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INVESTIGATION OF ENABLERS OF GREEN SUPPLY CHAIN MANAGEMENT IN PROCESS INDUSTRIES USING AHP

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Abstract

Environmental issues have become extremely important at every step of the supply chain i.e. manufacturing, distribution of finished goods to the customer and disposing of expired goods. This paper is highlighting these concerns by taking into account the green issues of supply chain such as procurement of raw material, manufacturing, distribution, waste disposal, reverse logistics etc. By giving priority to these concerns, an organisation not only saves the environment but also makes the entire business sustainable. This requires the overhaul in internal systems and operations of the business. This paper is considering the enablers and sub-enablers of green supply chain of process industries which impact overall sustenance of business in competitive environment and avoid various sanctions levied by world communities and regulatory authorities. A comparative list of enablers has been prepared using Analytical Hierarchy Process in order to deduce the importance of several green issues which must be addressed by the firms to save environment and be a business leader.

Keywords: Green Supply chain management, environment, sustainable, Analytical hierarchy process.

1. INTRODUCTION

In the current business context, supply chain of the companies is of primary significance and not the way they sell their products. Therefore, managing the sustainable supply chain is very important for the industries. The term 'Green supply chain management' (GSCM) refers to the concept of integrating environmental issues in supply chain which includes the processes such as product designing, material sourcing, manufacturing and various other operations till the end-of-product life. Thus, GSCM aims to create environmental impact of the supply chain. The traditional supply chain focuses on reducing the cost of the product thereby increasing the profitability in the business chain for every stakeholder. But Green supply chain is little ahead of direct profit thinking. As the business flourishes, some inherent bad practices creep in; like uninterruptedly using plastics which loses its value once the product is unwrapped. A supply chain must be made green to keep the product user friendly and making the business sustainable [1]. While the specific goal of GSCM is often the reduction of CO_2 emissions, other tangible benefits for an organisation include greater efficiency of assets, less waste production, greater innovation, reduction of production costs, reuse of raw materials, increased profitability, perception of added value to the client base, efficient waste management [2]. Process industries have been focussed in this paper to study the green supply chain drivers to make the business sustainable. Such industries are procuring, manufacturing, distributing, and are also expected to take back the used/expired product. The process industries are very much aware of the nature of product. This would help the industry to recycle and refurbish in the most efficient way and sell them to the market at a reasonable price. This would save the raw material, energy and cost else it would have been spent in bringing the fresh goods in supply chain. This paper highlights that Green supply chain is the need of this era. All business activities if paid little green attention, the environmental effects can be easily mitigated. The paper highlightssix major enablers of GSCM i.e. Green purchasing and procurement (GPP), Green manufacturing (GM), Green distribution (GD),Reverse logistics (RL), Waste management (WM) and Production of Renewable Energy (PRE). Besides these, many more enablers have been found in the literature like green designing, life cycle analysis, green packing, and government compliances (Dubey and Gawandey, 2011). Analytical Hierarchy Process, which has been used in this paper, is an important Multi-criteria Decision-Making (MCDM) to establish the hierarchy among the enablers and sub-enablers. This would make the industry to focus on the important issues with priority levels.

2. LITERATURE REVIEWS

Green issues of supply chain have been explored by various authors in literature. Issues like green procurement, use of natural energy in production and transportation, use of no-polythene/ plastic material in packaging etc are countered in literature.

Ashley, (1993), Srivastava, (2007) have pointed out the importance of reducing waste and preserving the quality of product-life and the natural resources in supply chain management. Eco-efficiency and remanufacturing processes are now important assets to achieve best practicesglobally. The authors examined the impact of re-manufacturing of the same product using green technology in terms of cost which is a bit higher. But the appreciation from world community is branding the product.

Balkrishna, (2017) has mentioned competitive priorities of the industry in identifying order winners for the industry and identify key decision areas or practices for improvements. The study also includes the green issues in manufacturing for future prospects.

Rakesh et. al. (2019), have carried out strategic approach to minimize an organizational supply chain effect on the environment while expanding its economic performance for agro industry. The authors have developed Collaborative Green Transportation and Cold storages system which have a higher influence on operational performance. The authors have used multi-attribute decision making tools to bring out important factors as per merits.

