1. Introduction

Typical supply chain involves suppliers, manufacturer, warehouse, retailers and finally customers. Due to existence of superior alternatives, today customers are more demanding, looking for wide variety of products at shortest possible delivery time, even willing to configure the product to their specifications. This has brought the shift from passive acceptance of customer to active involvement in the design and delivery of products and services. The exceptions of earlier supply chain like desired product delivered in right quantity to the right location in time, damaged free and correctly invoiced are reality of today. Traditionally the focus of supply chain network is economic benefit i.e. cost minimization or profit maximization.

The concept is changing from economic value to market value to Relevance. Increased pressure on cost and globalization of supply chain have further complicated the supply chain. These have brought tremendous changes in the traditional supply chain. The supply chain has become an integral part of strategic management with most of the companies and even considered as competing strategy.

In today's environment, the concept of integrated supply chain is widely used by large enterprises. Still in classic supply chain, the concept of environment or TBL (Triple bottom line) is not considered. It will be pertinent to mention here that organizations are also looking at CSR initiatives as part of their larger responsibility towards society. CSR activities focuses more on business ethics, local employment and local concerns whereas green supply chain management focus on environmental issues. *Shell Puget Sound Refinery, Anacortes, Washington, was fined $291,000 from 2006 to 2010 for violations of the Clean Air Act making it the second most-fined* *violator in the Pacific Northwest. As of 2011, it was listed as "high priority violator" since 2008(https://en.wikipedia.org/wiki/Shell_Oil_Company).* This indicates that legal framework is tightening noose around the companies for violations in regard to environment. There are many more alike examples.

Now-a-days manufacturing industries are seen as culprits for damaging the environment. The current state and trend of environmental degradation (from regulatory, consumer, and moral standpoints) indicate a need for a change in manufacturing philosophy. There must be a fundamental shift in the way production systems operate. There must be a move towards sustainability, achieved through vast reductions in resource use and waste generation, and a move away from one-time use and product disposal (Beamon, 1999).The greening of supply chain involves the consideration of environment. The increasing customer awareness about environment, legal framework and pressures from stakeholders (consumers, government regulatory bodies, competitors, non-profit or non-government organizations, investors, employees, shareholders, etc.) have forced the organizations to think of Green supply chain. Thinking Green has become buzz word in today's corporate world. In 1997, Kyoto protocol was adopted by both developed and developing countries to reduce the CO2 emission (Greenhouse gas).

The concept of green supply chain applies to product or services through entire product life cycle. All products manufactured within the supply chain, and the applied materials and substances used in the process are expected to meet environmental standards for design, development, distribution, use, disposal or recycling. The comprehensive approach includes reducing energy, water consumption and greenhouse gas emissions, increasing use of renewable energies, Enhancing appropriate waste management and training of employees. The growing awareness about the conservation of environment is partly attributed to media also. The consumers in the developed countries are more concerned about the environmental friendly products. The biggest challenge of the green supply is to integrate the suppliers and customers in a collaborative way.

A Green Sustainable Supply Chain can be defined as "the process of using environmentally friendly inputs and transforming these inputs through change agents - whose byproducts can improve or be recycled within the existing environment. Green supply chain management can be defined as integrating environmental thinking into supply-chain management, including product design, material sourcing and selection, manufacturing processes, delivery of the final product as well as end-of-life management of the product after its useful life. We can define green supply chain management (GSCM) as management practice which considers the impact of environment in its existing supply chain, use of resources efficiently, elimination or minimization of waste (energy, water, air, hazardous materials) and reverse logistics. Sustainable supply chain includes forward supply chain and closed loop supply chain including reverse logistics, remanufacturing, and product recovery.

Green supply chain management is now-a-days a part of strategic management at board level of many companies. European automotive companies like BMW Group, Volkswagen, PSA Peugeot, Ford, Volvo, Land Rover, Jaguar, Scania, Daimler and Toyota have already formed the automotive working group on supply chain sustainability. They are working on common guiding principles for sustainability. There is no conclusive evidence available which states that GSCM practices have positively impact the profitability of the organization.

The aim of the present research was to identify and analyses the interactions among drivers of implementing green supply chain management (GSCM) using AHP.

2. Literature review

Green supply chain is a concept in which classical supply chain takes care of its environmental impact. The green supply chain is an area of immense interest for research scholar, management and practitioners. There are many research papers and analysis available on the topic both with qualitative and quantitative approach. Literature revealed that green supply chain is important for organization from share value perspective as well as the image of the organization.

Various studies had mentioned that customers from western world are not only interested in low cost and good products but are also "environment conscious. Further driven by the new regulations by various Government on environment conservation, the concept of green supply chain is gaining momentum. In 2000, European Union launched the tool for measuring the value of sustainable development. The sustainable development is also termed as TBL is a challenge for the companies. The sustainable development includes environment as one of its core issue. In supply chain the concept of greening starts from raw material extraction and ends at the reverse logistics. Typical supply chain consists of suppliers, producers, distributors and retailers. The concept of supply chain was evolved over times as well as the definition, historically supply chain has been termed as "logistics". Success is no longer measured by a single transaction; competition is, in many instances, evaluated as a network of co-operating companies competing with other firms along the entire supply chain (Spekman et al., 1994).

The new dimension which is being added is the impact of supply chain on environment, companies operating either in manufacturing sector, mining, construction or agriculture or service sector needs to review the impact of their existing supply chain in the environment. R. Ganesh and T.

Harrison, define the supply chain as „a Network of facilities and distribution options that performs the functions of procurement of materials, transformation of these materials into intermediate and finished products, and the distribution of these finished products to customers" (Ganesha, Harrison., 1995).

"The supply chain is a network of organizations involved, through links with

Suppliers and customers, in a various processes and activities which create an add-value formed by products and services offered/distributed/supplied to the final consumers" (Christopher M. 1998).According to Chopra and Meindl, "a supply chain consists of all stages involved, directly or indirectly, in fulfilling a customer request. The supply chain not only includes the manufacturer and suppliers, but also transporters, warehouses, retailers, and customer themselves" (Chopra S., Meindl P., 2003).

