

# To Study the effect of Improvement in Logistics Management using Interpretive Structural Modelling

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## Abstract:

The purpose of this article is to study the effect of improvement in the logistics performance for a developing country like India, using interpretive structural modelling (ISM). This research presents a framework and the mutual relationships among the factors identified for improving the logistics performance. Investment by government and investment by logistics service providers are the two factors at the bottom level of the hierarchy, implying that developing countries need to focus on high investments for improving logistics performance. Improvement in logistics performance will improve the competitiveness of organizations and higher profits, leading to improvement in foreign direct investment and economic growth in the long run.

## Keywords

*Developing Country, Flexibility, India, Interpretive Structural Modelling, Logistics Cost, Logistics Performance, Logistics Performance Index, Logistics Time, Reliability, Safety*

## 1. Introduction

ISM enables individuals or groups to develop a map of the numerous relationships between many factors involved in a complex situation for taking effective decisions. Generally, ISM is a combination of three modelling languages – words, digraphs, and discrete mathematics – to ensure a solution to a structure of complex issues (Jia et al., 2015). Therefore, in this paper, the enablers for improvement in logistics performance have been analysed using the ISM methodology, which shows the interrelationships of the enablers and their levels. Sixteen critical success factors were identified from literature review for improving the logistics performance (table 1). Assessment of logistics improvement will be done through the LPI, which is considered as the weighted average of logistics cost, delivery time, reliability of services, flexibility of services and safety of the logistics system.

## 2. Identification of critical success factors

Table 1 introduces the sixteen factors chosen in the for logistics improvement using ISM modelling.

**Table 1 Critical Success Factors**

S.No	Factor and Author/s	Remark/s
1.	Investment by Government : Havenga (2011); Shepherd and Hamanka (2015)	<p>) A successful logistics trade cycle depends on the extent and pace of government measures to liberalise the supply chain of logistics including appropriate infrastructure investments.</p> <p>) Therefore, priority of government agencies should be on development of a strong infrastructure network and to introduce logistics conducive government regulations.</p>

2.	Investment by Logistics Service Provider : Shepherd and Hamanka (2015)	<p>) As private sector requires an efficient environment like high quality infrastructure and economically rational regulations to operate, public sector depends on the information flows from the private sector and a relationship of trust and confidence with operators to build a strong regulatory environment.</p> <p>) An additional aspect of internal logistics performance relates to the development of private sector capacity, including through improvements in human resources.</p>
3.	Development of Infrastructure: Dobbs et al. (2013); Mckinsey (2010)	<p>) An increase in infrastructure investment equivalent to 1% of GDP would translate into an additional 3.4 million direct and indirect jobs in India.</p> <p>) Infrastructure development is the backbone of the nation which helps in effective flow of goods and facilitation of trade</p>
4.	Improvement in Government Regulations: Vasavi(2009); Kothari (2011)	<p>) India needs better infrastructure and less bureaucracy.</p> <p>) There is a strong need to turn India as a “complex tax destination” to “competitive destination” for which there is a need for considerable improvement in tax structure and administration.</p>
5.	Development of Skilled Work Force: Jurcevic et al. (2009); Pandey et al. (2012)	<p>) Successful companies have been those that consider their human capital as their most important asset.</p> <p>) Training, collaborative performance systems and reward alignment achieves high levels of supply chain integration.</p>
6.	Development of IT enabled Logistics system: Pokharel (2005); Lai et al. (2006)	<p>) Use of IT leads to efficiency, cost savings, reduced data entry error and increased customer service level.</p> <p>) Also, it helps in improving delivery speed and reliability, customer relations and order accuracy, higher cost advantage.</p>
7.	Logistics Performance Index: Rantasila and Ojala (2012); Havenga (2011)	<p>) There is a strong relationship between country’s LPI and its level of logistics costs.</p> <p>) 10% improvement in the index in the exporting country is associated with increased trade of 36%.</p> <p>) Similarly, for every 10% increase in the LPI of a typical exporter, bilateral imports increase by more than 69% on average, while for every 10% increase in the LPI of a typical importing country, bilateral imports increase by 54% on average.</p>
8.	Reduction in Cost : FICCI (2011); Kaur (2011);	<p>) Logistics cost is directly proportional to distance and handling incurred while transporting goods and inversely proportional to share of 3PL in the country.</p>
9.	Reduction in Time: Nordas et al. (2006); De Sousa and Findlay (2007)	<p>) Time is an important competitive factor and also a barrier to trade, which affects the volume of trade and more importantly ability of the firms to enter the export markets.</p> <p>) A ten percent increase in time reduced bilateral trade volumes by between 5 to 8%.</p>

