and its responsiveness, and that postponement concludes the relation between the agile supply chain strategy and its responsiveness associated with enhanced firm performance. The paper justifies strategic supplier partnership and postponement are appropriate for mediating the impact of lean and agile supply chain strategies, respectively, on supply chain responsiveness. While at a higher level of abstraction, these relationships show how supply chain strategy can elicit the supply chain responsiveness by using these SC strategies.

Vanalle Rosangela Maria and Santos Leandro Blanco [15] (2013) analysed the important concepts of sustainability, environmental factors, financial, and operational performances for selecting the suppliers and manufacturers in the Brazilian automotive industry.

These strategies revolve around the exempting use of hazardous substances in all sections like development, and environmental performance assessment of suppliers. Companies value operational performances giving equal importance to other factors like amount of products delivered on time, delivery time, commitment to quality management and order compliance rate.

Simpson Dayna, Power Damien and Samson Daniel[16] (2007) explored how a customer and its suppliers on the uptake and effectiveness of the customer's environmental performance requirements (otherwise known as "green-supply").Suppliers were found to be more responsive to their customers' environmental performance requirements where increasing levels of relationship-specific investment occurred. Suppliers are less prone to believe that they would be penalized for defiance with the customer's environmental performance requirements with increasing the level of investment in the customer-supplier relationship.

6. Research Gap

From our Analysis, it can be concluded that an integrated study of Green and Sustainable Supply Chain Management is the need of the hour. GSCM has emerged as a trending phenomenon which includes all phases of a product's life cycle from design, production, distribution to the used and disposal of the product. Within companies, eco-programs are partly used. One important reason for companies to deal with ecological aspects is the polluter-pays principle, which was legislated by the government. The act on closed-loop recycling management is an example of the polluter-pays principle. The practices most valued by companies involve eliminating or reducing the use of hazardous substances. These practices are evaluated in the selection, development, and environmental performance assessment of suppliers. Operational performance was most valued by companies, with highlighted practices including the amount of products delivered on time, commitment to quality management, delivery time, and order compliance rate. This article discusses the carbon foot print across the

International Conference of Advance Research and Innovation (ICARI-2015)

supply chain, examines various ''heat'' transfer devices and presents an initial analytical model that measures carbon emissions from both stationary adnoun- stationary supply chain processes. Specifically, the ''heat links' 'across various stages in a supply chain are measured. The model helps to understand the heat flux and carbon wastage a teach node of the supply chain and allows to calculate the total heat (and hence carbon) transferred from one stage of the supply chain to another. Controlling this flux and carbon emissions requires monitoring of the entire supply chain. With the approach presented in this article, firm scan see what and where the areas of sensible heat flux and acceptable carbon emissions are .Further, based on this knowledge, firms can design supply chain networks and implement measures in their operations to reduce carbon emissions. Survey in sustainable supply chain. GSCM can be viewed at multiple levels including external and internal GSCM perspectives. Suppliers were found to be more responsive to their customers' environmental performance requirements where increasing levels of relationship-specific investment occurred. As the level of investment in the customer-supplier relationship increased, suppliers become less likely to believe that they would be penalized for non-compliance with the customer's environmental performance requirements.

7. Conclusions

With the keen and deep insight study of our topic, "Supply chain management", it can be concluded that this field has wide range of scope and requires intense study and knowledge to draw further conclusions and ameliorate the already stated results and researches. The disparate number of researches that has been studied and analyzed, make us realize the enormous amount of work still left in the field that motivates us all to further take this topic and work even harder to make robust and flawless outcomes after further detailed study. But even with months of hard work and perseverance, a lot of efforts have been put in to ascertain a few conclusions that not only helps people to optimize the cost of production but also protect the   environment by

using safer technology considering its harmful impacts on the environment.

The few important solutions and conclusion include-

- The use of 6R's of environment rather than the 3R's. These include, Recycle, Reduce, Reuse, Redesign, Recover, Remanufacture
- Using the Mitigation and Contingency Strategies in risk management to reduce the effects of natural disasters in case of mitigation strategies and preparing before these unforeseen events take place in case of Contingency strategies.
- Lean production that focuses on cutting out waste, whilst ensuring quality can be an important part of any management.

