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Identification of Critical Success Factors (CSF's) to implement Green Supply Chain Management (GSCM) in an automobile industry using Analytical Hierarchy Process (AHP) technique

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Abstract

Due to globalization, supply chains have grown more lengthy and complex and creating an adverse effect on environment, which paved a way in emergence of Green Supply Chain, management (GSCM).Total 77 papers dealing with GSCM were reviewed to understanding researcher's contribution in GSCM literature. Automobile industry is one of the largest polluter amongst all industries contributing 80% of total CO. In recent stretch most of automobile industries, alter their supply chain to GSCM to increase their competitive advantage. This study deals with the application of AHP method for evaluating and ranking Critical success factors for automobile company to implement GSCM. The weightages were attained based on the pair wise comparison of attributes with the help of industrial experts and academia. The results of the study revealed the most significant CSF's for implementation of GSCM in automobile industry.

Keywords: *Green Supply Chain Management (GSCM), Critical Success Factors (CSF's), Analytical Hierarchy Process (AHP), Automobile industry*

INTRODUCTION

It is very important for any Supply chain to know and comprehend the critical success factors (CSF's) that will help in implementation of Green Supply Chain Management (GSCM) practices. However, certain barriers existso to overcome these and to implement GSCM in successful manner CSF's are very vital. In this section, various CSF's are identified and discussed based on the available GSCM literature in the context of Indian automobile industries. Many researchers put their efforts to identify these factors by using different tools and techniques.

Automobile sector exhaust accounts for more than 75% of total air pollution. Automobiles are responsible for 80% of total CO emission, 36% of the HC's, 44% of the NOx, 4% of SOx and 18% of the particulate matter. Automobiles are responsible for over 75% of total pollution in India. If we look for different options for protecting the environment then GSCM is the most suitable and efficient one.

GSCM is one of the best strategies for meeting the challenge to reduce carbon emission and enhance sustainability because of its potential to improve the environmental performance of any organization. In today's world, people are more concerned than ever before about the environment and subsequent climate changes. Along with these concerns, in today's globalized world buyers' opportunities have increased. This has led to automobile companies to make adjust their strategies in many areas, including R&D and manufacturing (Schwarz, 2008; Jawahar Babu, 2012). Automobile companies have responded well to these concerns with companies like BMW, Ford, Toyota, Renault, and Volkswagen leading the pack.

Objectives of the paper

During the literature review, it has been observed that less research work is reported on CSF's to implement GSCM in Indian context, identification of variables relevant to Indian automobile industry need to be done; and dynamics of these variables needs to be examined.

The gaps identified in the literature review gave direction to carry out the present research. The objectives of the research are:

1. To identify the CSF's variables in implementation of GSCM
2. With the help of expert interviews final list is established
3. Using pair wise questionnaire importance of pairs are calculated
4. Using AHP ranking of factors done

Organization of Paper

The next section discusses the literature review of SCM and GSCM to understand basics of subject. Which is followed by identification of the CSF's variables in the implementation of GSCM in Indian automobile industry then using AHP final ranking of factor is done. Finally, the conclusions of research have been presented.

Literature review

SCM is a network of facilities that produce raw materials, transform them into intermediate goods and then final products, and deliver the products to customers through a distribution system. It spans procurement, manufacturing, and distribution. Coopert *et al.* (1996) stated SCM is as a planned production process in which raw material converted into finished goods, then delivered to end customers. A connected set of resources and process starts with the raw material sourcing and expands to delivery of finished goods to the end customers. However, traditional SCM is encountering challenges such as lack of communication, coordination, mutual trust etc. among supply chain partners that causes excessive amount of usage of resources and pollution. However, GSCM enables supply chain partners to communicate what they were missing earlier throughout the process.

According to Benita *et al.* (1999), GSCM integrates the environmental thinking in SCM, including product design, material resourcing, and selection, manufacturing process, delivery of the final product to the consumer as well as end of life management of the product after its useful life. Gilbert (2001) explained that greening the supply chain is the process of incorporating environmental criteria or concerns into organizational purchasing decisions and long-term relationships with suppliers. Many researchers stated that GSCM commonly consist of = Green Product Design + Green Material Management + Green Manufacturing Process + Green Distribution and Marketing (Bhateja et al., 2011; Nimawat and Namdev 2012; Kumar et al., 2014). Figure 1shows that in GSCM there is an interrelation between suppliers, manufacturer, retailers, consumers, and logistics providers, which results in minimization in emission of greenhouse gases and waste reduction.

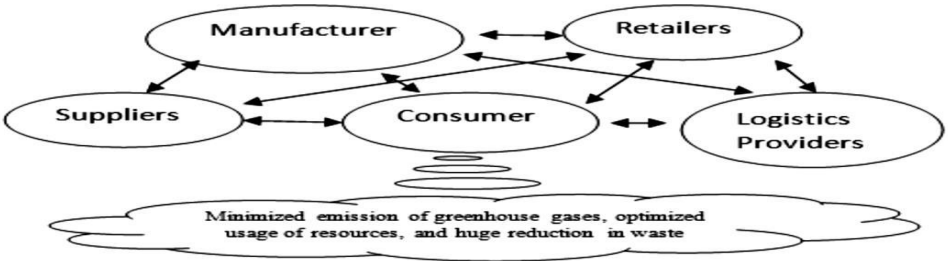

Fig1 : *GSCM components relationship (Bhatejaet al., 2011)*

Many researchers put their efforts in identifying parameters like drivers, barriers, pressures and CSF's.So total 77-research paper from Indian background is reviewed from prominent databases to understand researcher's contribution in GSCM parameters. Table1 below shows the list of papers which is reviewed.