10.	Improvement in Reliability: Simons (2004); Cook et al. (2002)	<p>) Reliability is the ability to perform the promised service consistently, dependably and accurately.</p> <p>) Reliability has often been cited as the most important dimension in assessing the quality of service and is therefore a fundamental requirement for businesses to compete in the marketplace</p>
11.	Improvement in Flexibility: Naim et al. (2006); Zhang et al. (2005)	<p>) Flexibility reflects the ability of a system to change or react with little penalty in time, effort, cost or performance</p> <p>) Logistics flexibility is the ability of a firm to respond quickly and efficiently to changing customer needs in inbound and outbound delivery, support, and services</p>
12.	Improvement in Safety: Cantor (2008); Pia (2010)	<p>) Safety refers to the safety of stock, human resources, physical infrastructure and the overall logistics system</p> <p>) Flow of information, co-operation between the various parties of the chain, and the training of employees have proven to be important in improving the safety of a logistic chain and that material damage and accidents causes a lot of additional work and costs.</p>
13.	Improved Profit: Randall and Farris (2009); Anderson (2011)	<p>) Improvement of logistics performance will lead to savings, leading to more profits.</p> <p>) Outstanding logistics performance is associated with high financial performance through low costs, high revenues and efficient and effective asset utilization.</p>
14.	Competitiveness of Organizations: Hausman et al. (2005)	<p>) Inefficiencies in logistics have been highlighted as an important constraint on firms; productivity and competitiveness in developing countries.</p>
15.	Improvement in FDI: Saidi and Hammami (2011)	<p>) Firms with better investment climate and better logistics have higher probability of exporting to international markets and attracting FDI.</p> <p>) Transportation and logistics are two factors which have an important role to enhance the FDI attractiveness for developing countries.</p>
16.	Economic Growth: Liu (2009)	<p>) Logistics industry's value added, total employment of logistics industry, new fixed assets investment, freight volume and freight turnover have huge impact on economic growth</p> <p>) There is a clear link between quality of infrastructure and transport costs and thus concludes that infrastructure investments are important for export led economic growth.</p>

### 3. Data Collection for ISM

For identifying the contextual relationship among the enabler's two experts from academia with research interests in the area and three managers working for a 3PL firm were consulted for the same. Management

techniques such as brain storming and nominal technique were used in developing the contextual relationship among the variables.

### 3.1 Application of proposed methodology

ISM is a methodology which facilitates the understanding of complex situations which deal with a large of number of interactive variables. It is identifying and understanding the interrelationships between these variables and bringing out the key driving and dependent variables. In ISM a set of different but directly related factors are structured in a comprehensive and systematic model (Warfield, 1974).The ISM methodology is interpretive from the fact that as the judgment of the group decides whether and how the variables are related. It is structural too, as on the basis of relationship; an overall structure is extracted from the complex set of variables.The application of the steps is as follows:

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

The development of SSIM requires depicting dependence among all possible pairs of enablers by choosing a contextual relationship showing which enablers lead to which others. For analysing the factors, a contextual relationship of ‘leads to’ or ‘influences’ type must be chosen. This means that one factor influences another factor. On the basis of this, contextual relationship between the identified factors is developed. 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;
- 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.

On the basis of the expert opinions, SSIM as shown in table 2 was developed.