In 2011, Hugo's mentioned five factors for supply chain

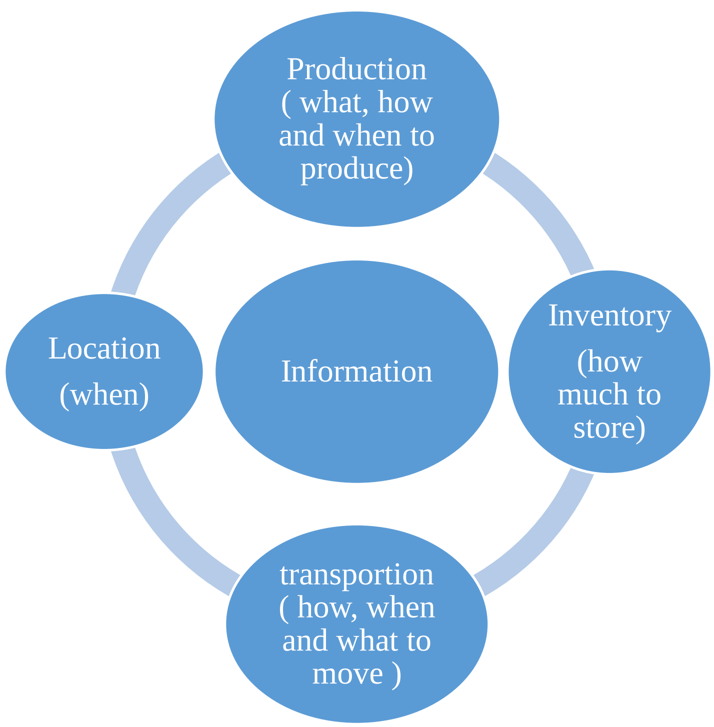

FIG 1: Five factors in supply chain (after Hugos 2011)

Bajdor and Grabara had mentioned in their publication that the classic supply chain can be transformed into green supply chain if appropriate solutions are implemented with case study from four companies (Bajdor, Grabara, 2011). They had further given the examples of four companies operating in various sectors, who have minimized the negative impact of environment with various actions (Bajdor, Grabara, 2011). They had further mentioned in their study that green supply chain integration is a process which includes environmental impact in all activities of supply chain such as sourcing decision and long term supplier relationship.

GSCM is an integration of natural environmental worries into supply chain management by implementing various green practices like life cycle analysis (LCA), green design, green purchasing, 3Rs (recycling, reuse, and remanufacturing), environmental technologies, green logistics, and collaborative practices with suppliers, distributors and customers (Ahi & Searcy, 2013; Cheng, Yeh, & Tu, 2008; Fu, Zhu, & Sarkis, 2012; Hervani, Helms, & Sarkis, 2005; Jabbour,2015; Jayant & Azhar, 2014; Sarkis, 2006; Srivastava, 2007; Youn,Yang, Hong, & Park, 2013).This (Ivascu, Mocan, Draghici, Turi, Rus;) emphasizes that sustainable development is an important criteria for future. The organizations must think about society and environment while achieving economical goals. They had tried to compare the traditional supply chain versus green supply chain. According to study, manufacturing and transportation are the biggest contributors of pollution to the environment.

Therefore innovation, new technologies, new techniques are required to develop the future green supply chain (Ivascu, Mocan, Draghici, Turi, Rus; 2015). The literature focus on Greenhouse effect mainly on Co2 emission and use of fossil fuel whereas actually six type of gases Carbon

Dioxide (CO_2), Methane (CH_4), Nitrous Oxide (N20),Sulfur Hexafluoride (SF_6) Hydrofluorocarbons (HFCs) Perfluorocarbons (PFCs) are considered in Kyoto Protocol for limited discharge during the entire product life cycle. Supply chain management is redefined as a process for designing, developing, optimizing, and managing the internal and external components of the supply system, including material supply, transforming materials and distributing finished products or services to customers, that is consistent with overall objectives and strategies. (Spekman, 1998)

Srivastava (2007) said that GSCM can be defined as “integrating environmental thinking into supply chain management, including product design, material sourcing and selection, manufacturing process, delivery of the final product to the consumers as well as end-of-life management of the product after its useful life”. (Dubey, Gunasekaran, Papadopoulos, Childe) they have identified antecedents and enablers for the adoption of GSCM practices and have uses multi criteria decision making modeling to establish the interrelationship and interdependence on various enablers.(Dubey, Gunasekaran Papadopoulos, Childe;2015). They had used interpretive structural modeling (ISM), 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 finally highlights the influence of enablers including, inter alia, top management commitment, institutional pressures, supplier and customer relationship management on financial and environmental performance (Dubey, Gunasekaran Papadopoulos, Childe; 2015).

Azadi, Jafarian, Saen Mirhedayatian had used data envelopment analysis (DEA) for sustainable supplier selection in green supply chain. According to them, their model will help the decision in selecting the sustainable supplier while considering TBL and measuring effectiveness, efficiency and productivity in uncertain environment. (Azadi, Jafarian, Saen, Mirhedayatian, 2014). The study proposed a model based on integrated fuzzy MCDM methods for evaluating GSCM performance of companies in terms of green design, green purchasing, green transformation, green logistics and reverse logistics. They further established the cause and effect interrelationship amongst GSCM dimensions using fuzzy DEMATEL method. Then, based on this interrelationship, fuzzy ANP method is implemented for calculating the weights of the related criteria (Özer Uygun, Dede; 2016) .The MCDM DEMAETEL is used to establish the important and causal relationships between GSCM practices and performances. The results reveal ‘‘internal management support’’, ‘‘green purchasing’’ and ‘‘ISO 14001 certification’’ are the most significant GSCM practices (Govindan, Khodaverdi, Vafadarnikjoo; 2016).

Zhu and Sarkis (2004) defined GSCM as organizational attempts, referring to environmental topics through inter-organizational collaboration to attain performance goals (e.g. Market share and financial performance). Hervani et al. (2005) described GSCM as an integration of green purchasing, green manufacturing, materials management, green distribution, green marketing and reverse logistics to close the loop. GSCM practices can create benefits to organizations in the form of reduced waste, better resource use, economic advantages and cost declines. (Govindam et al, 2016). GSCM implementation is highly dependent on organization involvement and supplier management and critical factors are top management support and environmental policy (Wu, Chang, 2015). Green supply chain is defined as an executive attitude that pursues to minimize the services ecological and societal influences (Rettab and Ben Brik, 2008). GSCM issues are implemented for all junctures ranging from point of origin to point of usage by the final customer including reverse logistics (if any) (Zhu et al., 2008a, 2008b, 2008c). Tyagi et al, 2015 identified the drivers for implementation of GSCM using ISM based model. Govindan et al prioritize various barriers for implementation of GSCM (Govindan, Kaliyan, Kannan, Haq, 2012)

Definition of Green Purchasing: Green purchasing is also known as environmentally preferred purchasing (EPP), environmentally responsible purchasing, green procurement, affirmative procurement, eco-procurement, and environmentally responsible purchasing.

