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Study the Select Issues in Flexible Sustainable Supply Chain using Weighted Interpretive Structure Modeling

Rishi sharma[1], Pawan Dagar[2]
Department of Mechanical Engineering, DITMR, Faridabad, INDIA

ABSTRACT

Flexibility in the framework of supply chain management plays an important role. Flexible sustainability in supply chain management is the crucial area for the competitiveness and the growth of industries. In this paper, ten flexibility factors have been identified through literature review; they are further analyzed by using weighted interpretive structural modeling (W-ISM) approach. ISM approach is used to develop a structural modeling between these factors and a method of effectiveness index (EI) is used to identify the key areas. The effectiveness index evaluated in this paper will help the industries to target their performance by managing the factorstestified in this study.

***Keywords*-----** Sustainable supply chain management (SSCM), Flexible sustainable supply chain management (FSSCM), ISM, WISM**.**

I. INTRODUCTION

"A supply chain is the alignment of firms that bring products or services to market."—from Lambert, Stock, and Ellramin their book Fundamentals of Logistics Management (Lambert,Douglas M., James R. Stock, and Lisa M. Ellram,1998,Fundamentals of Logistics Management, Boston, MA:Irwin/McGraw-Hill,)

Supply chain management (SCM) is an effective approach through which links between the factors is established and the production of the company increased with the reduction of cost. In this contemporary scenario, servetization of business has become a well proven strategy in the industrial world. This gave rise to the adoption of SCM principles in service sectors [Pramod and Banwet, 2010]. A service supply chain involves the series of activities from the analysis of customer need, service design to service delivery. It is the conglomeration of various SC aspects in service sector [Pramod and Banwet, 2010]. Supply chain management has some issues which are related to SCM and affects the supply chain, like risk management, operational management and sustainable supply chain management. Now effect of sustainability on supply chain is considered Supply chain sustainability is the management of environmental, social and economic impacts, and the encouragement of good governance practices, throughout the lifecycle of goods and services. The objective of supply chain sustainability is to create, protect and grow long-term environmental, social and economic value for all stake holders involved in bringing products and services to market**.**

Similar definition proposed by Seuring and Muller (2008: p.1700) where SSCM is defined as "the management of material, information and capital flows as well as cooperation among companies along thesupply chain while taking goals from allthree dimensions of sustainable development, i.e**.**, economic, environmental and social, into account which are derived from customer and stakeholder requirements**.**

Sustainable supply chain management can be regarded as the improved management of supply chains regarding social, economic and environmental issues. Through the integration of these issues, SCM plays an important role both in supply chain and environmental management. The main drivers for this transition have been the rapid consumption and increasing pollution of natural resources due to massive economic development and uncontrolled urbanization [Salmona et.al 2010]. The sustainable supply chain management reduces the cost of the product and increased the customer's satisfaction, increased the sales of the product and therefore increased the overall efficiency of the firm. Sustainable supply chain management is more effective if the production is flexible. Flexibility plays an important role in the production.

Flexibility may be defined as the ability to change or react with little penalty in time, effort, cost or performance .Flexibility can improve the company's competitiveness, particularly for the decision-making process of implementing technologies .But managers do not have a comprehensive view of flexibility because they focus more on machine flexibility than on total system flexibility. Flexibility in supply chain management is essential for industries. Today FMSs are not restricted to the machining parts, but is used in every phase of a manufacturing process (Rao and parnichkun 2009; Shayan and Liu 1995) [Dubey& Ali, 2014]. To produce products of global quality and according to the customer's need, Indian industries have to adapt flexibility in their manufacturing systems. Today there is emphasis on quality and variety than on quantity [Dubey& Ali, 2014]. To beat competition in the market industries have to be agile and adaptable. That's why, according to the market needs Indian industries realizes the need for FMS.

The main objective of this paper is to provide factors which affect the flexibility of sustainable supply chain management. We approach many factors which affects the flexibility of sustainability of supply chain. This paper examines how supply chain flexibility can be achieved in the production industry. Customers are demanding more variety, better quality and service including both reliability and faster delivery. Producing good quality and delivering the right quantity of product at right location and that is sold in the market only during a limited period of time also pose a series of challenges for manufacturing industries [Singh et.al 2011]. Sustainability, which we define in this paper is depends on three factors that is; social, economic and environmental. These factors also have subdivisions and they all affect the sustainability of supply chain.

