JOURNAL OF MARITIME RESEARCH

Vol XIII. No. IX (2014) pp 53–64

ISSN: 1697-4040, www.jmr.unican.es

Analysis of Lean - Agility Factors of Maritime Supply Chain: A Hybrid Approach

F. Khoshalhan[1], T. Kalantari[2,*]

ARTICLE INFO

Article history:
Received 31 January 2016;
in revised form 03 February 2016;
accepted 25 March 2016.

Keywords:
Leagile, Supply Chain, FCM, ISM.

ABSTRACT

Maritime superiority efficiency depends on four main areas of organization includes: supply chains, human resources, operations and information. Among the agents, the supply chain is one of the most important areas. The main objective of this article is to study the effects of the behavior of Interpretative Structural Modeling on fuzzy cognitive maps . In this article, first the primary factors of Lean-agility of supply chain has been identified based on the literature review. Then with designing the Interpretive Structural Modeling and fuzzy cognitive maps models, the quality and relevance between the main factors of lean - agility of Maritime supply chain has been analyzed . it shows, initially ,that the behavior of Interpretive Structural Modeling confirms the results of the Fuzzy Cognitive Maps. Second, the interaction of two models are the same. Third, according to the result of these two models, the variables are divided into static and dynamic categories. It is recommended that the model should be tested for those supply chains which have established themselves as lean, agile or leagile entities. Suggested model would help Maritime Logistics to select suitable supply chain strategy based on Customer requirements. Mapping supply chains based on quantification of fuzzy cognitive maps model and Interpretive Structural Modeling competency dimension are novel effort in the area of supply chain management.

1. Introduction

level promoting of development and national power and also have a great strategic value for each country. International trade of goods and materials is mainly done by means of Maritime. This is due to the superiority of Maritime transport from economical point of view and movement facilities compared to the other ways of transport (air, rail and road) is proved. Western Navigator Alfred Thayer Mahan, considered the control of the Maritimes as the main condition for becoming a world power. The ultimate goal Maritime power is to achieve a Maritime communication routes for product and material handling and also to access the consumer market and supplies. So the participation of the Maritime in the national economy of countries, is about between 2 and 9 percent of GDP. Maritime transport is a dominant mode as over 90% of global trade volume is carried by sea (IMO, 2008).

Maritime power efficiency depends on four main areas of organization, including supply chain, human resources, operations and the information. Among the agents, the supply chain is one of the most important areas. The process of material and information flow, providing money from suppliers, factories and storehouse and delivering the services to end users is called supply chain. But in the Maritime logistics, supply chain refers to support functional areas or processes with design and planning, ensuring supply, production, and transfer of logistical items, information, and financial, for operational units.

In this article, we showed the results indicate the equal interaction between the lean - agility factors in the all three approaches to respondents; meaning that, the original main fac-

[1]Associate Professor, Industrial Engineering, K.N.Toosi University of Technology, Iran. Tel 09123076428. E-mail address: khoshalhan@kntu.ac.ir
[2]PhD student, Industrial Engineering, K.N.Toosi University of Technology, Iran. Tel 09113951131. E-mail address: tkalantari@mail.kntu.ac.ir
*Corresponding Author: T. Kalantari. E-mail address: tkalantari@mail.kntu.ac.ir

tors of the maritime supply chain in the fuzzy cognitive maps was associated with high power relationship. The same factors with high influence and interdependence are connected to each other in the same level, and vice versa .This new achievement which has not been considered in the field of the supply chain, is accounted as a new strategy to improve the performance of supply chain of maritime logistics.

This article has been conducted in three parts. In the first part, the main factors for lean - agility of the supply chain in the scope of maritime logistic, was determined using the literature and Delphi method based on the expert opinions and Maritime logistics and using SPSS software. In the second part, to show the interaction of the main factors of lean - agility of the supply chain in Maritime logistics, the models of fuzzy cognitive maps and interpretive structural modeling was performed. In the third part, contemplated results from provided models were analyzed.

This paper has been organized in the following way. Section 2 a literature review of our research. In Section 3, we provide Research methodology, introduce the proposed algorithms, presents experimental results along with their analysis. Sections 4 is assigned to research findings. Finally, in Section 5, conclusions and future research topics are outlined.

2. Literature Review

Among the works that has been done over the past few decades in order to facilitate the management of business processes benchmark, was establishing the supply chain management (Lezgi and Ghaziasgar, 2013). Coordination between all entities in a supply chain and global planning is necessary to achieve effective Supply Chain Management (Alaei and Khoshalhan, 2015).

In addition, With the rapid development of information technology and its widespread application in supply chain management, Lean, agile supply chain and also their composition form (lean - agile) supply chain that has recently become popular and has relatively extensive been proposed in the supply chain literature (Konecka, 2010).

Lean supply chain, emphasizes the continuous improvement of activities to eliminate the unnecessary and redundant operation. Process time reducing and efficiency increasing indicate the importance of this approach. Furthermore, lean supply chain leads to reduce the costs and time and increase the profits in the production (Vonderembse et al., 2006). In the field of Maritime logistics, this kind of supply chain is more useful at the time of peace because in this situation timely supply and delivery of logistical items to operational and support units based on the projected demands which is combined with the minimizing the time and cost and maximizing the efficiency by eliminating redundant operations.

This approach is more likely to be demand-driven rather than forecast-centric (Gunasekaran, 1998). Supply chain agility means the ability of a supply chain to a quickly react to changes in the market and fulfill the customer needs (Jafarnejad, 2007). In other words, the ability of agile supply chain is to adapt and respond quickly to the changing environment of market (Swafford et al., 2008). This type of supply chain is used more in Maritime logistics domain during the instability. It is because of uncertainty and unpredicted demands of the supply chain. In this case logistical items must be in the access of the operational and support units in the shortest possible time with the lowest cost in order to meet the immediate needs of the units.

