

Analysis of Supply Chain Challenges Using Interpretive Structural Model

Ankit Kataria^{1*} and Dr. D.K. Singh²

^{1,2}Division of MPA Engineering Netaji Subhas Institute of Technology, New Delhi-110078
E-mail: ^{1*}katariaankit1993@gmail.com, ²dks662002@yahoo.com

Abstract—The retail industry in India is rapidly growing and is driving the country's economy. It provides lots of growth opportunities. Retailers are concentrating more on supply chain management (SCM) to reduce the overall costs involved in the supply chain. Disruption factors are common to every business and the ways to moderate and manage them is of current research interest. The research paper explores the selective challenges associated with the retail supply chains in India. It establishes the interdependencies among these challenges across various supply chain functions of retail industry by using Interpretive Structural Modeling (ISM). Globalization, outsourcing and unorganized sectors' dominance turns out to be strong drivers of other supply chain uncertainties. The effect of these challenges leads to a risk of business transformation for the organization.

Keywords: Supply chain management (SCM), Interpretive structural model (ISM), SCM-Challenges, Structural self-interaction matrix (SSIM).

1. INTRODUCTION

During the last two decades, supply chains of businesses have been experiencing rapid globalization and emerging technological changes especially in the manufacturing and retail business (Venkatesh, 2015). Understanding and execution of supply chain management practices have a key role for an organization in staying competitive and developing the organizational structure. Today, retailers give more emphasis to supply chains across industries. The most trusted brands do only the assembling of components, which are outsourced for manufacturing. This has made supply chains more complex, fragile and prone to many disruptions. Handling of information and coordination among manufacturer, distributors, suppliers, and retailers are major causes of supply chain disruptions. It is an established fact that recent commercial chains are dynamic networks of interconnected firms and industries (Hakansson and Snehorta, 2006). The search for better markets and cheaper sources of raw materials have made the supply chains more and more complex and retailers need to sustain their business (Sahin and Robinson, 2002; Ganesan et al., 2009 and Venkatesh et al., 2015).

Many disruptions have threatened production and retail distribution systems. The challenges directed a decline in the market share, cost escalation and dissatisfaction amongst customers. India, being a growing destination for the retail business, the challenges are to be analyzed from retailer's perspective, though the sector is highly fragmented. Challenges in supply chain may be categorized as intra-organization, inter-organization and customer-oriented, and these all are resulted in business model transformation. Intra-organization may include infrastructure, supply base, and scarcity of resources, whereas inter-organization consists of globalization, lead time and demand uncertainty. Customer behaviour and dissatisfaction fall under the category of customer-oriented challenges.

This paper explores and analyzes selective disruption factors in the domain of study. The study also proposes a methodology to prioritize challenges by analyzing the interdependencies between them. The contextual relationship is established through a technique, called Interpretive Structural Modeling (ISM). Thus, our proposed model is based on a notion that each challenge is associated with multiple ones in a way that either it drives them or is dependent on them. To design the mitigation strategies, the first step is to identify and analyze the challenges in terms of its frequency of occurrence, severity in terms of cost and what other disruptions it could lead to.

The paper is structured as follows. It starts with the introduction about the supply chain challenges, followed by the literature review on challenges and Indian retail industry from retailer's perspective. The subsequent sections explore the study on establishing the variables and ISM model formulation. It ends with the discussion on capabilities and conclusion that includes the managerial implications of the study.

2. LITERATURE REVIEW

Supply chain management (SCM) is defined by APICS as the "design, planning, execution, control and monitoring of supply chain activities with the objective of creating net value, building a competitive infrastructure, leveraging worldwide

logistics, synchronizing supply with demands and measuring performance globally". Technically, the term supply chain involves all the key functions from manufacturing of a product and to sell it in market. Primary purpose of any supply chain is to fulfill the customer needs and in process generates its profit.

The study explains the concept of supply chain from retailer's perspective. Over the past 20 years, fundamentals of governing power of supply chain have shifted from manufacturer to the retailers (Srinivasan, 2004), where producer once controlled the supply chain issues; organization closer to consumer are now taking the leadership control. Retailing in India is one of the pillars of its economy and accounts for about 10% of its GDP (Dikshit, 2011). Favourable foreign investment environment, strong economic growth and a consumption boom helped India to cross china to top the annual GRDI 2017. GDP is forecast to grow at 7.4% in 2017 and at 7.6% in 2018, growth of middle class and increased consumer spending beyond essentials (Kearney, 2017). As per NASSCOM's outlook for the year 2018, e-commerce sector of India is expected to grow by 17% in gross merchandised value (GMV) at \$38.5 billion.

