

Assessment of the Methods for the Implementation of Green Supply Chain Management in Industries

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Abstract

The generations hand over the resources and the environment of the earth to its future generation for utilization and the harnessing of the resources but over the years the under the pretext of development and the greed to earn more and in lesser time has made the mankind destroy the beautiful earth. However, efforts can be made following the Green Supply Chain Management approach so that that the production and the service activities go on as usual with least damage to the environment .In this
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1. Introduction

The human race has an insatiable appetite for the growth and the development and it is lured by the comfort accompanying it but has been selfish enough not to look beyond the narrow window of greed and selfishness and in the run up to self satisfaction it has been the main cause for the depletion of the forest cover, soil erosion, change of weather cycle, climatic turbulence and many man-made natural disasters. The human beings have tried to give an excuse for every of its mistake which is destroying the environment and making life difficult to sustain.

The need of the hour is that the human beings should adopt the practices which are not necessary for the short term gains but the long term benefits.

The industries are the workhorses which churn out the appetizers of the human beings and they further increase its appetite. The lure of producing more at a lesser time has always captivated the human minds thus resulting in the neglect of the safety

paper the authors have made efforts to understand Green Supply Chain Management and the approach to be adopted to implement it with an aim of reducing the adverse effect of the production processes used by the manufacturing industries. The effort is also made to emphasize upon the long term benefits of a Green Manufacturing process and also the important role which the industries can play in preventing further damage to the environment.

norms and the damage to the environment. The topline and the bottomline have become the matter of prime concern and the planning and the execution of the industrial policies of the production units circumvents around them. The atmospheric and the ground resources provided by the nature has been considered by the human beings to be perennially of a good quality and their inane production activities will not bring any harm to them but the same has been belied which the warming of the globe, the melting of the glaciers and the rising of the sea level has proven.

The fact remains that the production activities cannot be stopped or curtailed but sincere efforts should be made to identify the elements responsible for the degradation of the environment and ensure the implementation and the maintenance of sustainable technologies.

Self realization has become the matter of debate where the industry is vocal upon the implementation of the sustainable technologies but refrains from implementing it with sincerity and purpose.

The state of Chhattisgarh which has been carved out of the erstwhile state of Madhya Pradesh on the 1st of November 2000. is on the path of development across all cross-sections of the activities, which also includes the industrial activities. The nature has bestowed Chhattisgarh with abundant natural resources in the form of coal, iron ore, limestone, dolomite, bauxite, gold, diamond etc. The abundant ability of iron ore has resulted in the functioning of more than a hundred Cost and complexity are perceived as the biggest barriers to implementing Green Supply Chain Management, which highlights the need for cost effective and easy to implement solutions. Brand building is one of the top incentives for Green Supply Chain Management, highlighting the importance of public perception of how companies operate. Green supply refers to the way in which innovations in supply chain management and industrial purchasing may be considered in the context of the environment. "Sustainable Development" is the key concept as discussed in 1992 Earth Summit in Rio, in this, governments and other international organizations decided to take useful measures to protect environment for long term economic development.[1]

The researchers in GSCM have started to apply a number of organizational theories in explicit ways. Some of the research has also helped to further understand and strengthen some of these theories. The number of observations can make this initial review and integration of the literature. First, the organizational theory provides a very valuable source of theoretical underpinnings for investigating and furthering research in GSCM. Second, there are ample opportunities for future research and investigation with theories that have already been applied. Significant questions still exist that require investigation. Another one is also an ample room for new theories examining the GSCM management, introduction, and diffusion that have not seen significant investigations. Next is, much of the literature on the applications and uses of theory in GSCM research has been relatively recent.[2]

The traditional supply chain comprises of five parts: raw material, industry, distribution, consumer, and waste. Each of the links in the supply chain can be a reason for pollution, waste, and other hazards to the environment. Regarding raw materials, a company may use environmentally harmful materials such as lead. However, organizations can put pressures on suppliers to use more environmentally friendly materials and processes. Green supply chains aims at confining the wastes within the industrial system in order to

steel industries .The presence of the steel industries is a source of revenue and job generation but they have also become the reason for the active contribution towards the degradation of the environmental condition by way of introducing substances, generated out of the production activities, into the air which leads to it becoming of unacceptable standard for the human beings and the animals alike.