Dashore, & Sohani, (2013), studied Green supply chain management and observed that increasing pressures from a various directions have prompted the Chinese automobile supply chain managers to consider and initiate implementation of green supply chain management (GSCM) practices to improve both their economic and environmental performance. The

Kumar, & Chandrakar, (2012), have introduced Green Transportation Costs in Supply Chain Modelling in which they think escalating environmental concerns with prevalent transportation modes haveled to an increased interest in the adoption of green sustainable practices in the area of supply chain management.

While discussing importance of reverse logistics in green supply chain Nagorney and Toyasaki, (2005); Min et al. (2006), Arena et al. (2003) and Beamon (1999) have shown the best way to utilise the resources. The authors have done life-cycle analysis of the finished product.

A study by Kannan et al. (2013) to enlist Barriers of Green Supply Chain Management implementation in Indian Industries using Analytic Hierarchy Process (AHP) [6]. The authors have enlisted various hurdles in implementation of GSCM like; management willingness, Government desires, motivation of all stake holders of SCM and many other barriers.

Kumar, and Rahman, (2017), have studied this field to analyse enablers of sustainable supply chain using ISM and fuzzy AHP approach which takes account of green values and environmental issues of the business. The researchers have integrated all the above subjects with supply chain to make it sustainable and free from trade sanctions. [7].

Being the emergent issue, the literature of supply chain has attracted many researchers towards green values in supply chain but a systematic approach to figure out the important enablers in merit/ importance has not been explored much.

2.1 Objective: The objective of this paper is:

1. Enlisting the important GSCM enablers and sub-enablers which may make a difference in supply chain practices if recognised in priority order.

2. Using AHP method to measure intangible enablers in form of quantity and preparing a list of ranks.

3. METHODOLOGY

1. This research has used the literature and industry opinion to collect the elements of green supply chain of a process industry, which are influencing the supply chain at large.

2. The AHP has been used to prioritise the elements.

3.1 Analytical Hierarchy Process: This Multi-criteria Decision-Making (MCDM) approach is an operational research method that is normally used for dealing with complex decision problems. MCDM enables the assessment and multiple expert judgments and is employed to overcome the presence of imprecision and vague information in the evaluation process. Analytic hierarchy process (AHP) [15] is considered as the most effective and commonly used method of MCDM in various studies of the diverse fields. AHP provides a convenient approach to analyse decision making problems. It is a method to evaluate subjective and objective functions in multi-criteria decision-making and helps users to reach to an agreeable solution. Another important feature of AHP is to achieve consensus in the group decision-making processes. AHP has the ability to guide the decision-makers for achieving the best and optimal judgment for their problems rather than getting "correct" answers. It offers a broad and balanced hierarchical structure for addressing decision problems on a common goal and related criteria.

Step 1: Hierarchy Construction: The construction of the hierarchical structure is the foundation stone of AHP. It is considered as an important step of AHP and there is no specialized approach for making a hierarchy.

Step 2: Pair-wise Comparison: After the hierarchy construction, the next step is to establish the relative importance of the main criteria and sub-criteria by comparing them in pairs. It is an important step and also considered as a spine of AHP.

Step 3: Deriving Relative Weights: This step requires the estimation of relative weights for each criterion and sub-criterion of the decision hierarchy. Researchers have developed many approaches to estimate the relative weights from the comparison matrix. However, eigenvector and logarithmic methods are most commonly used for deriving relative weights. Saaty (1991), as a pioneer of AHP, has proposed the eigenvector method which is derived from the matrix theory. In this method, the corresponding weights of decision elements are determined by comparing the normalized Eigen value with the principal Eigen value.