Never the less lean and agile approaches are often considered as opposite models, they have a common goal on respond to customer needs with the lowest total cost (Goldsby and Garcia-Dastugue, 2003). In addition, many studies assert that lean and agile approaches can be integrated by different ways to create a strategy that is called "lean-agility" (Childerhouse and Towill, 2000). The efficient and effective strategy in the field of Maritime logistics is lean - agile supply chain. This integrated supply chain due to having the features of the both of lean and agile supply chains in Maritime logistics, can provide needful forecasts in mobilizing resources and facilities in the stabile time to have the ability of providing a quick reaction to unforeseen needs of operational and support units according to the characteristics of agility in time of instability.

Therefore, againstÂ lean approach that focuses on the relatively stable demand, reducing supply chain costs and improving market brand, the agile supply chain approach is based on the principles of flexibility and adaptation to changes and provision the level of services as the main criterion (Mason-jones R. et al., 2000). But the Maritime supply chain focuses on the urgent need items according to the new environment condition and updating the logistical items. a lean approach to stabile time and agile approach during instable time is more appropriate. There is an argument, it that everything should be used in instability, in the time of stabile and tranquility must be trained to staff. Maritime logistics experts believe that both lean and agile supply chain strategies are required but their degrees in the field of Maritime logistics are different. If the main objective of the prospect is changing the productivity and efficiency of the supply chain over the time, we should think about how to balance these principles against each other (Godsell, 2011). Table 1 discusses about this comparison (Naylor et al., 1996; Mason-jones R. et al., 2000).

Heretofore in this regard, studies on lean - agility of supply chain have been performed which are noted below.

(Naylor et al., 1996) stated in their study that lean and agile paradigms complement and support each other and have the same priority. Companies should seek lean - agility of their supply chain to make benefits of lean and agility simultaneously.

(Mason-jones R. et al., 2000) presented a model of Lean - agility in their study stating that the processes are separated by a separation point. Thus, the lean processes are applied above the separation point, and agile processes are used below the separation point. Moreover, the variability of demand and combined products will change the nature of the separation point.

(Van Hoek, R.I, 2001) made a model that virtual integration, network integration; integration of processes and customer sensitivity was the main capabilities of its agility. They found that the sensitivity of the customer is the most important dimension of agility in the supply chain of European companies.

Table 1: Lean, agile, leagile and Maritime supply chains

Atribute	Lean	Agile	Leagile	Maritime
Typical Products	Commodities	Fashion	Both	Low - High Tech
Demand	Predictable	Volatile	Unpredictable and Volatile	Predictable - Unpredictable
Product Variety	Low	High	Medium	Low - Continuous Upgrade
Product Bussiness Life Cycle	Long	Short	Medium	Long or Short
Customer Drivers	Cost	Avilabilty	Service Level	Cost - Aviability
Supplier Profit Margin	Low	High	Moderate	Low and Stable
Stock Out	Long-term Problem	Immediate - Volatile	No Place for Stock- Out	Life Critical
Purchasing Policy	Buy Goods	Assign Capacity	Both	Buy in Place - Assign capacity
Supplier Relation	Maker Transactions	Parthership	Both	Whole scale
Market Winner	Cost	Service Level	Both	Cost - Service Level
Forecasting	Algorithmic	Consultative	Both	Simulation

(Collin and Lorenzin, 2006) in their study believed that demand planning is a factor to increase the agility of the supply chain, in other words, the supply chain would not be agile spontaneously and suddenly and need to a continuous and steady programming. In fact, continuous planning is a method to increase the efficiency and effectiveness.

(Agarwal et al., 2007) introduced affecting Factors of supply chain agility as: sensitivity to the market, delivery speed, information accuracy, new product introductions, concentrative and cooperative planning, process integration, information technology, reducing the waiting time, improving the service levels, minimizing the resistance against the changes. Then they used interpretive structural modeling to show the interactions of these agents.

(Krishnamurthy and Touch, 2007) considered the lean and agile production as strategies that support each other in a way that production companies can simultaneously benefit from these strategies. They also have offered a theoretical infrastructure for lean - agility model. The proposed infrastructure is composed of the decentralized structure (networking) and small and medium organizational size for agility and also medium and large organizational size for leaning.

(Swafford et al., 2008) believed that, supply chain agility is a function of the integration of Information technology and supply chain flexibility. Thus, the integration of information technology enables companies to increase supply chain flexibility. It also increases the agility and ultimately increases the competitive performance of companies.

(Kisperska-Moron and Swierczek, 2009) thought that the relationships with main customers and main suppliers and the application level of information technology and communication with primary competitors are the most important features respectively affecting the supply chain agility. Moreover, the importance of the Factors on the supply chain agility depends on the industry and the nature of the company's operations.

(Gilaninia, 2011) investigated the lean and agile production and then analyzed the optimization models of lean-agile supply chain. Taking into account the value of the customer's perspective, to compare the characteristics and type of product and a period of the product was the next stage of their model to help the managers and decision makers in the supply chain.

(Costantino et al., 2012) offered a strategic management technique to improve supply chain performance by agility the supply chain.

(Gharaeipour, 2012) introduced a MARITIME model to evaluate the leanness degree of supply chain. MARITIME model is developed to evaluate the leanness ratio and promoting of effective cooperation level in the defense and aerospace industries.

(Salah and Elmoselhy, 2013) believed that the lean strategy, can enhance the competitiveness and profitability by reducing production costs. Meanwhile, the agile strategy can activate the companies against the production fluctuations. Lean - Agile Hybrid approach can be a ideal combination strategy for a production company in the face of these challenges.

