International Journal on Emerging Technologies **3**(1): 149-156(2012)

ISSN No. (Print) : 0975-8364
ISSN No. (Online) : 2249-3255

Supply Chain Management for Human Life Betterment: An ISM analysis

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(Recieved 15 March 2012 Accepted 30 April 2012)

ABSTRACT : Disaster is a natural or human-caused event which causes intensive negative impacts on people, goods, services and/or the environment, exceeding the affected community's capability to respond. A supply chain, or supply network is a coordinated system of organizations, people, activities, information and resources involved in moving a product or service in physical or virtual manner from supplier to customer .Customer in case of disaster are people facing the crisis.

The application of humanitarian supply chain in real life involves study of the critical factors or enablers and their effect along the supply chain. In order to gain proper advantage of relief supply chain, it is required to find the structural relationship between these enablers. The purpose of the paper is to identify the key enablers of Humanitarian Supply chain and find the structural relationship between them. In this paper, a framework is developed using interpretive structural modeling (ISM) is used to find the structural relationship between the enablers along relief supply chain.

Keywords : Supply Chain Management, Relief Supply Chain, Interpretive Structural Modeling (ISM).

I. INTRODUCTION

Relief supply chains involve delivery basic and essential commodities to the victims at the right place in the lowest time. In this context, the relief supply chain includes commercial supply chain activities such as planning, forecasting, procurement, logistics, warehousing and delivery. Apart from these, activities such as appeal to donors and resource mobilization also need to be carried out for relief purposes. Supply Chains are of three types - Commercial, Military and Relief Supply Chains. Relief supply chains are central to relief activities, during disaster management.

Supply Chain Management in disaster is not only about delivering supplies to disaster impacted areas. It requires orchestrating the transportation, distribution, warehousing and timely delivery of medicines, basic needs including food, apparels etc., while minimizing costs and serving the maximum number of consumers. Supply chain strategy has to be devised in a way to provide quick response, right services for the type of disaster. Critical to this the supply chain has to capable enough to maintain quality of materials, backup the ongoing services with right type of support services.

Thus the activities along the relief supply chain is a complex process and for efficient application of relief supply chain becomes a crucial process. The system, like relief supply chain, is characterized by many enablers like volume flexibility, customer satisfaction, delivery performance etc. For meeting the complexities of the system, it is require to study these enablers, which also acts as critical success factors of system, and find the inter relationship between them.

ISM is an interactive learning process in which a set of different and directly related elements is structured into a comprehensive systemic model [1]. The model so formed portrays the structure of a complex issue or problem, a system or a field of study, in a carefully designed pattern implying graphics as well as words. ISM methodology helps to impose order and direction on the complexity of relationships among elements of a system [2].

An application of the methodology is successfully employed in engineering research for evaluating interrelationship among variables. For example, [3] investigated the issue of waste water management in India using ISM, [4] investigated into the interrelationships among knowledge management variables, [5] developed an ISM model for IT enablers in supply chain, [6] analyzed barriers to reverse logistics using ISM. [7] developed ISM model for supplier development and developed the relationship between various factors for an automobile firm.

The intent of the present paper is to investigate the enablers affecting the performance of relief supply chain and develop structural relationship among the enablers. This will help to design the strategies for improving performance of the system. In nutshell, the focused objectives of this chapter are as follow :

- Identifying enablers and barriers along the supply chain; and
- Imposing the relationships between enablers to derive strategies for effective application of relief supply chain during disasters.

The organization of paper as follows. Section 2 presents literature review related to the work. The ISM analysis is presented in next section and paper is concluded in last section.

II. LITERATURE REVIEW

In this paper a humanitarian supply chain refers to the network created through the flow of supplies, services, finances and information between donors, beneficiaries, suppliers and different units of humanitarian organizations for the purpose of providing physical aid to beneficiaries [8]. Humanitarian supply chains include functionalities which do not typically fall into the field of humanitarian logistics. Managing relationships with donors, performing needs assessments, planning for supplies required and monitoring and evaluating the impact of distributed supplies, are usually the responsibility of non-logistics program units.

In creating ISM, [9-11] 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 analysed in terms of sets of elements and relations. From the viewpoint of the user, the structural models produced are communicated as a combination of words and digraphs with the mathematics being hidden in a computer program.

ISM is a method which enables handling the complexity of the system and resolves it into easily comprehendible form by working out the hierarchical arrangement of system variables. ISM is primarily intended as a group learning process [12]. The method is interpretive as the judgment of the group decides whether and how the variables are related. It is structural as on the basis of relationship, an overall structure is extracted from the complex set of variables. It is a modeling technique, wherein the specific relationships and overall structure is portrayed in a digraph model.

