

Sustainability in the Supply Chain: Analysing the Enablers

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Abstract The purpose of this chapter is to identify the enablers to sustainability in the Supply Chains and to understand their mutual relationships. Interpretive structural modelling was applied to present a hierarchy-based model and identify the contextual relationships among these enablers. This chapter defines sustainability, the Supply Chain (metastructure) and presents the ISM Methodology. The chapter presents the mutual relationships among the enablers of sustainability in the Supply Chain. Research shows that not all enablers to sustainability in the Supply Chain require the same amount of attention. A group of enablers that have high driving power and low dependence, requiring maximum attention exists. This classification will help Supply Chain managers to differentiate between independent and dependent variables. This classification will help them to focus on those variables that are most important for the transformation of the Supply Chain in sustainability.

Keywords Sustainability • Supply chain • Sustainable supply chains • Structural self-interaction matrix • ISM methodology

1 Introduction

A supply chain is a network of organizations that are involved in different processes and activities that produce value in the form of products and services in the hands of the ultimate consumer (Christopher 1998). The Supply Chain is a

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metastructure (Grzybowska 2010b). A metastructure is an intermediate form between a single enterprise (microstructure) and global economy (macrostructure). A metastructure is characterized by a dynamic holarchy of cooperating holons (commercial entities). They are parts and wholes at the same time (Wilber 2007). The enterprises join the Supply Chains and contribute various, unique capacities or skills (a characteristic of holons). The greater the supply chain grows, the less coherent and lacking close relationships it is (Grzybowska 2010a). In turn, this results in a situation in which in such a metastructure's connections and dependencies may vary in permanence. One differentiates permanent links (the so-called core supply chain) and dynamic ones which change depending on the task carried out (the so-called temporary links). After cooperation is concluded, the temporary links become disconnected from the supply chain cooperation. The Supply Chain is a concept designed to manage entire supply chains consisting of numerous participating organizations (Mentzer et al. 2001, p. 7).

The concept of sustainable development is the result of the growing awareness of the global links between mounting environmental problems, socio-economic issues to do with poverty and inequality and concerns about a healthy future for humanity (Hopwood et al. 2005, p. 39). Lee (2000), p. 32 has argued, 'sustainable development is an unashamedly anthropocentric concept'. The World Business Council for Sustainable Development defines sustainability as the "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Peters et al. 2007). According to Elkington, "a business needs to measure and report economic, social, and ecological business performance in order to achieve corporate sustainability" (Hamprecht 2006, p. 9).

But what is sustainability in the Supply Chain (or the Sustainable Supply Chain (SSC), the Environmentally Responsible Supply Chain, Green Supply Chain (GSC), green logistics and reverse logistics)? Sustainability in the Supply Chain is a key component of corporate responsibility. Sustainability in the supply chain is the management of environmental, social and economic impacts, and the encouragement of good governance practices, throughout the lifecycles of goods and services (Supply Chain Sustainability a practical Guide for Continuous improvement 2010). Sustainable Supply Chain is the management of raw materials and services from suppliers to manufacturer/service providers to customers and back with the improvement of the social and environmental impacts explicitly considered.

The supply chain has been traditionally defined as a one-way, integrated manufacturing process wherein raw materials are converted into final products, then delivered to customers. The change environmental requirements affecting manufacturing operations, increasing attention is given to developing Environmental Management (EM) strategies for the supply chain—Green Supply Chain (Beamon 1999). While traditional logistics seeks to organise forward distribution, that is the transport, warehousing, packaging and inventory management from the producer to the consumer, environmental considerations opened up markets for recycling and disposal, and led to an entire new sub-sector: reverse logistics (Rodrigue et al. 2001, p. 2). While the term reverse logistics is widely used, other

names have been applied, such as reverse distribution, reverse-flow logistics, and green logistics (Byrne and Deeb 1993).