Table 1: *Articles related to GSCM (Indian context)*

S.no	Year	Title/authors	Findings
	2009	Greening the supply chain practices: an Indian perspective of enablers' relationships (Mudgal*et al.*)	This paper aims at identifying enablers for greening the supply chain of manufacturing organizations. It also seeks to understand their inter-relationships. A questionnaire-based survey was conducted to rank these enablers. Using results of this survey and the interpretive structural modelling (ISM), the paper presents a hierarchy based model and the contextual relationships among these enablers. The study indicates that there exists a group of enablers having low dependence and high driving power and are of strategic importance.
	2010	An analysis of the drivers affecting the implementation of green supply chain management (Diabata and Govindan)	This paper developed a model of the drivers affecting the implementation of GSCM using an ISM framework.
	2010	Modelling the barriers of green supply chain practices: an Indian perspective (Mudgal*et al.*)	The purpose of this paper is to identify and analyze these barriers. A questionnaire-based survey was conducted to rank these barriers. The results of this survey and ISM approach have been used to model and analyze key barriers and drive managerial insights.
	2010	Concise Chronological Road Map of Evolving Green Supply Chain Management Concepts: A Review (Chakraborty)	This paper tries to portray the gradual development and a shifting trend towards imbibing green initiatives in the operational practices of organizations, so as to conform to the need of the hour and move towards a sustainable and eco-friendly business environment. This exhaustive review aims at recording and documenting the development and chronological evolution of GSCM concepts from its traditional SCM manifestation. The paper also tries to champion GSCM as a remedy to the increasing ecological footprint and ever increasing environmental concern involving SCM. The paper discusses the extension of GSCM from the traditional concepts, its definitional perspectives; implementation hurdles and puts forth a long list of empirical evidences and literary arguments to justify the massive positive impact of GSCM on environmental management.
	2011	Study of green supply chain management in the Indian manufacturing industries: a literature review cum an analytical approach for the measurement of performance (Bhateja*et al.*)	The Aim of this paper is to study the various activities of the supply chain processes of the various Indian manufacturing industries i.e. both small manufacturing enterprises & large scale industries and finds how much eco-friendly they are (i.e. how much % of the green factor are involved in their supply chain activities from the procurement of the raw material to the transportation of the final product)
	2011	Barriers to implement green supply chain management in automobile industry using interpretive structural modeling technique-an Indian perspective (Luthra*et al.*)	This study aims to develop a structural model of the barriers to implement GSCM in Indian automobile industry. The structured model developed helped to understand interdependence of the barriers. This paper also deals with the removal of these barriers.
	2012	An overview of green supply chain management in India/ (Nimawat and Namdev)	Emphasizes on importance of GSCM in India According to this paper many companies of India do not adopt GSCM which led to bad ranking in EPI (environmental performance index)

	2012	An empirical study of green supply chain management in Indian perspective (Toke *et al.*)	This study focuses mainly on rank, interactions, and weightage of critical success factors (CSF's) of the GSCM in Indian manufacturing sector The analytical hierarchy process (AHP) applied for determining relative importance and selecting appropriate approach in GSCM practice
	2013	A review of green supply chain management issues in Indian bottled water industry(case study) (Anoop and Kumar)	This paper reviews the factors affecting the implementation of green supply chain management for the Indian bottled Water industry using ISM, a multiple criteria decision-making method used for structuring complex decision-making problems
	2013	Green supply chain management - barriers & drivers: a review (Dashore and Sohani)	In this paper, a total number of 20 barriers and a total number of 16 drivers identified through extensive literature review and expert opinion to academics. These barriers and drivers are almost common for various organizations for the adoption and implementation of GSCM in them.
	2013	Exploring the green supply chain management: a technical review/ (Gardas and Narkhede)	The aim of this paper is to review the literature on GSCM and to identify the different initiatives of GSCM. This paper mainly deals with the steps required for successful implementation, waste management, and challenges in implementing the GSCM. Green supply chain initiatives play vital role in pursuing the financial, social, and environmental benefits
	2013	Identifying and ranking of strategies to implement green supply chain management in Indian manufacturing industry using analytical hierarchy process (Luthra*et al.*)	The study aims to identify and rank the major strategies that help achieve successful implementation of GSCM in the Indian manufacturing industry. The study categorizes the GSCM implementation strategies into four dimensions -nonmembers of supply chain, downward stream supply chain members, organizational members of the supply chain and upward stream supply chain members. These dimensions are found to play an important role in greening the supply chains enabling the practicing firms achieve enhanced operational performances.
	2013	Modelling the behavioural factors of green supply chain management implementation in mining industries in Indian scenario (Muduli and Barve)	In this paper an attempt has been made to identify the behavioral factors present in GSCM environment of Indian mining industries and to find out the extent of their effect on GSCM implementation through graph theory and matrix approach (GTMA)
	2013	Sustainable development practices in mining sector: a GSCM approach (Muduli and Barve)	The main aim of this paper is to develop a sustainable development framework for Indian mining industries through GSCM approach. A hierarchical model of the drivers affecting the implementation of green supply chain management in Indian mining industries has been developed using an ISM framework
	2013	Validation of performance measures for green supplier selection in Indian industries (Deshmukh and Sunnapwar)	The relationship between green supplier selection management practices and environmental performance is studied This paper developed a decision support tool which should help companies to integrate environmental criteria into their green supplier selection process In this study, factor analysis is done using Statistical Package for the Social Sciences (SPSS) software to help decision makers understand the important environmental dimensions
	2012	Green supply chain management: a case study from Indian electrical and electronics industry (Kumar *et al.*)	This paper investigate the GSCM practices likely to be adopted by the manufacturing industry of electrical and electronics products in India

	2013	An analysis of drivers affecting the implementation of green supply chain management for the Indian manufacturing industries (Bhool and Narwal)	The main objectives of this paper are to gain critical and crucial drivers for implementation of GSCM in Indian manufacturing industries in various sectors likewise, two wheeler, four wheeler, and general manufacturing sector wise companies.
	2013	Lean to green supply chain management :a case study (Vamsi*et al.*)	The purpose of this research is to analyze and investigate the relationship between lean and green supply chain strategies. It also tests the ways to implement it in Indian scenario to gain importance in global manufacturing and organizational stage. The case study approach has been used to show the applicability and success of lean tools to achieve sustainable supply chains. The case undertaken is of Indian steel company, where the data related to their inbound and outbound logistics is gathered. The data linked with vehicle movement inside the campus, the company layout, movement pattern and fuel consumption was collected.
	2014	Barriers analysis for green supply chain management implementation in Indian industries using analytic hierarchy process (Govindan*et al.*)	This research article reports numbers of barriers, which creates hindrance in implementing GSCM using AHP.
	2013	Role of behavioral factors in green supply chain management implementation in Indian mining industries (Muduli*et al.*)	This research article attempts to explore various behavioral factors affecting GCSM practices and their interactions, which help to attain green-enabled needs. Interpretive structural modelling (ISM) is employed in this research to extract the interrelationships among the identified behavioral factors.
	2013	Developing green supply chain system for Indian enterprises (Kumar *et al.*)	The study contributes to the literature on empirical examination of the construct of GSCM practices implementation and to the practices of managers/supervisors with a validated measurement scale to evaluate their strengths and weaknesses in different facets of implementing GSCM practices in their organizations. In this paper, issues are analyzed through the survey results and conclusions are drawn.
	2013	An Overview, Trends and Future Mapping of Green Supply Chain Management - Perspectives in India (Tonape and Owk)	This paper involves a gist about the scope of the GSCM in actual sense that could be practiced in the large corporations in India and about the practices adopted in the ITC Ltd along with Aditya Group. Apparently, this exploratory study would trigger and encourage the implementation of GSCM in FMCG sector as well as agribusiness sector. It also advocates the applicability of GSCM in every sector to build confidence in all associated entities of the business corporations- customers, stakeholders, shareholders, and employees.
	2013	Modelling the challenges of green supply chain management practices in Indian mining industries (Barve and Muduli)	In this research articles, 11 numbers of relevant barriers have been identified from literature and subsequent discussions with experts from academia and industry. Lack of environmental awareness, poor legislation, and inadequate pressure from societies positioned at the bottom of the hierarchy are found to be the key barriers. These barriers have high DP and less dependence.
	2013	Analysis of the influential pressures for green supply chain management adoption—an Indian perspective using interpretive structural modeling (Mathiyazhagan and Haq)	The objective of this paper is to identify the key pressures of motivation for adoption of GSCM in traditional SCM. This paper, initially identified 25 pressures from previous literature sources, secondly influential pressure was determined with help of interpretive structural modeling technique through expert's opinion. This technique identified five levels of influential pressures from recommended 25 pressures based on the impact. The result of this paper inferred that Indian auto component manufacturing industries are facing pressure from government and regulation policies categories.

