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Identifying and Prioritizing the Factors Affecting the Agility of the Supply Chain of Pharmaceutical Company using Multi-Criteria Decision-Making Methods in COVID-19 Pandemic

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ABSTRACT

The aim of this study is to identify, rank, and determine the importance of factors influencing the agility of pharmaceutical company in COVID-19 pandemic using Multi-Criteria Decision-Making Methods. One way to reduce recent pandemic problems is to make good use of agile suppliers and external resources. This research has identified and prioritized the factors affecting the agility of the supply chain of pharmaceutical companies using multi-criteria decision-making methods. Due to the slow financial turnover in pharmaceutical companies and their urgent need for financial resources during the pandemic, the need for agility in the supply chain led to research in this area. In the field study section, a questionnaire was designed to investigate the effect of factors and the relationship between factors in interpretive-structural modeling. After collecting the information, interpretive-structural modeling and agility measurement of supply chain with ISM technique have been discussed.

Keywords: Competition; Agility; supply chain; Interpretive structural modeling; COVID-19.

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INTRODUCTION

Changes in the business environment that result from changes in customer needs have led to uncertainty for companies. Therefore, there is a need for a flexible supply chain to deal with change. Agility is one way to empower organizations. Agility helps to build and provide the right product, at the right time, for the customers of that product. Supply chain management is one of the significant examples of the current era that has been created to improve the competitive situation of organizations and to integrate activities and institutions in the chain to achieve a reliable and sustainable competitive position. Supply chain management generally deals with two parts, internal and external. The internal and external parts receive the material and convert it into a suitable output and deliver it to the distribution network, but the external part is related to the external network or members and the external downstream.

Many companies are forced to significantly reduce their production capacity and volume due to the sharp decline in demand. Finding the right balance between taking the necessary steps to keep the company afloat and maintaining social responsibility for the workforce is hard work. Executive management should discuss this issue and decide on the possibility of raising liquidity in the short term and increasing medium-term production after the crisis.

Many companies are currently using strategic workforce planning, especially in the long run. But the quality of this process is not the same everywhere. Strategic planning tools need to consider dynamic short-term programs in this crisis. For the next 9 to 12 months, labor supply and demand must have a monthly or even a weekly basis. Different scenarios - including the worst, middle, and best scenarios that take into account the different levels of crisis in terms of length and severity - should include practical incentive models for all job profiles. These scenarios form the basis for modeling the requirements of personnel, showing what the consequences will be if a few percent reduction in income occurs in the job profile.

The workforce can adapt to short-term, medium-term and long-term measures. The first step is to take short-term action; Like reducing working hours. Companies can also offer unpaid leave to their employees. If these measures are insufficient, the next step is to apply long-term measures.

Perhaps few people thought that in just a few weeks, long queues would form to buy health and food items for curing the COVID-19. The shortage of disinfectant masks and alcoholic beverages caused great concern in everyone's mind, suggesting that the shortage could spread to other goods. Commodity hoarding has allowed governments to take action and control the market by setting quotas for purchasing goods and setting price orders. This crisis has shown how much reserves can play a decisive role for countries. Following the sudden onslaught of buying goods, online stores also announced the evacuation of their warehouses. Amazon's online store has announced that its stockpiles of goods have run out of stock, which is why deliveries to customers are delayed. During this time, any country with a richer warehouse would be better able to meet the demand. Of course, some also believed that the stockpiles were indicative of an imbalance in the country's economy.

Another issue is the agility of industrialized countries in the rapid production of goods. In some countries, a number of industries are changing; They quickly produced the goods needed by society to minimize the gap between demand and supply. On the other hand, due to the danger that the virus poses to individuals, employers and producers could not force all workers to work, which led to a shortage of manpower. Therefore, having well-equipped devices that work with minimal human intervention has won every industry.

Sina Pharmaceutical Company is active in the production of pharmaceutical active ingredients. The company's supply chain includes domestic and foreign suppliers of raw materials and the ingredients produced by the company are in fact the final producers of the drug.

To supply the primary materials needed by the manufacturing sector, the company needs regular and fast money circulation, while the money circulation in Sina Pharmaceutical Company is about one year, and this has made it difficult to supply primary materials in a timely manner. Meeting the timely needs of the company's customers has been effective. In order to have a faster turnover, the company's supply chain must be more agile. In this study, the factors affecting the agility of the company are identified and then analyzed and the agility model of the company is created.

