Analysis of Various Enablers of Sustainable Supply Chain using MICMAC Analysis

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Abstract

Industrialization has increased dramatically in recent decades. This has led to an increase in the production and consumption of various products. This rapid industrialization has seriously damaged society and the environment, in which the lack of natural resources, the production of waste during production, the increase in emissions and the amount of transport, the goods that are not eliminated at the end Product Life Cycle and Stressful Employees The work environment for these emerging issues has focused on sustainability issues and the need for sustainable supply chains to sustain this rapid economic growth in terms of environmental and social problems.

In this work, we present a modeling framework to examine the different activators of sustainable supply chains, to analyze their relationships, and to propose alternatives for the development of a sustainable supply chain. In a first step, a comprehensive review of the literature will be conducted to identify the moderators and provide information on the concept of the triple end result (environmental, social and economic) of sustainability. In the second step, interpretative structural models are used to develop the relationship between several factors for each dimension of sustainability. In the third and final step, the ISM results are used as information for the analytical network process along with a possible list of alternatives to determine the best alternative (s) to develop sustainable supply chains. The proposed approach is novel and addresses an important problem of modeling enablers and alternatives for sustainable management of the supply chain. The results have a strong practical applicability and can be adapted by organizations with fewer changes in their existing work structure.

Keywords - *Interpretative Structural Modelling (ISM), MICMAC Analysis.*

I. INTRODUCTION

In recent years, there has been growing concern about the environmental impact caused by industrialization and the advent of technology. In recent decades, several studies have been carried out that represent the past, present and future state of our planet (Markley and Davis, 2007). There are concerns about ozone depletion, natural resources and other accidental environmental impacts. As the population grows, as demand increases, production increases, ultimately affecting natural systems, resources and ecology. These problems make it more necessary than ever to focus on the environmental hazards caused by organizations. The term sustainability, which increasingly refers to the integration of social, environmental and economic responsibilities, has emerged in the specialized literature of business disciplines such as operations and management (Carter et al., 2007). Although the main research on sustainable management of the supply chain took place in the mid-1990s, demand has increased recently and organizations have begun to integrate sustainability into their operations.

Every process involved in the production, manufacture and distribution of products contributes to environmental problems. Supply chains are important links that connect the entrances of an organization with their products. Traditional challenges included reducing costs, just-in-time delivery, and shortening transport times to better meet business challenges. Given the increased environmental costs of these networks and increasing consumer pressure on green products, many organizations have considered sustainability of the supply chain as a new measure of profitable logistics management. This change is reflected in the understanding that sustainable supply chains often mean profitable supply chains.

Literature Review

In this section, we review the literature available on sustainable supply chains. For the purposes of this essay, we have considered all magazines and well-known publications on the subject and focused on the years 2008-2010. This does not mean that the documents before 2008 were not simply used in the study. They were excluded from the literature review since then, and Searing and Muller (2008) provided a very detailed literature review from 1994 to 2007, highlighting 191 articles from several journals. Your document can be used as a basic reference for a comprehensive review of sustainable supply chain research in the years 1994-2007.

The search for important journals published by Science Direct, Emerald Insight and Inter Science Wiley. The keywords used in our search include sustainability, sustainable supply chain, reverse logistics, sustainable production, green supply chain management, social sustainability, economic sustainability and green supplier development. The search took into account only the most relevant articles in terms of technical content. It has been noted that, from 2008 to date, a total of 37 publications related to sustainability and supply chains have been published. Table 2-1 contains the list of journals and the number of articles published in the 2008-2010 study period.

Interpretive Structural Modeling (ISM)

Interpretive Structure Modeling (ISM) is an interactive learning process. The various indirect and directly related components of a process are analyzed in an integral system model. The presence of indirect or direct components makes the structure of a system appear. It is difficult to manage such a system whose structure is not clearly defined. Therefore, a method is needed to identify a structure. One such method is interpretive structural modeling. There are many examples of the use of ISM in the research literature. The two limited concepts for understanding the ISM system are: accessibility and transitivity.

It is structured directly in an integrated, complete and reliable format. This model consists of a complex problem or the structure of a problem, system or structure of a study area, in a carefully planned manner, both graphically and verbally. The basic idea of the ISM is to use the practical experience and expertise of the experts to develop a complex system (element) into subsystems (element) and to create a multi-level structural model. The ISM method is the rule and guide to the complexity of the relationship between elements of system elements (Warfield, 1974, Sage, 1977).

You give the ISM several restrictions. The conversation relationship between variables always depends on the user's knowledge and their dependence on the company, its performance and its industry. ISM gives no weight to the variables. (Kannan et al., 2009).

The various steps in the ISM methodology are the following (Kannan et al., 2009):

Step 1. The variables (criteria) are taken into account for the system under consideration.