ISM starts with an identification of variables, which are relevant to the problem or issue and then extends with a group problem-solving technique. Later on a contextually relevant subordinate relation is identified. After resolving the variable set and the contextual relation, a structural self-interaction matrix (SSIM) is prepared based on pair-wise comparison of variables. The SSIM is transformed in to a reachability matrix which includes variable transitivity. Lastly, the partitioning of the variables and an extraction of the structural model, called ISM, is derived.

III. ISM ANALYSIS

For performing ISM analysis, many enablers were identified using extensive literature review. Then, the discussions were made regarding selection of enablers with experts from people from mock drills and people from academics. Some of factors were found less relevant and were neglected. Also, some factors were seemed to be quite similar and accordingly were combined. Based on these discussions, 16 factors have been identified for carrying the analysis and discussed hereafter.

A brief discussion of these factors is given below :

1. Volume flexibility : Volume flexibility can be defined as ability to respond to different magnitudes of disasters. Volume flexibility for the relief chain measures an organization's ability to respond to different magnitudes (or severity) of disasters.

2. Delivery flexibility : Delivery flexibility is defined as the ability of the supply chain to cater to a disaster area in any location of the world with a minimum required time. Many times disasters are in such remote areas that organizations find it difficult to reach up to those areas. For this response as the arrival of supplies to the disaster site is defined. Therefore, delivery flexibility for the relief chain will be defined as the time as the minimum response time, which is the elapsed time between the onset of the disaster and the arrival time of the organization's first supplies to the disaster site. A very critical factor for relief chain and some times whole success depends on this factor.

3. Mix flexibility : Over the course of a relief effort, there is a large number of different types of items that are required and shipped to the affected area, including tarps, blankets, jerry cans, high-energy biscuits, ready-to-eat meals, a variety of medicines, hygiene kits, kitchen sets, tents, and clothing.

Mix flexibility for the relief chain measures the number of different types of items that the relief chain can provide during a particular time period. An efficient relief supply chain should be capable of providing any kind of relief item according to the need of the hour.

4. Delivery time : Delivery time is defined as the time taken by supply chain to deliver the goods when they are already in procured. This factor depends on transportation facilities available, supply chain integration and location of ware houses.

5. Assessment/ Forecasting : Assessment and forecasting is an important factor in humanitarian supply chain. There can be huge variation in demand. A proper assessment can give clear picture of the situation and relief organizations can plan accordingly. Persons from the relief organization and government travels to the site to perform an assessment to estimate the supplies required to meet the relief needs of the affected population. Then they communicate the results of the assessment to an off-site logistician who translates the assessment into supply requirements.

6. Site and location planning : Location planning is very important factor in relief supply chain. There are various organizations and government agencies involved in relief work. Locations should be selected with the consensus of all the parties. A well planned location selection can reduce the lots of complexities.

7. Use of IT tools : Relief work generally involves various agencies and organizations which have never worked with each other earlier. Scope of work is very large and lots of planning is involved in it. Proper use of IT tools brings more clarity and understanding among the parties. It helps in quick planning and execution.

8. Centralized and collaborative planning : Like any other supply chain centralized and collaborative planning is important for relief supply chain but it becomes more important for relief supply chain because of involvement of large number of organizations, confusion about the exact situation in disaster area and need for quick response.

9. Customer satisfaction : In every supply chain customer satisfaction is ultimate aim but in relief supply chain end users are not ultimate customers as in other business supply chain. In relief supply chain donors are ultimate customers. If they are satisfied with the relief work of the organization, they will give donation next time. If donors are not satisfied with the relief work of the organization, they will move their money to other organizations.

10. Procurement cost : A preliminary appeal for donations of cash and relief supplies is often made within 36 hours of the onset of a disaster. If donors respond and the appeal is funded, relief supplies are mobilized. The logistician first attempts to procure the supplies from local sources, and if the relief organization owns a centralized warehouse, the logistician then checks available supplies in those warehouses. Anything that cannot be fulfilled locally or from centralized warehouses is procured from global suppliers through competitive bidding. There can be and are usually multiple suppliers supplying a single relief organization for each relief effort.

On the onset of disaster suddenly demand for basic items increases very fast. And relief agencies procure those items at a very high cost. A well planned supply chain can procure these items at low cost.