conserve energy and prevent the dissipation of dangerous materials into the environment. It recognizes the disproportionate environmental impact of supply chain processes within an organization. Conventional and green chains differ in several ways. First, conventional chains often concentrate on economic objectives and values, while green chains give significant considerations to ecological causes also. [3]

It is generally acknowledged that circular economy refers to the generic terms for the reducing, reusing and recycling activities in such process as production, circulation and consumption. Circular economy is essentially an ecological economy, which requires human economic activities in line with 3R principle, namely Reduce, Reuse and Recycle. Reduce means reducing the amount of substance in the process of production and consumption; Reuse is involved in extending the time intensity of product and service; Green supply chain management is involved in the following three problems: supply chain management problem, environmental protection problem, resources optimization problem. Green supply chain management is the crossover and integration of the three parts. However, traditional supply chain management rarely deals with environmental protection and resource conservation.

The difference of the benefits gained: Traditionally, the only goal for the enterprise is to pursue the maximal economic benefits. In order to pursue its own interests, the enterprise will not undertake the corresponding responsibility at the expense of external interests

To make products and services green the businesses need to focus on bringing the green in various aspects such as:

1. Raw Material
2. Manufacturing
3. Product Innovations /development
4. Alternative Ingredients
5. Supply Chain
6. Packaging

Green manufacturing 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. Green manufacturing can lead to lower raw material costs, production efficiency gains, reduced environmental and occupational safety expenses, and improved corporate image.[4]

2. Methodology

The purpose of this research investigation is to address “how” & “why” research questions.

The intent is to investigate specific issues with regard to the level of implementation of supply chain management practices in Indian industries. For this the following steps were carried out.

- A. Development of Survey Questionnaire based on literature review.
- B. Refinement of Survey questionnaire from Industrial experts & academicians.
- C. Mailing the survey questionnaire to different Industries in India.
- D. Multiple case study approach.
- E. Analysis of survey & case study data.
- F. Deriving conclusion based on results.[5]

Twelve different variables were introduced according to the methodology of structural equation modeling are described as follows: Environmental regulations, market pressure, suppliers and internal drivers are four exogenous latent variables used in this study. Environmental regulation reflects factors like regional laws, exporting country's regulations etc. The exogenous latent variables of market are reflected in exports, sales, domestic consumers' awareness towards environmental issues etc. Items like cost of hazardous materials, environment friendly goods and green packages are revealed in internal drivers.

The endogenous latent variables are divided into interpretative and outcome variables. Internal management, Green supply, cooperation with customers, investment recovery, eco-design and reverse logistics are variables which are defined as interpretative endogenous latent variables. Outcome endogenous latent variables include economic performance, environmental performance and operational performance.[6] In order to aid GSCM evaluation, this study finds practical application of the hybrid. The Interpretive Structural Modeling (ISM) is to evaluate the subjective judgment and interactive relations

among the criteria into a hierarchical structure and applies fuzzy set theory to appropriately express human's judgment in proposed criteria, the interactive relations present the interdependence among criteria. Moreover, the traditional statistical approach is not well-suited for evaluating these dependence relations. [7]

As part of the exploratory stage of the research, in order to test the proposition, the data collected by ways of a questionnaire survey and through two rounds of data collection was used. The questionnaire includes 45 items of GSCM practices targeting at the five categories from the precedent research of Zhu and Sarkis (2008). The respondents were also required to answer the questions according to the Likert-scale standard: 1=strongly disagree, 2=disagree, 3=neutral; 4=agree, and 5=strongly agree. With regards to the analysis approach, a one-way analysis of variance (ANOVA) was employed to identify the differences that exist within the GSCM practices among the four industrial sectors.

