

Interpretive Structural Modeling (ISM) Approach: A State of the Art Literature Review

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Abstract

The main objective of this paper is to provide an up-to-date and structured insight of the recent literature review relating to Interpretive Structural Modeling (ISM) and its deployment for modeling the variables of Supply Chain Management (SCM) and other related fields. The literature of ISM is examined in three ways. First, studying the concept of ISM and examining ISM as modeling technique. Second, application of ISM for modeling the supply chain Management. Third, application of ISM technique by researchers in their work for modeling in different fields. This whole literature overview provides good base and clear guidance to researchers about the ISM methodology. By using ISM methodology, researcher and industry manager can develop the model from the variables of different fields which improves the performance of these fields.

Keywords

Interpretive Structural Modeling, SCM, Area other than SCM

I. Introduction

The term “supply chain” “supply chain management”, “supply chain integration” is not well-defined constructs. They have different meanings to different people and organizations [1]. SCM can be defined as “the management of upstream and downstream relationships with suppliers and customers in order to create enhanced value in the final market place at less cost to the supply chain as a whole”[2]. A supply chain is a system of organizations, people, activities, information, and resources involved in moving a product or service from supplier to customer. Supply chain activities transform natural resources, raw materials, and components into a finished product that is delivered to the end customer.

John. T, Mentzer, William De Witt, James. S, Keebler, Soonhong Min, Nnacy. W, Nix, Cario. D, Smith, Zach. G and Zacharia [3] identified the three degrees of supply chains: a direct supply chain, an extended supply chain and an ultimate supply chain. SCM takes a system approach to viewing the supply chains as a single entity, rather than as fragmented parts, each performing its own functions [4].

A. Modeling Techniques

In the literature, three main techniques like: Interpretive Structural Modeling (ISM), Analytic Network Process (ANP) and Analytic Hierarchy Process (AHP) are used for modeling and multi criteria decision making (MCDM) in the different area. Jitesh Thakkar et al. [5] have compared these three techniques and extracts from that comparison is shown in the Table 1. This comparison aims to represent the main advantages of ISM technique.

The term “Interpretive Structural Modeling” (ISM) is used here to refer to the systematic application of some elementary notions of graph theory in such a way that theoretical, conceptual, and computational is exploited to efficiently construct a directed graph, or network representation, of the complex pattern of a contextual relationship among a set of elements [6]. ISM is defined as a

process aimed at assisting the human being to better understand what he/she believes and to recognize clearly what he/she does not know. Its most essential function is organizational. The information added is zero. The value added is structural. The ISM process transforms unclear, poorly articulated mental models of systems into visible and well-defined models. It is primarily intended as a group learning process but can also be used individually [7].

ISM is being employed to address problems that are complex and subjective. Many researchers like: Faisal. M.N, Banwet, D.K and Shankar. R [8], Jitesh. T, Arun. K and Deshmukh. S.G [5], Mathiyazhagan. K [9], Sunil. L [10], Kannan. G [11] etc. have used ISM methodology for modeling the variables of SCM for improving the performance of the supply chain. Many researcher like: Ms. Parveen. F [12], Feifei. W [13], Adel. A [14] etc have used ISM methodology for modeling the variables in different fields other than SCM.

The aim of this paper reviews a sample of recent and classic literature in this field of application of ISM and in doing so this study provides some good base & clear guidance to researchers in developing, defining and presenting their research agenda for applying ISM methodology in a systematic manner. The main purpose of this literature review is to list, classify and review existing literature for the application of ISM methodology. The rest of the paper is organized as follows: Second section discusses the framework for the literature review, fourth section gives detailed review of the literature and Section 5 is conclusions, then references are presented.