	2013	Developing a Framework for Study of GSCM Criteria in Indian Mining Industries (Muduli and Barve)	This paper used AHP approach to develop an analytical frame work that would facilitate the study of these criteria and sub-criteria
	2013	Barriers to green supply chain management in Indian mining industries: a graph theoretic approach (Muduli*et al.*)	This study focuses on the mining industry as a case study by which we will identify factors and sub-factors hindering GSCM implementation A graph theoretic and matrix approach (GTMA) has been used to quantify the adverse impact of these barriers on GSCM implementation.
	2013	An ISM approach for the barrier analysis in implementing green supply chain management (Mathiyazhagan*et al.*)	This research article analyzes the barriers for the implementation of GSCM concept which has been divided into two phases such as identification of barriers and qualitative analysis The ISM qualitative analysis was used to understand the mutual influences amongst the twenty-six barriers by survey.
	2013	Role of behavioural factors in green supply chain management implementation in Indian mining industries (Muduli*et al.*)	The present research attempts to explore various behavioural factors affecting GCSM practices and their interactions, which help to attain green-enabled needs. ISM is employed in this research to extract the interrelationships among the identified behavioural factors.
	2013	Multiple comparative studies of Green Supply Chain Management: Pressures analysis (Xua*et al.*)	This paper offers a comparative study of pressures that impact the adoption of GSCM. Thirty two pressures are identified from extensive literature reviews and they are classified into five distinct groups based on their similarities Statistical data analysis through one-way single factor Analysis of Variance (ANOVA), followed by pair-wise comparison of means using Tukey's test was used. The analysis was performed for different sectors and different scales of production
	2014	Environmental sustainability through green supply chain management practices among Indian manufacturing firms with special reference to tamilnadu (case study) (Meera and Chitraman)	Empirical study was conducted through survey method in 155 manufacturing industries in Tamilnadu, India This research article investigates the pressures for implementing GSCM practices and the relationship between GSCM practices and environmental performance The research proposes a model that demonstrates the relationship between green SCM pressures, green SCM practices, and environmental performance in manufacturing companies
	2014	Identification of pressures, barriers and drivers for the implementation of green supply chain management (Deepak *et al.*)	The objective of the paper is to identify the important pressures, barriers, and drivers for GSCM adoption in Indian automotive sector context from the available literature. The important pressures, the hindering barriers, and the efficient drivers are then identified using AHP approach Put light on 36 pressures, 40 drivers, 26 barriers in GSCM.
	2014	An interpretive structural model of green supply chain management in Indian computer and its peripheral industries (Aich and Tripathy)	This paper has attempted to identify the success factors for green supply chain management in Indian manufacturing firms and provides an ISM to develop a map of the complex relationships and magnitude among identified success factors
	2014	Critical success factors of customer involvement in greening the supply chain: an empirical study (Kumar *et al.*)	This paper is an attempt to explore factors influencing involvement of customers towards greening the supply chain. Twenty-five critical success factors of customer involvement in GSCM have been identified from literature review.
	2014	Greening the supply chain using SAP-LAP analysis: a case study of	The paper analyses a case study of ABC Ltd., a leading auto ancillary company in India, to throw light on the status of

		an auto ancillary company in India (Luthra*et al.*)	implementation of GSCM practices. A SAP-LAP model has been applied to understand and analyse the concept of implementation of GSCM.
	2014	Green supply chain management and environmental sustainability – a comparative study on global and Indian perspective/ (Kudroli. K)	The purpose of the paper is to development of a generic integrate approach for implementing green supply chain practices and generates important insights and findings. This paper synthesizes the past and current research efforts to develop a viable green supply chain strategy and then proposes promising future research themes.
	2014	Identification of critical success factors to achieve high green supply chain management performances in Indian automobile industry (Luthra*et al.*)	The study aims to identify CSFs to achieve high GSCM performances from three perspectives i.e., environmental, social and economic performance. CSFs to achieve high GSCM performances relevant to Indian automobile industry have been identified and categorized according to the perspectives from the literature review and experts' opinions.
	2014	Challenges in the development of green supply chain for plastic films: a review analysis (Golghat and Pawar)	The paper presents the unearthed challenges in the development of green supply chain for plastic industry. Succinct literature review of green supply chain partners and green practices implementations for plastic films is done to identify and confirm problems reported
	2014	Green supply chain management practices in India: an empirical study (Mohanty and Prakash)	This study confirms and validates that Indian MSMEs face significant pressures from external stakeholders to adopt GSCM practices. Among internal pressures, on-the-job training forces MSMEs in India to adopt GSCM practices. It has been also established that external pressures and adoption of GSCM are fully mediated by internal pressures.
	2014	Green supply chain management practices in India: a confirmatory empirical study (Mohanty and Prakash)	This paper illustrates the application of Structural Equation Modelling to understand the GSCM practices relating to Micro Small Medium Enterprises (MSME) in India. This study confirms and validates that the lower level of GSCM involvement of Indian MSME can be attributed to lack of the necessary external and internal pressures.
	2014	Pressure analysis for green supply chain management implementation in Indian industries using analytic hierarchy process (Mathiyazhagana*et al.*)	This work focuses mainly on identifying such pressures for implementation of GSCM. Initially 65 pressures were identified through detailed literature and categorised into six groups.
	2014	Adoption of green supply chain management practices and their impact on performance: an exploratory study of Indian manufacturing firms (Mitraa and Dattaa)	This article presents one of the earliest surveys on GSCM practices in Indian manufacturing firms. The items for the survey were developed based on the extant literature and feedback from corporates Results of data analysis showed that supplier collaboration for environmental sustainability had a positive impact on environmentally sustainable product design and logistics, which in turn was positively related to competitiveness and economic performance of the firm
	2014	A Framework for Research on Green Supply Chain Management (Mitraa)	This article reviews the impact of GSCM on firm performance with a view to identifying the most commonly used practices and proposing new constructs, variables, and construct relationships by drawing from the literature on SSCM/GSCM, reverse logistics, closed-loop supply chains, and strategic management This article also builds a conceptual framework, grounded in theory, linking GSCM practices with firm performance, and presents propositions that may be tested in future studies on SSCM.