The ANOVA test verified that some different industrial sector of SMEs differ in their GSCM practices [8]

Environment technologies are taken as preventing the pollution in forward supply chain, controlling pollution in reverse supply chain and technologies that improves the environmental performance in integrated supply chain. In the study, key criterion of technology selection is evaluated with Fuzzy AHP (Analytical Hierarchy Process); their priorities are defined and by using these priorities technology selection is made. Having a significance part in company's total cost, proper and suitable selection of technology investment is emphases.

Green Supply Chain Management (GSCM) has its roots in both environment management and supply chain management literature. Adding the “green” component to supply chain management involves addressing the influence and relationships between supply chain management and the natural environment. Similar to the concept of supply chain management, the boundary of GSCM is dependent on the goal of the investigator.

Environmental technologies in manufacturing include implementing environmental audits of manufacturing facilities, reformulating products to lower their environmental impacts, covering open process tanks to reduce evaporation, training employees to prevent process leaks, and cleaning up underground storage tanks that leak.

As being a close-loop supply chain, green supply chain is evaluated under two parts; forward and reverse supply chain.

Analytic Hierarchy Process (AHP) is one of the well-known multi-criteria decision making techniques that was first proposed by Saaty (1980). Although the classical AHP includes the opinions of experts and makes a multiple criteria evaluation, it is not capable of reflecting human's vague thoughts. By integrating fuzziness in AHP, prejudice or bias of the decision makers can be eliminated.

Used in a fuzzy environment for decision-making, the fuzzy AHP is one of the multi-criteria decision-making methods. AHP is used for selecting the best environmental technology from three different alternatives. For determining the criteria, interviews were conducted with the environmental experts of the company, and questionnaires were used for the evaluation process. The fuzzy AHP method can deal with the ratings of both quantitative as well as qualitative criteria and select the suitable software effectively. It's seen that the fuzzy AHP method may be a useful additional tool for the problem of technology selection in environment management systems.[9]

2.1 The Fuzzy-AHP Process

Fuzzy AHP is an extension of synthesized AHP method where the fuzziness of the decision making is considered. Initially AHP and FAHP scales are defined for pair wise comparison matrices and then measurement Indicators are defined Level I, level II pair wise comparison matrices are established for obtaining the priority weights these alternatives. The steps of the Fuzzy AHP methodology are summarized as follows.

- Define Fuzzy scale(triangular fuzzy)
- The procedure similar to the AHP process
- Calculate pair wise comparison matrices.
- Rank the strategies

By using the FAHP the global weight priorities are developed for sixteen measurement indicators. The global weight for GP,GM,CS, EM are calculated by FAHP and tabulated.

2.2 Fuzzy TOPSIS Approach

The TOPSIS (technique for order performance by similarity to ideal solution) is a solution to MCDM problem. According to this technique, the best alternative would be the one that is nearest to the positive ideal solution (PIS) and farthest from the negative ideal solution (NIS). The PIS is a solution that maximizes the benefit criteria and minimizes the cost criteria and the NIS is vice versa. This paper extends TOPSIS to the fuzzy environment,

which was introduced by Zadeh (1965) to map linguistic variables to numerical variables.

2.3 TOPSIS Methodology

Technique for Order of Preference by Similarity to Ideal Solution(TOPSIS). In this paper the Green supply chain strategies are defined by AHP and TOPSIS. This method consists of three types of attributes

- Qualitative benefits attributes
- Quantitative attributes benefits
- Cost attributes criteria

TOPSIS assumes that we have m alternatives (options) and n attributes and we have the score of each option with respect to each criterion [10]

A lot of research has been on the GSCM, though it is still difficult to implement and take economic benefits of the same. The foremost reason is the existence of different types of forces in the SC environment. This article in particular discusses three types of forces viz. stimuli (driving forces), enablers (green measures or initiatives) and inhibitor (the factors that inhibit or impede the progress of GSC), and describe a conceptual framework to implement GSC through various steps.