3. Research Methodology

The objective of the present research was to identify and analyses the interactions among drivers of implementing green supply chain management (GSCM) using AHP.

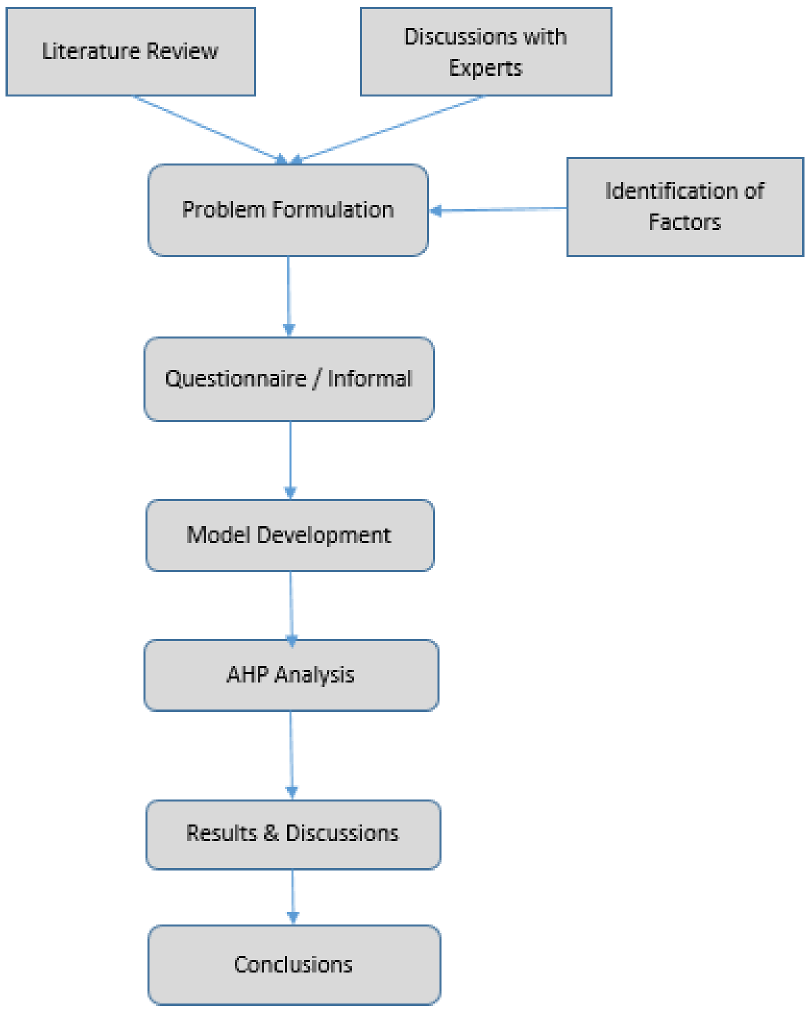

Fig2: Flow Chart for Research Methodology.

a) **Literature Review:** The literature was reviewed and following factors were identified from various studies.

Table 1: Factors identification from various studies

S.no	Factors	Sources
1	Pressure by customers to green supply Chain	Lamming and Hampson (1996), Walton et
		al. (1998), Green et al. (1996), Handfield et
		al. (1997), Hall (2001)
2	Legislative and regulatory compliance	Beamon (1999)
		Walton et al. (1998), Min and Galle (2001),
3	Collaboration with suppliers	Klassen and Vachon (2003)
4	Improve quality	Pil and Rothenberg (2003)
5	ISO 14000 certification	Montabon et al. (2000)
6	E-logistics and environment	Sarkis (2003)
7	Pressure by environmental advocacy group	Hall (2001)
8	Supply integration	Vachon and Klassen (2006)
9	Collaboration with customers	Vachon (2007), Paulraj (2009), Holt and Ghobadian (2009)
10	Public pressure	Beamon (1999)
11	Employee involvement	Hanna et al. (2000)

Thereafter factors were grouped into some categories and their sub-grouping was done.

Table 2: Factors identification

S.no	Factors	Sub-factors
1	Supplier management	1. Environmental auditing for suppliers
		2. Supplier environmental questionnaire
		3. Requesting compliance statement
		4. Asking for product testing report
		5. Demanding bill of material
		6. Establishing environmental requirements for purchasing items
		7. Implementing green purchasing
2	Product recycling	1. Joining local recycling organizations
		2. Collaboration on products recycling with the same sector industry
		3. Produce disassembly manual
3	Organization involvement	1. Green design
		2. Top management support
		3. Environmental policy for GSCM
		4. Cross-function integration
		5. Manpower involvement
		6. Effective communication platform within companies and with suppliers
		7. Establish an environmental risk management system for GSCM
		8. Supplier evaluation and selection
4	Life cycle management	1. Applying LCA to carry out eco-report
		2. Establish an environmental database of products

b) Interviews with industry experts: Interview with experts were carried out and finally the attributes and sub-attributes were identified.

Table 3: Factors Finalization based on discussions

S.no	Factors	Sub-Factors
1	Hazardous Chemicals and emissions	Restricted Chemicals
		Radioactive elements
		C02 Footprints
		Noise Emission
2	Society Preparedness	Awareness for Environment
		Willingness to pay for Ecofriendly products
		Moral/ Ethic values
		Local societal responsiveness
3	Regulatory Framework	Inadequate Law
		Implementation, monitoring and Control
		Education and Training of Staff
4	Green Design	Alternate Materials
		Life Cycle assessment
		Design for disassembly
5	Green Purchasing	Supplier selection
		Energy Efficient Products
		Recyclable and reusable products

4. Model development

In order to identify the performance measures for Green Supply chain management, the model is needed to develop the AHP approach. The methodology has been adopted from approaches mentioned in the literature review.

