EVALUATE THE GREEN SUPPLY CHAIN MANAGEMENT PRACITES USING FUSSY DEMATEL

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Abstract - To enhance environmental performance Green supply chain management become proactive approach. By using green supply chain practices the industries will improve economical and environmental performance. So aim of this study is to examine influencing practices and economic and environmental performances of organizations. The fussy set theory and decision making trial and evaluation laboratory method is used to form structural model which is used to find out cause and effect relationships between criteria. The results are discussed.

Keywords - GSCM, GSCM Practices, fussy DEMATEL.

I. INTRODUCTION

Increased pollution and scarcity of the natural resources has increased the concern about environment impact of the manufacturing industries [1]. Due to increased awareness about environmental protection the green trend of protecting environment and conservation of earth's resources has been increased worldwide. For managing any kind of business it is important to look after the changes in social, environmental and economical performance. Customer pressure encourages companies to implement green practices in their processes and respond with in- kind performance enhancement [2]. Green supply chain management (GSCM) has been considered as a management instrument to upgrade the environmental sustainability and performance of manufacturing firms. Environment-friendly practices increased environmental performance and enhance economic performance [3]. The main purpose of using GSCM is to minimize the environmental damage created by supply chain related activities [4]. In addition, GSCM is an integration of natural environmental concerns into SCM through the implementation of diverse green solutions and practices like green design, life cycle analysis, green purchasing, green logistics, environmental technologies, and collaborative practices with suppliers, distributors, and customers [5,6].To reduce energy consumption and environmental impacts of a product through the whole life cycle, manufacturers have to go beyond the boundary of their companies to implement green supply chain management (GSCM), that is, integrating environmental effort into their SCM [7].

The objective of this study is to investigate the aspects that implemented in GSCM and discover their interactive relationships using the fuzzy DEMATEL method. An extensive literature review of GSCM and GSCM practices was carried out and GSCM practices were identified for study. Human judgments are usually subjective and human preferences are unclear and difficult for decision makers to describe by exact numerical values, fuzzy logic evaluation is needed to cope with this problem [8,9]. A decision making trial and evaluation laboratory (DEMATEL) method is conducted to create a causal diagram of interdependent factors. This method is advantageous in revealing the relationships among factors and prioritizing the criteria based on the type of relationships and severity of their effects on each other criteria. Based on these advantages, DEMATEL is used to determine effect and cause criteria, and to gain the model in terms of Linguistics parameterized with triangular fuzzy numbers. The structure of this study is as follows: Section 1 introduces the background and motivation. The review of literature related to GSCM is mentioned in Section 2. The fuzzy DEMATEL is described in Section 3. The results are presented in Section 4. Finally conclusion, implications, and recommendations for future research is in Section 5.

II. LITERATURE REVIEW

This chapter presents the descriptions of different GSCM practices.

2.1 GSCM Practices

2.1.1 Green-Design (GD):- Green-Design (GD) requires that producers design products which reduce consumption of energy and materials, which facilitate the recycle, reuse, and recovery of component parts and materials and meanwhile reduce or avoid the use of toxic and harmful materials use in manufacturing processes [10]. Green design is closely related to environmental risk management, product safety, pollution prevention, resource conservation and waste management. In addition, life-cycle analysis is critical in green design concept which is used to evaluate environmental and resource related products through production process [11].

2.1.2 Green Purchasing (GP):- Green Purchasing (GP) emphasis on cooperating with vendors for the purpose of developing products under environment friendly processes and without any harm to environment [10].

2.1.3 Reverse Logistics (RL):- Reverse logistics allows expired or contaminated products as well as products that are at the end of their life cycles to be withdrawn from the market. Reverse logistics is generally referred to as a series of distribution activities involved in product returns, source reduction/conservation, recycling, substitution, reuse, disposal, refurbishment, repair and remanufacturing [12,13].

2.1.4 Internal environmental management (IEM):- Internal environment management is referred to as an organization's endogenous resources and capabilities dedicated to the environmental friendliness or sustainability of its products and/or services. The rationale being that cooperative organizational culture can facilitate the communication between different departments and thus increase the firm's ability to share knowledge and perspectives of environmental management initiatives across the different functional units of the firm.

2.1.5 Green manufacturing / production / process / operation (GM):- GM involves manufacturing planning and control, minimizing the energy consumption and material exploitation, and reducing waste during manufacturing processes [14].

2.1.6 Cooperation / collaboration with customers (CWC):- CWC requires cooperation with customers to develop cleaner manufacturing processes that produce green products with green packaging [10].

2.1.7 Green supplier development (GSD):- Supplier selection also acts as the pivotal role in an enterprise's transport business development, with future competitive ability in an industrial environment [15]. Only those suppliers who meet the firms' needs can provide material and parts with comparative low cost and high quality.