The growing concern about sustainable development has an increasingly greater impact upon the Supply Chains and SCM. As stated by Linton et al. (2007), p. 1078: sustainability also must integrate issues and flows that extend beyond the core of SCM: product design, manufacturing by-products, by-products produced during product use, product life extension, product end-of-life, and recovery processes at end-of-life.

The Sustainable Supply Chain requires a broadened approach to the Supply Chain. In the case of sustainable or “green” SCM, supply chain members are encouraged to fulfil customers’ needs concerning ecological or social products (Zhu and Sarkis 2004, p. 265).

The main objectives of this chapter are:

- to identify and rank the barriers to adoption of sustainability in the Supply Chain practices in business,
- to find out the relation and interaction among identified barriers using ISM.

2 Enablers of Sustainability in the Supply Chain

An enabler is defined as “as one that enables another to achieve an end” where enable implies to make able; give power, means, competence, or ability to (Merriam-Webster). An enabler is considered as a variable that enables (ability to) the attainment of the Sustainable Supply Chain. This definition is consistent with the use of the term enabler in ISM models (Raj et al. 2008), growth enablers in construction companies (Bhattacharya and Momaya 2009), information technology (IT) enablement in the Supply Chain (Jharkharia and Shankar 2004), enablers of reverse logistics (Ravi et al. 2005), IT enablers for Indian manufacturing small and medium enterprises (SMEs) (Thakkar et al. 2008), supply chain performance measurement system implementation (Charan et al. 2008).

In this chapter, 16 important variables (enablers) that inhibit sustainability in the Supply Chain, are selected based on a review of the literature and through discussions with practicing managers in operations and management functions from manufacturing industries (Table 1).

3 ISM Methodology

It is generally felt that individuals or groups encounter difficulties in dealing with complex issues or systems. The complexity of the issues or systems is due to the presence of a large number of elements and interactions among these elements. The presence of directly or indirectly related elements complicates the structure of the

Table 1 Sustainability in the supply chain—enablers (Svensson 2007; Min and Galle 1997a; Zsidisin and Siferd 2001; Zhu et al. 2007; Min and Galle 1997b)

No. Enablers	
1	Commitment from top management Buyer awareness Supplier awareness
2	Adequate adoption of reverse logistic practice (Environmental Performance): Reduction of air emission Reduction of waste water Reduction of solid wastes Decrease of consumption for hazardous/harmful/toxic materials Decrease of frequency for environmental accidents Improve a company's environmental situation
3	Eco-literacy amongst supply chain partner (Green purchasing): Providing design specifications to suppliers that include environmental requirements for purchased items Cooperation with suppliers for environmental objectives Environmental audit for suppliers' inner management Suppliers' ISO14000 certification Second-tier supplier environmentally friendly practice evaluation
4	Corporate social responsibility Environmental standards Auditing programs
5	Mutual transparency: Development of alliances—horizontal, vertical Collaborative practices Instantaneous information sharing via Internet aimed at improving supply chain sustainability
6	Market demand Environmentally friendly products
7	Logistics asset sharing The joint use of a warehouse by two or more actors of the SC Deliveries optimisation for two or more customers
8	Adoption of a cleaner technology (a logistics solution using the so-called clean transport modes): Barge Multimodal Piggyback traffic for deliveries to the points of sale
9	High level of supply chain integration
10	Partnership Partnerships to develop common sustainable solutions Pioneering experiences with ecological organizations, socially or environmentally involved non-governmental organizations (NGOs) Lobbies Adopt innovation Research and development (R&D) Suppliers' capability in product development

