

## Implementation of Green Supply Chain Management in the Premises of an Upstream Industry in India: A Case Study

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**Abstract**— The green supply chain management (GSCM) is an innovative and most influencing factor to differentiate an industry from its competitors. With increased awareness for corporate image and responsibility, customer satisfaction and the requirement to meet the terms with environmental regulations laid by Government, green supply chain management (GSCM) becomes an important consideration for Indian enterprises.

This research aims to survey current green activities in the premise of an upstream company located in the state Tripura of India and to evaluate green supply chain management along with developing a framework for implementation of GSCM in upstream industries. To evaluate green supply chain management, the measurement items/ questionnaire related to investigate GSCM practices, measure GSCM performance characteristics, and explore GSCM pressure/ driver within that upstream industry is used to obtain survey results. The questionnaire is also tested for reliability using Cronbach's alpha test and found much reliable. Also, an algorithm has been developed for automating the process of Green Purchasing in the supply chain management which can be integrated in the Materials Management monitoring software like SAP-ERP systems. This research contributes to the literature by giving insights about implementation of GSCM in upstream industries and by encouraging practitioners to work towards automation of green processes in different Indian industries. It also contributes to the practices of managers with a reliable measurement scale to evaluate their strengths and weaknesses in different dimensions of implementing GSCM. Suggestions to develop GSCM in that upstream industry are also presented.

**Keywords**— GSCM, Green Procurement, Green Distribution and Storage, Reverse Logistics

### 1. Introduction

When we talk of any business or industry, be it any small, medium or large-scale industry, it ultimately comes to making profit. To make any industry profitable, it needs a perfect optimization and balance in every aspect encompassing market conditions, Government regulations, investors' support, customer's demand and many other things. And for maintaining all these aspects, one generally ignores the environmental aspect and the degradation caused by that industry; directly or indirectly [1, 2]. And this refraining behavior adversely affects the environment and ultimately the daily life styles of people leading to boggling and devastating conditions [3]. So, it's too important to adopt some necessary changes which can prevent bad environmental impacts and we can envisage a Green World in near future.

Years ago, the concept of environmental quality was almost non-existent while relating to industries. However, the quality revolution of the 1980s and the supply chain revolution of the 1990s have made it evident that the business best practices call for integration of environmental management parallel with ongoing operations [2]. Here then, Green Supply Chain Management comes into picture which is a very new and innovative idea and is fast gaining attention in industries. Among researchers too, it is becoming a topic of great interest. GSCM basically is the correlation of Environmental issues to all the involved processes in Supply Chain Management. Although GSCM has been studied for some developed and developing countries, like China, Thailand, Brazil, USA etc. but there has been little information about the adoption of GSCM practices in India [4]. Concerning today's Indian Industries scenario, it can be concluded that some of them have started working towards integrating GSCM but the state of adoption is still in its starting phase due to many factors ranging from 'unawareness about environmental sustainability among consumers and ineffective regulatory frameworks' etc.

### 2. Literature Review

Supply chain is very important due to its cost effectiveness and on timely delivery and flow of goods from one destination to other destination for the business needs and it gives the profit to the organization too. Supply Chain consists of many trading partners, from raw materials to finished products [1]. Supply Chain Council [2] defines SCM as a process which "encompasses every effort involving producing and delivering a final product or service, from the supplier's supplier to the customer's customer. Supply Chain Management includes managing supply and demand, sourcing raw materials and parts, manufacturing and assembly, warehousing and inventory tracking, order entry and order management, distribution across all channels, and delivery to the customer." Greening all the involved processes in Supply Chain Management is known as Green Supply Chain Management. GSCM concept has ranged from green purchasing to integrated supply chains starting from supplier, to manufacturer, to customer and reverse logistics. Thus, we can say that along with considering environment in supply chain decision making, GSCM positively affects productivity and profit too. GSCM concepts minimize undesirable environmental impacts of supply chain processes where they occur, or actually before they occur. GSCM can be defined as:  $GSCM = \text{Green purchasing} + \text{Green manufacturing/materials management} + \text{Green}$

Distribution / marketing + Reverse logistics [3]. Although many definitions have been proposed but they have the same meaning and focus to the same objective of sustainable development as well as considerable cost reduction for some or even all of the involved enterprises.

GSCM is a systematic integrated process, from raw material to finished product, up to customer to disposal, to protect environmental degradation and to improve productivity and profitability [4]. The green productivity will possibly cause more environment friendly output from less inputs through clean manufacturing, and at the same time organizations can be free from legal or political restriction, mission of integrating economic development, social progress and ecological balance. Reducing waste and pollution, and using less energy and material resources, are obviously good for the environment, and are the best for supply chain because they cut operational costs [5]. GSCM has many financial and operational advantages apart from its positive environmental impacts. Although, adoption of GSCM initially seeks more effort and cost and restricts design and manufacturing practices, implementing it will lead to many advantages. These advantages can be categorized on different bases viz. costs, risks, environment, property worth, productivity etc.