11. Minimizing uncertainty : A supply chain with clear relation with its vendors and reliable resources is very important in disaster times. A little uncertainty can lead to many more lives. By proper use of IT tools, centralized and collaborative planning, proper assessment and forecasting uncertainty can be minimized.

12. Procurement speed : As most of the time demand is not clear before disaster, procurement is done only after the disaster takes place. This first procurement is very important for relief supply chains. This is the most dangerous phase of a disaster. Organizations which are capable in procuring at fast speed can provide timely help.

13. Integrated supply chain : Supply chain integration is required because of need of fast service, involvement of various parties, supply of very different kind of items etc.

14. Transportation system : Transportation system is the basic requirement of any supply chain. In relief supply chain various kind of modes of transportation are needed depending on the situation. Fast delivery of goods, procurement, and access to disaster area all depends on transportation system. An efficient supply chain must be ready for any situation. Depending upon the type of disaster it may need different kind of transportation media.

15. Distribution costs : Relief organizations often need to transport massive amounts of materials in a very short amount of time. However, the nature of the demand in humanitarian relief chains makes relationships with transportation companies more difficult to develop. Varied disaster locations lead to varied transportation modes (truck, train, airplane, etc.). Complexity may be increased by local tariffs and taxes for incoming goods. Furthermore, since disasters occur in different locations that are often remote, it may be necessary to use local distribution companies for the “last mile” delivery of goods. By measuring the different components of distribution cost, relief organizations can identify specific potential areas for cost reductions.

16. Inventory costs : Unlike supply and distribution costs, not all humanitarian relief chains will have substantial inventory costs. This is because only some relief organizations maintain and operate their own supply warehouses. There are many types of inventory costs, including: inventory investment, inventory obsolescence (and spoilage), order/setup costs, and holding (carrying) costs. Inventory control for supply warehouses in the relief chain is challenging due to the high variations in lead times, demands, and demand locations. The specific types of inventory costs to measure depend on the type of items being held. For example, if the relief chain stores many perishable items, then the costs associated with spoilage should be measured.

The application of ISM typically forces managers to reassess perceived priorities and improve their understanding of the linkages among the key concerns. The various steps involved in the ISM technique are :

1. Identification of the elements, which are relevant to the problem or issues, this could be done by literature review or any group problem solving technique.
2. Establishing a contextual relationship between elements with repect to which pair of elements will be examined.
3. Developing a structural self interaction matrix (SSIM) of elements, which indicates pair wise relationship between elements of the system.
4. Developing a reachability matrix from the SSIM, and 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 element B and B is reached to C, then A will be related to C.
5. Partitioning of reachability matrix into different level.
6. Based on the relationships given above in reachability matrix draw a directed graph (diagraph), and remove transtitive links.
7. Convert the resultant diagraph into an ISM, by replacing elements nodes with statements.

8. Review the ISM model to check for conceptual inconsistency, and make the necessary modification.

The detailed flowchart for the methodology of ISM is given in Fig. 1.

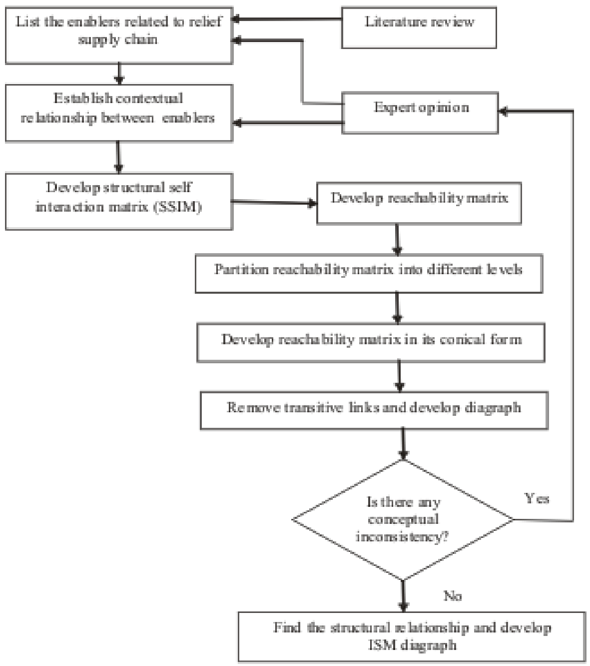


Fig. 1. Flowchart for conducting ISM analysis

Based on the above discussions, the ISM is now applied to relief supply chain.