Table 1: Brief comparison between AHP, ANP and ISM ((Source: Jitesh Thakkar 2008)

Analytic Hierarchy process (AHP)	Analytic Network Process(ANP)	Interpretive Structural modeling Technique(ISM)
Discipline of hierarchy has to be strictly followed	Deals with loose networks	Involves a set of interconnected criteria
Fails in complex real life problems	Useful in real life non-linear problems	Captures the complexities of real life problems
Assumes functional independence of an upper part of hierarchy from its lower one	Takes into account the interdependencies and non-linearity	Establishes the “leads to” relationships among the criteria
Moderate ability for capturing dynamic complexity	Lower ability for capturing complexity	Higher ability for capturing dynamic complexity

II. Framework for Literature Review

The research methodology employed for this literature review is the literature survey. The main intention of the literature review was to collect information from several research articles. Some articles published in the recent time on this issue: Mathiyazhagan.

K [9], Sunil, L [10], Kannan. G [11], Ms. Parveen. F [12], Feifei. W [13] etc. have provided the excellent ground to begin with. The literature search on ISM technique has been carried with the help of Science direct, Springer, E-Journals, Google search engine and SLIET e-library. From this no. of journals are accessed which are published by various publishers. The literature review methodology is shown in fig. 1.

To make review more clearly, scrutiny of collected papers is carried out based on the "Application of ISM in the research". As a result, 33 articles were chosen for the inclusion in this literature review. The area of research is SCM and other field rather than SCM. As a summary, the number of articles and their break up is shown in the Table 2.

Table 2: Number of papers in each classification

Classification area	Number of papers
Total paper collected	43
Basic concept/definition papers in ISM	4
Papers in the area of SCM	23
Others papers	16

III. Classification of the Literature

As the main objective of the literature is to investigate the literature for the use of ISM in supply chain management and other areas, therefore the selected articles are grouped in to three categories focusing on

1. ISM concept and definitions- basic papers
2. Application of ISM methodology in supply chain management (SCM): The papers in SCM are further sub-classified based on their area of application.
3. Application of ISM in the areas other than SCM

The main classification of literature is shown in the Figure 2 and summary of literature review under the proposed classification scheme are listed in the Tables-3, 4 and 5.

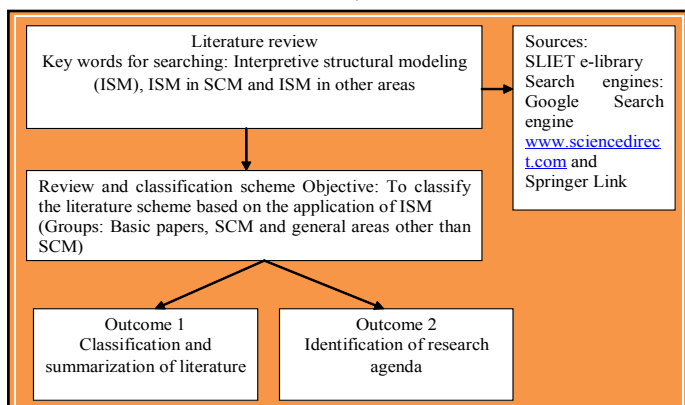


Fig. 1: Literature Review Framework

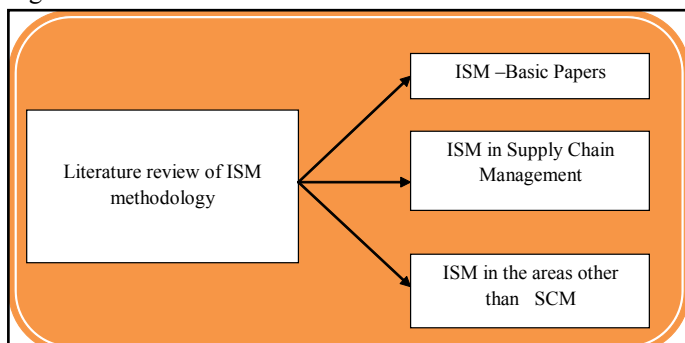


Fig. 2: Classification of the Literature

IV. Literature Review

In this section, literature is reviewed on the application and development of ISM.