As this work talks about integrating and implementing Green Supply Chain Management practices in the premises of Oil and Natural Gas Corporation Ltd. which is among the world leaders in the area of Oil and Gas Exploration and is an upstream industry, the concept of Green Supply Chain Management has been described keeping in mind the altogether different approach which will be faced by any upstream industry. This upstream industry like any other industry also needs a better approach and control over environmental issues and for that very good integration of GSCM is required [6]. While talking about any upstream industry, that produces/ explores only raw materials in the form of Oil and Gases and supply them to their customers (other manufacturing industries); unlike any other downstream industry that produces finished products and supply it to customers, the framework of Green Supply Chain Management will imply different meaning from the general frameworks applied to any industry. Green procurement is defined as an environmental purchasing which involves activities that include the reduction, reuse and recycling of materials in the process of purchasing [7]. Besides, green procurement is a solution for environmentally concerned and economically conservative business, and a concept of acquiring a selection of products and services that minimizes environmental impact [8]. Green procurement needs some points to take into account [11], which are given below:

(i) Supplier Selection: This includes the selection of suppliers that are green partners i.e. they satisfy green partner environmental quality standards and pass an audit process in following regulations for the environment-related substances, suppliers who acquire directives such as ISO14001; suppliers who control hazardous substances in company's standard lists and obtain green certificate achievements and suppliers who use standardized specifications for each spare.

(ii) 3Rs used in Procurement Process: Reuse, Recycle and Re-manufacturing are the 3Rs used in the procurement process. Before procuring any items (spare parts in this case) from any supplier, one must ensure whether they can reuse the used spare parts in the same machine as well as in any other machine or in any other usage. Similarly, if any spare part can be recycled, or can be re-moulded into some other useful products. Re-manufacturing on the other hand implies the manufacturing or repairing of any spare for the same usage.

The company under this study is an upstream industry, it need not import or buy any type of raw materials from any supplier. Instead, it buys spare parts for the equipment that are needed during the production and exploration process at drilling sites as well as in the offices and warehouses. Besides this, for green material management, following processes of material selection, separation and material recovery should be used [9, 10]:

- i. Different materials used in a product should be easy to separate;
- ii. While maintaining compatibility with the existing manufacturing infrastructure, fewer numbers of different materials in a single product should be used;
- iii. More adaptable materials for multiple product applications should be used

Smaller number of "secondary operations" should be used to reduce the amount of scrap and simplify the recovery processes. Green production is defined as production processes which use inputs with relatively low environmental impacts, which are highly efficient, and which generate little or no waste or pollution [7]. These include the adoption of many new trends such as different spare parts used in equipment which need to be rinsed, can be rinsed with clean water instead of using chemicals and then the used water can be reused easily for many other works. At the drilling sites, low power consuming CFLs and tube lights can be used instead of those highly power consuming electric bulbs and that too only at the location sites. There are several other ways which can be thought of and will certainly help in decreasing the energy consumption and at the same time, increasing the efficiency. Some of the proposed ways are:

- a. Using energy efficient upgraded technology which uses less resources
- b. Using non-conventional high efficiency giving materials which at the same time are non-hazardous to the environment.
- c. Using spares having large life-span that will ultimately lead to increased productivity.
- d. Improving the machine uptime so that less energy consumption takes place as compared to frequent shutdowns.
- e. Using those type of equipment which are regulated by environmental acts and that give high efficiency consuming low power in comparison to other equipment for the same operation.
- f. Promoting or encouraging the use of used spare parts instead of virgin materials.
- g. Using pollution control equipment to trap, store, treat and dispose the emissions coming out during the production processes.
- h. Choosing the location for drilling which can be considered safe for human population and doesn't affect the surrounding areas.
- i. Re-utilising the land mass which has been left over after the completion of production or exploration.