Currently in the Indian automobile industry the sustainable part of the supply chain has a lot of potential. Keeping the green and sustainable part of supply chain Tyre Pyrolysis Oil (TPO) is one such method of to implement the Green Supply Chain Management (GSCM) in the Indian Automobile industry. Disposal of waste tyres poses many problems as disposing in landfills can pollute the soil and in many cases is known to pollute water. Also disposing by burning release harmful gases that can affect lungs and are known to cause problems like asthma. Currently tyres are disposed in a harmful way in the environment. However tyres can be used to make TPO by the process known as pyrolysis. The TPO obtained can be used as an additive in the diesel engine and can increase the efficiency of diesel engines and reduce harmful emissions from the vehicles. The need for alternative fuels in engines can also be fulfilled by blending TPO with the diesel. In this project a number of research papers in the Indian Supply Chain have been reviewed and the research gap is identified accordingly. The Green and Sustainable part of the supply chain were the major research finding after reviewing the paper from the recent part. Our research finding suggest a need to implement TPO in the Indian automobile industry because of its numerous advantages.

References

[1] P. R. C Gopal, J. Thakkar, On Development of composite sustainable supply chain performance index for the automobile industry", Department of Industrial Engineering & Management (IEM), IIT Kharagpur, Kharagpur, India, 2014

[2] J. Chanchaichujit, M. Quaddus, M. West, J. Saavedra-Rosas, On an optimization based decision support model for Thai rubber industry supply chain: Preliminary results, Graduate School of Business, School of Information System, Curtin Business School, Curtin University, Western Australia, 2012

[3] F. Behrouzi, Y. W. Kuan, An investigation and identification of lean supply chain performance measures in the automotive SMEs, Department of Manufacturing and Industrial Engineering, Faculty of Mechanical Engineering, Universiti Teknologi Malaysia, 81310 UTM Skudai, Malaysia, 2011

[4] D. Joshi, B. Nepal, A. P. S. Rathore, D. Sharma, On supply chain competitiveness of Indian automotive component manufacturing industry, Malaviya National Institute of Technology, Jaipur, India Department of

Engineering Technology and Industrial Distribution, Texas A&M University, College Station, TX , United States, 2012

[5] Lin, Chen, Green supply chain management performance in automobile manufacturing industry under uncertainty, Graduate School of Business and Management, Department of Business Administration, Lunghwa University of Science and Technology, No. 300, Sec. 1, Wanshou Rd., Guishan, Taoyuan, Taiwan, 33306, 2011

[6] Choi, Narasimhan, Postponement strategy for international transfer of products in a global supply chain: A system dynamics examination, Division of Management, Hansung University, South Korea, Eli Broad School of Management, Michigan State University, United States College of Business Administration, Seoul National University, South Korea, 2012

[7] Sarac, Absi, A literature review on the impact of RFID technologies on supply chain management, Ecole des Minesde Saint- E´tienne, 2010

[8] CMP, Site Georges Charpak, 880 Avenuede Mimet, F-13541 Gardanne, France

[9] Matsuo, Implications of the Tohoku earthquake for Toyota's coordination mechanism: Supply chain disruption of automotive semiconductors, Graduate School of Business Administration, Kobe University, 2-1 Rokkodai, Nada, Kobe, Hyogo 657-8501, Japan, 2014

[10] S. Luthra, V. Kumar, S. Kumar, A. Haleem, Barriers to implement green supply chain management in automobile industry using interpretive structural modeling technique-An Indian perspective, Thapar University (INDIA); C.B.S Group of Institutions India, Jamia Millia Islamia, India, 2011

[11] Thun Jorn-Henrik, D. Hoenig, An empirical analysis of supply chain risk management in the German automotive industry, Industrieseminar, Mannheim Business School, University of Mannheim, 68131 Mannheim, Germany, 2009

[12] Thun Jörn-Henrik, A. Müller, An Empirical Analysis of Green Supply Chain Management in the German Automotive Industry, Industrieseminar, Mannheim University, Mannheim, Germany, 2009

[13] M. Saad, B. Patel, An investigation of supply chain performance measurement in the Indian automotive sector, Bristol Business School, University of the West of England, Bristol, UK, and KITS, Ramtek, Nagpur, India, 2006

[14] S. K. Sharma, A. Bhat, Supply chain risk management dimensions in Indian automobile industry, Department of Management, Birla Institute of Technology and Science (BITS) Pilani, India, 2013

[15] S. Qrunfleh, M. Tarafdar, Lean and agile supply chain strategies and supply chain responsiveness: the role of strategic supplier partnership and postponement, Department of Computer Information Systems, Eastern Michigan University, Ypsilanti, Michigan, USA, and Department of Management Science, Lancaster University, Lancaster, UK, 2013

[16] R. M. Vanalle, L. B. Santos, Green supply chain management in Brazilian automotive sector, Industrial Engineering Post Graduation Program, Universidade Nove de Julho (UNINOVE), S~ao Paulo, Brazil, 2013

[17] D. Simpson, D. Power, D. Samson, Greening the automotive supply chain: a relationship perspective, Department of Management, University of Melbourne, Australia, 2007