	2014	Green supply chain performance measurement using fuzzy ANP-based balanced scorecard: a collaborative decision-making approach collaborative decision-making approach (Bhattacharyaa*et al.*)	The purpose of this paper is to delineate a green supply chain performance measurement framework using an intra-organisational collaborative decision-making (CDM) approach
	2014	Green supply chain management: Implementation and performance – a literature review and some issues (Luthra*et al.*)	The objectives of this paper are to identify major research work conducted on GSCM and to classify them to identify gaps in literature and opportunities for future research. The paper has provided an integrative framework for study, design, implementation, and GSCM performance. The findings also identify a number of issues that need to be addressed.
	2014	Empirical Analysis of Green Supply Chain Management Practices in Indian Automobile Industry (Luthra*et al.*)	This research article identifies and empirically analyzes GSCM practices in Indian automobile industry. Six main GSCM practices (having 37 sub practices) and four expected performance outcomes (having 16 performances) have been identified by implementing GSCM practices from literature review.
	2014	Analysis of the Barriers for Implementing Green Supply Chain Management (GSCM) Practices: An Interpretive Structural Modeling (ISM) Approach (Jayant, and Azhar)	The main aim of this paper is to determine the relationship among the barriers and to identify the most influential barriers from the recommended barrier list with the help of interpretive structural modelling. Classification of barriers has been carried out based upon dependence and driving power with the help of MICMAC analysis.
	2014	Barriers analysis for green supply chain management implementation in Indian industries using analytic hierarchy process (Govindan*et al.*)	This work focuses on identifying barriers to the implementation of a GSCM based on procurement effectiveness Essential barriers/priorities are identified through recourse to analytic hierarchy process. Finally, a sensitivity analysis investigates priority ranking stability.
	2014	Monte Carlo Simulation Based Approach to Manage Risks in Operational Networks in Green Supply Chain (Mangla*et al.*)	In this paper, focus on the operational green supply chain risk evaluation and management by capturing of uncertainty and evaluating the risks by means of simulation to demonstrate the delay/disturbance consequences of the risk (i.e., the loss in business). This work follows a procedure in which, initially, the various uncertainties have been identified and assessed. Later, a risk evaluation has been followed in which the Monte Carlo Simulation (MCS) results exemplify the delay/disturbance consequence of the risk is carried out.
	2015	Analysis of critical activities for GSCM implementation in mining supply chains in India using fuzzy analytical hierarchy process (Muduli and Barve)	This paper makes a novel approach to establish a validated set of GSCM success activities. This paper further employs fuzzy analytical hierarchy process (FAHP) to evaluate the priority weights of these success activities which could be helpful for the decision makers in assessing and improving their GSCM effectiveness
	2015	Identification of critical success factors in Indian automobile industry: a GSCM approach (Rehman*et al.*)	This paper focuses on identifying CSF of GSCM implementation in the automobile industry located in India. Through a detailed literature review and study, it identified 12 success factors having 42 variables These success factors are identified with exhaustive literature survey and its validation is tested using confirmative factor analysis (CFA) to test the fitness of classification of elements among 12 CSF's

	2015	Green supply chain management: a review (Patil and Dolas)	The objective of this study is to correlate the term SCM with the GSCM. The purpose of this study is to demonstrate the new innovative areas of this emerging field. The study is focused on application of GSCM in the developed firms including all those innovations that are relevant to environmental and social sustainability towards operation management and SCM.
	2015	Green supply chain drivers in the Indian automobile industry (Dasari and Koul)	Study explores GSCM in the Indian automobile sector and addresses the question, 'What drivers can sustain GSCM for automobile companies in India?
	2015	Green supply chain management practices in textile and clothing sector: literature review (Touzi*et al.*)	Using studies from the literature, Authors try to identify the link between government regulation and the adoption of green supply chain practices by companies. Two results are worth remembering. Firstly, the practices of reverse logistics cannot be adopted without an adapted and regulatory framework. Secondly, the reaction of firms in front of government regulations is related to some conditions: the importance they attach to the environmental issue and the adequacy of regulations to business conditions.
	2015	Analysis of interactions among the drivers of green supply chain Management (Tyagi*et al.*)	The aim of the research article is to identify and analyse the interactions among drivers of implementing GSCM in automobile industries located in National Capital Region (NCR) of India. To meet out the above objective, 11 drivers were identified and analysed for the purpose of developing an ISM–based model
	2015	Effective implementation of green supply chain management (gscm) practices in three southern state manufacturing companies in India (Thirumaran, and Dhanaraj)	The aim of this research paper is to examine the green practices in the selected three southern states Indian manufacturing companies. The main objectives of this paper are to examine the impact of GSCM practices in the south Indian small, medium and large scale manufacturing industry in southern industry in India.
	2015	Green supply chain management strategy selection by analytical network process (ANP) approach: a case study (Bharti*et al.*)	The green supply chain strategy selection is a multi-criterion problem, which includes both qualitative and quantitative criteria. ANP is a multi-attribute, decision-making approach based on the reasoning, knowledge, and experience of the experts in the field ANP provides a general framework to deal with decisions without making assumptions about the independence of higher-level elements from lower level elements and about the independence of the elements within a level.
	2015	Critical success factors of green supply chain management for achieving sustainability in Indian automobile industry/ (Luthra*et al.*)	The aim of this study was to identify and analyse the key success factors behind successful achievement of environment sustainability in Indian automobile industry supply chains. Here, CSFs and performance measures of GSCM have been identified through extensive literature review and discussions with experts from Indian automobile industry
	2015	GSCM: practices, trends and prospects in Indian context (Soda *et al.*)	The study shows that in general, Indian companies are lacking on the front of adoption and implementation of GSCM measures in their supply chains. However, certain companies are showing appreciable enthusiasm for the eco-friendly concept; the same does not apply to majority of the Indian enterprises, owing to a multitude of factors. GSCM has the potential to drive economic gains, and can act as a big motivator for companies to go green.
	2015	Critical factors analysis and its ranking for implementation of GSCM in Indian dairy industry (Sharma *et al.*)	The work aims to examine the critical factors of GSCM and its ranking so as to implement GSCM practices in dairy industry in Indian context. Detailed questionnaire based on 79 parameters has been used for survey in dairy industry in northern India. Grouping of