Besides these, 3Rs can also be implemented into the production processes which will help to minimise the wastes as well as will increase the usability and salvage value of the unused parts. Thus, Green production can lead to lower raw material costs, production efficiency gains, reduced environmental and occupational safety expenses, and improved image of the industry [12]. Green distribution consists of processes such as Green Storage, Green packaging and green distribution or marketing. Green storage implies the storage of raw materials which have been produced using green production techniques. Green storage techniques are the techniques which help to store the raw materials in an energy efficient manner while minimizing the negative environmental impact. As is the case of this Petroleum Exploration industry, the raw materials are mainly crude oils, petroleum and natural gases etc. which are hazardous in nature if kept in open. So, special care is being taken to store them in a safe location or chambers. If, by any chance, it leaks, it'll be a great problem for both the industry as well as for the surrounding people. And there have been some cases where these types of accidents have happened which caused loss to all involved. So, careful and safe storage is a necessary criterion. Green storage takes care of this as well as the environmental issues related to it. Green Packaging or eco labeling can be defined as the process of packaging which involves the use of green materials which are of standardized manner and can be reused for many other operations or for other materials. Packaging characteristics such as size, shape, and materials effect distribution because they directly affect the transport characteristics of the product. Better packaging, along with rearranged loading patterns, can reduce materials usage, increase space utilization in the warehouse and in the trailer, and reduce the amount of handling required. In any upstream industry, as they produce or explore raw materials for other manufacturers, the raw materials, in this case, petroleum, oil or natural gases, do not need eco labeling because they are directly supplied to the warehouse or to the customers via pipelines which are very secure method of transportation of these materials. In that case, eco-labelling or green packaging of the spare parts, that are coming from the suppliers of those spare parts, are required from their side so that the same packaging must be reused, recycled or maybe remanufactured to be used in some other operations. It includes Green Logistics too which encourages the supplier to supply directly to the site, to use alternative fuels in the vehicle used for transportation and to distribute the products together, rather than sending them in shifts [16]. Green Marketing is a much broader concept which comprises product modification, changes to the production process, packaging changes, as well as modifying advertising [14, 15]. Green distribution is of extra importance in the greening of SCM, because it directly impacts the natural environment. Green distribution relies on green transportation which has a lesser or reduced negative impact on human health and the natural environment when compared with competing transportation services serving the same purpose. Reverse logistics can be defined as the process of retrieving the product from the end consumer for the purposes of capturing value or for proper disposal. RL includes many activities such as collection, combined inspection/selection/sorting, re-processing/direct recovery, redistribution, and disposal of the final product received from the end user [17, 18]. In the context of upstream industries, RL can't be applied to the end products because they serve as the raw material for the customer and nothing comes back in the form of disposal or unused materials. However, the industry itself can actively participate in the process of RL by sending the unused packaging, spare parts and disposed parts or components having no value or very less value as well as scrap materials to their respective suppliers and in the process, can make some revenue by its salvage value or by their after-life value.

As we know, for complete integration of GSCM, there are many aspects, techniques and factors such as awareness among people, support from the management etc., which needs to be resolved. GSCM has been classified or has

been categorized in three main aspects [19, 20] which have been described below:

- a. GSCM practices
- b. Performance Characteristics of GSCM
- c. GSCM Drivers/ pressures

The broader concept of GSCM ranges from implementation as well as monitoring of the general environment management programs to more adverse practices implemented through various techniques of reducing wastes (such as Reduce, Reuse, Recycle, Remanufacture etc.). These techniques of implementing GSCM are known as GSCM practices. There are many ways or techniques by which Green can be added to supply chain management or a better relationship between supply chain operations and environmental impacts can be established. These GSCM practices or techniques need to be understood by everyone and after changing the situation, from „greening as an obligation“ to „greening as a strategic weapon for competitive advantage“, only these practices can give an added advantage over other industries in terms of productivity, customer satisfaction, reliability and all-round growth of business. It can be concluded that implementing GSCM practices in industries lead to indirect improvement of their economic performance and environmental performance [21]. Companies with better implementation of GSCM practices with a focus on distribution activities have successfully improved their business and environmental performance on many levels. As of today also, some of remaining companies have not adopted green supply chain management, and due to this, environmental performance index (EPI) ranking of India is not good [3]. Some of the GSCM practices having more importance are:

- i. support and commitment from senior managers as well as from the lower-level employees
- ii. Environmental compliance and auditing programs
- iii. ISO 14001 certification
- iv. Employees Motivation, Health & Safety
- v. Producing in a way so as to reduce consumption of material/energy
- vi. Cooperation with customer for eco-design and cleaner production
- vii. Investment recovery (sale) of excess inventories/ materials etc.

The same is discussed in the section of Present Investigations. This topic explains the after effect of implementing GSCM in any industry. It tells us about the result of integrating GSCM in every aspect such as reduction in emission, reduction in wastes, reduction in power consumption etc. It almost gives positive feedback except in some areas viz. training costs, initial setup costs etc. Because, training employees about the awareness of GSCM initially takes a lot of effort and increased cost. Similarly, initial setup costs for integrating GSCM too asks for great amount of money input for acquiring certifications, maintaining standards, increased cost of products etc. And as soon as GSCM is fully established, it will ameliorate the productivity and efficiency to a greater extent and will give more output in comparison to increased costs. Some performance characteristics for GSCM are given as:

- i. reduction of air emission, solid wastes, waste water etc.
- ii. Decrement in cost for materials purchasing, energy consumption etc.
- iii. Increment in investment, operating costs, training costs etc.

GSCM drivers or pressures are the main factors behind the implementation of GSCM in any organization. In any industry, for minimizing the pollution as well as various types of wastes, the factors which help for the adoption and implementation of Green practices are called as GSCM Driver. There are many crucial and important factors or drivers of GSCM such as “employees, motivation, health & safety”. It has been considered very important factor in adopting GSCM for two-wheeler industries due to the active participation given by the physically and mentally fit employees in comparison to sick ones [22]. Different regulations led by Government as well as environment management are also major factors in implementation of GSCM which help industries avoid penalties and fines for non-compliance. While talking about Indian Micro, Small and medium enterprises (MSMEs), the major factors influencing the adoption of GSCM are „the pressure from external stakeholders“ and „on-the-job training“ [23].