The rapid growth in industrialization has led to an increase in production and consumption of various goods. As a result, there has been considerable amount of damage to the society and environment including depletion of natural resources, wastes generation during production, rising transport emissions and congestion, non-disposability of goods at the end of their product life-cycle, and stressful work environment for employees. Companies do not often change their business processes that allow inefficient processes to continue unabated causing unnecessary waste and pollution. There are a wide range of factors that can persuade an organization to extend sustainability management criteria and practices to its SC. In sustainable SC, these factors are called as stimuli are the elements which may be embodied in the form of a sustainability needs, requirements, changes, challenges, issues etc. and may be related to any segment of the SC. The stimuli may force the partners of the SC to take some actions to respond to changing business environment in order to streamline sustainability operations or processes of the SC. [11]

2.4 Fuzzy Analytic Hierarchy Process (FAHP)

A procedure with aforementioned functionality must be develop to cope with uncertain

environment of construction projects and lack of efficient measuring tool for sustainability of supply chain system. The fuzzy analytic hierarchy process (FAHP) is adopted to determine the relative weights linking the construct of GSCM. This study is to apply fuzzy concepts and aggregate this powerful tool with Artificial Neural Network concepts in favor of gaining ANFIS to handle the imprecise nature of attributes for associated concepts of sustainability. ANFIS is considered as an efficient tool for development and surveying of the novel procedure. The combination between FAHP and ANFIS has never been reported in literature before. The aggregation of current approaches can be criticized as they haven't considered the impact of enablers in assessing sustainability in supply chains and also the scale used to aggregate the performance of the construct of GSCM has the limitations. The first limitation is that the techniques do not consider the ambiguity and multi possibility associated with mapping of individual judgment to a number.

The second limitation is the subjective judgment, selection and preference of evaluators having a significant influence on these methods. Because of the fact that the qualitative and ambiguous attributes are linked to sustainability assessment, most measures are described subjectively using linguistic terms, and cannot be handled effectively using conventional assessment approaches. The fuzzy logic provides an effective means of handling problems involving imprecise and vague phenomena. Fuzzy concepts enable assessors to use linguistic terms to assess indicators in natural language expressions, and each linguistic term can be associated with a membership function. In addition, fuzzy logic has generally found significant applications in management decisions.

This section provides an overview of a fuzzy analytic hierarchy process (FAHP) for addressing uncertainty in the particular assessment. The fuzzy pair-wise comparison considers favorable and adverse effects of uncertainty. Fuzzy numbers are used to present uncertainty involved in the pair-wise comparisons by using parameters l and u to present favorable and adverse effects of uncertainty, respectively.

FAHP, which is one of the effective approaches used to address the uncertainty and vagueness from the subjective perception and the experience of humans in decision-making process.

The neuro-fuzzy system attempts to model the uncertainty in the factor assessments, accounting

for their qualitative nature. A combination of classic stochastic simulations and fuzzy logic operations on the ANN inputs as a supplement to artificial neural network is employed. Artificial Neural Networks (ANN) has the capability of self-learning, while fuzzy logic inference system (FLIS) is capable of dealing with fuzzy language information and simulating judgment and decision making of the human brain. It is currently the research focus to combine ANN with FLIS to produce fuzzy network system. ANFIS is an example of such a readily available system, which uses ANN to accomplish fuzzification, fuzzy inference and defuzzification of a fuzzy system.[12]

DEMATEL (Decision Making Trial and Evaluation Laboratory) is one the multi criteria decision making instruments and has the ability to convert the qualitative designs to the quantitative analysis (Lee *et al*, 2010). The aim of DEMATEL is to change the relation between criterions, causal dimensions from a complex system to an understandable structural model of that system (Dalalah *et al*, 2011)[13]

