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## ISM Based Model to Evaluate Flexibility Index of a Supply Chain

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### Abstract

*In present era of global competition, organizations are trying to improve the effectiveness of the whole chain of organizations involved from raw material to delivery of final product to consumer. In this regard, supply chain management is playing crucial role. Uncertainty and variation in customers' demand call for flexible supply chains. Supply chain flexibility gives an idea of inter-organizational relationships. In many industries supply chain flexibility is becoming a more and more important concept for gaining competitive advantages. By the design and use of strategic supply chain networks, significant improvements of supply chain flexibility can be achieved to improve overall flexibility of supply chain. Without analyzing the supply chain flexibility adequately, it is difficult to manage and organize the flow of material and information necessary for coordination in supply chain. This paper aims to find the main flexibility factors in supply chain and development of structural framework by using interpretive structural modeling approach (ISM). Further this ISM model is used to suggest a framework for evaluating flexibility index of a supply chain. Application of this framework is explained with the help of a case example. This approach of evaluating flexibility index will be highly useful to map their flexibility parameters and for taking corrective measures.*

**Keywords:** Coordination, Flexibility, ISM, Responsiveness, Supply chain management

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### Introduction

In globalized economy, market has become highly uncertain. Requirements of customers are fast changing in terms of cost, quality and delivery. Therefore to sustain in such an environment, organizations need to have flexible supply chain. Supply chain is a network of facilities and distribution options that performs the functions of procurement of materials, transformation of these materials into intermediate and finished products, and the distribution of these finished products to customers. Supply chains exist in both service and manufacturing organizations. Figure 1 shows a simple supply chain for a single product, where raw material is procured from suppliers, transformed into finished goods in a single step, and then transported to distribution centers, and then to retailers and ultimately, to customers. Realistic supply chains have multiple end products with shared components, facilities and capacities. Various modes of transportation may be considered, and the bill of materials for the end items may be both deep and large. Complexity of the chain may vary greatly from industry to industry and firm to firm (Chopra and Meindl, 2003). Associate Professor IIFT, Delhi-110016 Email-rksdce@yahoo.com Prof P. B Sharma Vice Chancellor Delhi Technological University, Delhi-110042

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Flexibility is the ability of a system to perform proactive and reactive adaptations of its configuration in order to cope with internal and external uncertainties. Increasing complexity of the value-added processes and the shortening of response times to demand changes are the main causes for having flexibility in supply chains (Wilding, 1998). A fast response to changing demands is necessary for competitive advantage in today's markets. Customers expect their needs to be satisfied at the time of their expression. Companies therefore must have quick response times to changing needs, in order to gain or hold market-shares (Talluri *et al.*, 2004). Thus, flexibility is necessary to stay in this competitive environment. The complexity of business processes is increasing as companies attempt to respond to their customers' needs with an increasing number of highly customized products. At the same time, the offered products themselves are becoming increasingly complex. This complexity results from the different embedded technologies. A single company can no longer produce or handle these technologies alone. The general trend of outsourcing and decreasing the vertical range of manufacturers intensifies the need of flexibility.

The objective of this paper is to identify different attributes of flexibility and develop a structural relationship between them. This paper is organized as follows. Section 2 discusses literature review. Section 3 discusses research methodology. It is followed by results and discussions and finally concluding remarks.

### Literature Review

In today's scenario, survival and growth of the organization depend on competitiveness of the supply chain. Consumers are highly sophisticated. They demand customized quality products, timely delivery and low cost. Therefore in order to compete in this scenario, organizations and their respective supply chain need to be more flexible. Flexibility reflects the ability of a system to respond rapidly to changes that occur inside and outside the system. Vickery *et al.* (1999) defined five supply chain flexibilities which include product, launch, volume, access and responsiveness flexibility. They considered flexibility dimensions that directly impact firms' customers and share responsibilities of two or more functions along the supply chain. Information plays a key role in decision making regarding changes in customers' needs, delivery dates, storage and transportation [Duclos *et al.* (2003), D'Souza and Williams (2000), Martinez and Perez (2005)]. The promptness and the degree to which the supply chain changes its speed, destinations and volumes in response to changes in customer demands gives the benefits of mass customization and positive relationship between each node of the supply chain [Das and Abdel-Malek (2003), Garavelli (2003), Lummus *et al.* (2003)]. Motivation and growth of employees [Efstathiads *et al.* (2002)] and adoption of TQM culture in the organization leads to better understanding among the workers in the organization thereby developing sound relationship with the suppliers and distribution personnel. Combination of the entire flexibilities give rise to supply chain flexibility should be seen as a tool for competitive advantage to the company and gaining success in all areas as well as satisfying customers.