The criteria's were identified based on literature review, discussions with industry experts and expert group. There were few criteria's which were used based on experience of various practitioners.

In addition, the presence of too many criteria makes the pair-wise comparisons is a difficult and time consuming process. To overcome these Problems, the cut-off value to reduce the number of criteria to a few is desirable finally, the five important criteria were selected are:

The model is applied on the basis of literature review on performance measurement of green supply chain. The model has been considered with five perspectives and five alternatives. The five perspectives are Hazardous Chemicals and emissions C1, Society preparedness C2, Regulatory Framework C3, Green Design C4 and Green purchasing C5. The five alternatives considered are Effective transportation A1, Manufacturing technology A2, Role of NGO (non-governmental organization) A3, collaboration with suppliers A4 and collaboration with customers A5

Figure3:

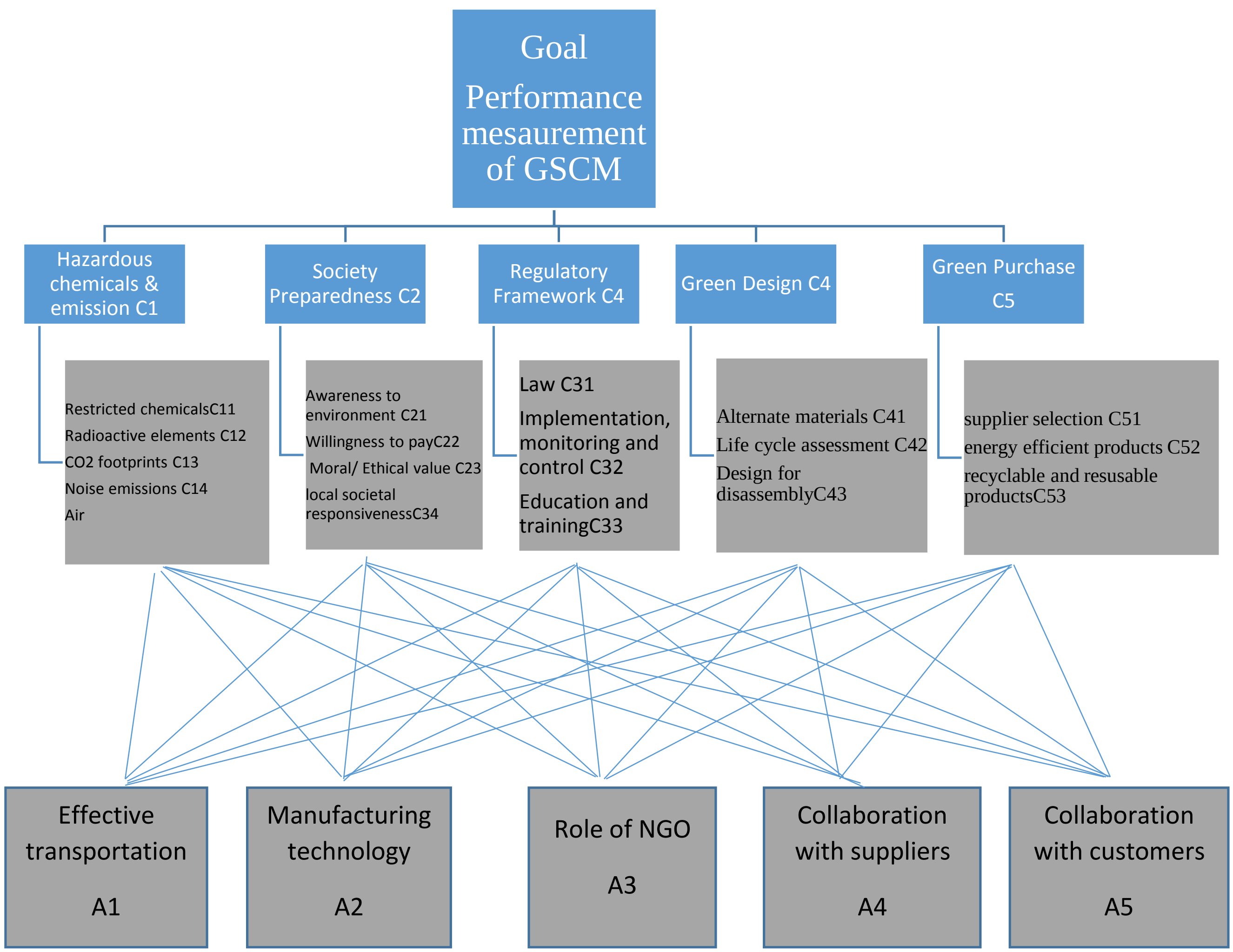

Figure3: Model for alternatives for GSCM Performance System

5. AHP Methodology

Analytical Hierarchical Process (AHP)

AHP, developed by Saaty, addresses how to determine the relative importance of a set of activities in a multi-criteria decision problem. The process makes it possible to incorporate judgments on intangible qualitative criteria alongside tangible quantitative criteria. The AHP method is based on three principles: first, structure of the model; second, comparative judgment of the alternatives and the criteria; third, synthesis of the priorities.

In the first step, a complex decision problem is structured as a hierarchy. AHP initially breaks down a complex multi criteria decision-making problem into a hierarchy of interrelated decision criteria, decision alternatives. With the AHP, the objectives, criteria and alternatives are arranged in a hierarchical structure similar to a family tree. A hierarchy has at least three levels: overall goal of the problem at the top, multiple criteria that define alternatives in the middle, and decision alternatives at the bottom.

The second step is the comparison of the alternatives and the criteria. Once the problem has been decomposed and the hierarchy is constructed, prioritization procedure starts in order to determine the relative importance of the criteria within each level. The pairwise judgment starts from the second level and finishes in the lowest level, alternatives. In each level, the criteria are compared pairwise according to their levels of influence and based on the specified criteria in the higher level. In AHP, multiple pairwise comparisons are based on a standardized comparison scale of nine levels. Table 1 shows the comparison scale.

