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ROLE OF AGILITY IN GREEN SUPPLY CHAIN MANAGEMENT

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ABSTRACT

Operations of any market face too much turbulence and volatility which are impossible to discard or ignore. Thus, the Green supply chain managers are forced to handle uncertainty on regular basis. This motivates Green Supply Chain Management (GSCM) researchers to propose various frameworks so as to enable the manufacturers in catering the demands of uncertainty at a feasible cost. This inclusion of uncertainty with other aspects of any Green supply chain can be called as Green Supply Chain Agility (GSCA). This paper highlights various factors of an Agile supply chain and thereafter suggests a procedure to determine mutual relationships among these factors using an Interpretive Structural Modelling (ISM). Finally, in this hierarchical relationship, the factors coming at root level are referred to as driving variables and those at lower level or influenced by other variables are referred to as dependent variables.

Keywords: Agility; Green Supply Chain Management (GSCM); Green Supply Chain Agility (GSCA); Interpretive Structural Modelling (ISM)

I. INTRODUCTION

Agility is the capability of a system for creating a good response mechanism while mastering the art of handling uncertainties. During the last few decades, the marketing companies usually emphasize only on money but now the time has changed forcing them to look around for Speed, Quality & Flexibility in addition to Cost of the product. These additional factors, required nowadays, provide much more effective responses for some unique need of customers and markets alike. Here, an attempt has been made to determine how a supply chain system can provide full satisfaction to consumers by emphasizing the changes desired to make it more effective.

Many research papers have been floated during last few years to determine the relationships between Agility dimensions and a Green supply chain [2,4,9,11]. The literature review consists of many academic articles, journals and research papers from the field of Logistics, Operations Management and Supply Chain Management.

According to Bagheri [12], firms must be quite Agile so as to be more responsive in this competitive world. He said organizations, that are Agile, prove to be more successful in the long run. Moreover, the Agility of an organization is dependent on the Agility of its supply chain. Green Supply Chain Agility (GSCA) is, in fact, linked to the other organization also, in terms of trust among buyer-supplier, dependence on IT, overall

performance, vendor selection and many more. In this context, Agarwal et al. [1] mentioned that trust is a binding force in most buyer-supplier transactions. It becomes critical when uncertainty and asymmetric product information are present in the transactions of a supply chain. One of the important characteristics in developing trust among trading partners of an e-enabled supply chain is Stage-wise trust development among partners. Another characteristic, named, Vendor selection is described by Mandal and Deshmukh [3] as one of the most important activity of a purchasing department. Traditionally, vendors are selected for their ability to meet the quality requirements, delivery performance and the price offered by them. However, as they are selected not only to meet the immediate requirements but also future needs, one has to consider many other factors, as well, while selecting a reliable vendor. Vendor must be flexible and should be able to fulfil demands on urgent basis even in case of last minute changes in requirements by the customer.

Kanda, in 2008 [5] explained that Green supply chains are generally complex and characterized by numerous activities spread over multiple functions and organizations, posing interesting challenges for effective coordination in the chain. To meet these challenges, Green supply chain members must work towards a unified system and coordinate with each other. Hoyt [6] explained that 'Buyer-Supplier relationship' play an important role in an organization's ability to respond to dynamic and unpredictable changes. If the relationship is too restrictive, flexibility will be difficult to achieve and if it is too lenient, the risk of opportunism will be there.

Further, it has been suggested by Storey [7] that 'Customer Responsive Green Supply Chain Management' and 'Agile Supply Chain Management' are necessary for the latest competitive conditions. However, there is an enormous gap between the ideal prescription and actual practice.

Regarding the Green Supply Chain Agility, Christopher [8] said that the twentieth century witnessed the lean production paradigm that has positively impacted many market sectors ranging from automotive to construction. In particular, there is much evidence to suggest that level scheduling combined with the elimination of wastefulness has successfully delivered a wide range of products to those markets where cost is the primary order winning criteria. However, there are many other markets where the order winning criteria is availability. This has led to the emergence of the Agile paradigm typified by 'Quick Response' and other similar initiatives. Nevertheless, 'Lean' and 'Agile' are not mutually exclusive paradigms and may be married for advantage in a number of different ways.

This Literature review clearly depicts that many approaches have been suggested in the literature to determine the various relationships among several factors of an Agile supply chain. This paper extends the previous work of eminent researchers by suggesting a model that determines certain factors of Agile supply chain and further describes a procedure to determine all the relationships among these factors using an Interpretive Structural Modelling (ISM).