Step 4: Checking the Consistency Ratio: The measure of "Consistency Ratio" (CR) is an important aspect of AHP. The optimal decision-making in pair-wise comparison is mainly associated with the permissible value of consistency ratio. This step acts as a gateway to observe the consistency and inconsistency of the decision matrix. Normally, cardinal and ordinal consistency checks are considered for pair-wise comparison. Ordinal consistency holds that if "a" is greater than "b" and "b" is greater than "c", then "a" must be greater than "c". However, cardinal consistency states that a stronger relationship is required between the factors to be evaluated. In this case, if "a" is two times more important than "b" and "b" is three times more important than "c", then "a" should be six times more important than "c". In order to calculate the consistency ratio, an index was formulated to measure the consistency of weights. In this regard, the acceptable range of CR should be equal to or less than 0.10.

(a) Maximum Eigen vector, (b) Relative weights, (c) CI i.e. consistency index, (d) Random Consistency index

Given formulae are used to find the above said terms:

Consistency Index = (λmax-n)/ (n–1) ----(1)

Consistency Ratio = CI/RI -----(2)

Value of RI fluctuates according to the order of matrix for which CR is to be calculated. Table 1 gives the value of the Random Consistency index for matrix of order(N) 1 to 6 attained by assessing random guides by means of a sample size 500 (Saaty, 2000).

Table 1. Random index

Order of Matrix	1	2	3	4	5	6
Consistency index	0	0	0.58	0.90	1.2	1.24

Table 2. Matrix size and CR table

Matrix Size	3 × 3	4x4	n>5
CR	0.05	0.08	0.1

The final step starts from the summation of relative values for each set of alternatives on all hierarchy levels. These values are combined together to establish the overall score or criteria weight of each alternative. As an outcome, the normalized local priority vectors are obtained due to this additional function. Now, the final priorities are synthesized by aggregating the product of local priority vector and the relative weights of the alternative respectively. The process of aggregation starts from the bottom level of the hierarchy and proceeds upwards to the highest level goal. It is pertinent to note that summation of all weights of alternatives and their corresponding importance is equal to 1.00.

4. GREEN SUPPLY CHAIN OF A PROCESS INDUSTRY

Zhu et. al. (2008) formulated and authenticated the GSCM practices and conceptualized five dimensions namely internal environmental management, Green purchasing, Cooperation with customers, Eco-design and Investment recovery. These dimensions have been used in this research work. There can be six broad way to consider any supply chain as green:

1. Green purchasing and procurement (GPP),
2. Green manufacturing (GM)
3. Green distribution (GD)
4. Reverse logistics (RL)
5. Waste management (WM)
6. Production of Renewable Energy (PRE)

4.1. Green Purchasing and Procurement: (GPP): Green purchasing is concerned with procurement of raw material and is the first step involved in manufacturing system. It is assumed that material to be used in production of the finished goods is environment friendly. These materials exhibit no bad impact on environment while in process as well as when disposed once the life expires. But procurement of such materials requires the easy availability, affordable cost and sustaining to the existing manufacturing processes. These constraints are highly restrictive to go green in manufacturing industries. Suppliers can contribute to be green through a wide range of activities which may include materials handling, manufacturing, warehousing and preserving, packing, transporting, distributing, technology acquisition and transfer to suppliers [4]. Modern organisations operating globally are required to maintain a sustained customer-relationship management, supplier-relations management and internal supply chain through effective Green supply chain practices [5]. Four important factors which can help in achieving Green supply chain are:

1. Local suppliers,
2. Green raw material
3. Green Supplier
4. Support to Supplier

4.1.1 Local Supplier: Most buyers prefer to keep the supply chain as close to home as possible. Local suppliers of manufacturing firms or trading firms are advantageous to keep the supply chain green by being flexible, providing high control to manufacturing firm and reducing the overall cost of supply chain. Moreover, by being local, suppliers are aware of natural richness and environmental complexities [4].

4.1.2 Green Raw Material: For manufacturing firms, supply of green raw material will enable them to produce non-hazardous finished goods [6].

4.1.3 Green Supplier: The firm should give the tag of "green supplier" to the supplier after careful evaluation of the standards followed by the supplier. Green Supplier selection is the process in which companies identify, evaluate, and contract with suppliers who also follow the Green criteria such as pollution control, green product, and environmental management systems [8].

4.1.4 Support to Supplier: The R&D support to the supplier is important to keep the supplier informed about the latest environmental trends. The suppliers must be trained initially and occasionally to keep the quality, cost, time and quantity right as per the process industry demand. [7].