The government of India currently allows 51% and 100% foreign direct investment (FDI) in multi-brand and single-brand retail respectively. These changes in FDI regulations are attracting foreign retailers and accelerating the growth in the government regulations, adoption of new technologies and evolving consumer needs are the major issues faced by the retailers in Indian market. According to Department of Industrial Policies and Promotion (DIPP), Indian retail trading has received FDI equity inflows totaling US \$ 1.09 billion during April 2000-September 2017. The indulgence of new strategies and technological advancement has great impact over supply chain management. Though modern retailing is not covered, the complete retailing sector of India, that is, the unorganized sector acts as a constraint in reaching the highest potential. Complex supply chain, poor infrastructure and lack of SCM professionals are a matter of concern in between retailers. Now retailers are not concentrating only on a single element of supply chain, but this evolution in retail industry has enforced them to transform the complete supply chain. Retailers are now much more cautious, while deciding the location of their stores. They prefer newer areas, which are not over retail as yet and are also looking at Tier II and III cities for expansion. Retailers would like to satisfy all the requirements of the consumer at one place so that consumers do not venture into competitors stores. Therefore on the basis of analysis of retail sector in India, challenges from retailers' perspective are identified and their risk priorities model is designed by using interpretive structural modeling (ISM).

3. RESEARCH METHODOLOGY

The main purpose of this paper is to develop contextual relationships between supply chain challenges and to prioritize them. The occurrence of one challenge gives rise to multiple

challenges resulting into a domino effect, which makes it very important for the managers to control these before they occur. Several journals, reports and studies on retail sectors are used to develop the ISM model to show the relationships between various challenges involved in the supply chain.

Table 1: Identification of Challenges

| CHALLENGE No. | CHALLENGES |
|---------------|---------------------------|
| C1 | Globalization |
| C2 | SCM Professionals |
| C3 | Scarcity of resources |
| C4 | Omni-channel fulfillment |
| C5 | Lack of co-ordination |
| C6 | Unorganized dominance |
| C7 | Infrastructure |
| C8 | lead time |
| C9 | Demand uncertainty |
| C10 | Customer behavior |
| C11 | Financial/business crises |
| C12 | Outsourcing |

4. INTERPRETIVE STRUCTURAL MODELING (ISM)

Interpretive structural modeling (ISM) is a process that transforms unclear and poorly articulated mental models of systems into visible, well-defined models useful for many purposes (Sushil, 2012 and Venkatesh et al., 2015). It is a structural relationship diagram, which makes it easy to visualize the inter relationship between various elements. In other words, it helps in presenting a complex system in a simplified format. It enables to make a mind map of elements, which depend on one another to form a complex relationship. The method has some limitations and it has been subsequently discussed. The model development is described in step by step approach in the next section. ISM facilitates the identification of the structure within a system.

Following are the steps involved in the ISM methodology (Jharkharia and Shankar, 2004; Faisal et al., 2006; Sushil, 2012 and Venkatesh et al., 2015):

1. Identification of Variables: The key variables of the system are identified using literature and journal studies.

2. Contextual Relationship: A contextual relationship is identified among each challenge (identified in step 1) with respect to which the pairs of challenge would be examined. The contextual relationship is in the form of a matrix called the structural self-interaction matrix (SSIM).

Following are the notations used to develop the SSIM:

V: Challenge i leads to variable j

A: Challenge j leads to variable i

X: Challenge i leads to variable j and vice versa

O: No relationship between the Challenges

3. Initial Reachability Matrix: The SSIM is then converted into a binary matrix, called initial reachability matrix by substituting *V*, *A*, *X* and *O* by 1 and 0 as per the following rules:

Rule 1: 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 is 0.

Rule 2: If the (i, j) entry in the SSIM is *A*, then the (i, j) entry in the reachability matrix is 0 and the (j, i) entry becomes 1.

Rule 3: 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.

Rule 4: 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.

4. Transitivity Check: The reachability matrix is developed from the SSIM and the matrix is checked for transitivity. The transitivity of the contextual relation is a basic assumption made in ISM. It states that if variable *A* is related to *B* and *B* is related to *C*, then *A* is necessarily related to *C*.

5. Priority Levels: The transitivity matrix obtained in step (4) is converted into the canonical matrix format by arranging the elements according to their levels.