A. Interpretive Structural Modeling (ISM)

Warfield [15] first proposes ISM in 1973. Warfield, J.N (1973a; 1974a; and 1 976) has developed a powerful methodology for structuring complex issues. Drawing upon discrete or finite mathematics, Warfield has produced a mathematical language applicable to many complex issues, provided that they can be analyzed in terms of sets of elements and relations. "Interpretive structural modeling" (ISM) is used here to refer to the systematic application of some elementary notions of graph theory in such a way that theoretical, conceptual, and computational leverage is exploited to efficiently construct a directed graph, or network representation, of the complex pattern of a contextual relationship among a set of elements [6].

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. Interpretive structural modeling (ISM) is a well-established methodology for identifying relationships among specific items, which define a problem or an issue. For any complex problem under consideration, a number of factors may be related to an issue or problem. However, the direct and indirect relationships between the factors describe the situation far more accurately than the individual factor taken into isolation. Therefore, ISM develops insights into collective understandings of these relationships [7].

ISM is a systematic application of some elementary graph theory in such a way that theoretical, conceptual and computational advantage are exploited to explain the complex pattern of conceptual relations among the variables [16]. The various steps for adopting the ISM methodology are extracted from [15], [17] and its logical flow are shown in fig. 3.

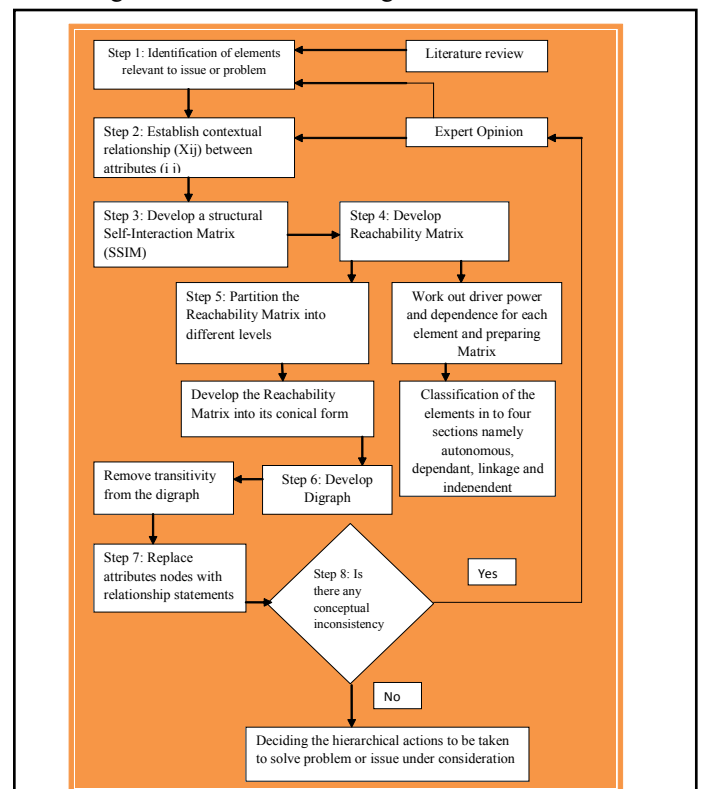


Fig. 3: Flow Diagram for Preparing Model by Using

Table 3: Summary of references under the detailed classification scheme for basic papers in ISM

Sr. No.	Authors and year of publication	Issues addressed/conclusions
1.	Malone (1975) [6]	Presents brief overview of ISM
2.	Warfield J (1976) [15]	Introduced ISM and he provided detailed descriptions and operating procedures
3.	F. R. Janes [18]	Brief introduction of ISM technique
4.	Rajesh Attri [7]	Brief overview of ISM and its Characteristics

B. ISM Methodology in Supply Chain Management

Supply chain management is a set of approaches, the management of upstream and downstream relationships with suppliers and customers in order to create enhanced value in the final market place at less cost to the supply chain as a whole [2]. The objective of literature review in this classification is to investigate the application of ISM in SCM.

