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Prioritization and Analysis of Different Factors of GSCM: A Small Scale Cotton Industry in India

Santosh Patidar

Assistant Professor, Department of Mechanical Engineering, Shri Vaishnav Vidyapeeth Vishwavidyalaya, Indore, Madhya Pradesh, India. Email: santoshpatidar102@gmail.com

Abstract

This paper aimed to define priorities for green practices that are observed in supply chain in cotton industry. Green Supply Chain Management (GSCM) is recent permutation for enhancing Supply Chain Efficiency. The "Green" component stresses upon the need of environment-friendly supply chain by emphasis on the reduction of waste. The requirement of GSCM in India has increased due to several factors including environment, corporate responsibility and computation. The focus of this study is on the area of prioritization of factors of Green Supply Chain Management for increasing eco-efficiency and eco-friendly performance of cotton industry using TOPSIS MCDM technique. Various factors of supply chain are available in different literature. Factors of supply chain can improve the performance of organization. The goal of the study is the selection of best factors, which can affect the supply chain and improve the performance of the cotton industry. For selecting appropriate factors, it is found that some Multi Criteria Decision Making Methods must be used due to their ability of converting a complex problem to a paired-wise comparison. These methods are used to provide a hierarchy-based relationship between goal of the research which consider criteria, sub-criteria and alternatives.

Keywords: Green Supply Chain Management; MCDM; Fuzzy Criteria

Introduction

In past a few decades air pollution has risen in India and it is much higher in industrial areas. Green supply chain plays an important role in the smooth and safe working of an organization. It works in the support of environmental sustainability. GSCM gives competitive edge and improves the financial status of an organization. Active implementation of GSCM in an organization leads to reduction in waste, reduction in environmental pollution, optimization of resource utilization, stress free working environment and reduction in costs. Designing and implementation of proper policies are required to address the different environmental issues. It leads to sustainability and the clear understanding of the hurdles and complications of the system (Narkhede & Gardas, 2013).

As the generic term of supply chain management (SCM), is consisting of procurement, storage, transportation and distribution activities with the objective of creating net value, building a competitive infrastructure, leveraging worldwide logistics, synchronizing supply with demand and measuring performance globally (Golinska & Romano, 2012). GSCM implementation is also based on several approaches like web-based technology, supplier-based technology, etc. These approaches are dependent on nine factors and three types of alternatives. There exists a vast scope in developing countries like India to adopt GSCM practices and achieve organizational excellence. By examining the Indian small, medium and large organizations, who have already adopted an Implemented GSCM practices (Bag, 2012).

Literature Review

Field of supply chain management is full of literature, directly or indirectly showing development in the field of SCM. Some of the work of different author has been chossen to explain the proper meaning of SCM.

The growing significance of GSCM is motivated mainly by the mounting deterioration of the environment. The waste and discharges caused by the supply chain have become one of the foremost sources of stern environmental problems including global warming and acid rain (Sharma, 2013).

Zigiaris (2000) in his research work titled as "Dessimination of innovation and knowledge management

technique" explore the SCM in the following manner, "Overall activity started from raw material phase and to moving goods and up to the end user".

Bernard et al. (1990) define SCM as "Delivery of the improved customer and economic characteristics through overlapping management in the line of tangible items and intangible information from origin to the phase of usable items."

Evolution of GSCM from SCM

The concepts of SCM was introduced by Oliver and Webber (1982). Concept of chain was first of all introduced by Porter in his work entitled as "Competitive advantage" which evaluate the relationship between the primary and secondary activities like operation, outboard, logistics operation, marketing, sales and services (Vrijhoef & Koskela, 1999).

Jain and Sharma (2012) in there study have explained and discuss the benefits of GSCM in small, medium scale industry and also opportunities for business to adopt more environmental friendly operations.

How to Evaluate the Green Supply Chain Management (GSCM)

Green supply refers to the way in which supply chain management is considered in the context of the environment. Environmental supply chain management of the activities in which reduction, recycling, reuse and the substitution of materials is considered.

GSCM =

Green purchasing +Green manufacturing/materials management + Green distribution/marketing + Reverse logistics.

Methodology

Going through the different research material, find and observed the phase transformation of SCM to GSCM. Further research work shows the different approaches to implement the GSCM. Therefore, the main aim of research study is to identify the different criteria affecting the GSCM and to prioritize the different alternatives available in the field of GSCM. Different literature related to SCM, GSCM are selected and reviewed deeply, the details of important text described in the literature review. For any decision-making process, there is requirement of some criteria and alternatives. Criteria are the important factors which directly or indirectly are related to the research problems, whereas alternatives are the list of best solutions available. From the review of research paper, selected nine different criteria and alternatives from the field of GSCM. They are as follow.