2.1.8 Green information technology and systems (GITS):- GIS is an information system that has been modified and is used to monitor environment-friendly practices and output [16,17].

2.2 Organizational performances

2.2.1. Environmental performance
The environmental performance is the environmental effects that the corporation's activities have on the natural milieu [18]. It is important to evaluate the performance of GSCM in the entire supply chain [19]. Environmental performance is commonly measured through operative performance indicators (i.e. energy/resource utilization, emission reduction, waste disposal) and management performance indicators (i.e. environmental policies and measures, the approval rate of management systems, and the improvement in community relations and corporation image) [20].

2.3.2. Economic performance
When firm's environmental performance is increased, it stimulates revenues, enhances market share, and creates more market opportunities. Positive economic improvement is reflected through the cost reduction in material purchasing, energy consumption, and waste treatment and waste discharge. In contrast, negative economic performance is observed through the increase of costs regarding investments and purchasing environmentally friendly materials [7,21].

III. THE FUSSY DEMATEL METHOD

The DEMATEL method was first conducted by The Battelle Memorial Institute through its Geneva Research Centre in 1973 [22]. DEMATEL is an extended method for building and analyzing a structural model for analyzing the influence relation among complex criteria. However, making decisions is very difficulty in fuzzy environment to segment complex factors. The current study uses the fuzzy DEMATEL method to obtain a more accurate analysis.

This study tempts to analyze fuzzy DEMATEL which is proposed method to identify main GSCM criteria described in practices, performances and external drivers that affect on implementing GSCM, also their criteria interrelationships assessment are acknowledged in this study. The study obtains direct and indirect influence among criteria using the DEMATEL technique, and computes the causal relationship and strength among criteria. The DEMATEL technique does not need large amounts of data.

Fuzzy theory introduces the concept of membership function in order to deal with different linguistic variables [23]. A certain degree of fuzziness exists in terms of people's thoughts, inference and perception. The theory aims to solve uncertain or fuzzy data in the environment.

DEMATEL is built on the basis of graph theory, enabling analyzes and solves problems by visualization method. This structural modeling approach adopts the form of a directed graph, a causal effect diagram, to present the interdependence relationships and the values of influential effect between factors. Through analysis of visual relationship of levels among system factors, all elements are divided into causal group and effected

group. And this can provides researchers a better understand of the structural relationship between system elements, and find ways to solve complicate system problems [24,25,26].

The relationships between cause and effect factors are converted into the DEMATEL. Supposed that a system composes a set of elements C = {c1, c2, c3,..,cn}, and particular pair-wise relations are decided for modeling with respect to a mathematical relation. The major following steps are:

1. Generating the direct relation matrix. Measuring the relationship between criteria requires that the comparison scale be designed into four levels: 0 (no influence), 1 (very low influence), 2 (low influence), 3 (high influence), and 4 (very high influence). An initial direct relation matrix A is a n X n matrix obtained by pair-wise comparisons, in which Tij is denoted as the degree to which the criterion i affects the criterion j, i.e.,

$T = [tij]_{nxn}$

2. Normalizing the direct relation matrix. On the base of the direct relation matrix A, the normalized direct relation matrix I can be obtained through the equation

$$S = A \times K \quad (1)$$

Where

$$K = \frac{1}{\max_{1 \le i \le n} \sum_{j=1}^{n} a_{ij}} \quad (2)$$

3. Attaining the total relation matrix. Once the normalized direct relation matrix S is obtained, the total relation matrix I is denoted as the identity matrix.

$$T = X (I - X)^{-1} \quad (3)$$

4. Producing a causal diagram. The sum of rows and the sum of columns are separately denotes as vectors D and R within the total relation matrix M. A causal and effect graph can be acquired by mapping the dataset of (D + R, D - R). The horizontal axis vector (D + R) named “Prominence” is made by adding D to R, which reveals how much importance the criterion has. Similarly, the vertical axis (D - R) named “Relation” is made by subtracting D from R, which may group criteria into a cause group. Or, if the (D - R) is negative, the criterion is grouped into the effect group.

$$T = [t_{ij}]_{n \times n}, \quad i,j = 1,2 \ldots\ldots\ldots n \quad (4)$$

$$D = [\sum_{i=1}^{n} tij]_{1 \times n} = [tj]_{n \times 1} \quad (5)$$

$$R = [\sum_{j=1}^{n} tij]_{1 \times n} = [tj]_{n \times 1} \quad (6)$$

Obtaining the inner dependence matrix. In this step, the sum of each column in total relation matrix is equal to 1 by the normalization method, and then the inner dependence matrix can be acquired.
The data was collected from team of expert. According to the experience they give their opinion. And the data use for fussy DEMATAL