By reviewing the literature and background research of the subject, in order to identify lean - agility supply chain in Maritime filed, 41 Factors with the most reliability and frequency in different studies that had the most importance from Maritime experts point of view, were considered as the primary factors of Lean - agility of Maritime supply chain

3. The General Framework of the Study

3.1. Research Methodology

The main purpose of this study was to identify the main factors of lean - agility of Maritime supply chain and analysis of the interaction of these Factors based on fuzzy cognitive maps models and Interpretive Structural Modeling in the lean - agile strategy of supply chain in the Maritime domain. Therefore, based on a combined approach, first, the primary Factors of Lean - agility of supply chain was identified. Then with designing the FCM and ISM models, the quality and relevance between the main factors of lean - agility of maritime supply chain analyzed that are given in.

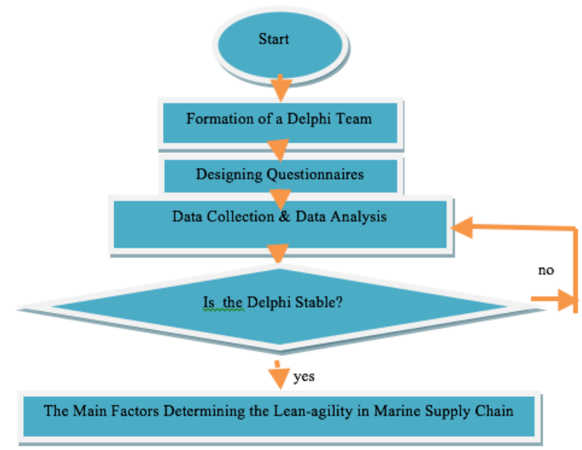
Figure 1: Research Methodology

3.2. *Delphi Method and the Main Factors of Lean - Agility of Maritime Supply Chain*

Delphi is a systematic approach to extract the opinions of a group of experts on a subject or question (Landeta, 2006). The Delphi method is repeated in several stages, so that the first iteration is allocated to generate new ideas and the result data is used for organizing and designing the questions in the next iterations (Brown and Libberton, 2007). The Delphi method is also a structured process for collecting and classifying the knowledge of an experts group that take place with distribution of the questionnaires among these people and their controlled feedback and comments determine the results (Adler and Ziglio, 1996) . In this article, the distributed questionnaire among experts was from the five-choice Liker questionnaire type which is more common in Delphi method. In different studies, the Delphi experts group (sample size) varied from 10 to 1685 people, but when there is congruence between the group members, it can be 10 to 20 people (Powell, 2003). The sample size in this study was considered as 15 persons. The validity of this method is not only depend on the number of participants in the study, but also depends on the reliability of the participating experts (Faizi and Iran dost, 2013). The number of repetitions in data collection, the papers have reported 2 to 10 repetitions. The repetition number of data collecting and result analyzing in this study was 3, because after the third repetition of the responses to the questions, Delphi stability is reached. Meanwhile, the Delphi process framework is given in Figure 2.

According to the previous discussions, in this article, questionnaires in three steps which has 41, 55 and 29 questions respectively, were designed based on the literature of research and experts of Maritime logistics. Then the questionnaires distributed among 15 experts of the field, and their answers to the questions were analyzed with SPSS statistical software and examined by researchers and in the final review the results were overviewed by experts.

Figure 2: Delphi Process



According to the discussion, results of the statistical analysis which in each step were reviewed and analyzed by experts in the field of maritime logistics and authors were listed in Table 2. sixteen factor that has higher mean and lower standard deviation than others are considered as the main factors of lean - agility of maritime supply chain.

3.3. *Casual relationships Between Variables*

In this study to identify causal relationships between variables, the main factors of lean - agility determined and were analyzed separately by using the Delphi method and fuzzy cognitive maps and structural interpretive modeling in order to design a structural model of lean - agile maritime logistic supply chain. According, quality and effectiveness degree of factors of Lean - agility of logistics maritime supply chain on each other can be determined then in order to accreditation, the results can be compared.

3.4. *Fuzzy Cognitive Maps*

Fuzzy Cognitive Maps (FCMs) is a modeling technique, arising from the combination of Fuzzy Logic and Neural Networks (Groumpos, 2015). Fuzzy Cognitive maps model, is a general model for the cause-effect phenomenon, which is taken from cognitive maps model (Kosko, 1986) . Fuzzy cognitive maps is a methodology for modeling method for decision complex systems. A fuzzy cognitive maps describes the behavior of a system based on its concepts . Each concept represents an identity, status, variable or characteristic of a system (Xirogiannis et al., 2004). Fuzzy cognitive maps have been applied in simulation, modeling, organizational strategies, supporting the compiling of strategic issues and decision analysis, creating the

Table 2: Main Factors of Lean - Agility of Supply Chain in Maritime Logistics

Row	Leagility Factors	Row	Leagility Factors
1	Information Integrity	9	Partnerships with Suppliers Pleasant
2	Networks	10	Quality
3	Training and Skill development of employees	11	Improve the Capacity
4	Virtualization	12	Budgeting
5	Intelligent	13	The Ability to Sustain Operations
6	Flexiblity	14	Satisfaction
7	Rapid Response to Changes	15	Planning
8	Risk Reduction	16	Decision Making

knowledge bases, diagnosis of management issues, specifications and system requirements, supporting of urban planning, relationship of airlines services and enhancing the utilization of network (Rodriguez-Repiso, L. and Setchi, 2007). Fuzzy cognitive maps, includes a set of nodes which each of them shows an environment phenomenon. There are edges between the Fuzzy cognitive maps nodes that get a weight from [-1 , 1] range as follows:

1) $W_i > 0$, when there is a positive casuality between C_j and C_i.