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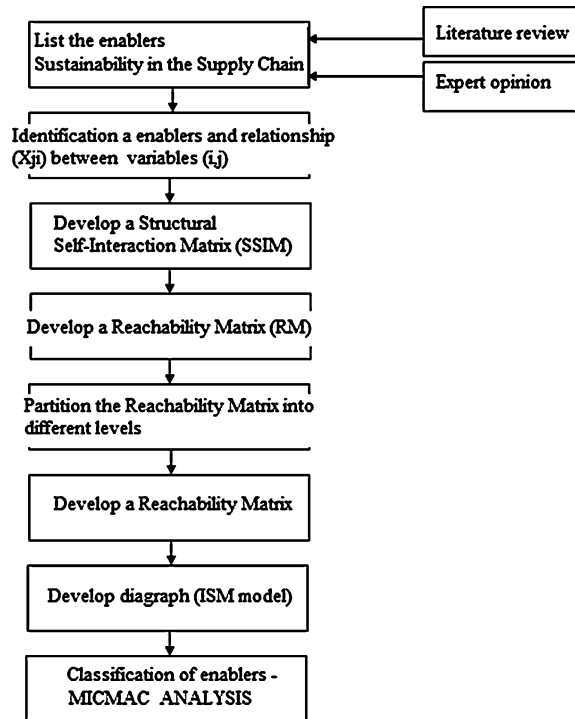
Table 1 (continued)

No.	Enablers
11	Continuous improvement Training and development Learning-by-doing
12	Collective development of labels, standards, norms, best practices databases, existing guidelines, voluntary agreements, and private sectors initiatives for self-regulation
13	Waste management Biodegradation Nontoxic incineration Scrapping Product returns Source reduction Recycling Material substitution Reuse of materials Waste disposal Re-manufacturing Repair
14	Logistics organisation ensuring goods safety and consumer health (ex: via the set up of tracking and tracing tools all along the chain, the search for transport scheduling and routing optimisation) (ex: load factor improvement, optimisation of replenishment and deliveries, delivery trip reconfiguration, the integrated planning of both production and sourcing sites, etc.)
15	Cooperation with customers including environmental requirements Cooperation with customer for eco-design Cooperation with customers for cleaner production Cooperation with customers for green packaging Cooperation with customers for using less energy during product transportation
16	Eco-design Design of products for reduced consumption of material/energy Design of products for reuse, recycle, recovery of material, component parts Design of products to avoid or reduce use of hazardous of products and/or their manufacturing process

system which may or may not be articulated in a clear fashion. It becomes difficult to deal with such a system in which the structure is not clearly defined (Raj et al. 2008).

Interpretive Structural Modeling (ISM) is defined as a process aimed at assisting the human being to better understand and clearly recognize what one does not know (Farris and Sage 1975). The ISM process transforms unclear, poorly articulated mental models of systems into visible and well defined models. ISM is an interactive learning process. In this technique, a set of different directly and indirectly related elements are structured into a comprehensive systematic model. The model so formed portrays the structure of a complex issue or problem in a carefully designed pattern implying graphics as well as words (Singh et al. 2003; Ravi and Shankar 2005).

Fig. 1 Flow diagram for constructing an interpretive structural modeling; based on (Kumar et al. 2009)



Interpretive Structural Modeling was first proposed by Warfield (1976). It enables individuals or groups to develop a map of the complex relationships between many elements involved in a complex decision situation (Charan et al. 2008).

It is a method for developing the hierarchy of system enablers to represent the system structure (Sharma et al. 2011). Interpretive Structural Modeling is often used to provide a fundamental understanding of complex situations, as well as to put together a course of action for solving a problem. The ISM process transforms unclear, poorly articulated mental models of systems into visible, well-defined models useful for many purposes (Ahuja et al. 2009).

The important characteristics of ISM are as follows (Sharma et al. 2011):

- This methodology is interpretive, as the judgment of the group decides whether and how the different elements are related.
- It is structural on the basis of mutual relationships as the overall structure is extracted from the complex set of elements.
- It is a modeling technique, as the specific relationships and overall structure are portrayed in a digraph model.
- It helps to impose order and direction to the complexity of relationships among various elements of a system (Sage 1977).

ISM is a powerful technique, which can be applied in various fields. Interpretive Structural Modeling is used by a number of researchers (Mandal and

Deshmukh 1994; Bolanos et al. 2005; Faisal et al. 2006; Ramesh et al. 2008; Faisal 2010; Sharma et al. 2011). The various steps involved in the ISM technique are represented in the form of a flow diagram (see Fig. 1).