**Table 2.Structural Self- Interaction Matrix (SSIM)**

S.No	Critical Success Factors	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	Reduction in cost	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
2	Reduction in time	O	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
3	Improvement in reliability	O	O	*	*	*	*	*	*	*	*	*	*	*	*	*	*
4	Improvement in flexibility	O	O	O	*	*	*	*	*	*	*	*	*	*	*	*	*
5	Improvement in safety	O	O	O	O	*	*	*	*	*	*	*	*	*	*	*	*
6	Improved Profit	A	O	O	O	O	*	*	*	*	*	*	*	*	*	*	*
7	Competitiveness of organizations	A	A	A	A	A	X	*	*	*	*	*	*	*	*	*	*
8	Logistics Performance Index	A	A	A	A	A	V	V	*	*	*	*	*	*	*	*	*
9	Improved FDI	O	O	O	O	O	A	A	A	*	*	*	*	*	*	*	*
10	Economic Growth	O	O	O	O	O	A	A	A	X	*	*	*	*	*	*	*
11	Skilled work Force	V	V	V	V	V	O	O	O	O	O	*	*	*	*	*	*
12	IT enabled logistics system	V	V	V	V	V	O	O	O	O	O	O	*	*	*	*	*
13	Infrastructure development	V	V	V	V	V	O	O	O	O	O	O	O	*	*	*	*
14	Government regulations	V	V	V	V	V	V	O	O	O	O	O	O	O	*	*	*
15	Investment by government	O	O	O	O	O	O	O	O	O	O	O	O	V	V	*	*
16	Investment by LSP	O	O	O	O	O	O	O	O	O	O	V	V	O	O	O	*

### 3.1.2 Reachability Matrix

**Table 3. Initial reachability Matrix**

CSF	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	1	0	0	0	0	1	1	1	0	0	0	1	0	0	0	0
2	0	1	0	0	0	0	1	1	0	0	0	0	1	0	0	0
3	0	0	1	0	0	0	1	1	0	0	0	0	0	1	0	0
4	0	0	0	1	0	0	1	1	0	0	0	0	0	0	1	0
5	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	1
6	0	0	0	0	0	1	1	0	1	1	0	0	0	0	0	0
7	0	0	0	0	0	1	1	0	1	1	0	0	0	0	0	0
8	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0
11	1	1	1	1	1	0	0	0	0	0	1	1	1	1	1	1
12	1	1	1	1	1	0	0	0	0	0	0	1	1	1	1	1
13	1	1	1	1	1	0	0	0	0	0	0	1	1	1	1	1
14	1	1	1	1	1	1	0	0	0	0	0	1	1	1	1	1
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0

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 1's and 0's 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.

**Table 4. Final Reachability Matrix**

CSF	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Driving Power
1	1	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	6
2	0	1	0	0	0	1	1	1	1	1	0	0	0	0	0	0	6
3	0	0	1	0	0	1	1	1	1	1	0	0	0	0	0	0	6
4	0	0	0	1	0	1	1	1	1	1	0	0	0	0	0	0	6
5	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0	6
6	0	0	0	0	0	1	1	0	1	1	0	0	0	0	0	0	4
7	0	0	0	0	0	1	1	0	1	1	0	0	0	0	0	0	4
8	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	5
9	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	2
10	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	2
11	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	11
12	1	1	1	1	1	1	1	1	1	1	0	1	0	0	0	0	11
13	1	1	1	1	1	1	1	1	1	1	0	0	1	0	0	0	11
14	1	1	1	1	1	1	1	1	1	1	0	0	0	1	0	0	11
15	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	0	13
16	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	1	13
Dependence Power	7	7	7	7	7	14	14	12	16	16	2	2	2	2	1	1	

Following the above rules, SSIM matrix was the input to the program in MATLAB version 7.0.1 to get the initial reachability matrix (table 3) and then the final reachability matrix (table 4).

The final reachability matrix is obtained by incorporating the transitivity as enumerated in step 4 of ISM methodology. This is shown in table 4. Here, the driving power and dependence of each enabler are also shown. The driving power of a particular enabler is the total number of enablers (including itself), which it may help achieve while dependence is the total number of enablers which may help in achieving it.

### 3.1.3 Level Partitions

From the final reachability matrix, the reachability and antecedent set for each factor are found. The reachability set consists of the factor itself and other factors to which it may help achieve, whereas the antecedent set consists of the factor itself and the other factors which may help achieving it. Then the intersection of these sets is derived for all factors. The factor for which the reachability and intersection sets are same is the top-level factor in the ISM hierarchy. The top-level factor of the hierarchy would not help achieve any other factor above their own hierarchy. Once the top-level factor is identified, it is separated out from the other factors. Then by the same process, the next level of factors is found. These identified levels help in building the digraph and final model. The iteration is repeated till the levels of each enabler are found out. Table 5 shows the level of all the enablers.