2) $W_{ij} < 0$,when the causality is negative and increase/decrease of the value of C_j causes a decrease/increase of the value of C_i

3) $W_{ij} = 0$,when there is no influence of concept C_j to concept C_i.

In fuzzy cognitive maps as well as cognitive maps, positive numbers indicate a direct relationship between phenomena and negative numbers indicate reverse correlation. In addition, fuzzy cognitive maps determine the effects content using edge weight.

In a conventional FCM, the value of each concept is computed, taking into account the influence of other concepts to the specific concept (Groumpos, 2010), by applying the following mathematical procedure:

$$A_i^{k+1} = f\left(k_2 \cdot A_i^k + k_1 \cdot \sum_{(j=1^{j\neq i})}^{N} A_j^k \cdot w_{ji}\right) \quad (1)$$

In (1), $A_i^{(k+1)}$ is the value of concept C_i at time $k+1$, $A_j^{(k)}$ is the value of concept C_j at time k, w_{ji} is the weight of interconnection between concepts C_j and C_i and f is the sigmoid threshold function.

Meanwhile, the designing process of fuzzy cognitive maps based on the model of Rodriguez-Repiso, L. and Setchi (2007) includes four stages of data collection, the degree of similarity between the concepts, causality assessment, and graphical representation of fuzzy cognitive maps.

- **Initial matrix of success**

Figure 3: A Simple Fuzzy Cognitive Map (Groumpos, 2015)

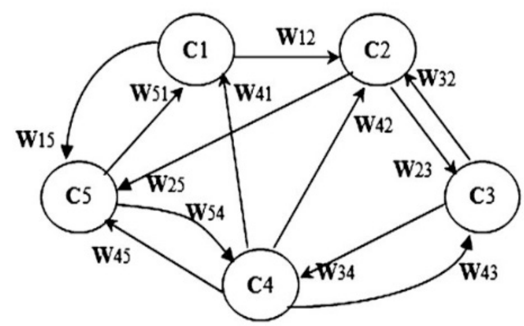
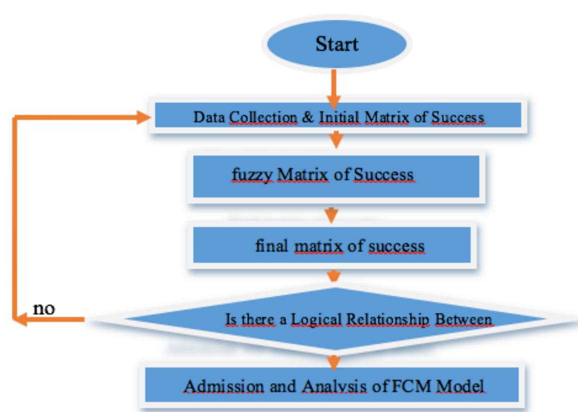


Figure 4: The Procedure of Fuzzy Cogntive



The variables of FCM model, are the same factors of lean - agility maritime logistics supply chain. initial matrix of success, is an M*N matrix that its lines present the main Factors of lean - agility of Maritime logistics supply chain and its columns shows the experts interviews. Moreover, the matrix elements are shown with O_{ij} that indicates the importance of I factor for person j. Meanwhile O_{i1}, O_{i2}, O_{im} are the elements of vector V_i that related to rows I of success matrix (Rodriguez-Repiso, L. and Setchi, 2007). In this study, after detection of the main Factors of lean - agility through expert questionnaires, another questionnaire which its lines are the lean - agility Factors and its columns are made of experts is distributed. The experts were asked to weight any of the Factors in the range of zero to one hundred. After analyzing the data from the questionnaires, the primary success matrix is created that is shown in Table 3.

- **Fuzzy matrix of success**

For this purpose, numerical vectors Vi are converted to fuzzy sets based on the below equations:

1) O_{ij} fuzzy importance degree in the vector
   $X_i(O_{ij}) = \frac{O_{ij}-min(O_{ij})}{max(O_{ij})-min(O_{ij})}$
2) Maximum fuzzy degree $[MAX(O_{iq} \rightarrow X_i(O_{iq}) = 1]$
3) Minimum fuzzy degree $[MIN(O_{iq}) \rightarrow X_i(O_{iq}) = 0]$

In this study, the importance degree of the numbers larger than or equal to 90 (as maximum amount) are considered 1, and the importance degree of the numbers less than or equal to 20(as minimum amount) are considered 0.

- **The matrix of success relationship**

MSR is an $N * N$ matrix that its rows and columns indicate success main Factors(main Factors of lean - agility) and its elements (W_{ij}) indicate the relationship between the Factors i and j that has a value in the interval [-1,1] .

According to these descriptions, W_{ij} is the closeness of the two vectors V_1, V_2. In other words it indicates the strength of success relation that is based on the distance between vectors that equations 4, 5, 6 and 7 are used to its calculation.

4) The distance between the vectors (two vectors have a direct relationship with each other)

   $d_j = \mid x_1(v_j) - x_2(v_j) \mid$

5) The distance between the vectors (two vectors are inversely related with each other)

   $d_j = \mid x_1(v_j) - (1 - x_2(v_j)) \mid$

6) The average distance

   $AD_{ij} = \frac{\sum_{j=1}^{m} \mid dj \mid}{m}$

7) Short distance between two vectors

   $W_{ij} = 1 - AD_{ij}$

$W_{ij} = 1$,indicates the closest distance and $W_{ij} = 0$, represents the longest distance between the two vectors.

- **The final matrix of success**

This matrix consists of a part of a relationship strength successful matrix that has been set based on maritime logistics experts' focal group. Elements that were not causally related or the relations between them were meaningless have been eliminated. It had been done Because of some misleading data of matrix of strength successful matrix.