2.5 Reliability Analysis

Reliability is defined as the extent to which a questionnaire, observation or any measurement procedure produces the same results on repeated trials. In short, it is the stability or consistency of scores over time or across raters (Carmines and Zeller, 1979). Internal consistency analysis is carried out to measure the reliability of the Reliability is defined as the extent to which a questionnaire, observation or any measurement procedure produces the same results on repeated trials. In short, it is the stability or consistency of scores over time or across raters (Carmines and Zeller, 1979). Internal consistency analysis is carried out to measure the reliability of the items under each critical factor using Cronbach's alpha. Cronbach alpha was used to estimate the proportion of variance that has been systematic or consistent in a set of test scores. It can range from 00.0 (if no variance is consistent) to 1.00 (if all variance is consistent) with all values between 00.0 and 1.00 also being possible. The acceptable value for Cronbach's alpha is greater than 0.6.[14]

Varieties of reports fall under the rubric of sustainability report. Only a very small percentage of companies (1%) incorporate sustainability reporting in the organization's annual report. Others choose various names to separate from annual reports: Sustainability Report (44%), Corporate Social Responsibility Report (25%),

Corporate Responsibility Report (18%), Corporate Citizenship Report (6%) and Environmental Report (6%) [15]

Companies should review each process along the supply chain to identify if a more environmentally sound approach will help cure the inefficiencies that occur. Many companies that have been through this exercise have identified processes where raw materials were wasted; resources underutilized and unnecessary energy used due to inefficient equipment. Successful supply chain management is an iterative process that evaluates the cost/benefit trade-offs of operational components. The supply chain strategy constitutes the actual operations of that organization and the extended supply chain to meet a specific supply chain objective. [16]

2.6 Entity of analysis

A GSC consists of various entities such as the manufacturer, supplier, retailer, distributor and the customer. Entity of analysis represents the focal entity under analysis in a given research article. These entities might be either from inbound side or outbound side of SC or as a whole. The entity of analysis can be identified based on the general theme of the article apart from a cursory reading of the title, abstract, keywords and full text/body of the paper. By doing this exercise the practical aspect of the research can be recorded. [17]

A simple and accurate definition of SEM is hard to find. SEM takes a confirmatory (hypothesis testing) approach to the multivariate analysis of a structural theory, one that stipulates causal relations among multiple variables. The causal pattern of inter-variable relations within the theory is specified a priori. The goal is to determine whether a hypothesized theoretical model is consistent with the data collected to reflect this theory to be called as default model. The consistency is evaluated through model-data fit, which indicates the extent to which the postulated network of relations among variables is plausible.

SEM is a large sample technique (usually $n > 200$; e.g. Hair et al., 2009) and the sample size required is somewhat dependent on model complexity, the estimation method used, and the distributional characteristics of observed variables that involve the evaluation of two identified models using 'positive definite sample moment matrix': a measurement model and a structural (path) model. If the sample moment matrix fails to be positive definite or remains unidentified, then path analysis (PA) can be considered as a special case of SEM in which only identified relations as measurement part and/or structural part among observed variables are modelled. [18]

Yasir, et al. revealed that sustainable or Green Supply Chain Management (SSCM) has implications for environmental concerns, declining profitability, corporate social responsibility and intense global competition. (SSCM) aims at using environment friendly raw material, green production processes that and using distribution packaging that is also environment friendly. Such company's final products are recycled through reverse logistics to gain sustainable development [19]

3. Conclusion

It has been found that it has become necessary to adopt the GSCM practices and it is done differently in different industries. The literature survey carried above indicates the way in the Green Supply Chain Management can be carried out and is specific to the condition. However, the objective remains that of protecting the environment and also giving boost to the manufacturing activities.