4.2. Green Manufacturing (GM): Green manufacturing is the renewal of production processes and the establishment of environment friendly operations within the manufacturing firm. It is the "greening" of manufacturing, in which workers use fewer natural resources, reduce pollution and waste, recycle and reuse materials and moderate emissions in their processes. The term "green" manufacturing can be looked at in two ways: the manufacturing of "green" products, particularly those used in renewable energy systems and clean technology equipment of all kinds, and the "greening" of manufacturing — reducing pollution and waste by minimizing use of natural resources, recycling and reusing what was considered waste, and reducing emissions [10]. But this requires environment concerned industrialists. The general trend is to maximise the profit by any means, sometimes by cutting cost on various sensitive issues of going green. The relaxed norms of government is utilised for maximisation of return on investment. In such situation, recycling, reducing emission and environmentally sustained manufacturing processes are treated as constraints (Dashore, &Sohani, 2013). They used four components to make the manufacturing green;

1. Use of renewable source of energy
2. Producing minimum scrap
3. Power off, when machine is not in use
4. Using optimised method at each floor shop.

4.2.1. Use of renewable sources of energy: The manufacturer or the process industry should maximise the use of renewable sources of energy in order to reduce the carbon foot print. This will reduce the overall supply chain cost. This effort will make the firm independent of power supply and reduce the adverse effect on environment by demanding lesser electricity from government or diesel power plants [7].

4.2.2. Producing minimum scrap: The manufacturing firm, producing minimum scrap saves a lot of natural resources which otherwise would have been consumed to bring the required finished goods in the market [6].

4.2.3. Power off, when machine is not in use: Machine running without any output requirement must be switched off to save power. The workers are often reluctant to do it, hence automatic switch-off devices should be installed to meet this requirement [10].

4.2.4. Using optimised method at each floor shop: Optimised processes should be used to reduce the release of pollutants in the operations. Also, greenhouse gas emissions should be reduced. Waste material should be reduced, collected, reused and recycled [11]

4.3. Green Distribution (GD)

Green distribution is a concept in which the finished product is fetched to the end user at the right time and at the right cost. The distribution process includes packaging, transportation and delivering. The three processes require green activities consuminggreen packaging materials, pooled transportation and shortest route of delivery in order to have no hazard on disposing packaging material and cause lower emissions due to transportation [16]. *Transportation and Logistics* consists of authorizing returns, collecting, sorting, testing, stocking, shipping(transportation) and disposition and has highlighted the following points to make distribution process green.

1. Full Load Transportation
2. Optimised route mapping
3. Efficient transporters
4. Green packaging

4.3.1. Full load Transportation: Truck carrying goods should be loaded to its full capacity to optimise the cost and environmental factors benefits.

4.3. 2. Optimised Route: The route of the truck should be predetermined with minimum distance as key constraint. By adapting this, the transporters would be able to meet the supply chain requirement easily. Cross docking and 3rd party logistics can also be utilised in this concept.

4.3.3 Efficient Transporter: Transporter must use the proper facility to fetch the goods from one place to another like correct selection of transportation method by air, water and rail or road. The most economical is rail transportation causing minimum emission.

4.3. 4. Green Packaging: Using of environmentally suitable material for packaging is very important. The firm must restrain to use Poly vinyl packaging material in its shipments. [15]