6. Building the ISM Model: Variables in each level are then connected based on their relationships as defined in the structural self-interaction matrix.

Identification of the Variables (Table 1): A supply chain is susceptible to many types of challenges. We identified and categorized challenges into 12 distinct types that can be controlled and mitigated, if proper steps are taken.

Contextual Relationship: The structural self-relationship matrix here, explores the interdependencies among the selected challenges. Globalization in the retailing sector may lead to several other challenges, such as infrastructure, complexities in supply chain, outsourcing the business and hiring of SCM professionals. Scarcity of resources has a reverse effect over globalization, as it triggers the material shipment through globalized partner (Venkatesh et al., 2015). The delay in the procurement of material is a result of lack of coordination, and uplifts the fault of SCM professionals in designing the supply chain. The dominance of unorganized sector restricts the establishments of modern retailing in Indian market, and acts as a barrier in Omni-channel fulfillment due to poor infrastructure and logistics. Customer perception depends upon the ease and the facility provided by the firm, and is very much important for its growth and stability. The contextual relationship is shown in Table 2.

Table 2: Structural Self-Relationship Matrix

| | C12 | C11 | C10 | C9 | C8 | C7 | C6 | C5 | C4 | C3 | C2 |
|-----|-----|-----|-----|----|----|----|----|----|----|----|----|
| C1 | V | V | O | O | V | V | O | O | V | A | V |
| C2 | O | O | V | O | O | V | O | O | O | A | - |
| C3 | O | V | O | O | V | O | O | V | V | - | - |
| C4 | O | V | O | O | V | O | O | A | - | - | - |
| C5 | X | V | O | O | V | V | A | - | - | - | - |
| C6 | V | V | O | O | V | V | - | - | - | - | - |
| C7 | A | V | V | O | X | - | - | - | - | - | - |
| C8 | A | V | V | A | - | - | - | - | - | - | - |
| C9 | O | V | O | - | - | - | - | - | - | - | - |
| C10 | A | V | - | - | - | - | - | - | - | - | - |
| C11 | A | - | - | - | - | - | - | - | - | - | - |
| C12 | - | - | - | - | - | - | - | - | - | - | - |

Table 3: Initial Reachability Matrix

| | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 | C11 | C12 |
|-----|----|----|----|----|----|----|----|----|----|-----|-----|-----|
| C1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 |
| C2 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| C3 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 |
| C4 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 |
| C5 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 1 |
| C6 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 |
| C7 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 |
| C8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 |
| C9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 |
| C10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| C11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| C12 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 1 |

Table 4: Transitivity Matrix

| | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 | C11 | C12 |
|-----|----|----|----|----|----|----|----|----|----|-----|-----|-----|
| C1 | 1 | 1 | 0 | 1 | 1* | 0 | 1 | 1* | 0 | 1* | 1 | 1 |
| C2 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1* | 0 | 1 | 1* | 0 |
| C3 | 1 | 1 | 1 | 1 | 1 | 0 | 1* | 1 | 0 | 1* | 1 | 1* |
| C4 | 0 | 0 | 0 | 1 | 0 | 0 | 1* | 1 | 0 | 1* | 1 | 0 |
| C5 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1* | 1 | 1 |
| C6 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1* | 1 | 1 |
| C7 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 |
| C8 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 |
| C9 | 0 | 0 | 0 | 0 | 0 | 0 | 1* | 1 | 1 | 1* | 1 | 0 |
| C10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| C11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| C12 | 0 | 0 | 0 | 1* | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 |

Table 5: Priority Level Matrices

5.1 Level 1

| Variables | Reachability set | Antecedent set | Intersection | Level |
|-----------|------------------------|----------------------------|--------------|-------|
| C1 | 1,2,4,5,7,8,10,11,12 | 1,3 | 1 | |
| C2 | 2,7,8,10,11 | 1,2,3 | 2 | |
| C3 | 1,2,3,4,5,7,8,10,11,12 | 3, | 3 | |
| C4 | 4,7,8,10,11 | 1,3,4,5,12 | 4 | |
| C5 | 4,5,7,8,10,11,12 | 1,3,5,6,12 | 5,12 | |
| C6 | 5,6,7,8,10,11,12 | 6 | 6 | |
| C7 | 7,8,10,11 | 1,2,3,4,5,6,7,8,9,12 | 7,8 | |
| C8 | 7,8,10,11 | 1,2,3,4,5,6,7,8,9,12 | 7,8 | |
| C9 | 7,8,9,10,11 | 9 | 9 | |
| C10 | 10,11 | 1,2,3,4,5,6,7,8,9,10,12 | 10 | |
| C11 | 11, | 1,2,3,4,5,6,7,8,9,10,11,12 | 11 | I |
| C12 | 4,5,7,8,10,11,12 | 1,3,5,6,12 | 5,12 | |