Present study tries to develop a framework for managing the flexibility in the supply chain. For this, twenty nine enablers of flexibility in supply chain have been identified. For developing the framework, interpretive structural modeling (ISM) has been used. These enablers have been categorized into seven groups. These groups are:

- Information flow flexibility
- Suppliers' Flexibility
- Organizational Flexibility
- Production System Flexibility

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- Transportation and Warehousing Flexibility
- Product Design and Development Flexibility
- Flexible Supply Chain

These groups along with the enablers have been shown in the Table 1.

**Table 1: Enablers of Flexibility in Supply Chain**

<b>Suppliers' Flexibility</b>	<b>References</b>
Ability to meet changes in volume requirement on short notice	Kumar <i>et al.</i> (2008), Singh <i>et al.</i> (2012)
Ability to alter the supply of products in line with customers' demand	Duclos <i>et al.</i> (2003), Singh (2011)
Ability to change delivery dates of raw materials to the suppliers	Duclos <i>et al.</i> (2003)Kumar <i>et al.</i> (2008)
<b>Transportation and Warehousing Flexibility</b>	<b>References</b>
Ability to serve distinct customers' shipping requirements	Koste and Malhotra (1999)
Ability to vary warehouse space Ability to vary transportation carriers	Martinez and Perez (2005)Garavelli (2003) Garavelli (2003)
<b>Production System Flexibility</b>	<b>References</b>
Ability to reconfigure assets (equipments) in line with customer needs	D'Souza and Williams (2000)
Ability to change processes as demand changes	Das and Abdel-Malek (2003)
Ability to adjust capacity	Das and Abdel-Malek (2003)
ability to produce parts in different ways	Vickery <i>et al.</i> (1999)
Ability to produce a part by alternate routes through the system	Duclos <i>et al.</i> (2003)Martinez and Perez (2005)
Ability to reduce the machine downtime	Lummus <i>et al.</i> (2003)
<b>Organizational Flexibility</b>	<b>References</b>
Flexibility of top management	Koste and Malhotra (1999)Lummus <i>et al.</i> (2003)
Motivation and growth of employees	Efstathiads <i>et al.</i> (2002)
Training and empowerment of employees	Efstathiads <i>et al.</i> (2002)
Development of multiskills and capabilities of workforce	D'Souza and Williams (2000)
Ability to form personal links with other nodes	Duclos <i>et al.</i> (2003)
Cultural Flexibility	D'Souza and Williams (2000)
<b>Information Flow Flexibility</b>	<b>References</b>
Ability to get point of sales data	D'Souza and Williams (2000)
Ability to synchronize information systems with supply chain partners (2000)	Duclos <i>et al.</i> (2003)D'Souza and Williams
Ability to share information across internal departments	Duclos <i>et al.</i> (2003)D'Souza and Williams (2000)
Ability to pass information along the supply chain	Duclos <i>et al.</i> (2003)Martinez and Perez (2005)
<b>Product Design and development Flexibility</b>	<b>References</b>
Ability to introduce and design new product	Vickery <i>et al.</i> (1999)Martinez and Perez (2005)
Ability to mass customize	Lummus <i>et al.</i> (2003)
Postponement of final product	Martinez and Perez (2005)
<b>Flexible supply Chain</b>	<b>References</b>
Ability to change the volume	Duclos <i>et al.</i> (2003)Martinez and Perez (2005)
Ability to change delivery time	Duclos <i>et al.</i> (2003)D'Souza and Williams (2000)
Ability to change design of product	Martinez and Perez (2005)
Ability to adapt processes to specific products	Duclos <i>et al.</i> (2003)

### Research Methodology

To develop structural relationship between different groups of flexibility in supply chain, interpretive structural modeling is used.