II. LITERATURE REVIEW

In this literature review many research papers related to the sustainable supply chain management studied and concluded about the flexible factors and their definition as explained below:

a)Environment flexibility: -It is defined as the flexibility in industrial environmental issues as unexpected changes of customers, suppliers, competitors, technology. Government support also playsan important role in this field. This factor is related to company's relationship withsuppliersand their level of trust and commitment.

b)Eliminate Bottleneck:-Bottleneck occurs when input comes in faster than the next step can use it to create output. It can be caused by inadequate equipment and production when capacityhas been surpassed, because of inefficient processes. Poor productivity and inefficient labour are also responsible for bottleneck.

c)Increase Responsiveness-alternative machines, It can be defined as the ability of the supply chain to respondfirmly and within ansuitable timeframe to customer requests or changes in marketplace.It is the capability of treating a part through varying routesby using flexible material handling, and flexible transporting network;.Zee and Gaalman 'Routing flexibility by sequencing flexibility – exploiting product structure for flexible process plans' describes the routing flexibility and their function in the paper. It explains issues related to the production industry which affects the routing flexibility.

d)Sourcing flexibility:-This may be defined as the ability to reconfigure a supply chain network through selection and deselecting of vendors. It is related to the ability of an industry to find another supplier for each component or raw material.

e)Vendor flexibility:-.It is the specific type of flexibility that relating to individual vendor that support manufacturing, warehousing or transport operations.

f)Transport flexibility:-Transportation is a key function in supply chain, it act as physical relationship between customers and suppliers, permitting the flow of materials and resources. For better supply chain management it is assumed that transportation will respond to short term demand changes. So the transportation flexibility should be a practical characteristic that is surrounded into carrier organization's policy, behavior, processes and technology.

g)Spanning flexibility:-It is defined as the capability of an industry to provide horizontal information connection across the value chain to meet a variety of customers' needs.

h)Access flexibility:-This is the ability of a firm to provide extensive coverage and reflects the capability of supply chain to provide the required geographical coverage for different customers (Naim et al.,2006)

i)Environmental cost:-Any organization is a part of composite supply chain with a variety of customers and suppliers of goods and services. Whenever customer set conditions and standards that suppliers must meet, the supplier will constantly endeavor to improve the efficiency and effectiveness of their operations in order to pleasure their customers. The cost associated for improving efficiency, reducing demand for material and cutting wastes integrate the environmental cost.

j)Human resource flexibility: -HR flexibility helps us in understanding the process in which an individual worth can be maximized for the benefit of individual as well as for the organization.

III. METHODOLOGY USED

For this analysis an approach W-ISM combination of (Interpretive structural Modeling) ISM and (Effectiveness Index) EI is used (Chand et al. 2014; 2015).

3.1Analyzing the factors of flexibility by using ISM

For analyzing the flexibility factors and developing the framework basis ISM approach isused. Framework is developed by using the ISM is further used to assess the effective index of factors in supply chain. The use of this framework is illustrated with the help of the survey.

3.1.1 Overview on ISM

ISM is an interactive learning process in which a set of different directly or indirectlyrelated elements/factors are structured into a comprehensive systematic model. Themodel so formed portrays the structure of a complex issue or problem, a system or field of study, in a carefully designed pattern implying graphics as well as words. Various steps involved in ISM methodology are as follows:

Step 1: Establishing the appropriate relationship between factors

For developing a contextual relationship of 'lead to' type is chosen for completing this purpose. Which means that one risk factor lead to another chosen risk factor? Based on this a contextual relationship among risk factors is developed. Six experts in this domain, three from industry and three from academia, were consulted in developing the contextual relationship among these factors. Keeping in mind the contextual relationship for each factor, the existence of a relation between any two factors (i and j) and the associated direction of this relation has been decided. The following symbols (V, A, X, O)have been used to denote the direction of the relationship between two risk factors (i andj):

V risk factors i will lead to j
A risk factors j will lead to i
X risk factors i and j will lead to each other
O no relation between two risk factors

Step 2: Development of the RM

The RM is obtained from SSIM. The RM indicates the relationship between operationalrisks in the binary form. The various relationships between risks depicted by symbols V,A, X and O used in SSIM are replaced by binary digits in the form of 0 and 1. The following rules are used to substitute V, A, X and O of SSIM to get reachability matrix:

1 if the cell (i, j) in SSIM is assigned with symbol V, then, this cell (i, j) entry becomes1 and (j, i) entry becomes 0 in the RM
2 if the cell (i, j) in SSIM is assigned with symbol A, then, this cell (i, j) entry becomes0 and (j, i) entry becomes 1 in the RM
3 if the cell (i, j) in SSIM is assigned with symbol X, then, this cell (i, j) entry becomes1 and (j, i) entry becomes 1 in the RM
4 if the cell (i, j) in SSIM is assigned with symbol, then, this cell (i, j) entry becomes 0and (j, i) entry also becomes 0 in the initial RM.