Step 2. Based on the variables identified in step 1, a contextual relationship is made between the variables to determine which variables should be examined.

Step 3. The Personalized Interaction Matrix (SSIM) structure is developed for the variables that indicate the matching relationships between the variables of the evaluated system.

Step 4. The access matrix is developed from SSIM and the matrix transition is verified. The transition of a contextual relationship is a fundamental requirement in ISM. It states that if the variable A is related to B and B to C, then A is necessarily related to C.

Step 5. The scope matrix obtained in step 4 is divided into different levels.

Step 6. Based on the previous relationships in the availability matrix, a target graphic is drawn and the transitive links are removed.

Step 7. The resulting digraph is converted to ISM by replacing the report node variables.

Step 8. The ISM model developed in step 7 is reviewed to verify the conceptual inconsistency and make the necessary adjustments.

Several researchers from around the world have used ISM to develop relationships between problems / factors / barriers in different areas. Researchers have also suggested possible areas for future research into the links between ISM and the ability of humans to cope with complexity.

Data collection

The barriers identified in the study come from the basic document of Shrimali&Soni (2017).

1. These barriers are little support from top management.
2. Resistance to the middle managers.
3. Poor lean training
4. Lack of a lean implementation team.
5. Lack of flexible labor agreements.
6. Absence of a consultant.
7. The reward system is missing
8. High cost / investment

Structural self-interaction matrix (SSIM)

In the first step of generating a matrix, taking into account the contextual relationship for each variable, the existence of a relationship between two barriers (i and j) and the associated direction of the relationship is called into question. The following four symbols are used to represent the direction of the relationship between the barriers (i and j):V : Barrier i will promote barrier j;

A : Barrier j will promote barrier i;

X : Barrier i and j will promote each other; and

O : Barriers i and j are unrelated.

The SSIM for barriers to the introduction of a green supply chain is presented in Table 2. The next section explains how to use the symbols V, A, X and O in the SSIM.

Initial Reachability Matrix

The SSIM has been converted to a binary matrix called Initial Access Matrix, where V, A, X and O are used for 1 and 0. The replacement of 1 and 0 is done according to the following rules:

i. If the entry (i, j) is in the SSIM V, the entry (i, j) in the area array becomes 1 and the entry (j, i) becomes 0.

ii. If the entry (i, j) in the SSIM is A, the entry (i, j) becomes 0 within the scope and the entry (j, i) becomes 1.

iii. If the entry (i, j) in the SSIM is X, the entry (i, j) in the accessibility matrix becomes 1 and the entry (j, i) also becomes 1.

iv. If the entry (i, j) in the SSIM is 0, the entry (i, j) in the accessibility matrix becomes 0 and the entry (j, i) also becomes 0.

Final Reachability Matrix

After introducing transitivity as described in step (iv) of the ISM methodology, the final accessibility matrix is shown in Table 4, also showing the motive power and the dependence of each variable. The power of the unit for each variable is the total number of variables (including itself) that can help. On the other hand, dependence is the total numbers of variables (including themselves) that can help achieve them. These driving forces and dependencies are used later to classify the variables in the four groups of independent dependent and independent drivers.

Level partitions

Accessibility and history (Warfield, 1974) for each barrier are obtained from the final matrix available. The input helper set set for a particular variable consists of the variable itself and other variables that can help. A number of backgrounds consist of the variable itself and other variables that can help to achieve it. Then the intersection of these sets is derived from all variables. The variable for which the accessibility and intersection sets are equal is given by the higher-level variable in the ISM hierarchy, which would not help to reach another variable above its own level. After identifying the top-level element, the remaining variables are discarded. In this study, 8 barriers are presented along with their accessibility set, background set, background set, and levels (see Table). The identification of these barriers is completed in eight iterations.

This iteration continues until the levels of each variable are reached. The specified levels help in creating the digraph and the final ISM model.

Formation of ISM based model

The final accessibility matrix is used to generate the structural model shown in Figure 2. The relationship between the barriers j and i is represented by an arrow pointing from i to j. The resulting graph is called a digraph. By eliminating transitivity, as described in the ISM methodology, the digraph is finally converted to the ISM model.

MICMAC Analysis

Matrices 'applied cross-multiplication application' and classification (cross-impact matrix multiplication for classification) is abbreviated as MICMAC. The MICMAC principle is based on the properties of matrix multiplication (Sharma et al., 1995). The purpose of the MICMAC analysis is to analyze the performance of the device and the dependency performance of the enablers. This identifies the key activators that control the system in different categories. Depending on their driving force and their dependency, the enablers in the present case have been divided into four categories as follows:

1. Autonomous enablers: These enablers have a weak driving force and a weak dependency. They are relatively unrelated to the system, so there are few connections that can be very strong. These enablers are displayed in quadrant I.