**Table 5. Level Partition**

CSF	Reachability Set	Antecedent Set	Intersection	Level
9	9,10	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16	9,10	I
10	9,10	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16	9,10	I
6	6,7	1,2,3,4,5,6,7,8,11,12,13,14,15,16	6,7	II
7	6,7	1,2,3,4,5,6,7,8,11,12,13,14,15,16	6,7	II
8	8	1,2,3,4,5,8,11,12,13,14,15,16	8	III
1	1	1,2,3,4,5,11,12,13,14,15,16	1	IV
2	2	2,3,4,5,11,12,13,14,15,16	2	IV
3	3	3,4,5,11,12,13,14,15,16	3	IV
4	4	4,11,12,13,14,15,16	4	IV
5	5	5,11,12,13,14,15,16	5	IV
11	12	11,12,16	12	V
12	13	13,15	13	V
13	14	14,15	14	V
14	11	11,16	11	V
15	15	15	15	VI
16	16	16	16	VI

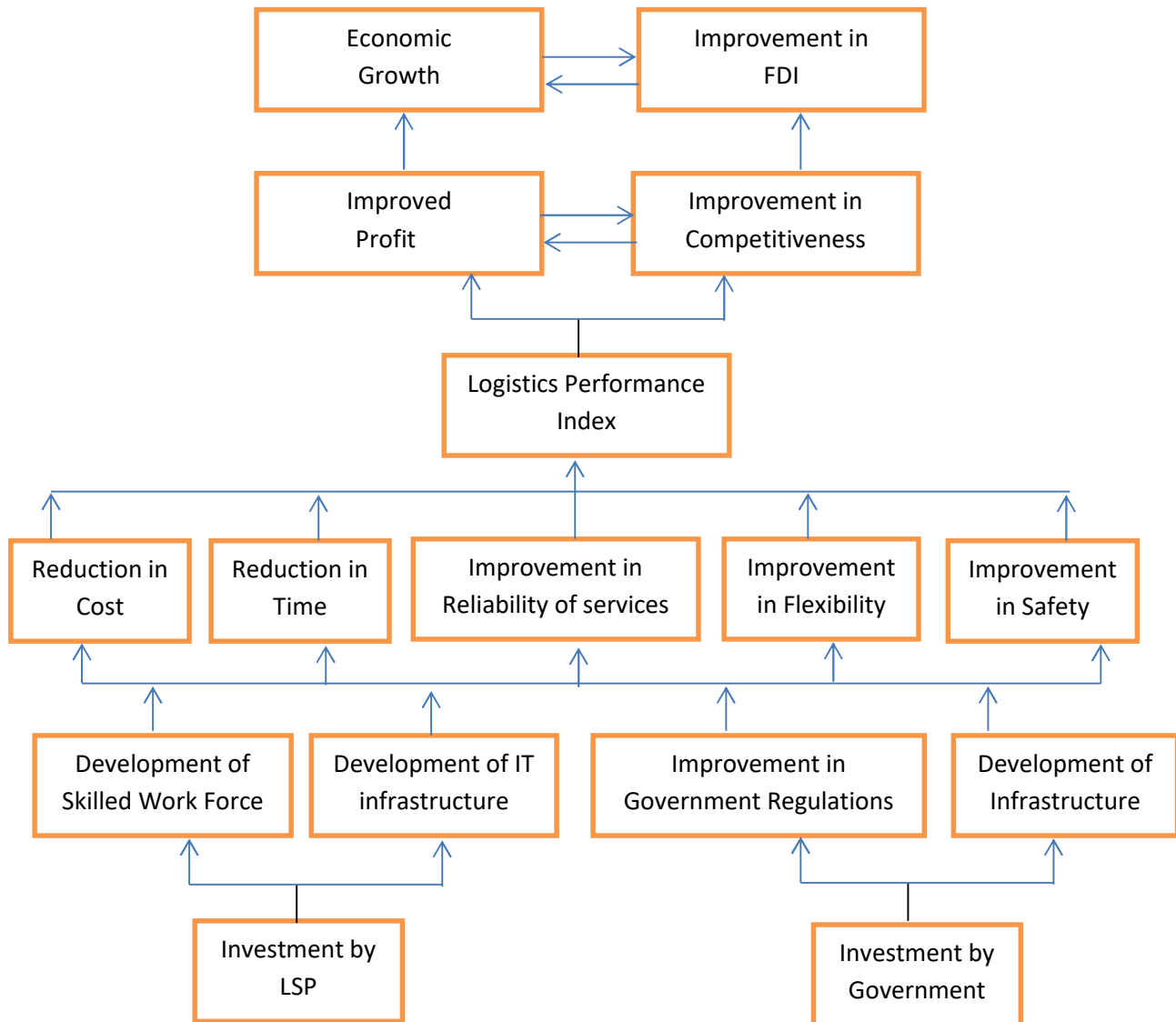
### 3.1.4 Formation of Digraph

From the final reachability matrix, a structural model is developed as shown in figure 1. The resulting graph is called a digraph.