4.4. Reverse Logistics (RL): Reverse logistics stands for all operations related to the reuse of products and materials. It is "the process of planning, implementing, and controlling the efficient, cost effective flow of raw materials, in-process inventory, finished goods and related information from the point of consumption to the point of origin for the purpose of recapturing value or proper disposal" More precisely, reverse logistics is the process of moving goods from their typical final destination for the purpose of capturing value, or proper disposal. Remanufacturing and refurbishing activities may also be included in the definition of reverse logistics [16]. By doing so, the utility of product increases and the life of product is enhanced remarkably. This reduces the carbon foot print at least in producing such goods. Reverse logistics includes the management and sale of surplus as well as returned equipment and machines from the hardware leasing business. Normally, logistics deal with events that bring the product towards the customer. In the case of reverse logistics, the resource goes at least one step back in the supply chain. For instance, goods move from the customer to the distributor or to the manufacturer. If the product is defective, the customer would return the product. In that case, the manufacturing firm would have to organise shipping of the defective product, testing the returned product, dismantling, repairing, recycling or disposing the product. The product would then travel in reverse through the supply chain network in order to retain any use from the defective product. The logistics employed for such matters is reverse logistics. Unfortunately most of the firms do not take responsibility to set up reverse logistics chains to take back their expired products or the product goes beyond economical repairing. ***Reverse Logistics*** manages the handling and disposition of returned goods, improving a company's ability to put returned goods back on the market. Srivastava (2007) has suggested three steps to implement reverse logistics.

1. Take back policies
2. Efficient recycling process
3. Refurbishment and sell

4.4. 1. Take back policies: Firms should be ready and capable of accepting the expired goods to their firms with corresponding appropriate incentives. This will save the littering of the expired goods into local Kabadiwala, who may resort to extremely hazardous method to retrieve the usable parts from the goods. This can save a lot of environmental impacts caused due to such practices.

4.4. 2. Efficient recycling process: The various risk free and eco-friendly recycling facilities should be developed by the manufacturing firms to generate the raw material at the firm itself. This would save the frugal methodologies employed to recycle the electronics and metallic parts [13]

4.4.3. Refurbishment and sell: Taken back expired goods having some aesthetic value can be refurbished and sent to the market for further use.[17]

4.5. Waste Management (WM): Efficient waste management is becoming extremely urgent to save the environment and save lives. Reducing and/or avoiding waste were already an important issue since early 1970s which later on gave birth to the concept of Lean. The emergence of waste is assignable to the product life cycle. Waste generated by the companies during operations should be used as an input material in some forms in order to reduce disposal liability [10]. Hazardous wastes which cannot be reused should be disposed with the help of technologies like e-waste. E-waste includes a wide range of electrical and electronic devices such as computers, cellular phones, portable audio equipment, refrigerators, and air conditioners. This sort of waste can contain more than 1,000 different substances, many of which are potentially hazardous to the environment and detrimental to human health. The constraints of such disposal and waste management must be addressed properly (http://www.downtoearth.org.in). Ithas been found that following four sub-enablers are important to discuss the waste management process [11].

1. Effort to produce minimum waste
2. Efficient Waste treatment
3. Re-use of waste
4. Eco friendly waste disposal

4.5.1. Effort to produce minimum waste: Efforts should be made to produce minimum waste while manufacturing, delivery and use of product..

4.5. 2. Efficient Waste treatment: The waste treatment in the plants should beefficient which would reduce the impact on environment. Waste produced in firms are water, solid waste, oil, and other chemicals. These should be treated well, before it is disposed [12]

4.5.3. Re-use of Waste: If the waste is brought into re-use, it will be in-debt to the environment. Generally, waste of agro industries are utilised in farming.

4.5. 4. Eco-friendly ways to dispose of waste: The waste disposal must be eco-friendly to avoid the poisonous effects. Like disposal of water from textile industries are treated and then released to the surroundings or in ponds.

4.6. Customer awareness (CA): Customer awareness is very important in green supply chain. It is the customer who drives the chain environmentally green. Measuring and reporting the environmental impact is the first step towards setting on the path of reducing them [17].

1. Full utilised product life (FPL)
2. Compatible State policy (CSP)
3. Availability of Green substitute (AGS)
4. Change of consumer behaviour (CCB).

4.6.1. Full utilised Product Life (FPL): Every product has some life. The customer is expected to use it fully before it is sent to recycling process.