1. ISM in Green Supply Chain Management

ISM technique is used in many Indian automobile industries to greening the supply chain. Sanjay. K [19] employed the ISM methodology for modeling the customer involvement variables in greening the supply chain. Mathiyazhagan. K [20] applied the ISM technique to study the influential pressures for green supply chain management adoption in Indian industries. Sunil. L [21] applied the ISM to analysis the Barriers to implement green supply chain management in automobile industry. Sreejith. B.S [22] employed ISM to study Hierarchical Framework for barriers to implement green supply chain management in the construction sector.

2. ISM in Sustainable Supply Chain Management

ISM methodology is used in various supply chain such as Sustainable Supply Chain Management. Shaikha. A. Z [23] employed the ISM methodology to analysis the interaction between the barriers for the implementation of sustainable supply chain management. 13 barriers are identified and relationship is developed in them.

3. ISM in Supply Chain Risk Management

Mohd. N.F, D.K, Banwet and Ravi. K [24] applied ISM for studying the variables of information risks management in supply chains. Faisal. M.N, Banwet, D.K and Shankar. R [8] employed ISM for modeling the enablers and barriers for supply chain risk mitigation.

4. ISM in Reverse Logistics

Reverse logistics is the process of moving goods from their typical final destination for the purpose of capturing value or proper disposal [25]. Reverse logistics is the process of moving goods from their typical final destination to another point, for the purpose of capturing value otherwise unavailable, or for the proper disposal of the products [26-27]. Reverse logistics is practiced in many industries, and its effective use can help a company to compete in all streams of advantages. Kannan. G [11] applied the ISM technique to analysis of third party reverse logistics provider from the n provider. Best third party reverse logistics is select by

ISM model.

5. ISM in Supplier Selection

ISM methodology is used for supplier selection in the Indian industries. Sudarshan. K [28] employed the ISM technique to study the Supplier Selection Process Enablers in the Indian industries. 12 Supplier Selection Process Enablers are identified and relationship is developed between them. The most important enablers are identified with help of ISM methodology.

6. ISM Methodology in the Areas other than SCM

In this section, application and development of ISM in the areas other than supply chain management are discussed in brief. A detailed review of the literature under this classification is shown in the Table 5.

7. ISM in Mobile Banking:

Manju. S [29] employed the ISM technique to study the Mobile Banking for SHG Bank Linkage Program in India for great reach. In this research barriers and drivers are identified and with the help of ISM methodology most dominate barrier and most important driver is identified. Highlighting the areas which need immediate attention at every level.

8. ISM in Total Productive Maintenance (TPM)

Rajesh. A [30] applied the ISM methodology to study about the enablers in the implementation of Total Productive Maintenance (TPM). In this 10 enablers are identified and model is developed with the help of ISM technique to find out the most important enabler in implementing the TPM.

9. ISM in Risk Control Decision

ISM methodology can be used in many risk control decision making. Chun. P.T [31] employed the ISM methodology to study a new viewpoint on risk control decision models for natural disasters and Identified major shortcoming with the employment of enhanced formal evaluation and decision making methods. With the help of ISM, elements are structured to form a comprehensive systemic model.

10. ISM in Business

Adel. A [14] employed the ISM methodology to Design a model for Business process-orientation. Identify the Dimensions and Indicators of Business process. Design an integrated business process orientation model through which dimensions and indicators of process orientation are identified and analyzed with the help of ISM methodology.

11. ISM in Olympic

Chinese government puts forward the concept of "Technology for Olympics", and implements "Technology for Olympics (2008) Action Plan" which have fund many researches projects. Feifei. W [13] employed ISM to study approaches on Evaluating Industrialization Potentiality of Olympic Technology Projects. Industrialization potential evaluation of "Technology for Olympics" based on ISM aiming at solving the conflict of "reality and reliability" and "time and resources limitation".