A. Structural Self Interaction Matrix

The development of SSIM requires depicting dependence among all possible pairs of elements by choosing a contextual relationship showing which elements lead to which others. For analyzing the criteria a contextual relationship of "leads to" is chosen here. For expressing the relationship between critical factors for analyzing the performance of ASC, four symbols have been used to denote the direction of relationship between parameters i and 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
4. O: parameter i and j are unrelated

Based on the contextual relationship between the critical parameters, the SSIM matrix is developed in table 1.

Table 1. SSIM Matrix

	16	**15**	**14**	**13**	**12**	**11**	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**
1.	A	A	A	A	A	A	O	V	A	A	A	A	O	O	O	X
2.	A	O	A	A	A	A	A	V	A	A	A	A	A	O	X	
3.	A	O	A	A	A	A	O	V	A	A	A	A	O	X		
4.	A	A	A	A	A	A	O	V	A	A	A	A	X			
5.	O	O	O	O	O	V	V	O	X	A	O	X				
6.	V	V	O	X	V	O	V	O	O	O	X					
7.	O	V	V	V	V	V	V	V	V	X						
8.	V	V	V	V	V	V	V	V	X							
9.	O	A	O	O	X	A	A	X								
10.	O	O	A	A	X	O	X									
11.	X	O	A	A	V	X										
12.	O	O	A	A	X											
13.	V	V	V	X												
14.	O	V	X													
15.	O	X														
16.	X															

B. Reachability Matrix

After getting SSIM matrix we transfer SSIM matrix into a reachability matrix (Table 2). by transforming the information in each entry of the SSIM into 1s and 0s in the reachability matrix.

Table 2. Reachabilty Matrix

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

C. Partitioning The Reachability Matrix

The matrix is partitioned, by assessing the reachability and antecedent sets for each variable. The reachability set consists of the element itself and other elements, which it may help to achieve, whereas the antecedent set consists of the element itself and other elements, which may help achieving it. Then the intersection of these sets is derived for all the elements. The elements for which the reachability and intersection sets are same are the top-level elements in the ISM hierarchy. The top-level elements of the hierarchy would not help to achieve any other element above their own level in the hierarchy. Once top-level elements are identified, it is separated out from the rest of the elements. Then, the same process is repeated to find the next level of elements.

Iteration 1 : In this iteration factor 9 (customer satisfaction) got the highest level.

Table 3. Iteration 1

Elements	Reachability Set	Antecedent Set	Intersection	Level
1	1, 9	1, 5, 6, 7, 8, 11, 12, 13, 14, 15, 16	1	
2	2, 9	2, 4, 5, 6, 7, 8,10, 11, 12, 13, 14, 16	2	
3	3, 9	3, 5, 6, 7, 8, 11, 12, 13, 14, 15, 16	3	
4	2, 4, 9	4, 5, 6, 7, 8, 11, 12, 13, 14, 15, 16	4	
5	1, 2, 3, 4, 5,8, 10, 11	5, 7, 8	5, 8	
6	1, 2, 3, 4, 6, 10, 12, 13, 15, 16	6, 13	9, 12	
7	1, 2, 3, 4, 5, 7, 8, 9, 10, 11, 12, 13, 14, 15	7	10, 12	
8	1, 2, 3, 4, 5, 8, 9, 10, 11, 12, 13, 14, 15, 16	5, 7, 8	11, 16	
9	9, 12	1, 2, 3, 4, 7, 8, 9, 10, 11, 12, 15	9, 10, 12	I
10	2, 9, 10, 12	5, 6, 7, 8, 10, 12, 13, 14	6, 13	
11	1, 2, 3, 4, 9, 11, 12, 16	5, 7, 8, 11, 13, 14, 16	14	
12	1, 2, 3, 4, 9, 10, 12	6, 7, 8, 9, 10, 11, 12, 13, 14	15	
13	1, 2, 3, 4, 6, 10, 11, 12, 13, 14, 15, 16	6, 7, 8, 13	11, 16	
14	1, 2, 3, 4, 10, 11, 12, 14, 15	7, 8, 13, 14		
15	1, 4, 9, 15	6, 7, 8, 13, 14, 15		
16	1, 2, 3, 4, 11, 16	6, 8, 11, 13, 16		

Iteration 2 : Ration factor 9 is removed from all the places. In this iteration factor 1 (Volume flexibility), 2 (delivery flexibility) and 3 (Mix flexibility) got the highest level.