			these parameters has been done using factor analysis. The ranking of these identified critical factors has been used by using AHP which is used to see the relative importance of these eight factors.
	2015	Green supply chain management (GSCM): a structured literature review and research implications (Malviya and Kant)	The major findings shows that survey research holds greater credibility and the trend in survey research is moving from exploratory to model building and testing. GSCM research related to organizational practices, environmental issues, process, performance and sustainability were found to be most widely published topics within the GSCM domain.
	2015	Green supply chain management enablers: Mixed methods research/ (Dubey*et al.*)	This paper contributes to the literature on GSCM by arguing for the use of mixed methods for theory building. The literature has identified antecedents and enablers for the adoption of GSCM practices. The paper firstly reviews systematically the literature on GSCM enablers; secondly, it argues for the use of mixed methods research to address questions related to GSCM enablers; thirdly, it uses ISM, Matrix Cross-Reference Multiplication Applied to a Classification (MICMAC) analysis, and confirmatory factor analysis (CFA) to illustrate the application of mixed methods in GSCM by testing a model on the enablers of GSCM; and fourthly, highlights the influence of enablers including, inter alia, top management commitment, institutional pressures, supplier and customer relationship management on financial and environmental performance
	2015	Risk analysis in green supply chain using fuzzy AHP approach: A case study (Mangla*et al.*)	This research article analyzes the risks relevant to adoption and effective implementation of green supply chain practices at industrial viewpoint. A two-phase research approach has been proposed and used in this study. In the first phase, six categories of risks and twenty-five specific risks, associated with the green supply chain were identified. In the second phase, the fuzzy analytic hierarchy process (fuzzy AHP), a qualitative and quantitative analysis was used to analyze the identified risks for determining of their priority of concern.
	2015	Parametric Selection of Alternatives to Improve Performance of Green Supply Chain Management System (Tyagi*et al.*)	In this research work, seven green criteria and three alternatives have been identified based on literature review and discussion with the field experts taken from Indian automobile industries located at Delhi region. On the basis of considered criteria and alternatives, a hierarchy type performance model has been developed and analysed using Fuzzy Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) approach to select the best alternative in order to improve the performance of GSCM system.
	2015	Performance evaluation and a flow allocation decision model for a sustainable supply chain of an apparel industry (Jakhar)	This paper aims to help decision makers, managers, and practitioners to achieve economic growth, societal development, and environmental protection by developing sustainable supply chain performance measures and proposes a partner selection and flow allocation decision-making model. Survey data from 278 business organizations from the Indian apparel industry supply chain network were used, and an integrated method of structural equation modeling, fuzzy analytical hierarchy process, and fuzzy multi-objective linear programming was applied to the proposed model. The results of the structural equation modeling analysis indicate that the survey respondents considered sustainable production performance to be of prime importance, which thus indicates its significance in developing a sustainable supply chain for the apparel industry.
	2015	Application of analytical hierarchy process to evaluate pressures to implement green supply chain management	The objective of the study was to investigate the pressures for GSCM adoption and to rank the pressures based on experts' opinion through an AHP technique in the mining and mineral industry context.

		(Mathiyazhaganaet *al.*)	
	2015	Green supply chains: A perspective from an emerging economy (Jayaram and Avittathur)	This paper focuses on the emerging economy of India and the unique insights of this qualitative Delphi study that relies on grounded theory makes key contributions to theory building and managerial practice in the area of sustainable SCM.
	2015	An analysis of interactions among critical success factors to implement green supply chain management towards sustainability: An Indian perspective (Luthraet *al.)*	This paper attempts to identify, analyze and model the CSFs to implement GSCM towards sustainability in industries in Indian perspective. ISM technique is used to propose a structural model, which not only helps in understanding the contextual relationship among these CSFs, but also in determining their interdependence to implement GSCM towards sustainability. Further, the importance of CSFs has been determined based on their driving and dependence power by using MICMAC analysis. "Scarcity of Natural Resources" has been identified as most important CSF that may force industries to implement GSCM practices to ensure their business sustainability.
	2015	Evaluating factors in implementation of successful green supply chain management using DEMATEL: A case study (Gandhi *et al.*)	This paper proposes a Decision Making Trial and Evaluation Laboratory (DEMATEL) approach to develop a structural model for evaluating the influential factors among recognized factors. The proposed DEMATEL method enables to study the interrelationship between the evaluated factors through a causal diagram. To show the real-life applicability of the proposed DEMATEL based model, an empirical case study of an Indian manufacturing company is conducted.
	2015	Building Theory of Green Supply Chain Management using Total Interpretive Structural Modeling (TISM) (Dubeyet *al.*)	The aim of this paper is to build a GSCM theory using total ISM. To achieve this they have used an exhaustive literature review and identified the enablers of and barriers to GSCM. Developed a total ISM. The model presents the complex relationships among enablers and can in future be statistically validated using a larger sample size.
	2015	Prioritizing the responses to manage risks in green supply chain: An Indian plastic manufacturer perspective (Manglaet *al.*)	Aim to identify and prioritize/rank the responses of risks in a green supply chain context. It would be useful for industries to focus on highly ranked responses and formulate strategies to practice them in accordance with their priority for managing the consequences of risks in green supply chain. This research seeks to propose a model by using the fuzzy Analytic Hierarchy Process and fuzzy Technique for Order Performance by Similarity to Ideal Solution (TOPSIS) methods to prioritize the responses in green supply chain to manage its risks under the fuzzy environment
	2015	Green vendor evaluation and selection using AHP and Taguchi loss functions in production outsourcing in mining industry (Sivakumaret *al*)	This paper deals with the suitable vendor selection for the production process in the green mining industries based on economic and environmental benefits and risk factors This paper proposes a model frame work with case study through the combined approach of AHP and Taguchi loss functions.
	2015	Green supply chain collaboration and incentives: Current trends and future directions (Gunasekaranet *al.*)	This editorial piece discusses the current trends and future research directions in green supply chain collaboration and incentives. The discussion begins with evolution of green supply chain collaborations and few contributions made so far.
	2016	Green supply chain performance measurement: an exploratory study (Bulsaraet *al.*)	This study classifies set of variables into operational, economic and environmental. It also provides systematic research guidelines and managerial implications.
	2016	Identification of performance measures in Indian automobile industry: a green supply chain management approach	This study aims to identify the various measures on which performance of GSCM can be evaluated and further validation of the identified performance measures (PM). Study is conducted in automobile industry