4.6.2 Compatible State Policy: The government is playing important role in deciding the ban and promotion of material in the country/state. Government should also establish the standard policy of recycling and waste disposal [11]

4.6.3 Availability of Green Substitutes: Availability of suitable green products/ material is urgent need in market. Due to absence of such materials, customers are bound to use the product available. Hence all green products of each variety should be made available in the market with green strategic supply networks.[9]

4.6.4 Change in Consumer Behaviour: It is not in the hands of manufacturer the awareness which a customer has. Customers should be ready to switch from use of Non eco-friendly products to green products especially in packaging materials, carrying goods etc. [3]

5. CONSTRUCTING HIERARCHY OF GSCM OF PROCESS INDUSTRIES

The six enablers of GSCM have been listed. The group of 3 academicians and 3 industry personnel from the field of supply chain have given the task of prioritising the enablers with respect to each other. For example if Green manufacturing (GM) is having a weightage of 3 over GPP in 2nd column of first row, weightage of GPP with respect to GM in 1st column of 2nd row is 1/3 i.e. 0.33. Like that, all enablers have been weighed with group consensus and the values are shown in table below. This process is followed for all sub-enablers too.

Table 3: Comparison of GSCM enablers

Elements of GSCM	GPP	GM	GD	RL	WM	CA	GPW
Green purchasing and procurement (GPP)	1	3	0.5	0.3	0.3	0.3	0.09397
Green manufacturing (GM)	0.33	1	2	0.5	0.4	0.2	0.08462
Green distribution (GD)	2	0.5	1	0.2	0.2	0.4	0.07764
Reverse logistics (RL)	3	2	2	1	0.4	2	0.22504
Waste management (WM)	3	2.5	2.5	2.5	1	0.2	0.23076

Customer Awareness (CA)	3	2.5	2.5	0.5	5	1	0.28793
Total:	12.3	11.5	10.5	5	7.3	4.1	1

Waste management is having highest Global Priority Weightage i.e. 0.224 for Waste management (WM). Similarly, sub-enablers are evaluated.

Table 4: Comparisons of Sub-enablers; GPP

Elements of GPP	LOS	GRM	EGS	STS	GPW
Local supplier (LOS)	1	2	2	0.5	0.2692
Green raw material (GRM)	0.5	1	1.5	0.3	0.1737
Economical Green Supplier (EGS)	0.5	0.6667	1	1.25	0.2046
Support to Supplier (STS)	2	3.333	0.8	1	0.3637

Maximum Weightage i.e. 0.3637i.e. Support to Supplier

Table 5: Comparisons of Sub-enablers; GM

ELEMENTS OF GREEN MANUFCTURING (GM)	REN	PMS	PO	OM	GPW
Use of renewable source of energy (REN)	1	3	1.5	2	0.40052
2. Producing minimum scrap (PMS)	0.333	1	0.2	0.3	0.0962
3. Power off, when machine is not in use (PO)	0.666	4	1	0.5	0.27219
4. Using optimised method at each floor shop(.OM)	0.5	0.33	2	1	0.231

Maximum Weightage is 0.40052 i.e. Use of renewable source of energy

Table 6: Comparisons of Sub-enablers; GD

ELEMENTS OF GREEN DISTRIBUTION	FL	ORM	ET	GP	GPW
Full Load Transportation (FL)	1	2	1.5	0.5	0.229043
Optimised route mapping (ORM)	0.5	1	2	0.5	0.179064
Efficient transporters (ET)	3	0.5	1	0.25	0.195301
Green packaging (GP)	2	2	4	1	0.396590

Maximum Weightage is 0.39,i.e. Green packaging (GP)

Table 7: Comparisons of Sub-enablers; RL

ELEMENTS OF REVERSE LOGISTICS	TBP	ERP	RAS	Normalised
Take back policies (TBP)	1	0.5	0.3333	0.172105672
Efficient recycling process (ERP)	2	1	3	0.523698524
Refurbishment and sell (RAS)	3	0.333333	1	0.304195804

Maximum Weightage i.e. 5237 is efficient recycling process (ERP)

Table 8: Comparison of Sub-enablers; Waste Management (WM)

ELEMENT ODF WASTE MANAGEMENT	MW	EWT	ROW	EWD	GPW
Effort to produce minimum waste (MW)	1	2	3	0.5	0.32564
Efficient Waste treatment (EWT)	0.5	1	2	1.5	0.24455
re-use of waste (ROW)	0.33	0.5	1	2	0.18999
Eco- friendly waste disposal (EWD)	2	0.667	0.5	1	0.23979

Maximum Weightage is 0.325 i.e. Effort to produce minimum waste (MW).