Step 3: Partitioning the RM

Based on the suggestions of Warfield (1974, 1987) and Farris and Sage (1975), from the final RM, the reachability set and antecedent set consist of risk factor and other factors which may help to achieve it. After finding the reachability set and antecedent set than the intersection of all of these sets is derived for the factors. These factors for which the reachability set and antecedent set having same value is places at the top level in ISM hierarchy.

Once the top level factor is identified, it is extracted from consideration and other top level factors of the remaining sub graph are found. This procedure is continued till all levels of the structure are identified. These identified levels help in the development of digraph and the final model. Top level factor is positioned at the top of digraph and so on.

Step 4: Development of conical matrix

Aconical matrix is developed by clubbing together all of the risk factors in the same level, across rows and columns of the final RM, as shown in Table 14. The drive power and dependence power of all of the risk factor is calculated by summing up the number of ones in the columns respectively

Step 5: Development of digraph and ISM model

Based on the conical matrix, a digraph including transitivity links is obtained. This is generated by nodes and lines of edges. After removing the indirect links, a final digraphis developed. In this development, the top level factor is positioned at the top of the digraph and second level factor is placed at second position and so on, until the bottomlevel is placed at the lowest position in the digraph. Then digraph obtained is converted into the ISM model by converting the node into risk factors

3.2.3 Classification of flexibility factors on the basis of MICMAC analysis

In this section all of the factors are classified into four clusters. This principle isbased on multiplication properties of matrices (Sharma et al., 1995). Matriced' Impactscroises-multipication appliqué anclassment (cross-impact matrix multiplication applied to classification) is abbreviated as MICMAC. The main purpose of this analysis is toanalyze the drive power and dependence power of factors. In this the first cluster consists of 'autonomous factors' which have weak drive power and weak dependence.

IV. EVALUATION OF EI

For computing the EI the mean score with their rank of operational factors has been calculated on the basis of Table 1. After this rank, inverse rank and weight for each factoris to be determined. For assigning weight to different factors of EI, the highest and lowest values of five-point Likert scale, i.e., 5 and 1 are mapped 100% and 0% respectively. For each of the issues of effectiveness a

weight is assigned. The criterion for weight (WI) is asunder:
1 (Strength), when percentage score 60% (Mean value 3).
0(Neutral), when percentage score is between 40-60% Mean value between 2 and 3).
–1(Weakness), when percentage score 40 %(Mean value 2)

S.No	Factors	Mean Score	Rank
1	Environment flexibility	3.93	1
2	Eliminate bottleneck	3.68	2
3	Increase responsiveness	3.49	3
4	Sourcing flexibility	3.31	4
5	Vendor flexibility	3.19	5
6	Transport flexibility	3.06	6
7	Spanning flexibility	2.96	7
8	Access flexibility	2.82	8
9	Environmental cost	2.76	9
10	HR flexibility	2.63	10

Table-2 Mean Score

V. RESULTS AND DISCUSSION

The major objective of this study is to identify the flexibility factors that significantly affect the operation of SC in an industry so that management may effectively deal with such type of factors. In this study, an ISM-based model has been developed to analyze the interactions among different operational risk factors. It identifies he hierarchy of actions to be taken for handling different factors which affect the operation of SC. The managers can get an insight of these factors and understand their relative importance and interdependencies. The driver power dependence matrix (Table 15) gives some valuable insights about the relative importance and interdependence among the flexibility factors. This study has some other implications for the practicing managers not only to deal with operational factors but also the other type of factors occurs in SC. The identified factors need to be overcome by the management of the firms. The driver power dependence diagram give ssome valuable insights about the relative importance and interdependencies of the factors.

The managerial implications as emerging from this study are as follows.

VI. CONCLUSION

In this paper, some important factors are discussed which affect the flexibility of a supply chain management. These factors are interrelated to each other directly or indirectly due to functional relationship between them. Here, ten factors are identified to observe their effects on flexibility of supply chain. This study will help the decision makers to develop suitable strategies in order to keep the sustainability of a supply chain management flexible. The factors are analyzed by using interpretive structure modeling technique to integrate their impact on each other as well as on the whole system. These are identified with their respective mean score and on the basis of their effects they are given ranking also.

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