The various steps involved in the ISM technique are as follows:

Step 1: Different enablers (or variables), which are related to defined problems, are identified.

Step 2: A Structural Self-Interaction Matrix (SSIM) is developed for enablers. This matrix indicates the pair-wise relationship among enablers of the system. This matrix is checked for transitivity.

Step 3: A Reachability Matrix (RM) is developed from the SSIM.

Step 4: The RM is partitioned into different levels.

Step 5: The Reachability Matrix is converted into its conical form, i.e. with most zero (0) elements in the upper diagonal half of the matrix and most unitary (1) elements in the lower half.

Step 6: Based upon the above, a directed graph (digraph) is drawn and transitivity links are removed.

Step 7: Digraph is converted into an ISM model by replacing nodes of the elements with statements.

Step 8: The ISM model is checked for conceptual inconsistency and necessary modifications are incorporated.

4 The Formation of Structural Self-Interaction Matrix (SSIM)

Identification of enablers. The elements of the system are identified which are relevant to the problem or issue and then achieved with a group problem-solving technique such as brain storming sessions. On the basis of the review of literature for sustainability in the Supply Chain, a total 16 enablers were identified.

After identifying and enlisting the 16 enablers through the review of literature and expert opinions, the next step is to analyse these enablers. For this purpose, a contextual relationship of “leads to” type is chosen. Bearing the contextual relationship for each enabler in mind, the existence of a relation between any two enablers (i and j) and the associated direction of this relation has been decided.

Contextual Relationship. From the enablers identified in step 1, a contextual relationship is identified among enablers with respect to which pairs of variables would be examined. This step transforms the list into a matrix and marks dependencies using expert opinions. After resolving the enablers set under consideration and the contextual relation, a Structural Self-Interaction Matrix (SSIM) is prepared.

Four symbols are used to denote the direction of relationships between the enablers (i and j):

- V: for the relationship from enabler i to enabler j and not in both directions;
- A: for the relationship from enabler j to enabler i and not in both directions;

Table 2 Structural self-interactive matrix (SSIM)

No.	Enablers	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2
1	Commitment from top management	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V
2	Adequate adoption of reverse logistic practice	A	O	O	X	A	O	A	O	O	O	O	O	O	O	A
3	Eco-literacy among supply chain partner	O	V	V	V	V	V	O	O	V	V	O	O	V		
4	Corporate social responsibility	O	O	V	V	V	O	O	O	V	V	O	V			
5	Mutual transparency	O	V	V	O	V	O	A	A	O	O	A				
6	Market demand	V	V	V	O	V	O	O	O	V	O					
7	Logistics asset sharing	O	O	O	O	O	O	A	A	O						
8	Adoption of cleaner technology	A	A	A	V	V	O	O	O							
9	High level of supply chain integration	O	A	A	V	V	O	V								
10	Partnership	O	V	V	O	V	O									
11	Continuous improvement	O	O	O	V	V										
12	Collective development of lables, standards, ...	O	V	V	V											
13	Waste management	A	O	A												
14	Logistics organisation ensuring good safety and consumer health	A	A													
15	Cooperation with customers including environmental	V														
16	Eco-design															

- X: for both the directional relationships from enabler i to enabler j and j to i ;
- O: if the relationships between the enablers did not appear valid (enablers i and j are unrelated).

The first step is to analyse the contextual relationship of “leads to” type. Based on this contextual relationship, a Structural Self- Interaction Matrix is developed.

Based on the review of literature and expert’s responses, the SSIM is constructed as shown in Table 2.