The method of this research is a descriptive model which is first identified by relying on the subject literature and reviewing previous researches of variables affecting the agility of the pharmaceutical industry supply chain and using the structural-interpretive method of ISM the relationships between these variables are identified by comparing their pairs. Prioritization will be done and finally the conceptual agility model of supply chain will be presented in Sina Pharmaceutical Company.

Theoretical concepts and research background

Supply chain management is a complex process, and due to its dynamic nature due to changes in the business environment, the complexity of the supply chain is constantly increasing. In business, changes result from changes in customer needs, changes in technology, changes in employee expectations, changes in rules, liquidity problems, changes in social needs, changes in competitiveness, changes in product quality, changes in product life. Industries that are slow to move and often face challenges such as short product life, high levels of business market fluctuations, uncertainty in customer demand and uncertainty in supply, the need for speed in work, flexibility, increase product diversity and customization, and thus feel the need to be agile. Because the economic success and survival of these production organizations depend on the correct fulfillment of customer needs at the right time and cheaply. Agility is all about being responsive to the customer, the people and the information, collaborating within and between organizations, and tailoring an organization to change. Agility is seen as a response to a large level of complexity and uncertainty in the advanced market. Yousef and his colleagues see the agile supply chain's actions as follows: cooperation with competitors, long-term cooperation with customers and suppliers, leveraging the effect of basic resources by forming a network with other companies, difficult operating conditions that force cooperation with other companies, Coalitions with business counterparts, integrating information with other companies based on computer systems, giving higher priority to the coalition over market penetration. Sufford et al., As well as Lynn et al., Similarly consider agility capabilities as: responsiveness, competency, flexibility, speed. Using his research literature and holding brainstorming sessions, Agarwal et al. Were able to provide a set of 75 variables for agility. These variables include: market sensitivity, speed, data accuracy, new product introduction, collaborative planning, process integration, use of technology tools, time delay reduction, service level improvement, cost minimization, customer satisfaction, quality improvement, minimize uncertainty, expand trust and reduce resistance to change. The most important criteria for agility evaluation based on the supply chain operations reference model (SCOR) are accountability and flexibility. These two criteria are in the form of indicators such as incremental supply flexibility, incremental manufacturing flexibility, distributive incremental flexibility, additional return flexibility to suppliers, increased procurement adaptability, incremental manufacturing flexibility, incremental distributive adaptability, Constructional adaptability is reduced and distributional adaptability is assessed. In 2011, Prasanna and Winwood examined agility in the supply chain as a functional dynamic and reflected dynamism as an ability to deal appropriately with uncertainties in the business environment and the speed of change. In 2013, Bloom et al. Demonstrated that supply chain agility is a complex set of dynamic aspects that demonstrate the need to develop competitive advantage. The dynamic agility aspects of supply chain performance are fundamental to changing market conditions in integrating, building, and rebuilding internal and external competition.

In the same year, Rajabzadeh Qatari et al. examined the development of an agility model in the supply chain of an Iranian pharmaceutical company and used the score model to evaluate agility factors and then use the TOPSIS algorithm to rank the criteria. The factors considered in this research are segmentation planning, prioritization of suppliers for purchase, use-IT, empowerment of suppliers, number of adjustments and modifications, integration of processes, cost reduction, shipping speed, trust development and environmental laws. Speed in product delivery, planning, trust development and improvement and adjustments were identified as the first priorities of this research. In 2014, Yang, in a study based on information theory, discussed IT technical capabilities and related factors such as information sharing, trust, and operational collaboration as agile predictions for the supply chain of manufacturers. The study also states that cost-effectiveness affects the relationship between agility and performance based on the cost of economic transactions. In 2015, Lee et al. Evaluated and selected a supplier as a multi-criteria decision-making problem with fuzzy goals. In this paper, the importance of agility criteria in the evaluation process and selection of an agile supplier by measuring the magnitude of the Bullwhip effect effect and costs Inventory is measured quantitatively, and a system consisting of a Fuzzy analytic hierarchy process and a fuzzy topsis is assumed to be the correct placement of the preferred weights and the selection of the best supplier, taking into account human ambiguities and inaccuracies.