5.2 Level 2

| Variables | Reachability set | Antecedent set | Intersection | Level |
|-----------|---------------------|-------------------------|--------------|-------|
| C1 | 1,2,4,5,7,8,10,12 | 1,3 | 1 | |
| C2 | 2,7,8,10 | 1,2,3 | 2 | |
| C3 | 1,2,3,4,5,7,8,10,12 | 3 | 3 | |
| C4 | 4,7,8,10 | 1,3,4,5,12 | 4 | |
| C5 | 4,5,7,8,10,12 | 1,3,5,6,12 | 5,12 | |
| C6 | 5,6,7,8,10,12 | 6 | 6 | |
| C7 | 7,8,10 | 1,2,3,4,5,6,7,8,9,12 | 7,8 | |
| C8 | 7,8,10 | 1,2,3,4,5,6,7,8,9,12 | 7,8 | |
| C9 | 7,8,9,10 | 9 | 9 | |
| C10 | 10, | 1,2,3,4,5,6,7,8,9,10,12 | 10 | II |
| C12 | 4,5,7,8,10,12 | 1,3,5,6,12 | 5,12 | |

5.3 Level 3

| Variables | Reachability set | Antecedent set | Intersection | Level |
|-----------|------------------|----------------------|--------------|-------|
| C1 | 1,2,4,5,7,8,12 | 1,3 | 1 | |
| C2 | 2,7,8 | 1,2,3 | 2 | |
| C3 | 1,2,3,4,5,7,8,12 | 3 | 3 | |
| C4 | 4,8,7 | 1,3,4,5,12 | 4 | |
| C5 | 4,5,7,8,12 | 1,3,5,6,12 | 5,12 | |
| C6 | 5,6,7,8,12 | 6 | 6 | |
| C7 | 7,8 | 1,2,3,4,5,6,7,8,9,12 | 7,8 | III |
| C8 | 7,8 | 1,2,3,4,5,6,7,8,9,12 | 7,8 | III |
| C9 | 8,9,7 | 9 | 9 | |
| C12 | 4,5,7,8,12 | 1,3,5,6,12 | 5,12 | |

5.4 Level 4

| Variables | Reachability set | Antecedent set | Intersection | Level |
|-----------|------------------|----------------|--------------|-------|
| C1 | 1,2,4,5,12 | 1,3 | 1 | |
| C2 | 2 | 1,2,3 | 2 | IV |
| C3 | 1,2,3,4,5,12 | 3 | 3 | |
| C4 | 4 | 1,3,4,5,12 | 4, | IV |
| C5 | 4,5,12 | 1,3,5,6,12 | 5,12 | |
| C6 | 5,6,12 | 6 | 6 | |
| C9 | 9 | 9 | 9 | IV |
| C12 | 4,5,12 | 1,3,5,6,12 | 5,12 | |

5.5 Level 5

| Variables | Reachability set | Antecedent set | Intersection | Level |
|-----------|------------------|----------------|--------------|-------|
| C1 | 1,5,12 | 1,3 | 1 | |
| C3 | 1,3,5,12 | 3 | 3 | |
| C5 | 5,12 | 1,3,5,6,12 | 5,12 | V |
| C6 | 5,6,12 | 6 | 6 | |
| C12 | 5,12 | 1,3,5,6,12 | 5,12 | V |

5.6 Level 6

| Variables | Reachability set | Antecedent set | Intersection | Level |
|-----------|------------------|----------------|--------------|-------|
| C1 | 1 | 1,3 | 1 | VI |
| C3 | 3 | 3 | 3 | VI |
| C6 | 6 | 6 | 6 | VI |

5. RESULT AND DISCUSSION:

Based on the six levels derived, a structural model is designed. A relationship between two variables is shown by an arrow which points from a higher level variable to a lower level variable. It implies that the higher level variable leads to the lower level variables. Lower level variables are at a higher level in the ISM hierarchy and are driven by the higher level variables. The ISM model for the interrelationships between the challenges is shown in Figure 1.