While talking about India, there are several government regulations for environmental upgradation such as, The Environment (Protection) Act, 1986, which is considered as an umbrella legislation to protect and improve environmental quality, prohibit or restrict the operation of any industrial facility on environmental grounds [24]. Also, an Environmental Information System (ENVIS) has been established as a comprehensive network in environmental information collection, storage, retrieval and dissemination to varying users. But in spite of imposing these regulations, India has not been successful in reducing water or air pollution due to the ineffectiveness of these regulations, as well as accusations of mismanagement of funds earmarked for these purposes, ranging from underuse and incorrect reporting to diversion of funds [25]. These problems prevent the full implementation of GSCM in industries. Most of the industries obey those regulations just to avoid penalties. Some important GSCM pressures are:

- i. Customers and suppliers' awareness, pressure & support
- ii. Governmental and environmental regulations
- iii. Competitors' green strategies
- iv. Green image, Global marketing & Competitiveness
- v. Scarcity of Resources, Higher waste generation & Waste disposal problem
- vi. Employees Motivation, Health & Safety etc.

### **3. Problem Statement**

During our recent visit to the said company's drilling site and warehouses at the official complex, it became clear that there is an urgent need to implement Green Supply Chain Management (GSCM) effectively. The company selected for the study is a crucial player in India's energy sector, responsible for a significant portion of the country's crude oil and natural gas production. With such a substantial impact on the nation's energy supply, it is essential to address the complexities associated with its operations. While some green management practices were in place, there was a noticeable lack of collaboration and understanding among officials. Recognizing these gaps, I have taken on the task of investigating the integration of GSCM and developing a comprehensive framework to address these issues in the upstream industry, with potential applicability to similar sectors. Some of the problems, which have been addressed during the case study are as follows:

- a. Scrap materials have been lying in the mechanical workshops for a long period (more than five years)
- b. Unnecessary usage of printing papers for circulating notices to different departments
- c. Improper placement and arrangements of materials or spare parts in the warehouses
- d. Improper or no disposal of packaging materials received during the receiving of ordered spare items, machineries, store items etc.
- e. Delayed and variable lead time for the same quantity of materials.
- f. Materials coming in small batches which should have bulk purchased.
- g. Unawareness about GSCM among the employees working in the said organization.
- h. conducted an in-depth investigation to identify the root causes of the aforementioned issues and developed specific techniques that, when implemented, will bring significant benefits to the organization.

### **4. Methodology**

Based on the theme problems identified at the company under study, which is one among the world's largest E&P upstream industries of India, the need was felt for identifying different aspects of Green Supply Chain Management viz. Different practices being exercised, outcomes and related changes due to the implementations and various pressures or drivers influencing the implementation of GSCM in that industry. To evaluate green supply chain management, the questionnaire related to investigate GSCM practices, measure GSCM performance, and explore GSCM pressure/ driver in the grounds of that upstream industry is designed based on different extant literatures and taking feedback and expert opinions from various employees of that industry. Before using this questionnaire, validity and reliability assessment of the same is also done taking the expert opinions from various departments and after analysing those data using IBM SPSS software, the value of coefficient of Cronbach's alpha is found which indicates that the questionnaire is reliable and valid. A total of 33 surveys were administered to the employees of 11 different departments of that industry, taking 1 team from each department as and when possible. Each team consisted of one DGM, one Officer and one Clerical grade employee respectively (as and when possible) to get unbiased and practical opinions. Based on these survey results, different barriers to implement GSCM are also identified. The methodology employed to guide the research process for this investigation is summarized in Fig. 4.1