Different Criteria:

C1: Retaining Energy	C2: Contiguous Design for Environment
C3: Minimization of Waste	C4: Reuse of Precarious Waste
C5: Green Concepts alertness	C6: Sharing Regarding Environmental Reg.
C7: Right Mode of Transport	

Different Alternatives are:

A1 Supplier Based System

A2 Web Based Technology

A3 Advance Manufacturing System

A questionnaire that measures attitudes is constructed as an attitude scale having scale measuring the reviews of experts in the field of GSCM. A sample questionnaire is presented below:

Linguistics Term for Criteria	Linguistics Term for Alternatives	Triangular Fuzzy Number
Very Low	Very Poor	(1,1,3)
Low	Poor	(1,1,5)
Medium	Fair	(3,5,7)
High	Good	(5,7,9)
Very High	Very Good	(7,9,9)

An intensive literature survey is important part of scientific investigation. Keeping this point in view, I studied and analyzed fundamental theories and some important previous researches based on selected problem and interacted with some of experienced researchers working in the similar area. In this process, a systematic questionnaire is prepared which includes questions based on GSCM to be investigated.

Surveys and meetings can be utilized to gather information, which is not specifically noticeable, they are more helpful to use than direct perception when utilized for gathering information on recognizable conduct. The upsides of utilizing surveys are as per the following:

- Can be given to extensive gatherings.
- Respondents can finish the poll at their own comfort, answer questions out of request, skip questions, take

a few sessions to answer the inquiries, and write in remarks. A questionnaire that measures attitudes is constructed as an attitude scale having scale measuring the reviews of experts in the field of GSCM.

Fuzzy Linguistics Scale

Table 1: Linguistics Terms for the Seven Criteria

Notation for Alternatives	Linguistics Ratings for the Seven Criteria		
C1	L	M	L
C2	VH	H	VH
C3	VH	M	H
C4	H	VH	H
C5	VH	H	VH
C6	H	M	H
C7	H	M	M

Table 2: Aggregate Fuzzy Criteria Weight

Criteria	D1	D2	D3	Aggregate Fuzzy Weight
C1	(1,3,5)	(3,5,7)	(1,3,5)	(1,3.67,7)
C2	(7,9,9)	(5,7,9)	(7,9,9)	(5,8.33,9)
C3	(7,9,9)	(3,5,7)	(5,7,9)	(3,7,9)
C4	(5,7,9)	(7,9,9)	(5,7,9)	(5,7.67,9)
C5	(7,9,9)	(5,7,9)	(7,9,9)	(5,8.33,9)
C6	(5,7,9)	(3,5,7)	(5,7,9)	(3,6.33,9)
C7	(5,7,9)	(3,5,7)	(3,5,7)	(3,5.67,9)

To calculate the aggregate Fuzzy weight for alternatives. As an example: collective rating of alternatives A_2 for criteria C_2 by considering the scores suggested by a team of three decisions makers is calculated as follow:-

$$\tilde{x} = (l_{ij}, m_{ij,} u_{ij}) \text{ where } l_{ij} = \min_k \{7,5,7\}\ m_{ij} = u_{ij} = \max_k \{9,9,9\}$$

$$\tilde{x} = \{5, 8.33, 9\} \ldots \quad (1)$$

Similarly calculate the aggregate rating for remaining alternatives with respect to corresponding criteria.

Table 3: Aggregate Fuzzy Ratings for Alternatives

Criteria	Alternatives		
	A1	A2	A3
C1	(3,5.67,9)	(3,5.66,9)	(5,7.66,9)
C2	(3,6.33,9)	(5,8.33,9)	(1,4.33,7)
C3	(3,6.33,9)	(3,5.66,7)	(5,8.33,9)
C4	(3,5.66,9)	(1,3.67,7)	(3,6.33,9)
C5	(5,8.33,9)	(5,7.67,9)	(1,4.33,7)
C6	(1,3.66,7)	(5,8.33,9)	(1,4.33,7)
C7	(3,5.66,9)	(3,5.66,9)	(1,4.33,7)