#### Interpretive Structural Modeling

Interpretive structural modeling (ISM) is an interactive learning process, which systemizes the different and directly related elements into a structured system (Warfield, 1974; Sage, 1977). It transforms a complex problem into visible, well-defined models serving the purposes (Sage, 1977). It helps in identifying the inter-relationships among variables and to impose order and direction on the complexity of the relationships among elements of a system. It is very difficult to handle all the enablers of a complex problem if the number of enablers is large. ISM develops collective understanding of relationships among the enablers. ISM is a modeling technique in which the specific relationships of the variables and the overall structure of the system under consideration are presented in a digraph model. It is primarily intended as a group learning process, but it can also be used individually. Jharkharia and Shankar (2005) applied ISM for understanding the barriers in IT – enablement of supply chains. Singh *et al.* (2007a, b) applied ISM for improving SMEs competitiveness and for implementation of advanced manufacturing technologies (AMTs) in firms. The various steps involved in the ISM technique are:

- (1) Identification of elements, which are relevant to the problem or issues, this could be done by any group problem solving technique.
- (2) Establishing a contextual relationship between elements with respect to which pairs of elements will be examined.
- (3) Developing a structural self -interaction matrix (SSIM) of elements, this indicates pair-wise relationship between elements of the system.
- (4) Developing a reachability matrix from the SSIM, and then checking the matrix for transitivity. Transitivity of the contextual relation is a basic assumption in ISM which states that if element A is related to B and B is related to C, then A will be necessarily related to C.
- (5) Partitioning of reachability matrix into different levels.
- (6) Based on the relationships given above in the reachability matrix draw a digraph, and remove transitive links.
- (7) Convert the resultant digraph into ISM, by replacing element nodes with statements.
- (8) Review the ISM model to check for conceptual inconsistency, and make the necessary modifications.

Above described steps, which lead to the development of ISM model, are discussed below.

#### Structural Self-Interaction Matrix (SSIM)

For analyzing the criteria a relationship of “leads to” is chosen here. For developing contextual relationships among variables, expert opinions based on various management techniques such as brainstorming, nominal group technique, idea engineering, etc. were considered. For expressing the relationship between different critical factors, four symbols have been used to denote the direction of relationship between the parameters  $i$  and  $j$  (here  $i, j$ ):

- (1) V: parameter  $i$  will lead to parameter  $j$ ;

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- (2) A: parameter j will lead to parameter i;
- (3) X: parameter i and j will lead to each other; and
- (4) O: parameters i and j are unrelated.

Considering above notations, SSIM is developed in Table 2.

**Table 2: Structural Self-Interaction Matrix**

S.No.	Factors	1	2	3	4	5	6	7
1	Information Flow Flexibility		V	V	V	V	V	V
2	Suppliers' Flexibility			X	X	V	V	V
3	Organizational Flexibility				X	V	V	V
4	Production System Flexibility					V	V	V
5	Transportation and Warehousing Flexibility						O	V
6	Product Design and development Flexibility							V
7	Flexible supply Chain							

**Initial Reachability Matrix**

The SSIM has been converted into a binary matrix, called the initial reachability matrix by substituting V, A, X and O by 1 and 0 as per the case. The substitution of 1s and 0s are as per the following rules:

- (1) If the (i, j) entry in the SSIM is V, the (i, j) entry in the reachability matrix becomes 1 and the (j, i) entry becomes 0.
- (2) If the (i, j) entry in the SSIM is A, the (i, j) entry in the reachability matrix becomes 0 and the (j, i) entry becomes 1.
- (3) If the (i, j) entry in the SSIM is X, the (i, j) entry in the reachability matrix becomes 1 and the (j, i) entry also becomes 1.
- (4) If the (i, j) entry in the SSIM is O, the (i, j) entry in the reachability matrix becomes 0 and the (j, i) entry also becomes 0.

Following above rules, the initial reachability matrix for the critical success factors is shown in Table 3.