Based on the contextual relationships between enablers, the SSIM has been developed. To obtain consensus, the Structural Self-Interaction Matrix was discussed among a group of experts. Based on their responses, the SSIM has been finalized and it is presented in Table 2. The following statements explain the use of symbols in Structural Self-Interaction Matrix, e.g.:

- Symbol V is assigned to cell (1, 16) as enabler 1 influences or reaches enabler 16.
- Symbol A is assigned to cell (2, 16) as enabler 16 influences the enabler 2.
- Symbol X is assigned to cell (2, 13) as enablers 2 and 13 influence each other.
- Symbol O is assigned to cell (5, 16) as enablers 5 and 16 are unrelated.

Table 3 Initial reachability matrix

No.	Enablers	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	Commitment from top management	1	1	1	1	1	0	1	1	1	1	1	1	0	1	1	1
2	Adequate adoption of reverse logistic practice	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0
3	Eco-literacy among supply chain partner	0	1	1	1	0	0	1	1	0	0	1	1	1	1	1	0
4	Corporate social responsibility	0	0	0	1	1	0	1	1	0	0	0	1	1	1	0	0
5	Mutual transparency	0	0	0	0	1	0	0	0	0	0	0	1	0	1	1	0
6	Market demand	0	0	0	0	1	1	0	1	0	0	0	1	0	1	1	1
7	Logistics asset sharing	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
8	Adoption of cleaner technology	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0
9	High level of supply chain integration	0	0	0	0	1	0	1	0	1	1	0	1	1	0	0	0
10	Partnership	0	1	0	0	1	0	1	0	1	1	0	1	0	1	1	0
11	Continuous improvement	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0
12	Collective development of lables, standards, ...	0	1	0	0	0	0	0	0	0	0	0	1	1	1	1	0
13	Waste management	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0
14	Logistics organisation ensuring good safety and consumer health	0	0	0	0	0	0	0	1	1	0	0	0	1	1	0	0
15	Cooperation with customers including environmental	0	0	0	0	0	0	0	1	1	0	0	0	0	1	1	1
16	Eco-design	0	1	0	0	0	0	0	1	0	0	0	0	1	1	0	1

4.1 Reachability Matrix

Final reachability matrix. The next step is to develop the Reachability Matrix (RM) from the Structural Self-Interactive Matrix. This is obtained in two sub-steps.

In the first sub-step, the Structural Self-Interaction Matrix is transformed into a binary matrix (see Table 3), called the initial reachability matrix by substituting V , A , X , O by 1 and 0 as per the case. The rules for the substitution of 1 s and 0 s are as follows:

- 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 .
- 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 .
- 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 also becomes 1 .
- 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 also becomes 0 .

In the second sub-step, the final reachability matrix is prepared (see Table 4). The concept of transitivity is introduced so that some of the cells

Table 4 Final reachability matrix

No.	Enablers	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Driver
1	Commitment from top management	1	1	1	1	1	0	1	1	1	1	1	1	0	1	1	1	14
2	Adequate adoption of reverse logistic practice	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	2
3	Eco-literacy among supply chain partner	1*	1	1	1	0	0	1	1	0	0	1	1	1	1	1	0	11
4	Corporate social responsibility	1*	0	1*	1	1	0	1	1	0	0	0	1	1	1	0	0	9
5	Mutual transparency	0	0	0	0	1	0	0	0	1*	1*	0	1	0	1	1	0	6
6	Market demand	0	0	0	0	1	1	0	1	0	0	0	1	0	1	1	1	7
7	Logistics asset sharing	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
8	Adoption of cleaner technology	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	3
9	High level of supply chain integration	0	1*	0	0	1	0	1	0	1	1	0	1	1	1*	1*	0	9
10	Partnership	0	1	0	0	1	0	1	0	1	1	0	1	0	1	1	0	8
11	Continuous improvement	0	0	1*	0	0	0	0	0	0	0	1	1	1	0	0	0	4
12	Collective development of lables, standards, ...	0	1	0	0	1*	0	0	1*	1*	1*	0	1	1	1	1	0	10
13	Waste management	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	2
14	Logistics organisation ensuring good safety and consumer health	1*	0	0	0	1*	0	0	1	1	1*	0	1*	1	1	0	0	8
15	Cooperation with customers including environmental	0	1*	0	0	1*	0	0	1	1	1*	0	1*	1*	1	1	1	10
16	Eco-design	1*	1	0	0	0	1*	0	1	0	0	0	0	1	1	1*	1	
	Dependence	6	10	5	4	9	3	7	10	8	8	5	12	12	12	10	5	–

Note 1* entries are included to incorporate transitivity

of the initial reachability matrix are filled by inference. The transitivity concept is used to fill the gap, if any, in the opinions collected during the development of the SSIM.