## 4. Result and Discussion

The digraph is shown in figure 1. Sixteen variables have been divided into six levels. As per the digraph, investment by government and investment by LSP appearing at level six play a very significant role in improving the logistics performance index. From the digraph it can be seen that LSPs should concentrate on

investment in information technology and in development of human resources. IT enabled logistics system will make the system more sophisticated and will ease the logistics processes making the system more reliable. To run such a system, skilled work force will be required; else investment in IT might backfire and can lead to huge losses. Also, if LSP decides to invest in IT and HR separately also, it will be able to gain competitive advantage against its competitors. Investment in the improvement of human resources will make the workforce more motivated, thereby improving organizational performance and also improving the rate of retention.



**Figure 1. ISM Framework to study effects of Improvement in Logistics Performance**

The four important components where India, have acquired the same level in the digraph, i.e. level 5. IT and HR will improve the logistics processes at the micro level. But development of infrastructure and easing of regulation will improve the processes at macro level. Government should concentrate on developing a strong and integrated infrastructure and make provisions for its maintenance also.

With a well-connected infrastructure, ease of government regulation will improve the business at the domestic and international level. Right now, all the twenty nine Indian states have their own set of taxes which leads to a very high indirect logistics cost. Having a single uniform tax all over the country will lead to reduction in

indirect costs and a lot of time will be saved in doing business and transportation of goods. These four components will act as the four pillars for logistics improvement, which will impact the five performance measures, namely, reduction in cost, reduction in time, improvement in reliability, improvement in flexibility and improvement in safety which have occupied the level 4 in the diagraph.

The performance measures at level 4 will help in improving the logistics performance index which is at level 3. It is the link between the enablers and the results. The enablers are the four pillars at level 5, which will improve the performance measure at level 4, leading to improvement in LPI at level 3. LPI has a huge impact on improving the profit and competitiveness of organizations at level 2. The performance measures are the components of competitiveness. Therefore, it is obvious that improvement at level 4, will lead to improved profit and competitiveness through LPI. Competitive firms will attract more investment. Therefore, improvement in FDI and economic growth has acquired level 1. More FDI will bring more investment leading to more economic growth, thereby increasing more investments by government and LSPs leading to more improvement in LPI.

## 5. Conclusion

This paper has tried to identify the critical factors for improving the logistics performance for a developing country like India. Better logistics performance will help the organizations improve its competitiveness in the market and to sell product at lower prices, thereby improving profit. At the macro level, better logistics performance will attract foreign direct investment and will help Indian companies to hold a strong place in the global market which will further boost the economic growth.

Logistics processes depends on several factors like infrastructure, use of information technology, skilled work force, logistics conducive government regulations etc. In this context, total 16 variables were identified in the present study. For establishing relationship between these critical variables, ISM approach has been applied. It has also helped in determining driving and dependence power of all variables.

It is observed that the key to good logistics performance is investment by government and investment by logistics service providers. Government should concentrate on building infrastructure and ease regulations for enhancing domestic and international trade. Through strong infrastructure, connectivity will improve which will save a lot of time and money in delivering goods. Also, good infrastructure will reduce damages to the vehicles thereby improving reliability of delivery. If the connecting links are strong, then last minute delivery changes can be made and flexibility can be improved. Good infrastructure will reduce accidents, damages to the goods etc., hence safety will also improve.

When infrastructure is backed by logistics conducive government regulations, ease of trade will provide the businesses with the necessary edge. Also “red- tape” has been quoted as the biggest hindrance after poor infrastructure to do business in India. Hence, improving that will attract a lot of foreign players to investment in the country.

LSPs should invest in the use of latest technologies along with a trained workforce. The combined investments by government and LSPs, will improve logistics performance through reduction in cost, reduction in time, improvement in reliability, improvement inflexibility and reducing damages and accidents thereby improving safety.

Better logistics performance will help the organizations improve its competitiveness and profit and at the country level it will improve economic growth and FDI.

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