		(Ahemad*et al.*)	
	2016	The impacts of critical success factors for implementing green supply chain management towards sustainability: an empirical investigation of Indian automobile industry (Luthra*et al.*)	This paper explores the importance of CSFs to implement GSCM towards sustainability taking into account the automobile industry of India This study examined impacts of CSFs to implement GSCM towards sustainability on current green practices implemented by Indian automobile industry and expected organizational performance outcomes by using multiple regression analysis
	2016	Green initiatives: a step towards sustainable development and firm's performance in the automobile industry (Kushwahal and Sharma)	This paper develops an approach towards the adoption of the green initiatives at the firm, and also tries to build a relationship between the performance of the firm and sustainable development through the adoption of green initiatives The paper would discuss various green initiatives such as green marketing, green supply chain management, green innovation, etc. which firms are adopting. The study would focus on the facts and opportunities of green initiatives for the success of the firm as well as sustainable development.
	2016	Investigation of the influential strength of factors on adoption of green supply chain management practices: An Indian mining scenario (Govindan*et al.*)	This research article attempts to identify the drivers of GSCM and extract the causal relationship among them through the use of decision making trial and evaluation laboratory (DEMATEL). Further, the strength of influence of these drivers on each other as also on the entire system is investigated to prioritize the drivers according to their influential strength

From the above table distribution is drawn. Figure 2 shows the pie diagram indicating various factors researched in Indian context. A close study of it reveals that CSF's attracted the maximum attention of the researchers followed by drivers, pressures and barriers. In this literature review It is very important for SCM to know and understand the critical success factors (CSF's) that will help in implementation of GSCM practices. CSF's are context specific and generally vary according to different country settings. In this section, various CSF's are identified and discussed based on the available GSCM literature in the context of Indian industries.

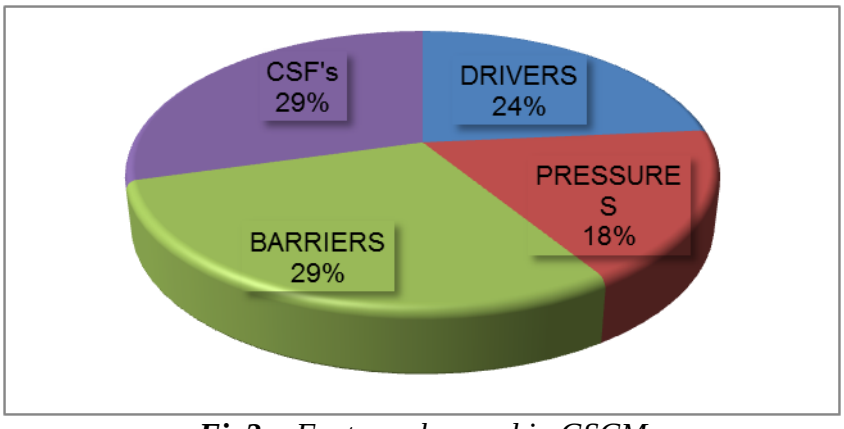

Fig2 : *Factors observed in GSCM*

Identification of Critical success factors for green supply chain management implementation

CSF's identification plays very crucial role for any industry because that indirectly influences performance measures of a supply chain. There are various CSF's on environmental practices proposed by

different authors and researchers. From table 1 articles dealing with CSF's are sorted out. Table 2 presents a summary authors dealing with CSF's for successful implementation of GSCM.

Table 2: *CSF's application*

Toke *et al.*(2012)	A set of fifteen performance measure i.e. CSF's and 113 sub factors of GSCM
Aich and Tripathy(2014)	Identified various success factors for green supply chain management in Indian manufacturing firms
Kumar *et al.*(2014)	Twenty-five CSFs were identified by literature review
Luthra*et al.*(2014)	CSFs to achieve high GSCM performances relevant to Indian automobile industry have been identified from the literature review and experts' opinions
Ahemad*et al.*(2015)	Identified 12 success factors having 42 variables
Luthra*et al.*(2015)	Six CSFs to implement GSCM for achieving sustainability and four expected performance measures of GSCM practices implementation were extracted using factor analysis
Sharma *et al.*(2015)	Identification of critical factors through extensive literature review, personal interviews, etc
Luthra*et al.* (2015)	Twenty six CSFs to implement GSCM towards sustainability are recognized by means of the literature review and in discussions with experts
Luthra*et al.* (2016)	CSFs is used to implement GSCM towards sustainability taking into account the automobile industry of India

Toke *et al*, (2012) suggested fifteen sets of CSF's factors, which commonly used by many researchers. CSF's are briefly outlined in Table 3.

Table 3: *CSF's (Toke et al., 2012)*

S.NO	GSCM- Critical success factors
1.	Top management commitment
2.	Government policies and regulations
3.	Eco-literacy amongst supply chain partners or team responsibility for GSCM
4.	Proper workplace, employee involvement management
5.	Green product development
6.	Green procurement practices
7.	Availability of clean technology
8.	Economic interests and benefits from GSCM
9.	Green packaging or Eco-labeling of products
10.	Reverse logistics practices
11	Lean manufacturing practices
12.	Environmental management system (EMS)- ISO: 14001 Certification
13.	Competitiveness
14.	Customer satisfaction and involvement through environmental performance
15.	Societal concern for protection of natural environment

Methodology
Methodology of study is divided into interview sessions and application AHP.

Sample size selection
Study is conducted in automobile industry. Total number of 20 respondents is selected from industry and academia. Table 3 shows the list of respondents and their profile.

Table 4: *Respondent information*

	Respondents profile	Number of Respondent	Experience (year)
Experts from industry	Managers	4	5-10
	Assistant managers	3	3-6
	Supervisors	5	1-3
Academia experts	Professors	2	10-15
	Assistant professors	2	3-8
	Post graduates students	4	2-4
		Total - 20	

Interview sessions
Interview sessions with the industrial experts and academia's were taken place in two phases:
First phase – from the list of general CSF's few factors were deleted which are not applicable in this industry as per expert's opinion. After 3 sessions of interview and discussions with expert, the final list of CSF's categories is given in table 4 below:

Table 4: *Final CSF's list*

S.NO	Final GSCM- Critical success factors
1	Top management commitment (TMC)
2	Government policies and regulations (GP&R)
3	Supply chain partners or team responsibility for GSCM (SCPR)
4	Reverse logistics practices (RLP)
5	Lean manufacturing practices (LMP)
6	Environmental management system (EMS)- ISO: 14001 Certification (EMS)
7	Customer satisfaction and involvement through environmental performance (CS)
8	Societal concern for protection of natural environment (SC)