Let C = {Cj |j = 1, 2,...., n} be the set of criteria. The result of the pairwise comparison on n criteria can be summarized in an (n_n) evaluation matrix A in which every element aij (i,j = 1,2,..., n) is the quotient of weights of the criteria, as shown below in Figure-2.

$$A = \begin{bmatrix} a_{11} & a_{12} & a_{1n} \\ \vdots & \vdots & \vdots \\ a_{21} & a_{22} & a_{2n} \\ \vdots & \vdots & \vdots \\ a_{n1} & a_{n2} & a_{nn} \end{bmatrix} \quad \text{such that, } a_{ii} = 1,\ a_{ji} = 1/\,a_{ij} \text{ and } a_{ij} \neq 0$$

At the last step, the mathematical process commences to normalize and find the relative weights for each matrix. The relative weights are given by the right eigenvector (w) corresponding to the largest Eigen value λmax as: $Aw = \lambda max\ W$.

If the pairwise comparisons are completely consistent, the matrix A has rank 1 and $\lambda max = n$. In this case; weights can be obtained by normalizing any of the rows or columns of A. It should be noted that the quality of the output of the AHP is strictly related to the consistency of the pairwise comparison judgments. The consistency is defined by the relation between the entries of A : $aij*ajk = aik$. The consistency index

CI is: $CI = (\lambda max - n)/(n-1)$

The final consistency ratio (CR), usage of which let someone to conclude whether the evaluations are sufficiently consistent, is calculated as the ratio of the CI and the random index (RI) CR=CI/RI. The consistency ratio should be less than 0.1.

Table 4:

Table-4 Saaty's scale of relative importance

Definition	Intensity of Importance
Equally Important	1
Moderately more important	3
Strongly more important	5
Very strong more important	7
Extremely more important	9
Intermediate values	2,4,6,8

To complete the model at this stage, the priority weight of each criterion in each level was determined. A second structure, an interview consisting of all factors in each level of the AHP model is used to collect the pair-wise comparison judgments from all evaluation team members. This approach is found to be very useful in collecting data. This determination is performed through using pair-wise comparisons. The function of the pair-wise comparisons is by finding the relative importance of the criteria and sub criteria which is rated by the five-point scale proposed by Saaty (1980), as shown in Table 3.1, which indicates the level of relative importance from equal, moderate, strong, very strong, to extreme level by 1, 2, 3, 4, and 5, respectively.

6. MODEL ANALYSIS USING AHP

Sample of pair-wise comparison matrix shows that the entry for the first row and the second column gives the importance of that row's criterion relative to the column's criterion as shown in Table 5.

Table -5 Pair-wise comparison matrix for criteria

Matrix of paired comparison of attributes					
	C1	C2	C3	C4	C5
C1 Hazardous Material	1	4	2	3	4
C2 Society Preparedness	1/4	1	2	2	1
C3 Regulatory framework	1/2	1/2	1	3	3
C4 Green Design	1/3	1/2	1/3	1	2
C5 Green Purchasing	1/4	1	1/3	½	1

Table-6 Paired comparison matrix in decimal for with priority weights

Matrix of paired comparison of attributes						
	C1	C2	C3	C4	C5	Eigen value
C1 Hazardous Material	1.00	4.00	2.00	3.00	4.00	0.4265
C2 Society Preparedness	0.25	1.00	2.00	2.00	1.00	0.1712
C3 Regulatory framework	0.50	0.50	1.00	3.00	3.00	0.2013
C4 Green Design	0.33	0.50	0.33	1.00	2.00	0.1103
C5 Green Purchasing	0.25	1.00	0.33	0.50	1.00	0.0907

Consistency Index	0.0949
Random Index	1.12
Consistency Ratio	0.0847

The consistency ratio (C.R.) for the comparison above is calculated to determine the acceptance of the priority weighting. The consistency test is one of the essential features of the AHP method which aims to eliminate the possible inconsistency revealed in the criteria weights, through the computation of consistency level of each matrix. The calculations are being performed using excel spreadsheet, alternatively software system called Expert Choice can be used to determine the normalized priority weights. The consistency ratio (CR) was used to determine and justify the inconsistency in the pair-wise comparison made by the respondents. Based on Saaty's (1980) empirical suggestion that a C.R. = 0.10 is acceptable, it is concluded that the foregoing pair-wise comparisons to obtain attribute weights are reasonably consistent.

If the CR value is lower than the acceptable value, the weight results are valid and consistent. In contrast, if the CR value is larger than the acceptable value, the matrix results are inconsistent and are exempted for the further analysis. The pairwise comparisons were done to establish hierarchical relationships.

Table-7 Pairwise comparison of sub attribute of C1

Matrix for sub attribute C11, C12, C13, C14 with respect to C1.					
C1	C11	C12	C13	C14	Eigen Value
C11	1	1	2	2	0.3407
C12	1	1	2	2	0.3407
C13	0.5	0.5	1	2	0.2026
C14	0.5	0.5	0.5	1	0.1432

Consistency Index	0.0535
Random Index	0.9
Consistency Ratio	0.0595

Table 8- Pairwise comparison of sub-attributes with respect to C2.

Matrix for sub-attributes C21, C22, C23, C24 with respect to Society Preparedness					
	C21	C22	C23	C24	Eigen value
C21	1.000	2.000	3.000	2.000	0.4105
C22	0.500	1.000	3.000	3.000	0.3212
C23	0.333	0.333	1.000	1.000	0.1273
C24	0.500	0.333	1.000	1.000	0.1409

Consistency Index 0.0470
Random Index 0.5800
Consistency Ratio 0.0810

Similarly we can summarize the priority weights of for other sub attributes with respect to criteria's.

Table-9 matrix for alternatives with respect to C11.

Matrix for alternatives with respect to C11 Restricted Materials						
	A1	A2	A3	A4	A5	Eigen value
A1 Effective transportation	1.00	2.00	3.00	2.00	2.00	0.3325
A2 Manufacturing technology	0.50	1.00	2.00	3.00	3.00	0.2732
A3 Role of NGO	0.33	0.50	1.00	3.00	4.00	0.2023
A4 Collaboration with suppliers	0.50	0.33	0.33	1.00	1.00	0.0988
A5 Collaboration with customers	0.50	0.33	0.25	1.00	1.00	0.0933

Consistency Index 0.0470
Random Index 0.5800
Consistency Ratio 0.0810

Table-10 matrix for alternatives with respect to C21.