**Table 3: Initial Reachability Matrix**

S.No.	Factors	1	2	3	4	5	6	7
1	Information Flow Flexibility	1	1	1	1	1	1	1
2	Suppliers' Flexibility	0	1	1	1	1	1	1
3	Organizational Flexibility	0	1	1	1	1	1	1
4	Production System Flexibility	0	1	1	1	1	1	1
5	Transportation and Warehousing Flexibility	0	0	0	0	1	0	1
6	Product Design and development Flexibility	0	0	0	0	0	1	1
7	Flexible supply Chain	0	0	0	0	0	0	1

**Final Reachability Matrix**

The final reachability matrix is obtained by incorporating the transitivity as enumerated in Step (4) of the ISM methodology. This is shown in Table 4. In this, the driving power and dependence of each factor are also shown. The driving power of a particular factor is the total number of factors (including itself), which it may help achieve while the dependence is the total number of factors, which may help achieving it. On the basis of driving power and dependencies, these factors will be classified into four groups of autonomous, dependent, linkage and independent (driver) factors.

**Table 4: Final Reachability Matrix**

S.No.	Factors	1	2	3	4	5	6	7	D.P.
1	Information Flow Flexibility	1	1	1	1	1	1	1	7
2	Suppliers' Flexibility	0	1	1	1	1	1	1	6
3	Organizational Flexibility	0	1	1	1	1	1	1	6
4	Production System Flexibility	0	1	1	1	1	1	1	6
5	Transportation and Warehousing Flexibility	0	0	0	0	1	0	1	2
6	Product Design and development Flexibility	0	0	0	0	0	1	1	2
7	Flexible supply Chain	0	0	0	0	0	0	1	1
	Dependence	1	4	4	4	5	5	7	

**Level Partitions**

From the final reachability matrix, the reachability and antecedent set for each factor are found. The reachability set consists of the element itself and other elements to which it may help achieve, whereas the antecedent set consists of the element itself and the other elements which may help achieving it. Then the intersection of these sets is derived for all elements. The element for which the reachability and intersection sets are same is the top-level element in the ISM hierarchy. The top-level element of the hierarchy would not help achieve any other element above their own. Once the top-level element is identified, it is separated out from the other elements. Then by the same process, the next level of elements is found. These identified levels help in building the diagraph and final model. From Table 5, it is seen that the performance improvement is found at level I. Thus, it would be positioned at the top of the ISM hierarchy. This iteration is repeated till the levels of each factor are found out (Tables 5-8).

**Table 5: Iteration 1**

Factors	Reachability set	Antecedent set	Intersection set	Level
1	1,2,3,4,5,6,7	1	1	I
2	2,3,4,5,6,7	1,2,3,4	2,3,4	
3	2,3,4,5,6,7	1,2,3,4	2,3,4	
4	2,3,4,5,6,7	1,2,3,4	2,3,4	
5	5,7	1,2,3,4,5	5	
6	6,7	1,2,3,4,6	6	
7	7	1,2,3,4,5,6,7	7	

**Table 6: Iteration 2**

Factors	Reachability set	Antecedent set	Intersection set	Level
1	1,2,3,4,5,6	1	1	II
2	2,3,4,5,6	1,2,3,4	2,3,4	
3	2,3,4,5,6	1,2,3,4	2,3,4	
4	2,3,4,5,6	1,2,3,4	2,3,4	
5	5	1,2,3,4,5	5	
6	6	1,2,3,4,6	6	

**Table 7: Iteration 3**

Factors	Reachability set	Antecedent set	Intersection set	Level
1	1,2,3,4	1	1	III
2	2,3,4	1,2,3,4	2,3,4	
3	2,3,4	1,2,3,4	2,3,4	
4	2,3,4	1,2,3,4	2,3,4	

**Table 8: Iteration 4**

Factors	Reachability set	Antecedent set	Intersection set	Level
1	1	1	1	IV

**Classification of Factors**

In this section, the critical success factors described earlier are classified into four clusters (Figure 2). This classification is similar to that made by Mandal and Deshmukh (1994). The first cluster consists of the “autonomous factors” that have weak driving power and weak dependence. These factors are relatively disconnected from the system, with which they have only few links, which may not be strong. The “dependent factors” constitute the second cluster which has weak driving power but strong dependence. Third cluster has the “linkage factors” that have strong driving power and strong dependence. These factors are unstable due to the fact that any change occurring to them will have an effect on others and also a feedback on themselves. Fourth cluster includes the “independent factors” having strong driving power but weak dependence. The driving power and dependence of each of these factors are shown in Table VI. In this table, an entry of “1” added along the columns and rows indicates the dependence and driving power, respectively. Subsequently, the driver power-dependence diagram is constructed as shown in Figure 2. For illustration, the factor five having a driving power of 2 and dependence 5 is positioned at a place corresponding to driving power of 2 and dependency of 5 in the Figure 2. Similarly all other factors considered in this study are positioned on different quadrants depending on their driving power and dependency.