Second phase- in the second phase of interview, experts were asked about pair wise importance among factors with the help of questionnaire containing 54 questions using saaty comparison scale among different categories based on CSF's final list. Figure3shows that 15 questionnaires are selected for study, 3 questionnaire is discarded due to incompletion and two respondent didn't re -spond to questionnaireFigure 4represents the percentage of respondent considers

from industrial expert and academia. Then with the help of AHP technique ranking of categories are computed

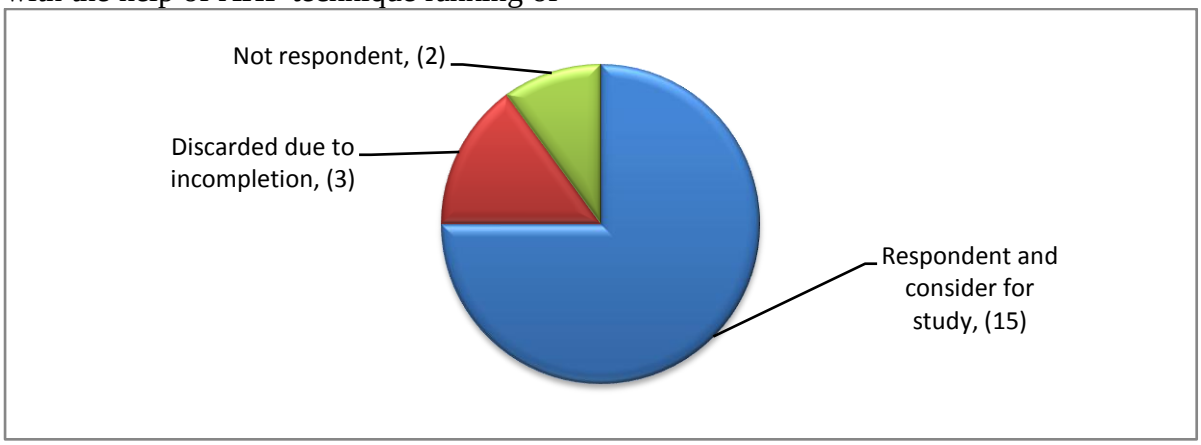

Fig 3: *Responses of questionnaire based survey carried out*

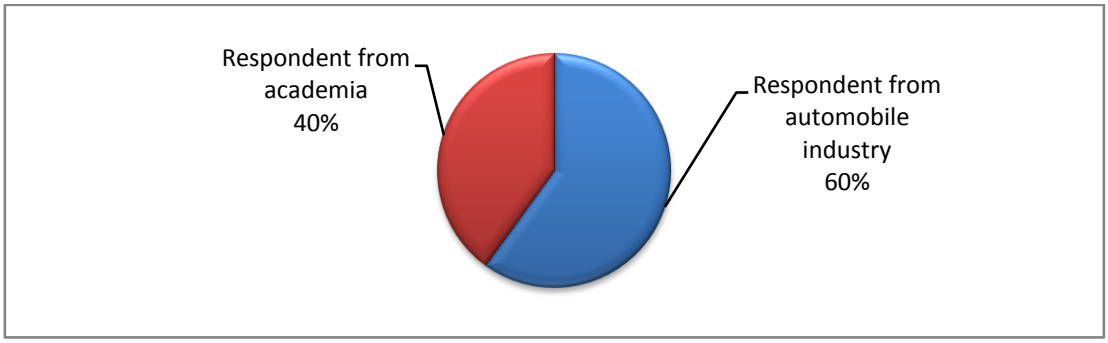

Fig 4:*Respondent from industries and academics considered for the study*

Application of AHP

AHP is a widely used and well-known decision support tool I business industries. The foundation of Analytic Hierarchy Process (AHP) is a set of axioms which carefully delimits the scope of the Problem environment (Wind and Saaty, 1980). It is based on a well-defined mathematical structure of consistent matrices and their associated right Eigen vector's ability to generate true or approximate weights (Merkin, 1979; Wind and Saaty, 1980). The AHP methodology compares criteria, or alternatives with respect to a criterion, in a natural, pair-wise mode (Wind and Saaty, 1980).

AHP framework for ranking CSF's categories

Working AHP framework is drawn on the basis of final framework of factors representing different levels of hierarchy. Figure 5 below represents the structure of levels of AHP.

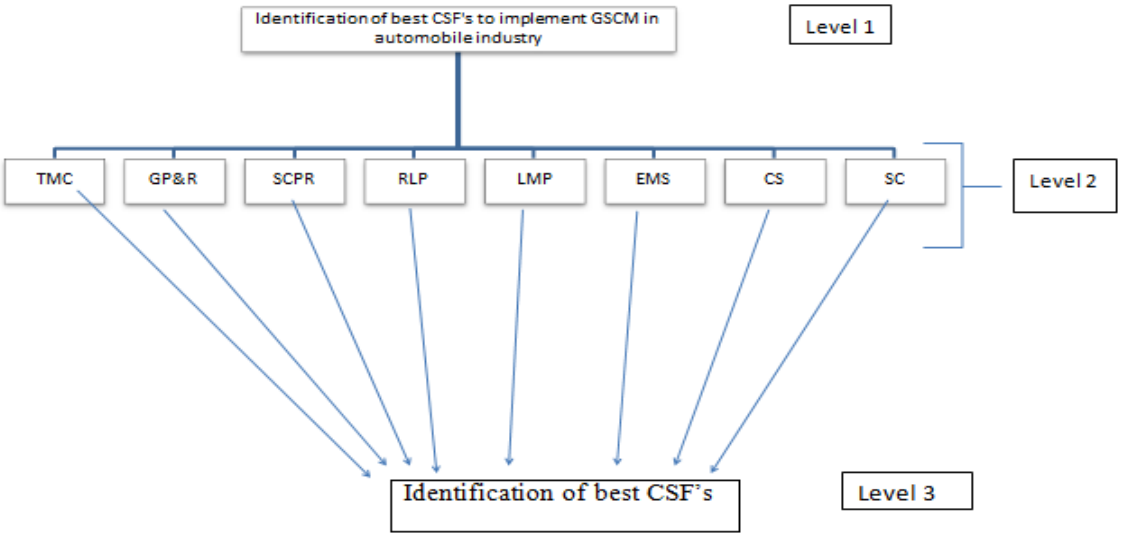

Fig 5: *AHP different levels*

Level-1: The objective/overall goal.
Level-2: This level represents the CSF's category.
Level-4: Priorities of essential factors are found at this level.

Formation of pairwise comparison questionnaire and matrix for CSF's

On the basis of AHP framework first step is to calculate weightage values of all main factors. Pairwise matrix is drawn with the help of pair wise questionnaire using saaty scale (1-9) shown in figure 6 below.