Table 4: Normalized Fuzzy Decision Matrix for Alternatives

Criteria	Alternatives		
	A1	A2	A3
C1	(0.33,0.63,1)	(0.33,0.63,1)	(0.56,0.85,1)
C2	(0.33,0.70,1)	(0.56,0.93,1)	(0.11,0.48,0.78)
C3	(0.33,0.70,1)	(0.33,0.63,1)	(0.56,0.93,1)
C4	(0.33,0.63,1)	(0.11,0.41,0.78)	(0.33,0.63,1)
C5	(0.56,0.93,1)	(0.56,0.85,1)	(0.11,0.48,0.78)
C6	(0.11,0.41,0.78)	(0.56,0.93,1)	(0.11,0.48,0.78)
C7	(0.33,0.63,1)	(0.33,0.63,1)	(0.11,0.48,0.78)

Table 5: Normalized Fuzzy Weight for Alternative, FPIS, FNIS

Criteria	Alternatives			FNIS (A-)	FPIS (A+)
	A1	A2	A3		
C1	(0.33,2.31,7)	(0.33,2.31,7)	(0.56,3.12,7)	0.33	7.00
C2	(1.67,5.86,9)	(2.78,7.72,9)	(0.56,4.01,7)	0.56	9.00
C3	(1,4.93,9)	(1,4.41,9)	(1.67,6.48,9)	1.00	9.00
C4	(1.67,4.83,9)	(0.56,3.12,7)	(1.67,5.40,9)	0.56	9.00
C5	(2.78,7.72,9)	(2.78,7.10,9)	(0.56,4.01,7)	0.56	9.00
C6	(0.33,2.58,7)	(1.67,5.86,9)	(0.33,3.05 ,7)	0.33	9.00
C7	(1,3.57,9)	(1,3.57,9)	(0.33,2.73,7)	0.33	9.00

Further, Fuzzy Negative Ideal Solution (FNIS) and Fuzzy Positive Ideal Solution (FPIS) are calculated. Then determine the distance or remoteness of each alternative from the FPIS and FNIS through using a formula stated below:

If we assume two triangular Fuzzy number $\tilde{l} = (l_1, l_2, l_3)$ and $\tilde{m} = (m_1, m_2, m_3)$ then by using the vertex method distance between them is given as

$$d(A_2, A^+) = \sqrt{\{1/3[(l_1-m_1)^2+(l_2-m_2)^2+(l_3-m_3)^2]\}} \ldots\ldots\ldots 3$$

For example, the distance $d_v(A_2, A^+)$ and $d_v(A_2, A^-)$ for alternatives A_2 with respect to criteria C_2 are calculated as follows:

$$d_v(A_2, A^+) = \sqrt{\{1/3[(2.78-9)^2+(7.72-9)^2+(9-9)^2]\}} = 3.668$$

$$d_v(A_2, A^-) = \sqrt{\{1/3[(2.78-0.56)^2+(7.72-0.56)^2+(9-0.56)^2]\}} = 6.723$$

Similarly distances for remaining alternatives are calculated. A summary of calculated distances for each alternative from FPIS and FNIS is given in table:

Distance $d_v(A_i, A^+)$ and $d_v(A_i, A^-)$

Table 6: Fuzzy Positive/Negative Ideal Solution

Criteria	dv(Ai, A-)			dv(Ai, A+)		
	A1	A2	A3	A1	A2	A3
C_1	4.014	4.014	4.174	6.426	6.426	6.051
C_2	5.986	6.723	4.398	4.605	3.668	5.779
C_3	5.676	5.542	6.183	5.183	5.326	4.477
C_4	5.689	4.174	5.846	4.871	6.051	4.718
C_5	6.723	6.503	4.398	3.668	3.756	5.779
C_6	4.062	5.986	4.156	6.333	4.605	6.178
C_7	5.355	5.355	4.090	5.583	5.583	6.283