- **Model of fuzzy cognitive maps**

The graphical representation of ultimate success matrix of a phenomenon, which includes a number of nodes and edges is called a fuzzy cognitive maps model. In the graphical representation of this study, each node represents a factors of lean - agility and each edge related to the elements i, j with a marked weight that reflects the strength of the causal relationship between these Factors is direct or inverse. Furthermore, the causal relationships vector between these factors were determined according to focal groups of experts. In this study, the group was consisting of four responsible persons in maritime logistics. The graphical representation of the model is given in Figure **??**.

According to the fuzzy cognitive maps model, the main factors of lean - agility maritime supply chain based on the close relationship between the variables have been classified into two groups as follow. The first group includes factors such as networking, virtualization, information integrity, intelligence, training and development of staff skills, the ability of continuation of operations and managers' satisfaction with the low relationship strength (Static variables). The second group, including planning, budgeting, participation with suppliers, improving the capacity and decision-making, risk reduction, flexibility, ability to quick react and the quality with high relationship strength (Static dynamic). Dynamic variables, variables that any changes, cause changes in the lean - agility supply chain maritime but, Static variables, are variables that underlie lean - agility supply chain, because these factors have a fundamental role in setting up a lean - agility supply chain or these factors themselves are results of derived from lean - agility of maritime supply chain.

3.5. *Interpretive Structural Modeling*

ISM indicates the relationship between the elements of a complex system (Huang, et al.,2005) which can be used to analyze the effect of one variable on other variables. In general, interpretive structural modeling algorithm is an interactive process, in which a set of interconnected and related elements are structured in a comprehensive and systematic model. This method can also be used to prioritizing and level determining of the elements of a system. The interpretive structural modeling process is shown in Figure 6

- **Model variables**: The variable components of the ISM model are the same Factors of lean - agility maritime logistics supply chain.
- **Structural Self-Interaction Matrix**: This matrix has the size of $i * j$ which in its first row and column, the variables are mentioned respectively. Then the relationship between the two variables are identified by symbols as follows:
- **V**: the element of row i is an underlying element for column j.
- **X**: the elements in row i and column j has a mutual communication.

Table 3: Initial Matrix of Success

Model Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Information Infrity	40	90	10	70	85	20	60	50	40	45	30	88	67	55	75
Networks	80	30	20	45	70	90	70	75	73	68	70	68	20	82	40
Training and Development of Staff Skills	20	40	45	55	80	80	20	83	20	72	73	85	68	79	91
Virtualization	50	45	30	60	60	55	75	45	70	63	70	63	53	70	80
Intelligent	50	30	40	70	50	30	45	60	73	65	63	50	43	20	30
Flexibility	60	4	70	50	90	65	75	63	75	85	70	78	65	90	80
Rapid Response to Changes	80	75	60	45	80	75	80	70	69	88	60	90	75	55	85
Risk Reduction	97	90	75	70	85	85	83	80	71	85	90	92	80	87	98
Partnerships with Suppliers Pleasant	70	60	65	40	93	60	70	68	65	80	75	95	85	80	77
Quality	90	80	73	50	98	65	75	78	70	90	80	85	78	79	88
Improve the Capacity	80	70	85	73	83	70	90	70	72	80	70	90	75	65	60
Budgeting	75	85	50	80	75	60	83	74	85	78	60	70	90	82	85
The ability to Sustain Operations	55	45	60	85	70	68	70	69	90	83	65	57	47	25	55
Satisfaction	70	60	75	90	80	85	80	72	85	82	90	95	85	80	79
Planning	80	70	65	50	75	73	68	68	70	80	65	70	50	40	47
Decision Making	60	50	45	63	70	72	55	57	65	70	30	70	60	50	40

Figure 5: Model of fuzzy cognitive maps of Maritime Lean - agility of Supply Chain