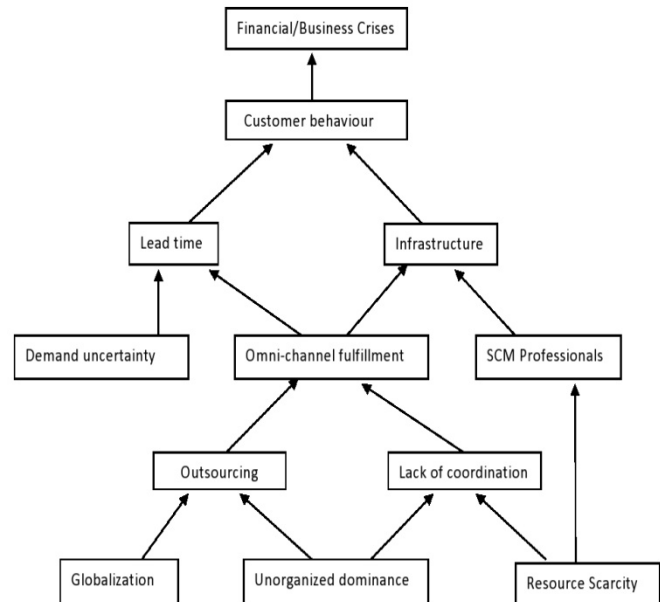


Figure 1: An ISM model for SCM-Challenges.

6. CONCLUSION

It is very important for the managers to know and understand the challenges involved in retail supply chains. One challenge may lead to various other disruptions, and may also cause

Domino effect. It is, therefore, essential to take preventive action after thorough analysis of each challenge and prioritizing them using the suggested method. The probabilities of known challenges must be carefully assigned by looking into past records. This approach could help manager to understand whether the retail professionals are on the same line with respect to the interdependencies of challenges or causes of a particular problem. It would then help to take corrective action with total employee involvement and through other modes as well. While the supply chains are operating under uncertainties, studies pertaining to supply chain management challenges are becoming very practical and relevant according to the chosen business domain. This paper endorses the practice based research in the Indian context. The retail strategists/managers can use ISM framework within their service environment to classify disruption factors depending on their impact on the supply chain system using the structured approach. The study gives directions on risk evaluations with a discrete approach. Along with the analysis of current situation inside the company with respect to challenges, it is equally important to anticipate the future. One of the methods could be pure play analysis of companies from the same domain. Thus, by giving importance to supply chain challenges management, a company can reduce extra costs and improve their bottom line. Also, retail chains trying to enter India or currently operating can also apply these models building and the findings of this paper would help them to design the strategies for mitigating those disruption factors.

REFERENCES

- [1] Dikshit, A. 2011. The Uneasy Compromise - Indian Retail. The Wall Street Journal, 12 August.
- [2] APICS, 2011. Supply Chain Strategy Challenges and Practices.
- [3] Kearney, A.T.2017. The Age of Focus, Global Retail Development Index.
- [4] Faisal, M.N., Banwet, D.K. and Shankar, R. 2007. Supply Chain Risk Management in SMEs: Analyzing the Barriers, International Journal of Management Enterprise Development, Vol. 4 (5), 588-607.
- [5] Ganeshan, S., George, M., Jap, S., Palmatier, R.W. and Weitz, B. 2009. Supply Chain Management and Retailer Performance: Emerging Trends, Issues, and Implications for Research and Practice, Journal of Retail, Vol. 85(1), 84-94.
- [6] Hakansson, H., Snehota, I., 2006. No Business is an Island: The Network Concept of Business Strategy, Scand. Journal of Management, Vol. 22 (3), 256-270.
- [7] Jharkharia, S. 2011. Inter Relations of Critical Failure Factors in ERP Implementation: An ISM-based Analysis, 3rd International Conference on Advanced Management Science, Vol. 19, 170-174.
- [8] Sahin, F. and Robinson, E.P. 2002. Flow Coordination and Information Sharing in Supply Chains: Review, Implications, and Directions for Future Research, Decision Science, Vol. 33 (4), 505-536.
- [9] Sushil, 2012. Interpreting the Interpretive Structural Model, Global Journal of Flexible Systems Management, Vol. 13 (2), 87-106.
- [10] Venkateshan, V.G., Snehal Rathi B, SriyansPatwa, 2015. Analysis on Supply Chain Risks in Indian Apparel Retail Chains and Proposal of Risk Prioritization Model using Interpretive Structural Modeling, 6969-6989.