Matrix for alternate with respect to C21 awareness to environment conservation						
	A1	A2	A3	A4	A5	Eigen value
A1 Effective transportation	1.00	8.00	3.00	7.00	9.00	0.5586
A2 Manufacturing technology	0.13	1.00	0.25	0.50	4.00	0.0742
A3 Role of NGO	0.33	4.00	1.00	4.00	5.00	0.2491
A4 Collaboration with suppliers	0.14	2.00	0.25	1.00	0.33	0.0612
A5 Collaboration with customers	0.11	0.25	0.20	3.00	1.00	0.0570

Consistency Index	0.0770
Random Index	1.1200
Consistency Ratio	0.0687

Similarly other paired comparison for alternatives can be made with respect to various sub-attributes.

Table-11 Matrix for alternatives with respect to attribute Hazardous Chemicals and emission C1.

Matrix for alternates with respect to Hazardous Chemicals and emissions					
	0.3407	0.3407	0.2026	0.1432	
	C11	C12	C13	C14	Eigen value
A1 Effective transportation	0.3325	0.3283	0.3240	0.4016	0.3483
A2 Manufacturing technology	0.2732	0.2635	0.2138	0.2008	0.2549
A3 Role of NGO	0.2023	0.1566	0.2189	0.1896	0.1937
A4 Collaboration with suppliers	0.0988	0.1396	0.1301	0.1153	0.1241
A5 Collaboration with customers	0.0933	0.1120	0.1132	0.0926	0.1061

Table-12 Matrix for alternatives with respect to attribute Society Preparedness C2

Matrix for alternates with respect to Society Preparedness					
	0.4105	0.3212	0.1273	0.1409	
	C21	C22	C23	C24	Eigen value
A1 Effective transportation	0.5586	0.4374	0.5056	0.5006	0.5047
A2 Manufacturing technology	0.0742	0.2718	0.1320	0.0723	0.1448
A3 Role of NGO	0.2491	0.1619	0.2633	0.0254	0.1914
A4 Collaboration with suppliers	0.0612	0.0820	0.0570	0.1295	0.0770
A5 Collaboration with customers	0.0570	0.0470	0.0421	0.2723	0.0822

Table-13 matrix for alternatives with respect to attribute Regulatory Framework C3

Matrix for alternates with respect to Regulatory Framework				
	0.2764	0.5951	0.1284	
	C31	C32	C33	Eigen value
A1 Effective transportation	0.4895	0.5006	0.5006	0.4975
A2 Manufacturing technology	0.1256	0.0723	0.0723	0.0870
A3 Role of NGO	0.2689	0.0254	0.0254	0.0927
A4 Collaboration with suppliers	0.0811	0.1295	0.1295	0.1161
A5 Collaboration with customers	0.0349	0.2723	0.2723	0.2067

Table-14 matrix for alternatives with respect to attribute Green Design C4

Matrix for alternates with respect to Green Design				
	0.4932	0.3109	0.1959	
	C41	C42	C43	Eigen value
A1 Effective transportation	0.0758	0.4993	0.4272	0.2763
A2 Manufacturing technology	0.2543	0.0759	0.0793	0.1645
A3 Role of NGO	0.5515	0.0241	0.0278	0.2849
A4 Collaboration with suppliers	0.0776	0.1291	0.1420	0.1062
A5 Collaboration with customers	0.0409	0.2716	0.3238	0.1680

Table-15 matrix for alternatives with respect to attribute Green Purchasing C5

Matrix for alternates with respect to Green Purchasing					
	0.2865	0.3407	0.2026	0.1703	Eigen Value
	C51	C52	C53	C54	
A1 Effective transportation	0.5025	0.4929	0.5083	0.4944	0.4990
A2 Manufacturing technology	0.0726	0.0734	0.0734	0.0731	0.0732
A3 Role of NGO	0.0255	0.0257	0.0257	0.0262	0.0257
A4 Collaboration with suppliers	0.1260	0.1315	0.1315	0.1309	0.1298
A5 Collaboration with customers	0.2734	0.2765	0.2610	0.2753	0.2723

In all the above calculations, sum of Eigen value in respective paired comparison is approximately equal to 1. This was also suggested by Saaty.

Table-16 Final Summary

		Alternates				
Attribute	Attribute weights	A1	A2	A3	A4	A5
C1	0.4265	0.3483	0.2549	0.1937	0.1241	0.1061
C2	0.1712	0.5047	0.1448	0.1914	0.0770	0.0822
C3	0.2013	0.4975	0.0870	0.0927	0.1161	0.2067
C4	0.1103	0.2763	0.1645	0.2849	0.1062	0.1680
C5	0.0907	0.4990	0.0732	0.0257	0.1298	0.2723
Alternate weighted evaluation		0.4108	0.1758	0.1678	0.1129	0.1442

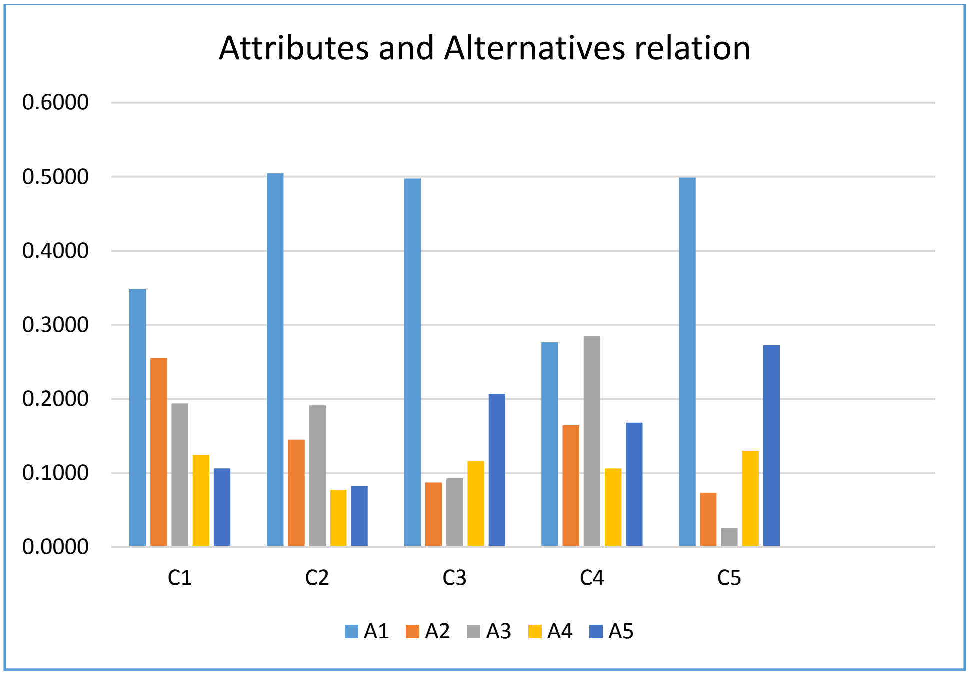

Figure 4: Graphical presentation of alternatives with respect to attributes

The weighted evaluation for each alternative can be obtained by multiplying the matrix of evaluation ratings by the vector of attribute weights and summing over all attributes.