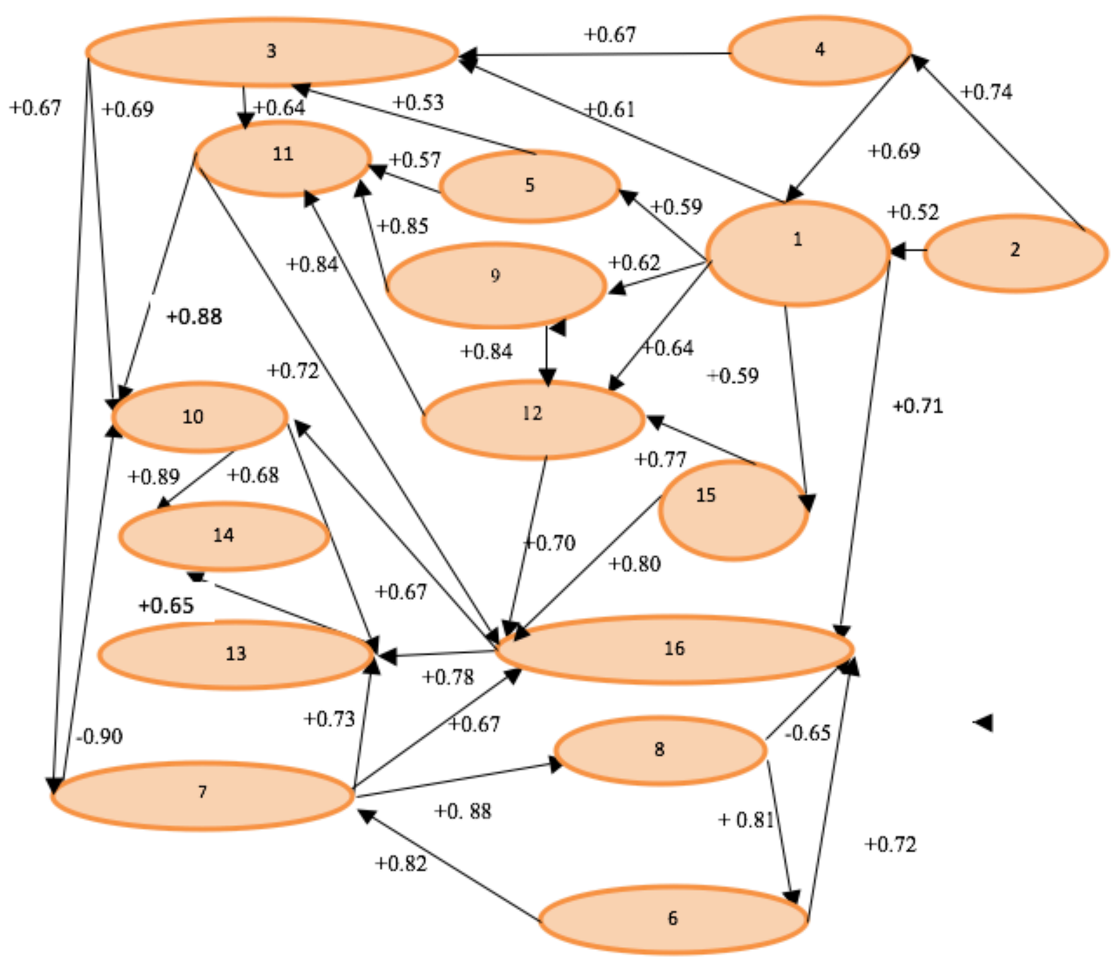
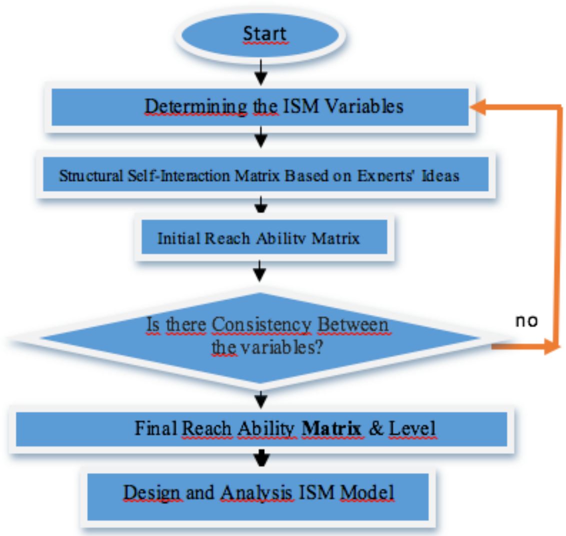


Figure 6: Interpretive Structural Modeling Process



- **A**: the element of column j is an underlying element for row i.
- **O**: There is no relationship between the elements of row i and column j.

For this purpose, first, a questionnaire was designed which its variables were the same factors of lean - agility maritime supply chain that were determined by Delphi method in the previous section. In the questionnaire, experts were asked again to identify the relationships between these Factors and mentioned symbols. The questionnaires were collected and analyzed by the focal group of experts to resolve these differences which make a structured matrix that is shown in Table 4.

- Initial reach ability matrix

Using the structural matrix and the matrix order was determined by the following rules.

1) If the relationship between the two elements i, j is V, the matrix elements will be in the order form of $(i, j) = 1$ and $(j, i) = 0$
2) If the relationship between the two elements i, j is A, the matrix elements will be in the order form of $(i, j) = 0$ and $(j, i) = 1$
3) If the relationship between the two elements i, j is X, the matrix elements will be in the order form of $(i, j) = 1$ and $(j, i) = 1$
4) If the relationship between the two elements i, j is V, the matrix elements will be in the order form of $(i, j) = 0$ and $(j, i) = 0$

- **Final reach ability matrix**: Considering the transitivity relationship between the elements, it is necessary to initial matrix to be consistent. If the internal consistency of access matrix was established, then the matrix would be called the final matrix. Otherwise the questionnaires must be filled by the experts again until the time that it get consistent (Krishnamurthy and Touch, 2007). Or the original matrix should reach in the power of $(k + 1)$. So that steady state is established. In this way, some zero elements of matrix will be converted into 1 that are shown as $(*1)$ are shown. In this study the second method is used.

- **Level partitions**

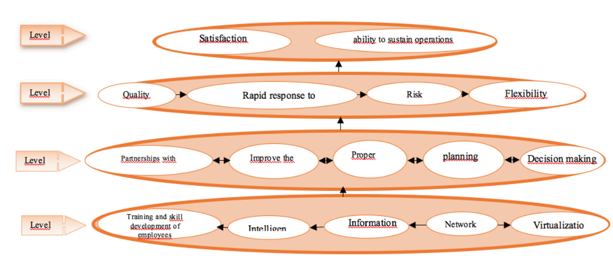
  After determining the accessible, prior and common sets, the access set for each element is a set that in which the rows are appear to be 1 and a prior set is a set in which the columns appear to be "one". Obtaining the participation of these two sets, a share of the common set will be achieved. Elements that are same in shared set and in the access set, get the first level priority of are the first priority to account.

  Repeat this step for the removal of metals and other elements. With eliminating these elements and repeating this step for all other elements (of lean - agility).

- **ISM Model Design**

  Regarding the levels of variables and their relationships, the Factors of lean-agility in Maritime supply chain, have been placed in four levels as a structural model of the ISM. Stratification has been done and the relationships between them show the effect of these variables on the Maritime supply chain. Meaning that, the variables 1, 2, 3, 4 and 5, which are known as the first level variables, are at the diagram first level and similarly, other parameters are specified in other levels of diagram. This model is shown in Figure 7.