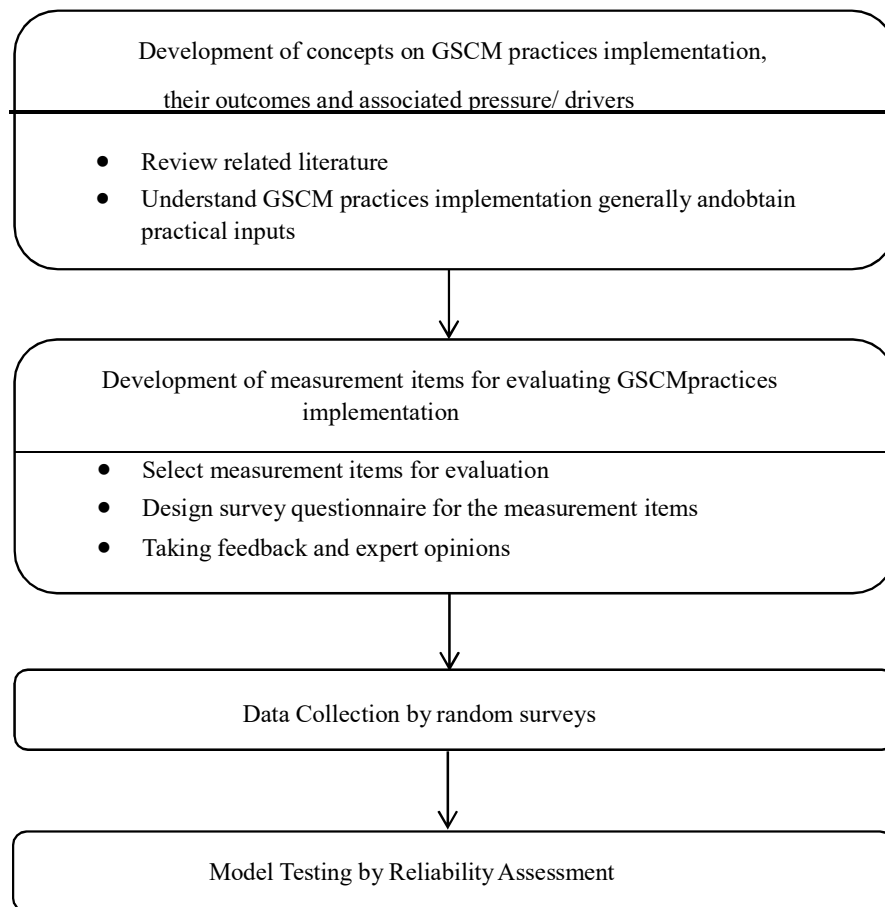


Fig. 4.1 Flow chart of the methodology implemented

#### 4.1 GSCM Practices Implementation, Performance Characteristics and GSCM Drivers

IEM has become the most widely adopted set in most of the Indian Industries because it contains environmental regulatory practices such as ISO 14001 integration and support from top level and mid-level managers. GP is sometimes considered as the complete scope of GSCM practices implementation while some consider it just as an integral element of GSCM Practices. While GSCM implementation is in its initial stages, CC has got very less attention mostly due to unawareness of customers. EcoD is considered as a critical factor which governs the environmental impacts of finished product. In India, though it is an emerging field and gaining gradual attention as there are so many products coming in the market with less energy consumption. IR has already been considered as a critical aspect in US and European industries but in India, very less attention is given to it due to inadequate waste management policies, lack of awareness, and lack of efficient recycling systems. Similarly, different performance outcomes of GSCM implementation are conceptualized by analysing various literatures and extensive research. These are categorized into three dimensions viz. 'Environmental impact', 'Positive economic impact' and 'negative economic impacts. Both EI and PEcoI are given more attention due to the consideration of emission reduction, waste management, and reduced energy consumption. All the three outcomes are in their infancy due to improper management and integration. But, NEcoI has not been accepted by most of the industries due to an increment in cost for various activities. It is necessary to create awareness among industries, their employees, suppliers as well as the ultimate customers about the environmental impacts and the advantages of using environmentally friendly products. It will incur a huge proportion of revenues but ultimately, will prove to be an outstanding performer in the long run and will improve a lot in terms of quality and productivity. There has been a gradual but continuous increment in GSCM implementation due to several factors or drivers. These drivers or pressures have been also conceptualized in three dimensions viz. 'Market Pressure', 'Government Regulatory' and 'Competition'. Based on the Indian market, it can easily be concluded that the most influencing driver is the pressure from the Government regulations which force industries to minimize carbon emission, reduce wastes and

minimize negative environmental impacts. Though, only imposing the regulations doesn't affect much but it helps industries to initiate in the positive direction. Competition and Market pressures are not significant drivers because of customer's unawareness and supplier's unwillingness. Customers go by the brand value or minimum cost and suppliers don't want to sweep out a part of revenue or investment on green activities.

#### 4.2 Measurement Development

For the implementation of GSCM practices, a measurement scale was necessary to be developed. For that, a list of 25 measurement items on GSCM practices implementation, 15 measurement items on Performance Characteristics of GSCM and 16 measurement items on GSCM drivers that are generally given importance in industries, was developed. Those measurement items have been tabulated in Appendix I, Appendix II and Appendix III respectively. Those measurement items were developed on the basis of opinions from different level employees working in the company along with previous literatures. All these measurement items were refined with the comments and feedbacks from academics and various experts in supply chain management. This process ensured the validity of those measurement items. These items were then organized into a survey questionnaire which was administered to all the departments of that industry. They were requested to indicate the extent to which they remark the implementation of different dimensions of GSCM practices by using a five-point Likert scale (1 = not considering it, 2 = planning to consider it, 3 = considering it currently, 4 = carrying out to some degree, 5 = carrying it out fully) for GSCM practices, a five-point Likert scale (1 = not at all, 2 = a little bit, 3 = to some degree, 4 = relatively significant, 5 = significant) for GSCM performance characteristics and a five-point scale (1 = not at all important, 2 = not important, 3 = not thinking about it, 4 = important, 5 = extremely important) for GSCM drivers respectively.