Expressed in conventional mathematical notation, we have

Weighted evaluation for alternative k = Σ attribute weight (i) x evaluation rating (ik)

For A1 = 0.4266*0.3483+0.1712*0.5047+0.2013*0.4975 +0.1103*0.2763+0.0907*0.4990
= 0.4108

7. Results and Discussions

The Final summary of numerical illustration and analysis in Table-17

Table-17 Final Weight

Alternative	Final Weight
A1	0.4108
A2	0.1758
A3	0.1678
A4	0.1129
A5	0.1442

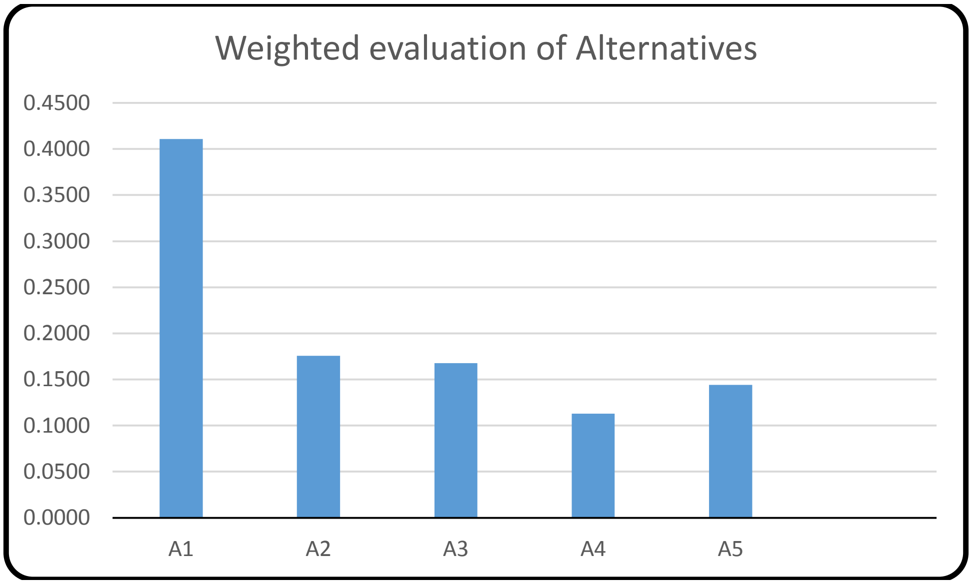

Fig5: Graphical presentation of weightage of alternatives.

The above summary shows the priority of alternatives for performance measurement of Green supply chain. The alternative A1 comes on top ranking, followed by alternative A2 on second rank, A3 on third rank, A5 on fourth rank and A4 on fifth rank. This means that highest priority should be given to effective transportation for the performance measurement of Green Supply chain. The second priority should be given to manufacturing technology. From industry perspective, the real challenge lies in effective transportation (for example: mode of transportation, use of bio fuel, delays and management of supply chain), similarly our manufacturing technology is not upgraded to produce green products. There is less / lack of awareness in the society about green products, therefore role of NGO is vital. In India we are still at primitive stage about research and development of green products at designing stage which is supported by our findings. The collaboration with suppliers and customers is also of almost equal priority.

Therefore we must focus on top three alternatives to improve performance measure of GSCM.

8. Managerial Implications of the Study

There is vast need of developing infrastructure, mode of transportation and use of bio fuels, 4PL logistics to improve the performance of green supply chain. Further Industry needs to develop manufacturing technology (processes, equipment's, investment in technology, lower energy consumption, waste reduction) which will enhance the performance of GSCM. There are very few players who are working on some of the above mentioned parameters. Supplier, customer and consumer awareness in this direction is also very important. Therefore Indian industry must align with NGO to increase the awareness among all stakeholders. The effective use of social media will enhance the awareness.

9. Conclusion

The goal of this project was the selection of appropriate alternative, for the Performance measure of Green supply chain in context of Indian industry. We have used AHP methodology and developed an AHP model for the Performance measure of Green supply chain in context of Indian industry This proposed model measures the performance of the five alternatives namely: Effective transportation A1, manufacturing technology A2, Role of NGO A3, Collaboration with suppliers A4, Collaboration with customers These five alternatives have an impact on Performance measure of Green supply chain in context of Indian industry, the alternative A1 has come out with a higher priority weight in comparison to the other alternatives A2 , A3, A4 and A5. The study concludes that alternate A1 is on the top priority.

10. Limitations and Future Scope

The study is not focused on any particular industry, therefore future studies can be done on industry specific. Since the GSCM has legal / regulatory implications, therefore involvement of law makers in future studies will bring more insight to legal framework.