Table 9: Comparison of Sub-enablers; CUA

ELEMENT ODF CUSTOMER AWARENESS (CUA)	FPL	CSP	AGS	CCB	GPW
full utilised product life (FPL)	1	0.75	2	2	0.3434
Compatible State policy (CSP)	1.33	1	0.5	0.3	0.2037
Availability of Green substitute (AGS)	0.5	2	1	0.5	0.23839
change of consumer behaviour (CCB)	0.5	0.33	2	1	0.21441

Maximum Weightage is 0.34 i.e. Full utilised product life (FPL)

Table 10: Comparative score of each enabler and Sub-Enabler

Elements of GSCM	Critical Elements	PW	G*PW
Green purchasing and procurement (GPP)	Local supplier (LOS)	0.269	0.023
0.086212397	Green raw material (GRM)	0.173	0.014
	Economical Green Supplier (EGS)	0.20468	0.0176
	Support to Supplier (STS)	0.3637	0.0313
Green Manufacturing	Use of renewable source of energy (REN)	0.4005	0.0328
0.082040627	Producing minimum scrap (PMS)	0.09628	0.0078
	Power off, when machine is not in use (PO)	0.2721	0.0223
	Using optimised method at each floor shop(.OM)	0.2310	0.0189
Green Distribution	Full Load Transportation (FL)	0.2290	0.0174
0.07635277	Optimised route mapping (ORM)	0.1790	0.0136
	Efficient transporters (ET)	0.1953	0.0149
	Green packaging (GP)	0.3965	0.0302
Reverse Logistics	Take back policies (TBP)	0.1721	0.0378
0.219873622	Efficient recycling process (ERP)	0.5236	0.1151
	Refurbishment and sell (RAS)	0.3041	0.3041
Waste Management	Effort to produce minimum waste (MW)	0.3256	0.0730
0.22429041	Efficient Waste treatment (EWT)	0.2037	0.0456
	Re-use of waste (ROW)	0.19	0.0426
	Eco- friendly waste disposal (EWD)	0.2397	0.0537
Customer awareness	Full utilised product life (FPL)	0.3434	0.3112
0.311230174	Compatible State policy (CSP)	0.2037	0.0634
	Availability of Green substitute (AGS)	0.2383	0.0741
	Change in consumer behaviour (CCB)	0.2144	0.066

Table 11: Rank on Comparative score of each enabler and Sub-Enablers

Rank	Critical Elements	PW	G*PW
1	Full utilised product life (FPL)	0.343444	0.31123
2	Refurbishment and sell (RAS)	0.304196	0.304196
3	Efficient recycling process (ERP)	0.523699	0.115147
4	Availability of Green substitute (AGS)	0.238398	0.074197
5	Effort to produce minimum waste (MW)	0.325649	0.07304
6	change of consumer behaviour (CCB)	0.214419	0.066734
7	Compatible State policy (CSP)	0.203739	0.06341
8	Eco- friendly waste disposal (EWD)	0.239796	0.053784

9	Efficient Waste treatment (EWT)	0.203739	0.045697
10	Re-use of waste (ROW)	0.19	0.042615
11	Take back policies (TBP)	0.172106	0.037841
12	Use of renewable source of energy (REN)	0.400526	0.032859
13	Support to Supplier (STS)	0.363751	0.03136
14	Green packaging (GP)	0.39659	0.030281
15	Local supplier (LOS)	0.269252	0.023213
16	Power off, when machine is not in use (PO)	0.272193	0.022331
17	Using optimised method at each floor shop(.OM)	0.231053	0.018956
18	Economical Green Supplier (EGS)	0.204688	0.017647
19	Full Load Transportation (FL)	0.229044	0.017488
20	Green raw material (GRM)	0.173765	0.014981
21	Efficient transporters (ET)	0.195301	0.014912
22	Optimised route mapping (ORM)	0.179064	0.013672
23	Producing minimum scrap (PMS)	0.096228	0.007895