#### 5. Data Collection

Data has been diligently collected through the administration of a comprehensive survey questionnaire to the employees of various departments of the company. A total of 56 measurement items, structured in the form of a questionnaire survey along with indications of the Likert scale, were provided to 33 employees from diverse levels across all 11 departments of the company selected for our research. The resulting data has been assembled and tabulated in Appendices V, VI, and VII, outlining GSCM practices, Performance Characteristics, and GSCM Drivers, respectively.

#### 6. Reliability Test

Reliability is defined as the consistency or stability of scores with change in time or factors [1]. Or in other words, it can be defined as the extent to which any questionnaire, observation or measurement process gives almost same type of results when trials are taken repeatedly. To measure the reliability of the items under each critical factor, internal consistency analysis is being done using Cronbach's alpha. It is used to determine the proportion of set of trial scores which contain systematic or consistent variances [4]. It can have values ranging from 0 to 1.

Mathematically,

$$0.0 \leq \alpha \leq 1.00$$

Where,  $\alpha$  = value of Cronbach's alpha

' $\alpha$ ' gives a value of 0.00 when no variance is consistent or stable whereas in the case of full stability of variances, it gives a value of 1.00. The acceptable value for Cronbach's alpha is greater than 0.6 [2]. High value of ' $\alpha$ ' shows high variance and it is considered good as high variance indicates that there is no chance of biased opinions.

The Cronbach's alpha ( $\alpha$ ) is calculated by the formula:  $\alpha = (k/k-1) (1 - \frac{\sum Vi}{Var(X)})$

Where:  $V_i$  = Variance of scores on each question

$Var(X)$  = Variance of all summed scores

Along with the calculation of ' $\alpha$ ', Standard Error of Measurement (SEM) is also being calculated to give an estimate of variability in actual score points due to some unreliable variance [3]. The standard error of measurement (SEM) is calculated by following formulae:  $SEM = DEV(X) * \sqrt{(1 - \alpha)}$   
 $DEV(X)$  = Composite Standard Deviation  $\alpha$  = Cronbach's alpha.

## 7. Results and Discussion:

### 7.1 Reliability test result:

As stated above, the assessment of reliability is crucial for establishing correlation among different measurement dimensions. Our reliability analysis, conducted on three dimensions of GSCM adoption, is shown in Table 4.1, revealing high values of Cronbach's alpha. These values indicate the high reliability of the questionnaire prepared. The questionnaire, formulated with input from industry experts, practitioners, and existing literature, is thus considered equally valid.

**Table 7.1: Reliability Test Result**

GSCM Aspects	No. of questions	Value of Cronbach's alpha with SEM
GSCM Practices	25	0.91
i. IEM	8	
ii. GP	4	
iii. EcoD	6	
iv. CC	3	
v. IR	4	
GSCM Performance Characteristics	15	0.83
i. EI	6	
ii. PEcoI	5	
iii. NEcoI	4	
GSCM Drivers	16	0.78
i. MP	6	
ii. GR	3	
iii. Comp.	7	

### 7.2 Survey Results

The survey results were derived from a diverse group of employees across different departments of the company, using a 5-point Likert scale questionnaire. Each employee's responses were used to calculate the mean, which was then plotted against question numbers in radar charts created in MS Excel. The response sheets for GSCM Practices, Performance Characteristics, and GSCM Drivers can be found in Appendices 5, 6, and 7, respectively, while the list of respondents is provided in Appendix IV.

#### 7.2.1 GSCM Practices

In Figure 8.2.1, the mean values of all measurement items for GSCM practices are plotted against the question numbers. The results reveal that the upstream petroleum E&P industry has demonstrated a significant degree of adoption of GSCM practices, with mean values exceeding 4.00 for three key factors: ISO 14001 Certifications, Employees Motivation, Health & Safety, and Design of product in accordance with the regulation. The highest mean value of 4.42 was observed in Production/ Exploration according to regulation, followed by ISO Certifications with a mean value of 4.36. On the other hand, factors such as Sale or disposal of non-moving inventories, Investment recovery (sale) of excess inventories/materials, and Environmental audit for suppliers' internal management exhibited the lowest mean values of 2.21, 2.27, and 2.27, respectively.

The company is committed to producing oil and natural gas while strictly adhering to government regulations and industry standards. We have implemented comprehensive safety measures at our drilling sites and obtained ISO 14001 certification for all our facilities. Ensuring the health, safety, and motivation of our employees is a top priority for us, as it directly impacts productivity in a clean and healthy work environment. Additionally, we recognize the importance of proper inventory management and are taking steps to address issues such as non-moving inventories and excess materials in our warehouses. We are dedicated to optimizing our inventory turnover and minimizing holding costs to improve overall efficiency. Furthermore, we are conscious of the local market dynamics and strive to procure spare parts from local suppliers whenever feasible, while promoting fair competition and environmental sustainability.