2. Dependent enablers: This category includes those enablers who have a low but high dependency performance and who are in quadrant II

3. Link Enablers: These have a great driving force as well as a strong dependency and are placed in Quadrant III. They are also unstable and therefore each action has an impact on others and feedback on themselves.

4. Independent Enablers: These have a strong driving force, but a weak dependence. These are shown in quadrant IV.

Table: Structural Self-Interaction Matrix (SSIM)

Table: Initial Reachability Matrix

	j	Lake of Support from Top Manage ment	Resistan ce to change Middle Manage ment	Rigid Mana gemen t Policy	Lake of Lean Training	Absence of Lean Implemen tation Program	Lack of Flexible Workin g Arrange ment	Non availabilit y of Consultan t	Lack of Rewar d Syste m	Highe r Invest ment/ Capita l
i		1	2	3	4	5	6	7	8	9
1	Lake of Support from Top Management		V	X	V	V	O	V	V	X
2	Resistance to change Middle Management			X	O	X	V	V	V	V
3	Rigid Management Policy				V	V	V	V	V	V
4	Lake of Lean Training					A	O	O	O	A
5	Absence of Lean Implementation Program						V	O	O	A
6	Lack of Flexible Working Arrangement							O	O	A
7	Non availability of Consultant								O	A
8	Lack of Reward System									A
9	Higher Investment/ Capital									

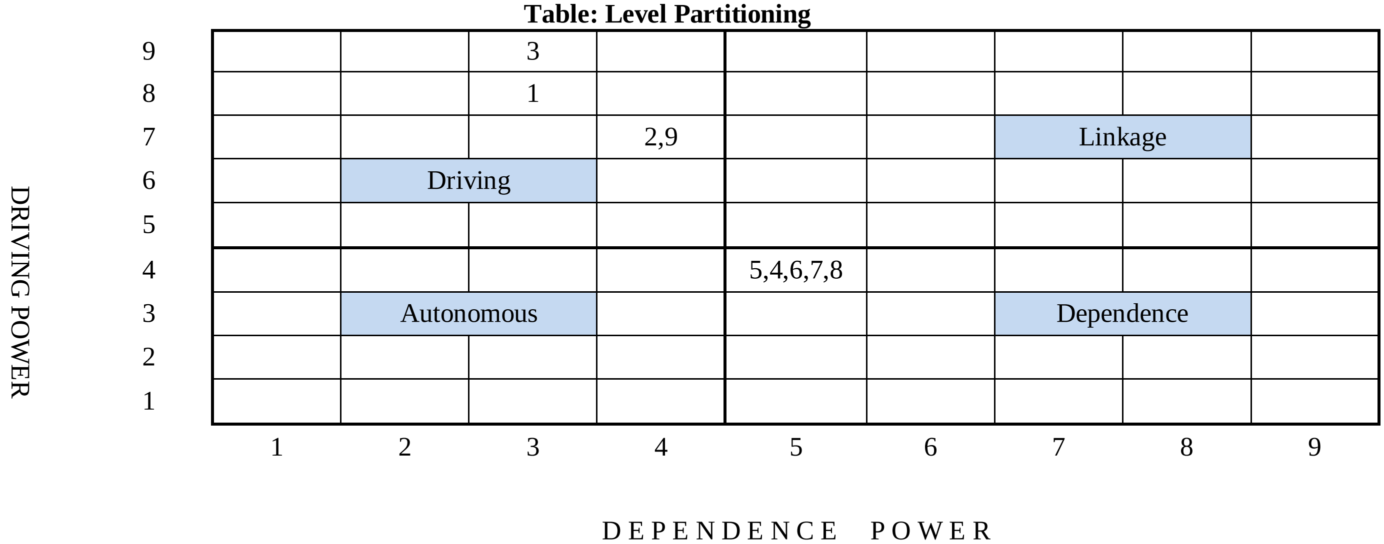
	j	Lake of Support from Top Mgmt	Resistance to change Middle Mgmt	Rigid Manage ment Policy	Lake of Lean Training	Absence of Lean Implementat ion Program	Lack of Flexible Working Arrangem ent	Non availability of Consultant	Lack of Reward System	Higher Investm ent/ Capital
i		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
1	Lake of Support from Top Management	1	1	1	1	1	0	1	1	1
2	Resistance to change Middle Management	0	1	1	0	1	1	1	1	1
3	Rigid Management Policy	1	1	1	1	1	1	1	1	1
4	Lake of Lean Training	0	0	0	1	0	0	0	0	0
5	Absence of Lean Implementation Program	0	1	0	1	1	1	0	0	0
6	Lack of Flexible Working Arrangement	0	0	0	0	0	1	0	0	0
7	Non availability of Consultant	0	0	0	0	0	0	1	0	0
8	Lack of Reward System	0	0	0	0	0	0	0	1	0
9	Higher Investment/ Capital	1	0	0	1	1	1	1	1	1