II. FACTORS AFFECTING AGILITY IN A GREEN SUPPLY CHAIN

Agility has come out as a concept which could help the firms in analysing and realising the practices and skills, they are lacking in. This provides a clear way to handle uncertainties for delivering better products to their end customer. In order to meet the requirements of the consumer, the organisations need to be spontaneous enough to understand the immediate areas where they are lacking in and also to respond as well as adapt the changed

environment. That is how Agility is viewed in a Green supply chain of an organisation. Christopher [10] kept a point that some organizations can be lean in their operations but not necessarily Agile in their supply chain. According to him "The notion of agility is recognized to be holistic rather than functional and is of strategic rather than tactical importance". Certain factors that can affect Green supply chain agility in an organization are given below.

a) Organizational Integration
b) Willingness for Improvement
c) Outsourcing of Logistics
d) Collaborative Relationships
e) Lead Time Reduction
f) Information Sharing & Trust
g) Flexibility in System
h) Customer Sensitivity & Responsiveness
i) Customer Satisfaction
j) Commitment of Top Management
k) Cost and Quality of Services

III. ISM METHODOLOGY FOR MODEL DEVELOPMENT

Interpretive Structural Modelling (ISM) helps in making learning process interactive by structuring a set of directly related elements (which are different from each other) into a comprehensive systemic model. The model, so formed, portrays the structure of a complex issue or a problem in a carefully designed pattern using graphics as well as words. ISM methodology is helpful in imposing order and direction on the complexity of relationships among the elements of a system. Various steps involved in ISM modelling are as follows.

a) Variables relevant to the problem or an issue are identified.
b) Contextual relationship among variables is established.
c) A Structural Self-Interaction Matrix (SSIM) is developed.
d) A Reachability matrix is developed from SSIM
e) Transitivity of the above matrix is checked.
f) The Reachability matrix is partitioned into different levels.
g) Transitive links are removed based on the relationships in the Reachability matrix.
h) Then the ISM model is constructed by replacing the element nodes with statements.
i) This ISM model is reviewed for conceptual inconsistency
j) Finally necessary modifications, if any, are made.

The important milestones of the process are explained below.

3.1 Structural Self-Interaction Matrix (SSIM)

To create the contextual relationship between the variables, the ISM methodology suggests the use of opinions made by experts on the basis of different management techniques such as Nominal group technique, Brain

storming etc. In this research, it has been suggested that to identify the nature of contextual relationship between the variables of Agility, experts from the academia and industry should be consulted. In order to analyse the relationship among the Agility variables, a contextual relationship 'Lead to' is suggested. Four symbols are used to denote the direction of relationship between the variables (i and j):

V = Variable i will help achieve variable j

A = Variable j will be achieved by variable i

X = Variable i and j will help to achieve each other, and

O = Variables i and j are unrelated.

Based on the contextual relationships, the SSIM is developed for the variables identified to enable the Agility.

3.2 Reachability Matrix

The SSIM prepared is converted into a Binary matrix, called initial Reachability matrix by substituting V, A, X, O by 1 and 0 as per the case. The rules for the substitution of 1s and 0s are as follows.

a) If the (i, j) entry in the SSIM is V, then the (i, j) entry in the Reachability matrix becomes 1 and the (j, i) entry becomes 0.

b) If the (i, j) entry in the SSIM is A, then the (i, j) entry in the Reachability matrix becomes 0 and the (j, i) entry becomes 1.

c) If the (i, j) entry in the SSIM is X, then the (i, j) entry in the Reachability matrix becomes 1 and the (j, i) entry becomes 1.

d) If the (i, j) entry in the SSIM is O, then the (i, j) entry in the Reachability matrix becomes 0 and the (j, i) entry becomes 0.

Following these rules, initial Reachability matrix for the Agility variables is identified. The final Reachability matrix is obtained by incorporating the transitivity of the ISM methodology.

3.3 Level Partitions

The Reachability and Antecedent sets for each variable are obtained from final Reachability matrix. The Reachability set for a particular variable consists of the variable itself and the other variables which it may help. The antecedent set consists of the variable itself and the other variables which may help in achieving the former. Subsequently, the intersection of these sets is derived for all variables. The variable, for which the Reachability and the Intersection sets are same, is assigned as the top-level variable in the ISM hierarchy as it would not get help by any other variable above its own level. After the top level element is identified, it is discarded from the list of remaining variables. This iteration is repeated till the hierarchical levels of each variable are found. The identified levels aid in building the digraph and the final model of ISM.

3.4 Formation of ISM-Based Model

The final Reachability matrix helps in generating the structural model and thereafter the digraph is drawn. Transitivities are removed as described in the ISM methodology and the digraph is finally converted into the ISM.

3.5 MICMAC Analysis

The objective of the MICMAC analysis is to analyse the driving power and the inter-dependence of the variables [3]. In this analysis, the Agility variables, determined in earlier steps, are classified into certain clusters. It is necessary to mention here that if independent Agility variables have more driving power then they must be implemented very to carefully during Green supply chain management, since these variables help to achieve the desired result variables (which appear at the top of the ISM hierarchy).

IV. CONCLUSION

The interrelationship of Green supply chain agility and Agility dimensions could prove to be a very strong model for enabling markets to handle uncertainties efficiently. Agility along with its dimensions like flexibility, responsiveness, adaptability and resilience can assist the Green supply chain in becoming more efficient. It actually helps the organisations to create a workspace where they act fast and can quickly move from one stage to another because of the Agility. The present paper has suggested several aspects or factors of an Agile supply chain. Further, it has put forward a model to determine mutual relationships among these factors using an Interpretive Structural Modelling (ISM) technique. This work can be extended in future by identification of mutual relationships among the variables through Literature review method or Survey method. In addition, the Hierarchical relationship among variables (factors) can also be used to determine various driving variables and dependent variables.

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