Table 4. Iteration 2

Elements	Reachability Set	Antecedent Set	Intersection	Level
1	1	1, 5, 6, 7, 8, 11, 12, 13, 14, 15, 16	1	II
2	2	2, 4, 5, 6, 7, 8, 10, 11, 12, 13, 14, 16	2	II
3	3	3, 5, 6, 7, 8, 11, 12, 13, 14, 15, 16	3	II
4	2, 4	4, 5, 6, 7, 8, 11, 12, 13, 14, 15, 16	4	
5	1, 2, 3, 4, 5, 8, 10, 11	5, 7, 8	5, 8	
6	1, 2,3, 4, 6,10, 12, 13, 15, 16	6,13	6, 13	
7	1 , 2 , 3,4,5,7,8,,10,1-1,12,13,14,15	7	7	
8	1, 2, 3,4, 5, 8, 10, 11, 12, 13, 14, 15, 16	5, 7, 8	5, 8	
10	2, 10, 12	5, 6, 7, 8, 10, 12, 13, 14	10 12	
11	1, 2, 3, 4, 11, 12, 16	5, 7, 8, 11, 13, 14, 16	11, 16	
12	1, 2, 3,4,1 0, 12	6,7, 8, 10, 11, 12, 13, 14	10, 12	
13	1, 2, 3, 4, 6, 10, 11,12, 13, 14, 15, 16	6, 7, 8, 13	6, 13	
14	1, 2, 3, 4, 10, 11, 12, 14, 15	7, 8, 13, 14	14	
15	1, 4, 15	6, 7, 8, 13, 14, 15	15	
16	1, 2, 3 ,4,1 1, 16	6, 8, 11, 13, 16	11, 16	

Iteration 3 : In this iteration we removed factors 9, 1, 2, 3 from all the places and we finally got factor 4 and 10 at highest level.

Table 5. Iteration 3.

Element	Reachability Set	Antecedent Set	Intersection	Level
4	4	4 5, 6, 7, 8, 11, 12, 13, 14, 15, 16	4	III
5	4, 5, 8, 10, 11	5, 7, 8	5 ,8	
6	4, 6, 10, 12, 13, 15, 16	6, 13	6, 13	
7	4, 5, 7, 8, 10, 11, 12, 13, 14, 15	7	7	
8	4, 5, 8, 10, 11, 12, 13, 14, 15, 16	5, 7, 8	5 ,8	
10	10, 12	5, 6, 7, 8, 10, 12, 13, 14	10, 12	III
11	4, 11, 12, 16	5, 7, 8, 11, 13, 14, 16	11,16	
12	4, 10, 12	6, 7, 8, 10, 11, 12, 13, 14	10, 12	
13	4, 6, 10, 11, 12, 13, 14, 15 ,16	6, 7, 8, 13	6, 13	
14	4, 10, 11, 12, 14, 15	7, 8, 13, 14	14	
15	4, 15	6, 7, 8, 13, 14, 15	15	

Iteration 4: In this iteration we removed factors 9,1,2,3,4,10 from all the places and we got factors 12,15,16 at highest level.

Table 6. Iteration 4.

Element	Reachability Set	Antecedent Set	Intersection	Level
5	5, 8, 11	5, 7, 8	5, 8	
6	6, 12, 13, 15, 16	6, 13	6, 13	
7	5, 7, 8,11,12, 13, 14, 15	7	7	
8	5, 8, 11, 12, 13, 14, 15, 16	5, 7, 8	5, 8	
11	11, 12, 16	5, 7, 8, 11, 13, 14, 16	11, 16	
12	12	6, 7, 8, 11, 12, 13, 14	12	IV
13	6, 11, 12, 13, 14, 15, 16	6, 7, 8, 13	6, 13	
14	11, 12, 14, 15	7, 8, 13, 14	14	
15	15	6, 7, 8, 13, 14, 15	15	IV
16	11, 16	6, 8, 11, 13, 16	11, 16	

Iteration 5 : From the matrix got in iteration 4, we removed factors 12, 15, 16 from all the places and we got factor 6 and 11 at highest level.

Table 7. Iteration 5.

Element	Reachability Set	Antecedent Set	Intersection	Level
5	5, 8, 11	5, 7 ,8	5, 8	
6	6, 13	6, 13	6, 13	V
7	5, 7, 8, 11, 13, 14	7	7	
8	5, 8, 11, 13, 14,	5 ,7, 8	5, 8	
11	11	5, 7, 8, 11, 13, 14	11	V
13	6, 11, 13, 14,	6, 7, 8, 13	6, 13	
14	11, 14	7, 8, 13, 14	14	

Iteration 6 : After removing factors 6 and 11 from the matrix we got the matrix below and element 5 and 14 got the highest level.