6. RESULT AND DISCUSSION

The six enablers of Green supply chain management are chosen with consultation from experts from industry and academia mentioned earlier. The comparative weightage between ranges of 1 to 5 are given. Where 1 indicates the lowest impact and increasingly 5 indicates the highest impact of the enablers on other. By the use of AHP, one can find out the final outcome as Global priority weightage of each enabler given in the last column of Table 3. From Table 3, it is found that enabler of GSCM, customer awareness (CUA) has maximum score i.e. 0.311. This is the most important in the eyes of experts whereas green distribution has the least score of 0.076 and is showing relatively less important. Now, from table 4-9, comparisons of sub-enablers of each enabler are compared and relative weightage has been received from the experts. By applying AHP, most important sub-enablers are pointed out based upon maximum weightage scored by that sub-enabler. Thus, complete lists of sub enablers are prepared based on priority of importance.

7. VALIDATION OF RESULT BY USING WEIGHTED SCORING MODEL

The above result can be validated by using weighted Scoring model. The importance of GSCM enablers are likely to face the application challenges. Bennet and Kathryn, (2002) suggested to test the priorities by using weighted Scoring model [16] .In this model the six enablers are tested on five parameters viz; 1) Value; 2) Risk; 3) Difficulty; 4) success; 5) urgency. These parameters are common in nature and must be assessed before we proceed for some project. In this method, the other expert team comprising of 03 academicians and 03 industrial people of not lower than senior manager in designation were contacted. The team was requested to give their opinion about numeric value with respect to each parameters and enabler of GSCM. The five Parameters were first assessed for its proportional weightage in GSCM terms like 20%, 10% etc. and then each enabler is given proportional weightage out of six enablers. The experts suggested the following weightage shown in table 12.

Table 12: Scoring of various alternatives

Parameters / Enablers	Weight %	Alternatives **%**					
		GPP	GM	GD	RL	WM	CA
VALUE	20	20	30	10	10	10	20
RISK	20	30	10	10	20	10	20
DIFFICULTY	10	40	10	10	20	10	10
SUCESS	10	30	20	20	10	10	10
COMPLIANCE	10	30	10	10	20	10	20
URGENCY	30	40	20	10	10	10	10

For example, in table 12, Green procurement and purchasing (GPP) with respect to value is given 20% weightage among five parameters while 20% among the six enablers. The actual effect is shown in table 13 is 4. The total score of weightage of GPP is 32, which is highest among all the enablers. This shows that most important point in GSCM is the 1st step of supply of raw material, which is required to be green for further realisation of GSCM. These results validate the AHP result shown in Table 3.

Table 13: Scoring of various alternatives

Criteria	Weight %	Alternatives %					
		GPP	GM	GD	RL	WM	CA
VALUE	0.2	4	6	2	2	2	4
RISK	0.2	6	2	2	4	2	4
DIFFICULTY	0.1	4	1	1	2	1	1
SUCESS	0.1	3	2	2	1	1	1
COMPLIANCE	0.1	3	3	1	1	1	2
URGENCY	0.3	12	6	3	3	3	6
	1	32	20	11	13	10	18

8. CONCLUSION

Green supply chain has emerged as an important issue being discussed recently among academician and industries. The most important challenges for upcoming generation are environment issues. The global discussion on environment preservation has brought the supply chain in green scanner. As all business is bound to take place in some network, integrating the "Green" issues in SCM has become inevitable. The Article has highlighted the important enablers and sub-enablers. The AHP has been used to rank those enablers as per criticality in nature. The finding has been validated by using some other method of MADM. In this paper, process industries have been targeted which are procuring of raw material, manufacturing and distributing as main functions. Making these processes environmentally sustainable will make the business sustainable. The six GSCM enablers are further broken into sub-enablers with the help of experts and it is found that customer awareness is most important factor to propel the supply chain as GSCM.

Limitations: Only six enablers have been used in this research where as many more can be taken into consideration. The research is mainly based upon the opinion of some experts which may differ from other experts.

Applications: The research can be used to encourage the industry to adopt green measures. The paper is a novel effort in order to make the business environmentally sustainable and making the lives healthy in a pollution free atmosphere.

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