Figure 7: Proposed ISM Model of Lean - agility in maritime Supply Chain



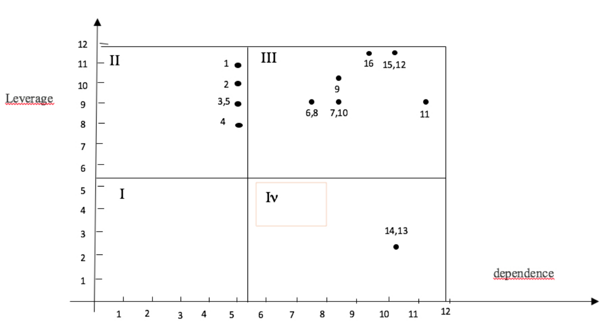
According to the ISM model and the final access matrix, power of influence chart and dependency diagram are shown in Figure 7. According to this chart, firstly, Factors 1, 2, 3, 4, and 5 which are located in the area of high influence power and low dependency, indicate the basic factors in the formation of lean - agility maritime supply chain. Secondly; the factors 6, 7, 8, 9, 10, 11, 12, 15 and 16 which are located in the third area, have a high power influence and dependency that this property implies that any kind of change in these factors will cause changes in the

Table 4: Structural Self-Interaction Matrix (SSIM)

Row	Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	Information Integrity	X	X	X	X	X	O	O	O	V	O	O	O	O	O	O	**O**
2	Networks	-	X	O	X	O	O	O	O	O	O	O	O	O	O	O	**O**
3	Training and Skill Development of Employees	-	-	X	O	V	O	O	O	O	O	O	O	O	O	O	**O**
4	Virtualization	-	-	-	X	O	O	O	O	O	O	O	O	O	O	O	**O**
5	Intelligent	-	-	-	-	X	O	O	O	O	O	O	O	O	O	O	**O**
6	Flexibility	-	-	-	-	-	X	X	X	O	O	O	O	O	O	O	**V**
7	Rapid Response to Changes	-	-	-	-	-	-	X	X	O	O	O	O	V	V	O	**O**
8	Risk Redution	-	-	-	-	-	-	-	X	O	O	O	O	O	O	O	**O**
9	Partnerships with Suppliers Pleasant	-	-	-	-	-	-	-	-	X	O	X	A	O	O	O	**O**
10	Quality	-	-	-	-	-	-	-	-	-	X	O	O	O	O	O	**O**
11	Improve the Capacity	-	-	-	-	-	-	-	-	-	-	X	V	O	O	O	**O**
12	Proper Budgeting	-	-	-	-	-	-	-	-	-	-	-	X	V	O	V	**X**
13	The Ability to Sustain Operations	-	-	-	-	-	-	-	-	-	-	-	-	X	X	O	**O**
14	Satisfaction	-	-	-	-	-	-	-	-	-	-	-	-	-	X	O	**O**
15	Planing	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	**X**
16	Decission Making	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**X**

lean - agility maritime supply chain. Thirdly, the factors of 13 and 14 which are in the fourth level with low influence power and high dependency represent the resulted characteristics of producing a lean - agile supply chain in maritime logistics.

Figure 8:



4. Research Findings

In this article, we have shown the equal interaction between the lean - agility factors in the both approaches of fuzzy cognitive maps and Interpretive Structural Modeling; In fact, our research reveals that, when the low factors of the maritime supply chain in the FCM approach has been associated with high power relationship, then, they are connected to each other at a certain level with high influence and interdependence based on ISM approach, Vice versa. In this paper, we have shown initially that, the behavior of Interpretive Structural Modeling confirms results of the fuzzy cognitive maps. Second, the interaction of two mention model are the same. Third, according to the result of these two model the variables, are divided into static and dynamic. Static variables, are variables that underlie lean - agile supply chain, but dynamic variables, variables that any changes they cause changes in the lean-agile supply chain maritime. To the best knowledge of the authors this achievement has not been mentioned in any other articles.

5. Conclusion

In this article, fuzzy cognitive map and interpretive structural modeling approach combines the analysis of the degree of interaction between, lean - agility factors the maritime supply chain. So the obtained results indicate that lean - agility factors are located close to each other in the fuzzy cognitive maps with a high strong relationship strength. In the interpretive Structural Modeling these factors are located in the same level too with high influence power and high dependency. Moreover, the lean - agility factors that are close to each other in FCM with low relationship power, are located in the same level in ISM too with high influence power and low dependency. On the other hand, the first results confirm the ISM and FCM behavior. Second, they show identical interaction of lean - Agility in the two models. Third, the variables are divided into two categories: static and dynamic. Static variables, are variables that underlie lean - agile supply chain, but dynamic variables, variables that any changes, cause changes in the lean-agile supply chain maritime. This is one of the major achievements of this study that no one utilized this combined approach so far. As well as, identical interaction image of lean - agility, factors in this approach has improved the scientific power of this research. Therefore, taking an appropriate strategy in the field of lean - agile supply chain in the maritime logistics domain based on these models have been facilitated.

Table 5: The comparison of the FCM & ISM results

Variable	FCM	ISM		Interaction of Variables	Types of Variables
	Dependency Power	Relationship Strength	Influence Power		
Planing	High	High	High	High	Dynamic
Decision Making	High	High	High	High	Dynamic
Proper Budgeting	High	High	High	High	Dynamic
Improve the Capacity	High	High	High	High	Dynamic
Partnership with Suppliers Pleasant	High	High	High	High	Dynamic
Quality	High	High	High	High	Dynamic
Rapid Response to Changes	High	High	High	High	Dynamic
Risk Reduction	High	High	High	High	Dynamic
Flexibility	High	High	High	High	Dynamic
Satisfaction	High	High	Low	High	Dynamic
The Ability to Sustain Operations	High	High	Low	High	Dynamic
Information Integrity	Low	Low	High	Low	Static
Networks	Low	Low	High	Low	Static
Virtualization	Low	Low	High	Low	Static
Intelligent	Low	Low	High	Low	Static
Training and Skill Development of Employees	Low	Low	High	Low	Static

References

Adler, M., Ziglio, E., (1996). Gazing into the oracle. Jessica Kingsley Publishers: Bristol, PA.