Table 4: Summary of references under the detailed classification scheme for ISM in SCM

Sr. No.	References	Deployed ISM to study
1.	Sunil. L [10]	Green supply chain practices implementation in Indian automobile industry
2.	Mathiyazhagan. K [9]	An ISM approach for the barrier analysis in implementing green supply chain management
3.	Sivaprakasam. R [32]	Implementation of interpretive structural modeling methodology as a strategic decision making tool in a Green Supply Chain Context
4.	Naveen. K [33]	ISM based framework for mitigating the bullwhip effect in supply chain for operational variables
5.	Sanjay. K [19]	Customer involvement in greening the supply chain: an interpretive structural modeling methodology
6.	Sudarshan. K [28]	Supplier selection process enablers: an interpretive structural modelling approach
7.	Sunil. L [21]	Barriers to implement green supply chain management in automobile industry using interpretive structural modeling technique-An Indian perspective
8.	Mathiyazhagan. K [20]	Analysis of the influential pressures for green supply chain management adoption— an Indian perspective using interpretive structural modeling
9.	Kannan. G [11]	Analysis of third party reverse logistics provider using interpretive structural modeling
10.	Shaikha. A.Z [23]	Analysis of interaction between the barriers for the implementation of sustainable supply chain management

11.	Sreejith. B.S [22]	A Hierarchical Framework of Barriers to Green Supply Chain Management in the Construction Sector
12.	Mohmad [24]	To study information risks management in supply chains
13.	Faisal M.N [8]	ISM in modelling the enablers and barriers for supply chain risk mitigation

V. Conclusion

In this paper, an attempt has been made to review the literature for deployment of ISM in SCM and area rather than SCM. This literature survey serves as a good base for identifying the agenda and provides a clear guidance to researchers in developing, defining and identifying their research agenda for applying ISM methodology in the research. Besides, from the foregoing discussion on the literature review, it can be concluded that ISM is used by various researchers for modeling the variables of supply chain management for improving the performance of supply chains. ISM is used in supplier selection, reverse logistics and Green Supply Chain Management. ISM is also used in other areas by the researchers to increase the performance of that field. ISM is used for modeling the risk control management in various natural disasters and it is also used for modeling the knowledge management barriers.

Table 5: Summary of references under the detailed classification scheme for ISM

Sr. No.	References	Issues addressed
1.	Manju. S [29]	Mobile Banking for SHG Bank Linkage Program in India: Structural Modeling for greater reach
2.	Rajesh. A [30]	An ISM approach for modeling the enablers in the implementation of Total Productive Maintenance (TPM)
3.	Chun. P.T [31]	A new viewpoint on risk control decision models for natural disasters
4.	Adel. A [14]	Designing a model for "Business process-orientation" using interpretive structural modeling approach (ISM)
5.	Feifei. W [13]	Approaches on Evaluating Industrialization Potentiality of Olympic Technology Projects Based on Interpretive Structural Modeling
6.	Cagno. E [34]	An interpretive model of occupational safety performance for Small- and Medium-sized Enterprises

7.	Parveen. F [12]	An Interpretive Structural Model for Project Planning and Success
8.	Md. Fahim. A [35]	Analysis of barriers to implement solar power installations in India using interpretive structural modeling technique
9.	M. D. Singh [36]	Knowledge management barriers: An interpretive structural modeling Approach
10.	Vimal. K.E [37]	Enhanced Renewable Energy Adoption for Sustainable Development in India: Interpretive Structural Modeling Approach
11.	Wei. L [38]	The research on the affecting factors of safety management of nuclear power based on improved ISM.
12.	Liu. Y.L [39]	Development of an Interpretive Structural Model of Factors in Emergency Materials Support
13.	Chidambaranathan. S [40]	Analyzing the interaction of critical factors of supplier development using Interpretive Structural Modeling—an empirical study
14.	Joseph. S [41]	Evaluating Environmentally Conscious Manufacturing Barriers with Interpretive Structural Modeling
15.	Prakash. K.K [42]	Total Interpretive Structural Modeling of Strategic Technology Management in Automobile Industry
16.	Karen. O.C [43]	Using Interpretive Structural Modeling in Senior High School Environmental Studies

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