Table 8. Iteration 6.

Element	Reachability Set	Antecedent Set	Intersection	Level
5	5, 8	5, 7, 8	5, 8	VI
7	5, 7, 8, 13, 14	7	7	
8	5, 8, 13, 14,	5, 7, 8	5, 8	
13	13, 14,	7, 8, 13	13	
14	14	7, 8, 13, 14	14	VI

Iteration 7 : We removed factors 5 and 14 from the matrix and in this iteration we got factor 13 at highest level.

Table 9. Iteration 7.

Element	Reachability Set	Antecedent Set	Intersection	Level
7	7, 8, 13	7	7	
8	8, 13	7, 8	8	
13	13	7, 8, 13	13	VII

Iteration 8 : On removing factor 13 from the matrix 7 and 8 were left. Factor 8 was at higher level than factor 7.

Table 10. Iteration 8.

Element	Reachability Set	Antecedent Set	Intersection	Level
7	7, 8	7	7	IX
8	8	7, 8	8	VIII

D. Conical Matrix

A conical matrix is developed by clustering variables in the same level, across row and columns of the final reachability matrix, as shown in table 11. Based on the analysis, diagraph (Fig. 2) is developed.

Table 11. Conical Matrix.

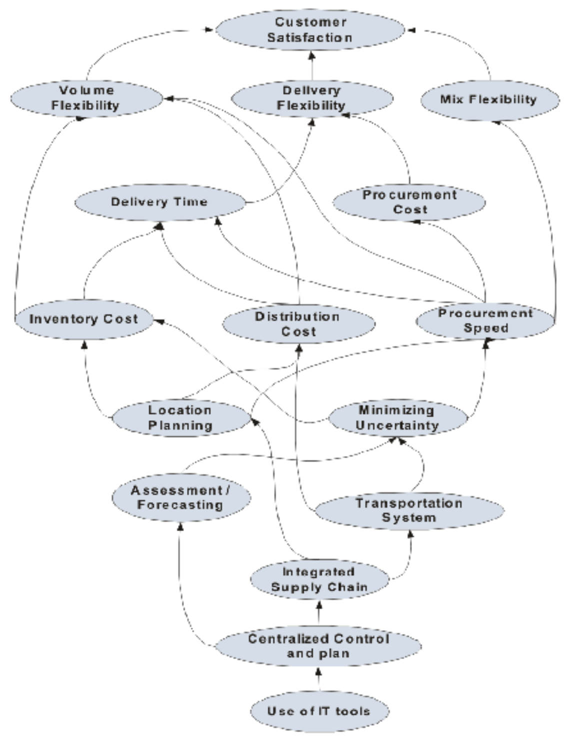
	9	1	2	3	4	10	12	15	16	6	11	5	14	13	8	7
9	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
3	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
4	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0
10	1	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0
12	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0
15	1	1	0	0	1	0	0	1	0	0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

IV. DISCUSSIONS AND CONCLUSION

The present model will help to increase the awareness of decision makers, whilst assisting them to better understand the mutual influence among different supply chain risks and the consequences this implies for decisions about risk mitigation strategies. Substantial discussion of the identified risks among the experts lead to significant learning about the inter-relationship and total risk exposure of the company or supply chain under study.

The application of ISM showed its practicability as an analysis and decision-support tool in order to facilitate thorough understanding of a complex problem. The complex problem studied was the inter-relationship of key enablers of Humanitarian Supply chain and finally a framework is constructed. The process of building an ISM develops subject matter knowledge throughout the discussion and analysis. In the present work, only 16 enablers have been used for modeling. More enablers can be identified to develop ISM.

It now should be clear that disaster relief supply chains operate in a different environment from the types of supply chains that are more widely known and researched. These differences are important and offer opportunities to conduct potentially useful research. One obvious reason why studying disaster relief supply chains is important is because of the potential to save lives and reduce suffering for those people affected by a disaster. Another, less obvious, reason is that there are lessons to be learned for the private sector. The study of such highly responsive supply chains could help inform other contexts in which a growing importance is placed on customer responsiveness and product innovation, contrasted with cost and efficiency. Moreover, increasing the breadth of supply chain research will help in developing classifications, identifying drivers of attributes and uncovering transferable practices than can benefit other sectors. The more that can be learned about effective practices in supply chain responses to different needs, the better the designs of future supply chains can be.



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