**Formation of ISM-based Model**

From the final reachability matrix (Table 4), the structural model is generated by means of vertices or nodes and lines of edges. If there is a relationship between the flexibility factors i and j this is shown by an arrow which points from i to j. This graph is called a directed graph or

digraph. After removing the transivities as described in ISM methodology, the digraph is finally converted into ISM as shown in Figure 3.

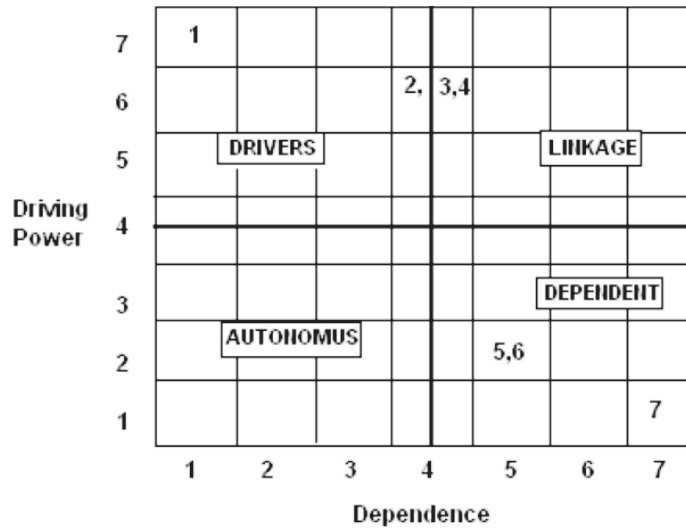


Figure 2: Driving Power and Dependence Diagram

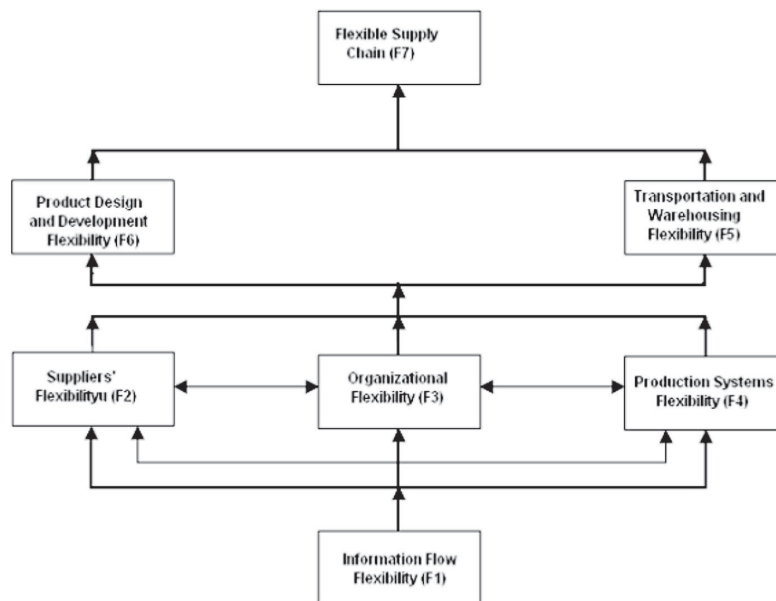


Figure 3: ISM Based Model for Enablers of Supply Chain Flexibility

Some of the observations based on this analysis are

1. The driver power-dependence matrix shows that there is no autonomous factor for flexibility in supply chain.
2. Information flow flexibility has the strong driving power and is capable to lead the organization to achieve the desired objective independently.

### ISM Based Model to Evaluate Flexibility Index of a Supply Chain

- Suppliers' flexibility, Organizational flexibility and Production system flexibility have strong driving power and medium dependence. Thus they also acts as driver next to Information flow flexibility. They are categorized as linkage variables.
- Dependence increases as we move from Transportation and Warehousing flexibility to Product design and development flexibility till Flexible supply chain. Flexible supply chain has the highest dependence and represents the ultimate goal to be achieved in the supply chain.