Agarwal, A., Shankar, R., Tiwari, M., (2007). Modeling agility of supply chain, industrial marketing management.

Alaei, S., Khoshalhan, F., (2015). A hybrid cultural-harmony algorithm for multi-objective supply chain coordination. Journal of Scientia Iranica 22 (3), 1227–1241.

Brown, J., Libberton, P., (2007). Principles of professional studies in nursing. Hampshire, Palgrave Macmilla.

Childerhouse, P., Towill, D., (2000). Engineering supply chains to match customer requirements. Logistics Information Management Vol 13 (No. 6), pp 337–345.

Collin, J., Lorenzin, D., (2006). Plan for supply chain agility at nokia lessons from the mobil infrastructure industry. International Journal of physical Distribution & Logistics Management Vol 36 (No. 6), pp 418–430.

Costantino, N., Dotoli, M., Falagario, M., Fanti, M., (2012). A model for supply management of agile manufacturing supply chains. Int. J. Production Economics 135, pp 451–457.

Faizi, K., Iran dost, M., (2013). The delphi method to study future remaritimerch decisions. Industrial Management Institute, Tehran.

Gharaeipour, R., (2012). Lean and lean supply chain model for the assessment of the supply chain. Automotive industry,Special Issue of Supply Chain No. 16.

Ghazanfari, (2011). Supply chain management. Journal of Tadbear No. 117.

Gilaninia, S., (2011). Comparative study of lean and agile supply chain management along with the optimal model presentation of agile supply chain management. Journal of Business and Management Vol 1 (No. 4), pp 46–56.

Godsell, J., (2011). Enabling supply chain segmentation through demand profiling. International Journal of Physical Distribution & Logistics Management Vol 14 (No. 2), pp 33–52.

Goldsby, T., Garcia-Dastugue, S., (2003). The manufacturing flow management process. International Journal of Logistics Management Vol 14 (No. 2), pp 33–52.

Groumpos, P., (2010). Fuzzy cognitive maps: Basic theories and their application to complex systems. M. Glykas, ed., Fuzzy Cognitive Maps: Advances in Theory, Methodologies, Tools and Applications, Springer-Verlag Berlin Heidelberg, pp 1–22.

Groumpos, P., (2015). Modelling business and management systems using fuzzy cognitive maps: A critical overview, international federation of automatic control. papers online, 48–24 , 207–212.

Gunasekaran, A., (1998). Agile manufacturing: enablers and an implementation framework. International Journal of Operation and Production Managemen Vol 36 (No. 5).

Huang, J., Tzeng, G., Ong Ch, (2005). Multidimensional data in multidimensional scaling using the analytic network process. Pattern Recognition Letters Vol 26.

International Maritime Organisation (IMO), (2008). International shipping and world trade: Facts and figures.

Jafarnejad, A., (2007). Organizational agility and agile manufacturing. book company of Mehraban nashre , Tehran, first printing.

Kisperska-Moron, D., Swierczek, A., (2009). The agile capabilities of polish companies in the supply chain: An empirical study. int. j. production economics.

Konecka, S., (2010). Lean and agile supply chain management concepts in the asect of risk management. Electronic Scientific Journal of Logistics, Vol 6 (No. 3), pp 23–31.

Kosko, B., (1986). Fuzzy cognitive maps. International Journal of Man-Machine Studies Vol 24, pp 65–74.

Krishnamurthy, R., Touch, C., (2007). Leagile manufacturing: a proposed corporate infrastructure. International Journal of Operations & Production Management Vol 6, pp 588–604.

Landeta, J., (2006). Current validity of the delphi method in social sciences. Technological forecasting and social change Vol 73 (No. 5), pp 467–482.

Lezgi, M., Ghaziasgar, S., (2013). A process model scor. reference model for supply chain management processes, the automotive industry magazine No 174, p. 18.

Mason-jones R., Nalor, J., Towill, D., (2000). Lean, agile or leagile? matching your supply chain to the marketplace. International Journal of Production ReMaritimerch 38, 4061–4070.

Naylor, J., Naim, M., Berry, D., (1996). Leagility: integrating the lean and agile manufacturing paradigms in the total supply chain. International Journal of Production Economics Vol 62, pp 107–118.

Powell, C., (2003). The delphi technique: myths and realities. Journal of Advanced Nursing Vol 41 (No. 4), pp 376–382.

Rodriguez-Repiso, L., Setchi, R., (2007). Modeling it projects success with fuzzy cognitive maps. Expert Systems with Applications Vol 32 (No. 2), pp 543–559.

Salah, A., Elmoselhy, (2013). Hybrid lean–agile manufacturing system technical facetin automotive sector. Journal of Manufacturing Systems Vol 32, pp 598–619.

Swafford, P., Ghosh, S., Murthy, N., (2008). Achieving supply chainagility through it integration and flexibility. International Journal of Production Economics 116.

Van Hoek, R.I, (2001). Epilogue: moving forward with agility. International Journal of physical distribution & Logistics managemen Vol 31 (No. 4).

Vonderembse, M., Uppal, M., Huan, S., Dismukes, J., (2006). Designing supply chains: towards theory development. International Journal of Production Economics Vol 100, pp 223–238.

Warfield, J., (1974). Toward interpretation of complex structural modeling. IEE Trans. Systems Man cybernet Vol 4 (No. 5).

Xirogiannis, G., Stefanou, J., Glykas, M., (2004). A fuzzy cognitive maps approach to support urban design. Expert Systems with Applications 26, pp 257–268.