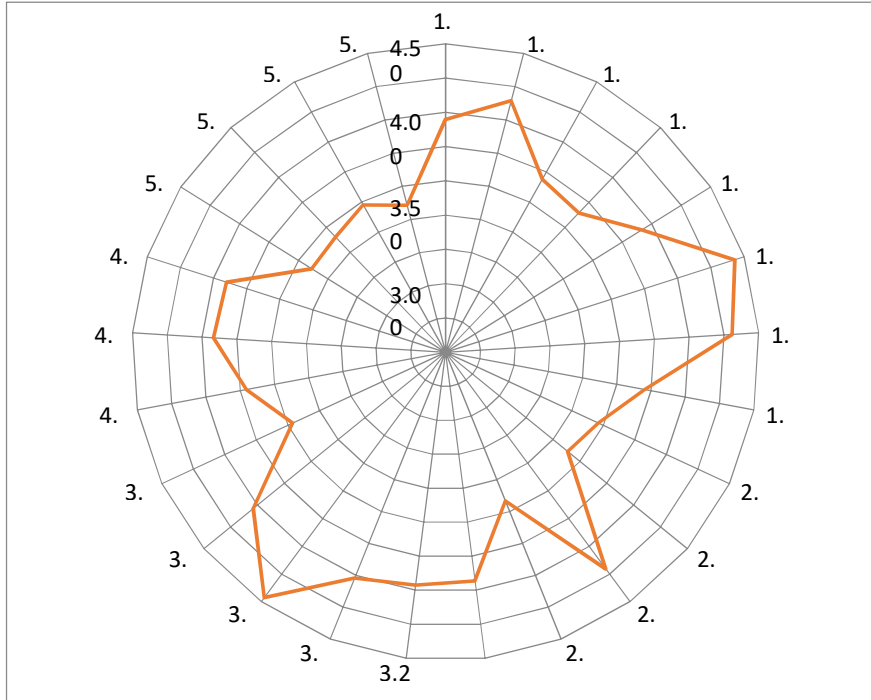
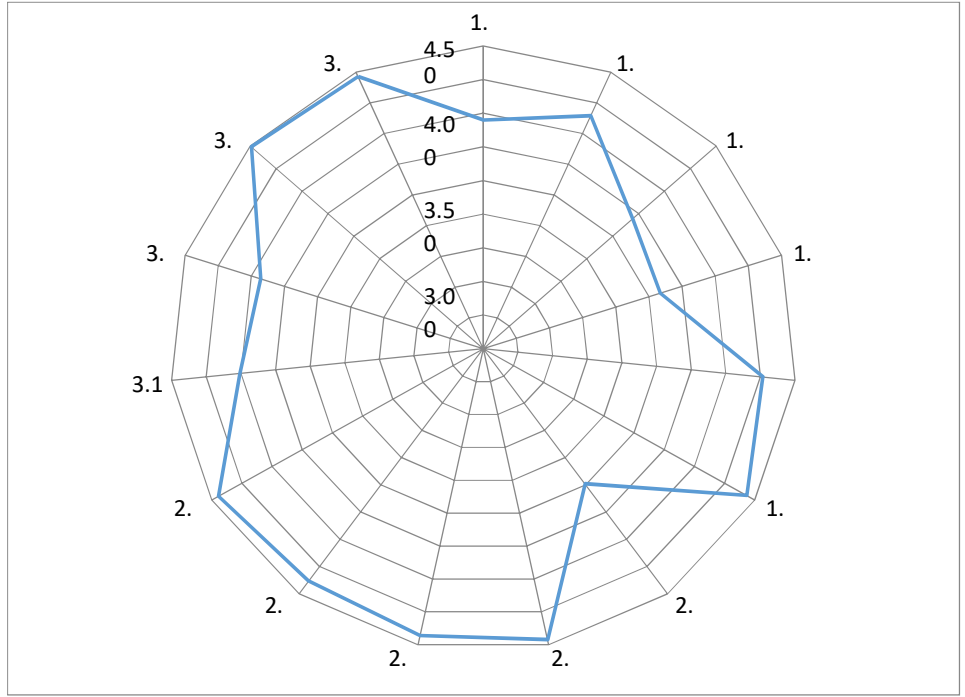


Fig. 7.2.1 Survey results of GSCM practices

**7.2.2 Performance characteristics of GSCM**

The plot in fig. 8.2.2 displays the mean values of all GSCM practice measurement items against the question numbers. GSCM performance dimensions are consistently ranked relatively high, with mean values falling within the 3.00 to 4.50 ranges. The lowest mean value of 2.48 is assigned to "decrement in cost of materials purchase," indicating a slight decrease in the cost of materials purchase. It's clear that GSCM is beneficial in the long run, and if the Green trend in Supply Chain Management continues, there will be a significant decrease in the cost of materials purchase. Additionally, there has been a relatively significant increase in training costs, with a mean value of 4.48. This indicates that effort and investment are required for training personnel to create awareness about GSCM and implement them in their department. These findings are evident from Fig.8.2.2