#### Model for Evaluating Flexibility Index of Supply Chain

Based on interaction from experts and literature review, different factors have been identified for evaluating flexibility index of supply chain. These factors have been grouped into seven areas/issues (Table 9). These are Suppliers Flexibility, Transportation and Warehousing Flexibility, Production System Flexibility, Organizational Flexibility, Information Flow Flexibility, Product Design and development Flexibility, Measures for Flexible supply chain. The framework of Cleveland *et al.* (1989) for production competence is extended to compute SC flexibility index. Singh *et al.* (2006) and Singh (2011) have used this framework to evaluate competitiveness/coordination index of a medium scale organization. On the basis of Cleveland *et al.* (1989) model and competitiveness index model (Singh *et al.* 2006), SC flexibility index can be given as:

$$S_{\text{Flexibility}} = \sum \{W_i \text{ Log } K_i\}$$

Where  $S_{\text{flexibility}}$  = SC Flexibility index for a the given supply chain

$i$  = SCM issue ( $i=1$  to 7)

$R$  = Rank of SCM issue

$K_i$  = Inverse Rank (If  $R=1$ ,  $K= 7$ , when  $i =7$ , if  $R=2$ ,  $K= 6$ )

$W_i$ = Weight assigned to particular SCM issue.

For assigning weight to different issues of flexible supply chain, the highest and lowest values of five point Likert scale i.e 5 and 1 are mapped 100% and 0% respectively. For each of the seven issues of flexible supply chain, a weight is assigned. The criteria for weight ( $W_i$ ) is as under:

$W_i = +1$  (Strength), when percentage score > 60% (Mean value>3).

= 0 (Neutral), when percentage score is between 40-60% (Mean value between 2 and 3).

= -1 (Weakness), when percentage score< 40% (Mean value <2)

For illustration, an example of computation of weight is given below. Say, the mean score for a flexible SCM issue = 4.2 on a scale of 1 to 5. Using two-point equation, percentage may be calculated i.e.  $4.2/5= 84\%$ , therefore it is assigned weight of +1.

Computation of SC flexibility index of Alpha Ltd is illustrated with the help of a worksheet as shown in Table 10. First of all key items of different issues of flexible SC framework are graded in Likert scale of 1 to 5 (1- Very low, 5- Very high). Mean for a particular issue is calculated after taking average of scores for all its key items. After this rank, inverse rank and weight for each issue is decided. Sum of entries of last column ( $W_i \text{ Log } K_i$ ), will give SC flexibility index of Alpha Ltd. On the basis of the score, organization can visualize its position in industry/ sector and identify gaps with respect to market leaders. It can also help in SWOT analysis of organization.

#### Case Illustration of the Model

For illustrating use of this model a two wheeler manufacturing company has been considered.

### **Background of Case Company**

Alpha Ltd. is the world's largest manufacturer of two – wheelers, based in India. In 2001, the company achieved the coveted position of being the largest two-wheeler manufacturing company in India and the 'World No.1' two-wheeler company in terms of unit volume sales in a calendar year by a single company. Alpha Ltd has retained that coveted position till date. Alpha Ltd has sold over 15 million motorcycles and has consistently shown a double digit growth since its inception.

Alpha Ltd bikes are manufactured across three globally benchmarked manufacturing facilities. Two of these are based at Gurgaon and Dharuhera which are located in the state of Haryana in northern India. The third and the latest manufacturing plant is based at Haridwar, in the hill state of Uttarakhand.

In 2010-11, Total unit sales was 46, 00,130 two-wheelers with growth of 23.6 per cent Total net operating income was 158600 million INR with growth of 28.1 per cent Net profit after tax was 22310 million INR with growth of 74.1 per cent.

Alpha Ltd key strategy has been driven by innovation in every sphere of activity i.e. building a robust product portfolio across categories, exploring new markets, aggressively expanding the network and continuing to invest in brand building activities. In the 1980's Alpha Ltd pioneered the introduction of fuel-efficient, environment friendly four-stroke motorcycles in the country. Today, it continues to be technology pioneer. It became the first company to launch the Fuel Injection (FI) technology in Indian motorcycles, with the launch of the Glamour FI in June 2006. Alpha Ltd product range includes variety of motorcycles that have set the industry standards across all the market segments. The company also started manufacturing scooter in 2006.