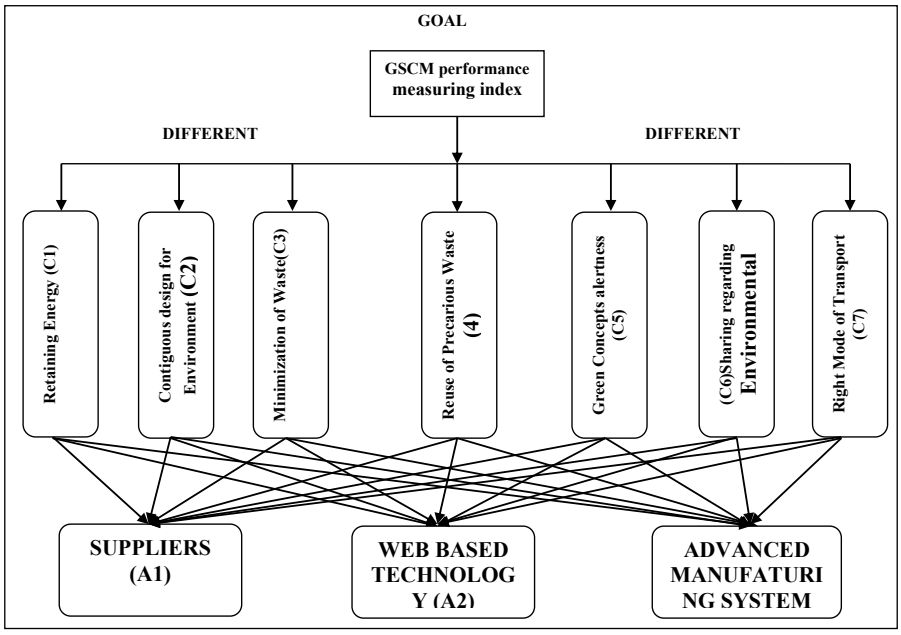


Fig. 1: Hierarchal Relationship Between Different Alternatives of GSCM

Then we calculate the distances $d_i^+$and d_i^- by using above equations. The values of d_i^+ and d_i^- for each of the alternative are shown in table below:

Table 7: Fuzzy positive/Negative Ideal Solution

Criteria	Alternatives		
	A_1	A_2	A_3
d_i^-	37.504	38.297	33.245
d_i^+	36.670	35.415	39.265
CC_i	0.5056	0.5195	0.4585

Results and Discussion

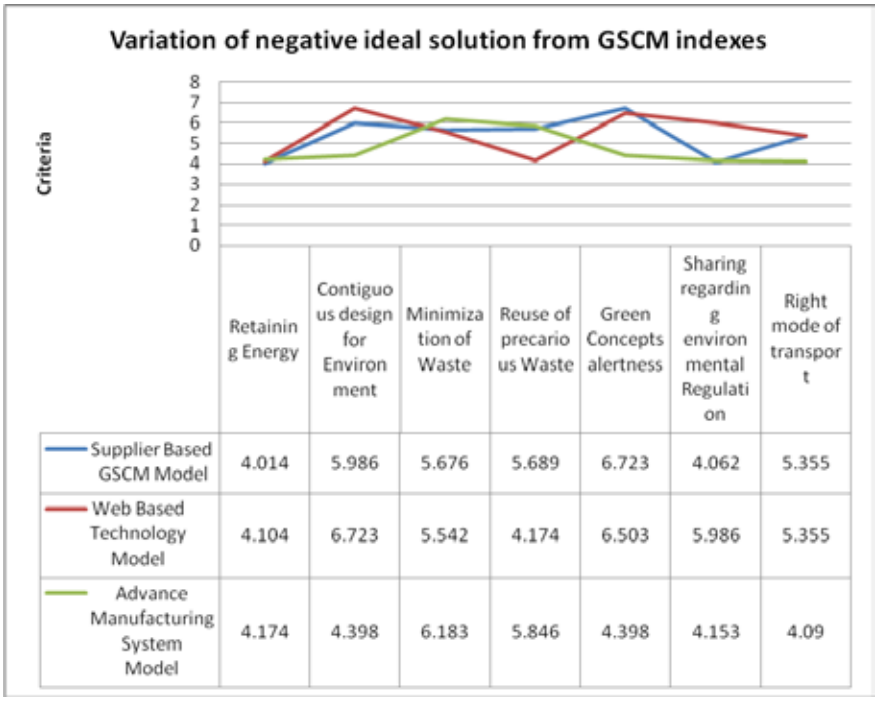
Finally, determine the closeness coefficient of each alternative by using the corresponding values of d_i^+ and d_i^-. For alternative A_1 closeness coefficient CC_i is calculated as:

$CC_i = d_i/(d_i^-+d_i^+) = 37.504/(37.504+36.670) = 0.5056$

Similarly calculate the value of CC_i for alternative A_2 and A_3, values comes 0.5195 and 0.4585 respectively. This part manages the outcomes and results of the examination performed in the zone of green supply network administration. On the basis available criteria and alternatives, the Fuzzy TOPSIS decision-making technique is applied. The variations of positive and negative ideal solution accompanied with the closeness coefficient are presented in the table below:

Table 8: Variation of Negative Ideal Solution from GSCM Indexes

Criteria	$d_v(A_i, A^-)$		
	Suppliers Based GSCM Model (A_1)	**Web Based Technology (A_2)**	**Advance Manufacturing System (A_3)**
Retaining Energy (C_1)	4.014	4.014	4.174
Contiguous design for Environment (C_2)	5.986	6.723	4.398
Minimization of waste (C_3)	5.676	5.542	6.183
Reuse of Precarious Waste (C_4)	5.689	4.174	5.846
Green Concepts Alertness (C_5)	6.723	6.503	4.398
Sharing information regarding environmental regulations (C_6)	4.062	5.986	4.156
Right Mode of Transport (C_7)	5.355	5.355	4.090



Closeness Coefficient Determination

Here we determine the closeness coefficient of each alternative by using the corresponding values positive/ negative ideal solution.

Table 9: Closeness Coefficient of Different Alternatives

Alternatives	Scores ($d_i^- / (d_i + d_i^+)$)
Supplier based GSCM Model	0.5056
Web based GSCM Model	0.5195
Advanced manufacturing System	0.4585

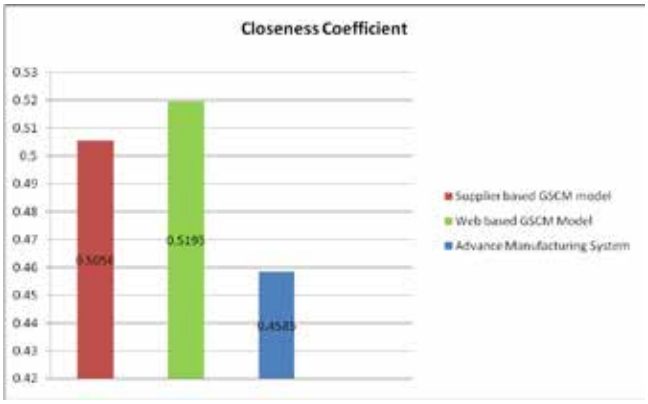


Fig. 2: Closeness Coefficient of Different Alternatives

Proposed Suggestions

Results shows that Web Based Technology for Green supply chain management is found to be the most suitable technology in the green constraints and that should be implemented in the case organization for enhancing productivity and performance.

Following suggestion has been proposed to the case organization for implementing the web-based technology:

- To design and install a web based application interface, which covers all the requirements of the system.
- To train the existing employees for filling and reading the data related to their shop, which can reduce the time and cost for operation.
- To recruit skilled personnel is who are well acquainted with the use of new technology and designs.
- To train and push the suppliers to support the GSCM system which is yet to be implemented in the case organization.
- To spread awareness among customers for GSCM.
- To plan an internal audit following up the implementation of GSCM in the system and take corrective action.
- To motivate the employees to learn and understand GSCM by appraising them time to time.
- Cotton recycling from pre-consumer (post-industrial) and post-consumer cotton waste. The discarded textile products can be used for producing very high quality paper.
- During process like fiber preparation, knitting, dying etc. glycol, NaOH, hydrogen peroxide are used with water. This water becomes hazardous for aquatic life. Therefore various biological treatment like activated sludge method, oxidative chemical treatment, organic flocculants etc. can be used to treat the water after use.
- For improvement in the area of transport system likes Eco-management and Audit scheme (EMAS) or Standards of ISO-14001 can be adopted to measure the environmental performance.

Limitation and Future Direction

This paper has shown the current status of GSCM in small cotton industry from AHP decision making method, but it is limited in several ways that might be addressed in future direction.

it has found that the web-based technology or digitalization of supply chain practice can also improve the efficiency and effectiveness of green supply chain. The following points offer some limitation and direction for future:

- This research study is limited in reviewing those papers which contains the word green supply chain in the title and the phrases.
- This research provides a detailed look at environment safety in only cotton industry. Results are limited to small scale industry.
- The Analytic Hierarchy Process is a useful tool for multi-objective decision making but it has own limitation also, for future study we suggest Interpretive Structural Modelling (ISM), to find correlation among various attributes in GSCM.

- Industry, academia and the community will need to work closely to the safe environment.

Conclusions

Because of rising mindfulness toward natural dishonor circumstance GSCM is turning into the most important region of exploration. In this exploration work, the case study had concentrated on various variables of green production network administration and their effect on the green execution of association. By applying the Fuzzy TOPSIS strategy, the study organize the distinctive components, the finding acquired that web-based innovation is more attractive among the considered elements for the association, which give the assistance in upgrading the green supply network execution of the association.

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