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References

- [1] Nimawat Dheeraj and Namdev Vishal, An Overview of Green Supply Chain Management in India, International Science Congress Association, Res.J.Recent Sci., ISSN 2277-2502, Vol. 1(6), 77-82 (2012)
- [2] Balon Virendra, et al , A Performance Measurement of Green Supply Chain Management in Indian Auto Industries, National Conference on Emerging Challenges for Sustainable Business ,ISBN - 978-93-81583-46-3(2012)
- [3] Johnny C. Ho, Opportunities In Green Supply Chain Management , The Coastal Business Journal : Volume 8, Number 1 (2009)
- [4] Bhateja Ashish ,et al , Study of the Critical factor Finding's regarding evaluation of Green supply chain Performance of Indian Scenario for Manufacturing Sector, IJCEM International Journal of Computational Engineering & Management, Vol. 15 Issue 1,ISSN (Online): 2230-7893(2012)
- [5] Shrihari Upasani, Emerging Supply Chain Management Practices In Indian Manufacturing Industries, International Journal of Research in IT & Management, IJRIM Volume 2, Issue 2 (ISSN 2231-4334) (2012)
- [6] Pandya Amit R. & Mavani Pratik M., An Empirical Study Of Green Supply Chain Management Drivers, Practices And Performances With Reference To The

Pharmaceutical Industry Of Ankleshwar (Gujarat),, I.J.E.M.S., VOL.3(3):339-355 , ISSN 2229-600X 339(2012)

[7] Ming-Lang Tseng, Yong Geng , Evaluating the green supply chain management using life cycle assessment approach in uncertainty, WSEAS Transactions On Environment And Development ,(2012)

[8] Xiangmeng Huang et al, Green Supply Chain Management Practices: A Sectoral Investigation into Manufacturing SMEs in China, International Conference on Economics, Business and Marketing Management, IPEDR Vol.29 ,(2012)

[9] Ömür Tosun and Fahriye Uysal, Linking Green supply chain management with environmental Technologies and an application of technology selection , 3rd International Symposium on Sustainable Development, Sarajevo,(2012)

[10] Muralidhar.P et al, Evaluation of Green Supply Chain Management Strategies Using Fuzzy AHP and TOPSIS , IOSR Journal of Engineering, Vol. 2(4), pp: 824-830 ISSN: 2250-3021(2012)

[11] More Dileep and Mitra Simanti , Identification of Stimuli, Enablers and Inhibitors of Green Supply Chain Management and an Analysis of Their Dynamics(2012)

[12] Thoetida Thipparat, Evaluation of Construction Green Supply Chain Management, IPEDR vol.14, IACSIT Press, Singapore (2011)

[13] Alireza Irajpour, Mahdi Golsefid-Alavi, Mehdi Hajimirza, Nasrin Soleimani-Nezhad, Evaluation of the Most Effective Criteria in Green Supply Chain , 6: 474 (2017)

Management in Automotive Industries Using the Fuzzy DEMATEL Method, Journal of Basic and Applied Scientific Research, 2(9)8952-8961(2012)

[14] Toke. L.K. et al , An empirical study of green supply chain management in Indian perspective, Int. Journal of Applied Sciences and Engineering Research, Vol. 1, No. 2(2012)

[15] John Wu, Steve Dunn , Howard Forman , A Study on Green Supply Chain Management Practices among Large Global Corporations , Journal of Supply Chain and Operations Management, Volume 10, Number 1 (2012)

[16] Kushwaha Gyaneshwar Singh, Sustainable Development Through Strategic Green Supply Chain Management, I.J.E.M.S., VOL. 1(1): 7-11 ISSN 2229-600X, I.J.E.M.S., VOL. 1(1): 7-11 ISSN 2229-600X(2012)

[17] Pratiksha Singh et al, An Era Of Changing The Environmental Condition By Green Supply Chain Management , International Journal of Research – Granthaalayah, Vol.5 (Iss.1), ISSN- 2350-0530(O), ISSN- 2394-3629(P) (2017)

[18] R.P. Mohanty and Anand Prakash , Green supply chain management practices in India: a confirmatory empirical study, Production & Manufacturing Research, ISSN: (Print) 2169-3277 (Online)438-456 (2014)

[19] Chaturvedi S, and Talesara D ,A Study of Green Supply Chain Management (GSCM) Practices Adopted by the Textile Industry of Pali District, Rajasthan., International Journal of Economics and Management Science,