Table1: The fussy linguistic scale

Linguistic variable	Triangular fuzzy number
Zero influence (0)	(0, 0, 0.25)
Very low influence (VL)	(0, 0.25, 0.5)
Low influence (L)	(0.25, 0.5, 0.75)
High influence (H)	(0.5, 0.75, 1)
Very high influence (VH)	(0.75, 1, 1)

Note:(V1)Green Design, (V2) Green purchasing, (V3)Reverse Logistics, (V4)Internal environmental management (IEM), (V5) Green manufacturing / production / process / operation, (V6) Cooperation / collaboration with customers, (V7) Green supplier development, (V8) Green information technology and systems (GITS)

Table 2: Average Matrix

	V1	V2	V3	V4	V5	V6	V7	V8	AVG
V1	0	0	0.5	0.13	0.5	0.38	0.13	0.63	2.25
V2	0.63	0	0.38	0.75	0.63	0.75	0.25	0.25	3.63
V3	0.25	0.38	0	0.5	0.63	0.25	0.5	0.63	3.13
V4	0.63	0.13	0.75	0	0.63	0.63	0	0.75	3.5
V5	0.5	0.25	0.5	0.38	0	0.63	0	0.13	2.38
V6	0.63	0.25	0.38	0.5	0.75	0	0.5	0.5	3.5
V7	0.38	0.38	0.75	0.75	0.38	0.63	0	0.5	3.75
V8	0.63	0.63	0.25	0.63	0.63	0.5	0.13	0	3.38

Table 3: Normalized Matrix

	V1	V2	V3	V4	V5	V6	V7	V8
V			0.	0.0	0.			0.
1	0	0	1	3	1	0.1	0	2
V	0.1		0.		0.		0.	0.
2	7	0	1	0.2	2	0.2	1	1
V	0.0			0.1	0.	0.0	0.	0.
3	7	0.1	0	3	2	7	1	2
V	0.1	0.0	0.		0.	0.1		0.
4	7	3	2	0	2	7	0	2
V	0.1	0.0	0.			0.1		
5	3	7	1	0.1	0	7	0	0
V	0.1	0.0	0.	0.1	0.		0.	0.
6	7	7	1	3	2	0	1	1
V			0.		0.	0.1		0.
7	0.1	0.1	2	0.2	1	7	0	1
V	0.1	0.1	0.	0.1	0.	0.1		
8	7	7	1	7	2	3	0	0

Table 4: The Prominence and relation axis for cause and effect group

	Ri	Ci	Ri+Ci	Ri-Ci
V1	0.32548	0.51745	0.84293	-0.192
V2	0.53242	0.28667	0.81908	0.24575
V3	0.44286	0.51418	0.95704	-0.0713
V4	0.52999	0.56945	1.09944	-0.0395
V5	0.33857	0.59019	0.92876	-0.2516
V6	0.52392	0.56638	1.09029	-0.0425
V7	0.53245	0.20381	0.73626	0.32864
V8	0.49513	0.4727	0.96782	0.02243

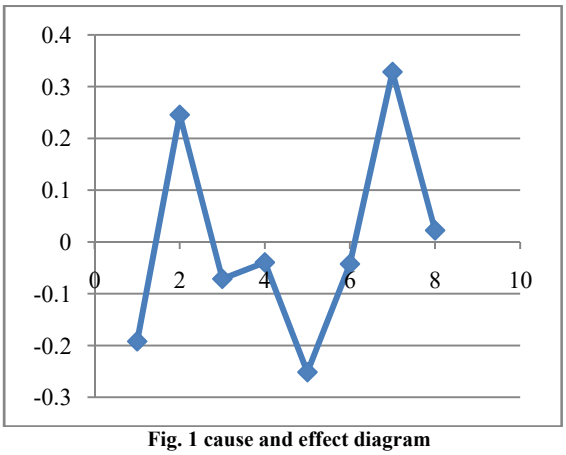


Fig. 1 cause and effect diagram

RESULT AND DISCUSSION

From the average value Table.2 we can rank the green supply chain management practices like (V4) Internal environmental management, (V6) Cooperation / collaboration with customer, (V7) Green supplier developer, (V2) Green Purchasing, (V8) Green information technology and system,(V3) Reverse Logistics,(V5) Green manufacturing/ production/process/operation, (V1) Green design

The study finding from the cause and effect Fig.1are describe as follows. (V2), Green Purchasing (V7) Green supplier developer, (V8) Green information technology and system are influence practices. These practices influence (V1) Green design, (V3) Reverse Logistics, (V4) Internal environmental management, (V5) Green manufacturing/ production/process/operation, (V6) Cooperation / collaboration with customer practices.

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