The company's growth in the two wheeler market in India is the result of an intrinsic ability to increase reach in new geographies and growth markets. Alpha Ltd extensive sales and service network now spans close to 4500 customer touch points. These comprise a mix of authorized dealerships, Service & Spare Parts outlets, and dealer-appointed outlets across the country. The company has been continuously investing in brand building utilizing not only the new product launch and new campaign launch opportunities but also through innovative marketing initiatives revolving around cricket, entertainment and ground- level activation. Quality policy of the company is as "We are committed at all levels to achieve high quality in whatever we do, particularly in our products and services which will meet and exceed customer's growing aspirations through", innovation in products processes and services, continuous improvement in our total quality management systems, teamwork and responsibility.

**Table 9: Score on Flexibility Measures for Alpha Ltd.**

<b>Flexibility Attributes</b>	<b>Rating in scale of 1-5</b>	<b>Mean Value</b>
<b>Suppliers' Flexibility</b>		3.67
Ability to meet changes in volume requirement on short notice	4	
Ability to alter the supply of products in line with customers' demand	4	
Ability to change delivery dates of raw materials to the suppliers	3	
<b>Transportation and Warehousing Flexibility</b>		2.33
Ability to serve distinct customers' shipping requirements	3	
Ability to vary warehouse space	2	
Ability to vary transportation carriers	2	

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Production System Flexibility		
Ability to reconfigure assets (equipments) in line with customer needs	5	4.00
Ability to change processes as demand changes	4	
Ability to adjust capacity	3	
ability to produce parts in different ways	4	
Ability to produce a part by alternate routes through the system	4	
Ability to reduce the machine downtime	4	
Organizational Flexibility		
Flexibility of top management	5	4.67
Motivation and growth of employees	5	
Training and empowerment of employees	5	
Development of multiskills and capabilities of workforce	5	
Ability to form personal links with other nodes	4	
Cultural Flexibility	4	
Information Flow Flexibility		
Ability to get point of sales data	4	4.5
Ability to synchronize information systems with supply chain partners	4	
Ability to share information across internal departments	5	
Ability to pass information along the supply chain	5	
Product Design and development Flexibility		
Ability to introduce and design new product	4	3.33
Ability to mass customize	3	
Postponement of final product	3	
Measures for Flexible Supply Chain		
Ability to change the volume	4	3.50
Ability to change delivery time	3	
Ability to change design of product	3	
Ability to adapt processes to specific products	4	

***Supply Chain Flexibility Index for Alpha Ltd***

Alpha Ltd is aggressively trying to make its supply chain flexible. In this regard, this organization has taken multiple initiatives. To evaluate flexibility index of its supply chain, different attributes of supply chain flexibility were rated in Likert scale of five. These are shown in table 9. Then above discussed model was applied to evaluate flexibility index as shown in table 10. Overall supply chain flexibility index for Alpha Ltd was found equal to 3.71. Based on these results, it is observed that Alpha Ltd need to improve its performance in terms of transportation and warehousing flexibility as well as in terms of product design and development flexibility. This model can be also used to compare flexibility index of two supply chains. It can be also useful to do SWOT analysis of a given supply chain for taking different initiatives to improve its flexibility.

## Conclusions

In today's scenario, the demand of the customer changes very rapidly and there is lots of complexities in the products. Also, the competition is very high. So, in order to survive, flexibility is necessary in the supply chains which allow them to adapt to market uncertainties. This paper has identified important enablers of flexibility in supply chain. These enablers are categorized into seven flexibility sub-groups and ISM approach has been applied to develop a structural relationship between these groups for managing flexibility in supply chain. Information flow flexibility has emerged as major driving force for flexibility in supply chain. It implies that organization should focus on generating accurate information and its availability at the right time. Based on this model, further a framework is suggested to evaluate flexibility index of the supply chain. Based on this framework, any organization can evaluate its supply chain flexibility index. It can be also used for SWOT analysis and strategy development.

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