Table 5 Iteration 1

No	Reachability set	Antecedent set	Intersection set	Level
1	1,2,3,4,5,6,7,8,9,10, 11,12,13,14,15	1,3,4,16	1,3,4,14	1
2	2,13	1,2,3,9,10,12,13,15,16	2,13	
3	1,2,3,4,7,8,11,12,13,14,15	1,3,4,11	1,3,4,11	
4	1,3,4,5,7,8,12,13,14	1,3,4,6	1,3,4	
5	5,9,10,12,14,15	1,4,5,6,9,10,12,14,15	5,9,10,12,14,15	1
6	4,5,6,8,12,14,15,16	6,16	6,16	
7	7	1,3,4,7,9,10	7	
8	8,12,13	1,3,4,6,8,12,14,15,16	8,12	
9	2,5,7,9,10,12,14,15	1,5,9,10,12,14,15	5,9,10,12,14,15	1
10	2,5,7,9,10,12,14,15	1,5,9,10,12,14,15	5,9,10,12,14,15	
11	3,11,12,13	1,3,11,12	3,11,12	
12	2,5,8,9,10,11,12,13,14,15	1,3,4,5,6,8,9,10,11,12,14,15	5,8,9,10,11,12,14,15	
13	2,13	2,3,4,8,9,11,12,13,14,15,16	2,13	1
14	1,5,8,9,10,12,13,14	1,3,4,5,6,9,10,12,14,15,16	1,5,9,10,12,14	
15	2,5,8,9,10,12,13,14,15,16	1,3,5,6,9,10,12,15,16	5,9,10,12,15,16	
16	1,2,6,8,13,14,15,16	6,15,16	6,15,16	

Table 6 Iteration 2–4

No	Reachability set	Antecedent set	Intersection set	Level
8	8,12	1,3,4,6,8,12,14,15,16	8,12	II
11	3,11,12	1,3,11,12	3,11,12	II
5	5,9,10,14,15	1,4,5,6,9,10,14,15	5,9,10,14,15	III
9	5,9,10,14,15	1,5,9,10,14,15	5,9,10,14,15	III
10	5,9,10,14,15	1,5,9,10,14,15	5,9,10,14,15	III
12	5,9,10,14,15	1,4,5,6,9,10,14,15	5,9,10,14,15	III
14	1,5,9,10,14	1,4,5,6,9,10,14,15,16	1,5,9,10,14	III
1	4	4,16	4	IV
3	4	4	4	IV
4	4	4,6	4	IV
6	4,6,16	6,16	6,16	IV
15	16	6,16	16	IV
16	6,16	6,16	6,16	IV

4.2 Level Partitions

Level partition. In the present case, the 16 enablers, along with their reachability set, antecedent set, intersection set and levels, are presented in Tables 5 and 6. The level identification process of these enablers is completed in four iterations as shown in Tables 5 and 6.