Table: Level Partitioning

	j	Lake of Support from Top Mgmt	Resistance to change Middle Mgmt	Rigid Management Policy	Lake of Lean Training	Absence of Lean Implementation Program	Lack of Flexible Working Arrangement	Non availability of Consultant	Lack of Reward System	Higher Investment/ Capital	**Driving Power**
i		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	
1	Lake of Support from Top Management	1	1	1	1	1	0	1	1	1	**8**
2	Resistance to change Middle Management	0	1	1	0	1	1	1	1	1	**7**
3	Rigid Management Policy	1	1	1	1	1	1	1	1	1	**9**
4	Lake of Lean Training	0	0	0	1	0	0	0	0	0	**1**
5	Absence of Lean Implementation Program	0	1	0	1	1	1	0	0	0	**4**
6	Lack of Flexible Working Arrangement	0	0	0	0	0	1	0	0	0	**1**
7	Non availability of Consultant	0	0	0	0	0	0	1	0	0	**1**
8	Lack of Reward System	0	0	0	0	0	0	0	1	0	**1**
9	Higher Investment/ Capital	1	0	0	1	1	1	1	1	1	**7**
	Dependence Power	**3**	**4**	**3**	**5**	**5**	**5**	**5**	**5**	**4**	**39**

S. NO.	**Reachability Set**	**Antecedent Set**	**Intersection Set**	**Level**
1	1,2,3,4,5,7,8,9	1,3,9	1,3,9	I
2	2,3,5,6,7,8,9	1,2,3,5	2,3,5	
3	1,2,3,4,5,6,7,8,9	1,2,3	1,2,3	
4	4	1,3,4,5,9	4	III
5	2,4,5,6	1,2,3,5,9	2,5	II
6	6	2,3,5,6,9	6	III
7	7	1,2,3,7,9	7	III
8	8	1,2,3,8,9	8	III
9	1,4,5,6,7,8,9	1,2,3,9	1,9	II

Table: Level Partitioning



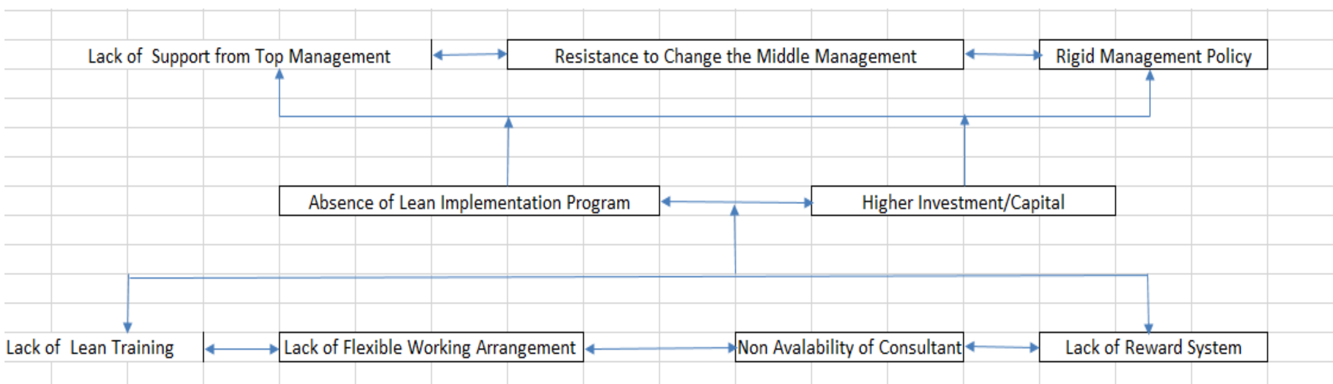


Table: ISM Model Hierarchy

RESULT & DISCUSSION

Autonomous variables generally appear as weak and weak dependent drivers and are relatively separate from the system. These variables do not have much impact on the other variables of the system. The absence of the implementation team, the lack of flexible working conditions, the lack of consultants and the lack of a reward system are included in the category of autonomous variables and are linked in the structure. Therefore, these are stable factors. Less support from top management, less support from middle management, and higher investment costs drive the barriers. Therefore, these barriers must be emphasized in order to do a lean job.Nowadays, competition exists between integrated lean barriers and not between individual organizations. To be more competitive, a lean practice must be well coordinated and receptive. This study has identified eight hurdles.

The interpretive structural model (ISM) approach was used to develop the structural relationship between these barriers. The ISM approach helped to determine the drive power and the dependency of all variables. It is noted that resisting the change in mid-level management and high investment costs are the main drivers of lean barriers. These barriers must be considered in order to achieve a lean practice.

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