**Fig. 7.2.2 Survey results of GSCM performance**

**7.2.3 GSCM drives**

The upstream industry is under significant pressure to adopt green supply chain management (GSCM), with mean values exceeding 4.20 for all three drivers. The need to establish a global presence and compete with other industries in terms of environmental strategies tops the list, with mean values of 4.33 and 4.27 respectively. It's natural for industries to pursue profits, which come from the market and customers. To become a global brand, one must outcompete rivals. The driver "Scarcity of Resources, Higher waste generation & Waste disposal problem" scored the lowest mean value of 2.58. This indicates that, currently, resources are not a major issue. However, it's important to highlight that if waste continues to be generated at the current rate, resource scarcity will likely become a key driver for implementing green strategies in the near future. These survey results are depicted in Fig. 4.3.

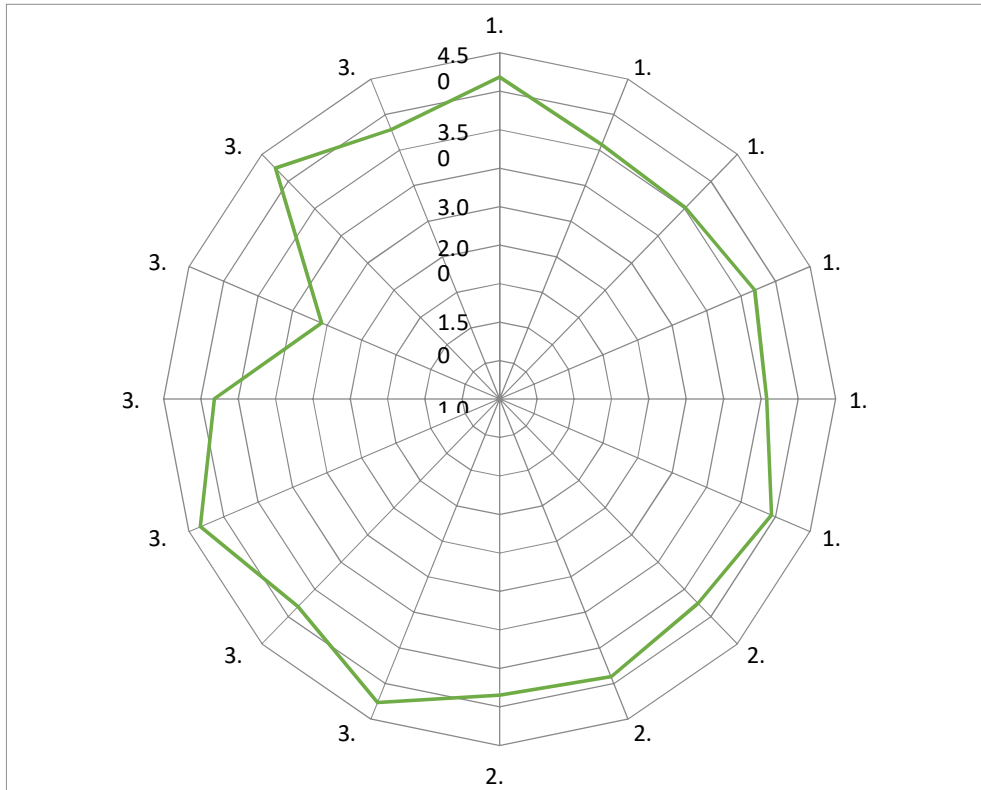


Fig. 7.2.3 Survey results of GSCM drives

## 8. Conclusion

After researching the environmental impact of industries, the study focused on implementing Green Supply Chain Management (GSCM) in Indian industries, particularly in the upstream sector. A leading upstream industry engaged in exploring oil and natural gasses was chosen as the subject. A reliable questionnaire survey was conducted to gather insights from different departments, identifying common barriers to GSCM adoption. Additionally, an algorithm was developed to automate green purchasing processes, potentially integrating into the SAP system.

To effectively adopt GSCM, it's essential to improve supplier relations, raise employee awareness of environmental impacts, and implement the following:

1. Regular disposal of non-moving inventories to minimize carrying costs.
2. Introduction of a reverse logistics system for surplus spare parts.
3. Dissemination of GSCM knowledge to promote eco-friendly products.
4. Establishment of a dedicated team to manage waste and enhance reverse logistics efficiency.
5. Launching of campaigns to encourage the 3Rs (Reuse, Recycle, and Remanufacture).
6. Training of skilled workers and recognition of teamwork in reverse logistics.
7. Recommendation of eco-design and environmental protection strategies to suppliers.
8. Promotion of dematerialized services to reduce environmental impact.

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