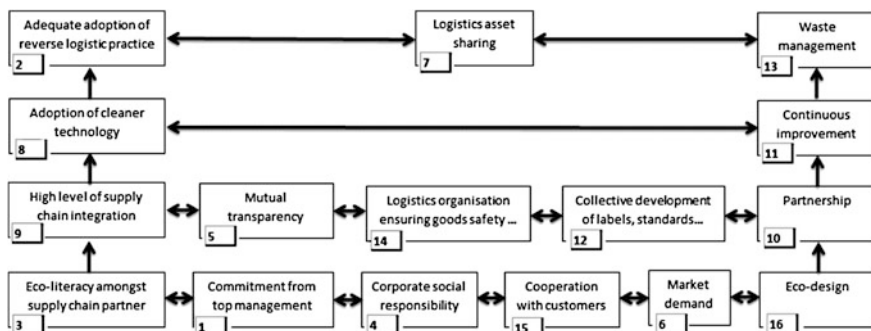


Fig. 2 The ISM based model for enablers of sustainability in a supply chain

4.3 Building the ISM Model

The development of the ISM model. The diagram for interpretive structural modelling is drawn. Having identified the levels of the elements, the relations between the elements is drawn with the help of an arrow. The level I enablers are in the top level in the hierarchy. The enablers of the same level are kept on the same level of hierarchy. The diagrams give information about the hierarchy between the elements of enablers for the successful implementation of sustainability in the Supply Chain (see Fig. 2).

The most important enablers in this case are: 'Eco-literacy amongst supply chain partners', 'Commitment from top management', 'Corporate social responsibility', 'Cooperation with customers including environmental requirements', 'Market demand' and 'Eco-design'. Enablers are the base of ISM hierarchy. 'Market demand' (enabler 6) leads to 'Eco-design' (enabler 16) and 'Cooperation with customers including environmental requirements' (enabler 15). 'Eco-literacy amongst supply chain partners' (enabler 3) and 'Commitment from top management' (enabler 1) leads to more 'Corporate social responsibility' (enabler 4).

4.4 Classification of Enablers: MICMAC Analysis

The purpose of Cross-Impact Matrix Multiplication Applied to the Classification analysis (MICMAC) is to analyse the drive power and dependence power of enablers (Mandal and Deskmukh 1994). This is done to identify the key enablers that drive the system in various categories. The variables are classified into four clusters (see Fig. 3).

In the present case, they have been classified into four categories as follows:

- The first cluster consists of autonomous variables (*Autonomous enablers*). These enablers have a weak drive power and weak dependence. They are relatively

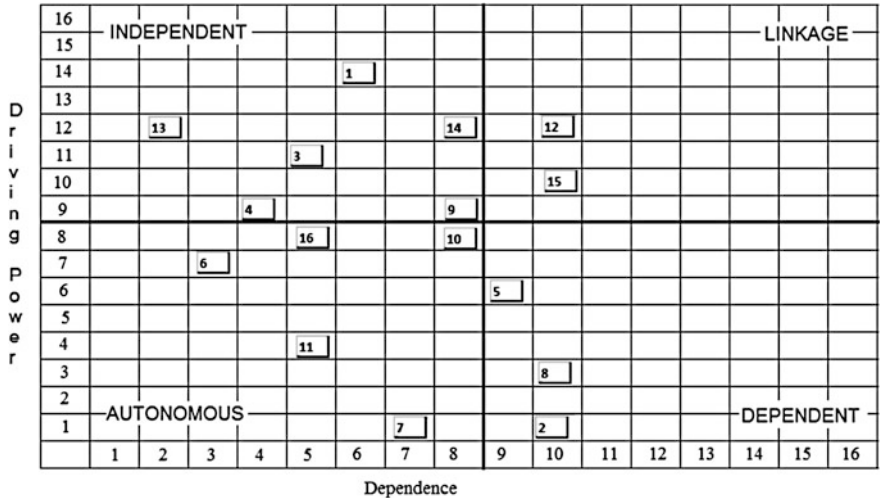


Fig. 3 Clusters of enablers in the implementation of sustainability in the supply chain

- disconnected from the system, with which they have few links, which may be very strong.
- The second cluster consists of the dependent variable (*Linkage enablers*). These have strong drive power as well as strong dependence. They are also unstable. Any action on them will have an effect on others and also a feedback effect on themselves.
 - The third cluster has the linkage variables (*Dependent enablers*). This category includes those enablers which have a weak drive power but strong dependence power.
 - The fourth cluster includes the independent variables (*Independent enablers*). These have a strong drive power but a weak dependence power. It is generally observed that an enabler with a very strong drive power, called the ‘key enabler’ falls into the category of independent or linkage enablers.