		Criteria		more important ?	Scale
i	j	A	B	A or B	(1–9)
1	2	TMC	GP&R	A	3
1	3		SCPR	A	5
1	4		RLP	A	1
1	5		LMP	A	1
1	6		EMS	A	3
1	7		CS	A	5
1	8		SC	A	7
2	3	GP&R	SCPR	A	2
2	4		RLP	B	5
2	5		LMP	B	3
2	6		EMS	B	5
2	7		CS	A	3
2	8		SC	A	3
3	4	SCPR	RLP	B	5
3	5		LMP	B	3
3	6		EMS	B	5
3	7		CS	A	1
3	8		SC	A	5
4	5	RLP	LMP	A	3
4	6		EMS	A	1
4	7		CS	A	5
4	8		SC	A	5
5	6	LMP	EMS	B	3
5	7		CS	A	3
5	8		SC	A	5
6	7	EMS	CS	A	3
6	8		SC	A	3
7	8	CS	SC	A	5

Fig 6

Now on the basis of following questionnaire pair wise comparison is drawn and normalized principal eigen vector of all factors are calculated as shown in figure 7 below.

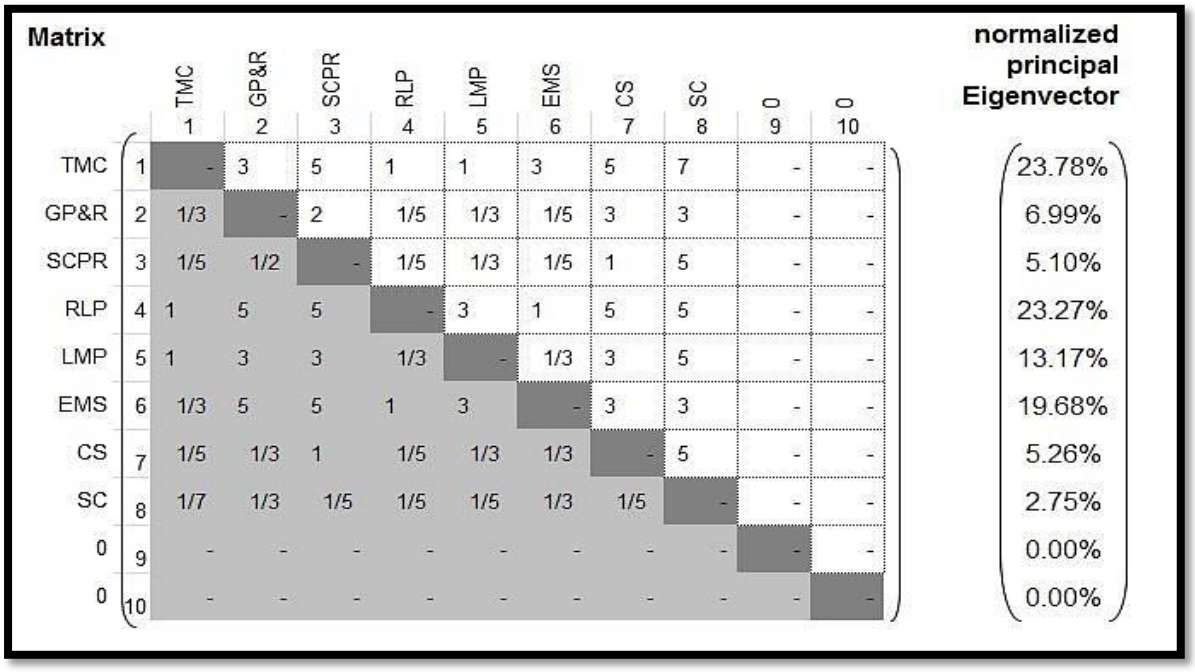

Fig 7: Matrix

Results

From pairwise comparison matrix weightage ranking of CSF's are done which is shown in figure 8.

	Criterion	Comment	Weights	Rk
1	TMC		23.8%	1
2	GP&R		7.0%	5
3	SCPR		5.1%	7
4	RLP		23.3%	2
5	LMP		13.2%	4
6	EMS		19.7%	3
7	CS		5.3%	6
8	SC		2.7%	8

Fig 8: Rank table

Checking consistency of result: - Prof. Saaty proved that for consistent reciprocal matrix, the largest Eigen value is equal to the number of comparisons, or **max = n**. In our case, **max= 8.88** and **n= 8**so, both are approximately equal. Then he gave a measure of consistency, called Consistency Index as deviation or degree of consistency using the following formula

$$CI = \frac{\lambda_{max} - n}{n-1}$$

Thus in our case, we have **max**= 8.88and n= 8, thus the consistency index is

$$CI = \frac{\lambda_{max} - n}{n-1} = (8.886\text{-}8)/\ (8\text{-}1) = \mathbf{0.126}$$

Knowing the Consistency Index (C.I) and with the help of Random Consistency Index (R.I) Consistency ratio(C.R) is

calculated. Saaty proposed Random Consistency Index (R.I) scale with respect to number of factors which is shown below:

n	1	2	3	4	5	6	7	8	9	10
RI	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49

Random index (R.I)

Consistency Ratio, which is a comparison between Consistency Index and Random Consistency Index, or in formula $CR = \frac{CI}{RI}$

If the value of Consistency Ratio is smaller or equal to 10%, the inconsistency is acceptable. If the Consistency Ratio is greater than 10%, we need to revise the subjective judgment. For our case, we have **C.I = 0.126**and **R.I for n = 8 is 1.41**, then we have C.R= (0.126/1.41)= **8.9%**< 10%. Thus, your subjective evaluation about CSF's preference is consistent.

CONCLUSION

CSF's are those factors, which are critical to the success of any organization in the sense that if objectives associated with the factors are not achieved , the organization will fail woefully (Laureani and Antony 2012 ; Kumar *et al.*, 2006). In this paper, using AHP techniques important CSF's to implement GSCM in context of automobile industry is evaluated. Result shows that top management commitment is a leading factor to implement GSCM in successful manner attaining highest weightage of 23.8%. Putting more focus on top management involvement leads to supports long-term GSCM process, supports prefers GSCM over budget schedule, increases profit, help in resource allocation for GSCM and monitoring the process of GSCM. Second most important factor is reverse logistic practices having weightage of 23.3%. In automobile industry reverse logistic plays a very crucial role and help company to adopt GSCM. Reverse logistics includes recycle and reuse of material along with Green packing, Environmental friendly methods of product recovery, reverse logistic program reduces the consumption of virgin material. Third most crucial factor is environmental management systems like ISO 14000certificationwith weightage of 19.7%. The Certification to ISO: 14001 EMS helps to boost company image, EMS Certification is a mechanism for higher profit, certification leads to about good business sense and it is legitimate indicator of organizations practices. These are top three critical success factors which will surely help company to attain green competitiveness.

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