References

1. Ahi, P., & Searcy, C. (2013). A comparative literature analysis of definitions for green and sustainable supply chain management. Journal of Cleaner Production, 52,329–341.
2. Andic, E., Yurt, O., & Baltacıoglu, T. (2012). Green supply chains: Efforts and potential applications for the Turkish market. Resources, Conservation and Recycling, 58, 50–68.
3. Barari, S., Agarwal, G., Zhang, W. J., Mahanty, B., & Tiwari, M. K. (2012). A decision framework for the analysis of green supply chain contracts: An evolutionary game approach. Expert Systems with Applications, 39, 2965–2976.
4. Buckley, J. J. (1985). Fuzzy hierarchical analysis. Fuzzy Sets and Systems, 17, 233–247.
5. Büyüközkan, G., & Cifci, G. (2012). A novel hybrid MCDM approach based on fuzzy DEMATEL, fuzzy ANP and fuzzy TOPSIS to evaluate green suppliers. Expert Systems with Application, 39(3), 3000–3011.
6. Chang, D. Y. (1992). Extent analysis and synthetic decision, optimization techniques and applications (Vol. 352)Singapore: World Scientific.
7. Chang, D. Y. (1996). Applications of the extent analysis method on fuzzy AHP. European Journal of Operational Research, 95, 649–655.
8. Chen, C. T. (2000). Extensions of the TOPSIS for group decision-making under fuzzy environment. Fuzzy Sets and Systems, 114, 1–9.
9. Chen, S. J., & Hwang, C. L. (1992). Fuzzy multiple attribute decision making: Methods and applications. Berlin: Springer-Verlag.
10. Chen, C. C., Shih, H. S., Shyur, H. J., & Wu, K. S. (2012). A business strategy selection of green supply chain management via an analytic network process. Computers and Mathematics with Applications, 64, 2544–2557.
11. Cheng, C. H. (1997). Evaluating naval tactical missile systems by fuzzy AHP based on the grade value of membership function. European Journal of Operational Research, 96, 343–350.
12. Deng, H. (1999). Multicriteria analysis with fuzzy pairwise comparison.
13. International Journal of Approximate Reasoning, 21, 215–231.
14. Diabat, A., & Govindan, K. (2011). An analysis of the drivers affecting the implementation of green supply chain management. Resources, Conservation and Recycling, 55, 659–667.
15. Fahimnia, B., Sarkis, J., & Eshragh, A. (2015). A trade off model for green supply chain planning: A leanness-versus-greenness analysis. Omega, 54, 173–190.
16. Gabus, A., & Fontela, E. (1972). World problems. An invitation to further thought within the framework of DEMATEL.Geneva: Battelle Geneva Research Centre.
17. Hwang, C. L., & Yoon, K. S. (1981). Multiple attribute decision making: Method and applications.New York: Springer.
18. Jamshidi, R., Fatemi Ghomi, S. M. T., & Karimi, B. (2012). Multi-objective green supply chain optimization with a new hybrid memetic algorithm using the Taguchi method. Scientia Iranica E, 19(6), 1876–1886.
19. Kainuma, Y., & Tawara, N. (2006). A multiple attribute utility theory approach to lean and green supply chain management. International Journal of Production Economics, 101, 99–108.

20. Lee, V.-H., Ooi, K.-B., Chong, A. Y.-L., & Seow, C. (2014). Creating technological innovation via green supply chain management: An empirical analysis. Expert Systems with Applications, 41, 6983–6994.
21. Leung, L. C., & Cao, D. (2000). On consistency and ranking of alternatives in fuzzy AHP. European Journal of Operational Research, 124, 102–113.
22. Lin, R. J. (2013). Using fuzzy DEMATEL to evaluate the green supply chain management practices. Journal of Cleaner Production, 40, 32–39.
23. Lin, C. J., & Wu, W. W. (2004). A fuzzy extension of the DEMATEL method for group decision making. European Journal of Operational Research, 156, 445–455.
24. Lin, C. J., & Wu, W. W. (2008). A causal analytical method for group decision making under fuzzy environment. Expert Systems with Applications, 34, 205–213.
25. Mastrocinque, E., Yuce, B., Lambiase, A., & Packianather, M. S. (2013). A multiobjective optimisation for supply chain network using the bees algorithm. International Journal of Engineering Business Management, 5, 1–11.
26. Mathiyazhagan, K., Diabat, A., Al-Refaie, A., & Xu, L. (2015). Application of analytical hierarchy process to evaluate pressures to implement green supply chain management. Journal of Cleaner Production, 107, 229–236.
27. Mathiyazhagan, K., Govindan, K., NoorulHaq, A., & Geng, Y. (2013). An ISM approach for the barrier analysis in implementing green supply chain management.Journal of Cleaner Production, 47, 283–297.

    Mikhailov, L. (2004). A fuzzy approach to deriving priorities from interval pairwise comparison judgments. European Journal of Operational Research, 159.
28. Bagchi P.K., 2000. On measuring supply chain competency of nations: A developing countryperspective. Cardiff LERC,
29. Beamon B.M., 1999. Designing the Green Supply Chain, in Logistics Information Management, vol 12,.
30. Chopra S., Meindl P., 2003. Supply Chain. NJ., Second Edition, Prentice Hall,
31. Christopher M., 1998. Logistics and supply chain management: Strategies for reducing costs and improving service, London Financial Times – Prentice Hall,.
32. Emmett S., Sood V., 2010. Green Supply Chain, UK., John Wiley&Sons.
33. Ganesha R., Harrison T., 1995. An Introduction to Supply Chain Management, Department of Management Sciences and Information Systems, Penn State University
34. Gilbert S., 2001. Greening Supply Chain: Enhancing Competitiveness Through Green Productivity, Taiwan Taipei,
35. Hugos M., 2011. Essentials of Supply Chain Management, NJ., John Wiley&Sons.
36. Hwa T.J., 2001. Green Productivity and Supply Chain Management, Greening Supply Chain: Enhancing Competitiveness Through Green Productivity, Taiwan Taipei,
37. Koulikoff-Souviron M., Harrison A., 2000. A model of perspectives on supply chain management, Cardiff LERC,
38. Lambert D., Stock J., Ellram L., 2001. Fundamentals of Logistics Management, Boston McGraw-Hill,
39. Mentzer J., Dewitt W., Keebler J., Min S., Nix N., Smith C., 2001. What is Supply Chain Management?, in Supply Chain Management, Mentzer J. (ed)., Sage Publications
40. Nunes B., Marques S., Ramos R., 2004. A theoretical approach for green supply chain, Brazil Federal University Do Rio Grande Do Norte.

41. Zhong H., 2006. Model and algorithms for supply chain Network with Bi-directional floks, NJ., The State University of New Jersey.
42. Website visited
http://www.mhi.org/media/news/7056

https://www.researchgate.net/post/What_is_difference_between_green_supply_chain_management_and_sustainable_supply_chain_management

https://financial.ucsc.edu/Pages/Purchasing_GreenPurchasing.aspx

https://en.wikipedia.org/wiki/Supply_chain_sustainability