The driver power and dependence of each of these enablers is constructed as shown in Fig. 3 (The driver power-dependence Matrix).

4.5 Discussion

In this research, an ISM-based model has been developed to analyse the interactions among different enablers. The main objective of this research is to analyse the effectiveness of various enablers which help in the implementation of sustainability in the Supply Chain in any industry. The methodology proposed here identifies the hierarchy of actions to be taken for handling different enablers’ ability to implement sustainability in the Supply Chain. These enablers need to be use for success in the Supply Chain.

The managers can gain insight into these enablers and understand their relative importance and interdependencies. The driver dependence diagram gives some valuable insight about the relative importance and interdependencies among the sustainability in the Supply Chain enablers.

Some of the important implications emerging from this study are as follows:

Figure 3 shows that in Autonomous enablers are five enablers: 'Market demand' (enabler 6), 'Logistics asset sharing' (enabler 7), 'Partnership' (enabler 10), 'Continuous improvement' (enabler 11), 'Eco-design' (enabler 16). Autonomous enablers are weak drivers and weak dependents and do not have much influence on the system.

Two enablers are Linkage enablers. Linkage enablers are 'Collective development of labels, standards, norms, best practices databases, existing guidelines, voluntary agreements, and private sectors initiatives for self-regulation' (enabler 12) and 'Cooperation with customers including environmental requirements' (enabler 15). They have a strong driving power as well as high dependencies. If they are implemented in a proper way they can create a positive environment for the successful implementation of sustainability in the Supply Chain.

Enablers' 'Commitment from top management' (enabler 1), 'Eco-literacy amongst supply chain partner' (enabler 3), 'Corporate social responsibility' (enabler 4), 'Waste management' (enabler 13) and 'Logistics organisation ensuring goods safety and consumer health' (enabler 14) are Independent enablers. They have a strong driving power and weak dependency on other enablers.

'Adequate adoption of reverse logistic practice' (enabler 2), 'Mutual transparency' (enabler 5) and 'Adoption of cleaner technology' (enabler 8) are Dependent enablers. These enablers are weak drivers but strongly depend on one another. The managers should take special care to handle these enablers.

5 Conclusions

This model proposed for the identification of enablers of sustainability in the Supply Chain can help in deciding the priority to take steps proactively. The results of this research can help in strategic and tactical decisions for a company wanting to create sustainability in the Supply Chain. The main strategic decision relies on 'Eco-literacy amongst supply chain partners', 'Commitment from top management', 'Corporate social responsibility', 'Cooperation with customers including environmental requirements', 'Market demand' and 'Eco-design'. Enablers at the bottom of the ISM-based model are the most important enablers that initiate strategic activities.

The analysis reveals that six enablers 'Commitment from top management', 'Eco-literacy amongst supply chain partners', 'Corporate social responsibility', 'High level of supply chain integration', 'Waste management' and 'Logistics organisation ensuring goods safety and consumer health' are ranked as Independent enablers as they possess the maximum driver power. This implies that these

variables are key barriers in the successful implementation of sustainability in the Supply Chain.

The most important among them are 'Eco-literacy amongst supply chain partners', 'Commitment from top management' and 'Corporate social responsibility'.

There are a number of enablers affecting the implementation of sustainability in the Supply Chain. In this research, an interpretation of sustainability in the Supply Chain enablers in terms of their driving and dependence power has been carried out. With plain common sense, one can think that by focusing on the enablers 9, 10, 12, 14, 15 are essential components of sustainability in the Supply Chain and should to focus more on these enablers. But the results of research show that enablers 1, 13 have a higher driving power and are considered to be the key enablers.

The ISM-based model provides a very useful understanding of the relationships among the enablers. The present model can be statistically tested with use of structural equation modelling (SEM) which has the ability to test the validity of such models.

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