Research Methods

In this research, library and survey methods have been used to collect the required information. The data collection tool is a questionnaire to examine the conceptual relationship between the indicators that the respondents' community of the research questionnaire; Includes 12 top executives, experts and specialists from Sina Pharmaceutical Company.

The current type of research is applied. Also, the research method in this survey research is descriptive-analytical. In this study, we have used ISM model to level the agility indicators of the supply chain.

1-3 Interpretive structural model

Interpretive structural modeling was introduced by Andrew Sage in 1977. The ISM method is an interpretive structure method proposed by Agarwal in 2006 and presented in an article by Canan in 2007. In this method, first, the effective and basic factors are identified and then, using the method presented, the relationships between these factors and the way to achieve progress by these factors are presented. The ISM method analyzes the relationship between the indicators by analyzing the criteria at several different levels. The model of interpretive structure is able to determine the relationship between indicators that are individually or in groups. The ISM method analyzes the relationship between the indicators by analyzing the criteria at several different levels. The ISM method can be used to analyze the relationship between multivariate attributes defined for a problem, as well as to analyze the relationship between multivariate attributes defined for a problem.

Designing an interpretive structural model (ISM) is a way to examine the effect of each variable on other variables; This design is a comprehensive approach to measuring communication, and this design is used to develop the model framework to make the overall research objectives possible.

Step 1: The criteria or elements considered (in this study the agility criteria of the supply chain) are listed.

Step 2: Using the criteria or variables identified in the first step, Contextual relation between them is defined according to each aspect of the criteria. Content relationship means the conceptual relationship between the components of the system, so that in terms of meaning and content it is appropriate to the goals of the system (Warfield 1974). For example, suppose a cloud causes rain, "cloud" and "rain" make up the components of the system, and "causes rain" is the content relationship between them. Other examples that can show these relationships are "takes precedence over", "supports", "restores", "reports to", and "affects". Content relations between the two components are classified into several forms, including the Definitive relationship, the comparative relation, influence relationship, the temporal relationship, the spatial relationship, and the mathematical relationship. In this study, we will use the influence relationship.

Step 3: Structural Self-Interaction Matrix (SSIM) is developed for the indicators.

Structural self-interaction matrix consists of the dimensions and indicators of study and their comparison using four forms of conceptual relations. This matrix is completed by experts and process experts. The obtained information is summarized based on the interpretive structural modeling method and the final structural self-interaction matrix is formed. The logic of interpretive structural modeling (ISM) operates in accordance with non-parametric and fashion-based methods in frequencies.

In order to form the structural interaction matrix, a 14 by 14 matrix, including indicators, will be formed and made available to managers. Managers will complete the matrices based on the following principles.

For each j, i, the relationship between these two variables in the context of the study is as follows.

V: The variable i helps to reach the variable j.

A: The variable j is improved only by the variable i.

x: The variables j, i will help to reach each other.

O: The variables j, i are unrelated.

If i, j in the SSIM matrix is V, then in the access matrix, (i, j) becomes one and (j, i) becomes zero. If (i, j) in the SSIM matrix is A, in the access matrix, (i, j) becomes zero and (j, i) becomes one. If (j, i) is entered as x, then (j, i) in the matrix of achieving one and j, i also becomes one. If (i, j) is entered as O, then i, j and j, i become zero.

Step 4: The access matrix is developed using its interactive structural matrix, and this matrix is checked for expediency. Extending the content relationship is a fundamental hypothesis in interpretive structural modeling. Extension means that if the variable "A" is related to "B" and the variable "B" is also related to the variable "C", then the variable "A" is also related to the variable "C".

There are two ways to adapt a matrix:

Method 1

A number of researchers believe that after collecting the opinions of experts and SSIM and access, if incompatibility is observed within the access matrix, the questionnaire should be re-filled by experts and then the compatibility of the access matrix should be checked again. This must continue until compatibility is established. Among the works done according to this method, we can mention Agral and Shankar and Tiwari, Faisal, Banut and Shankar.

Method 2

In this method, mathematical rules are used to create compatibility in the access matrix, in such a way that the access matrix reaches the power of k + 1 (, k> = 1). Of course, the operation to enable the matrix must be in accordance with the Bolin rule. According to this rule:

$$1=1 \text{ and } 1+1=1\times1$$

Step 5: The access matrix in step 4 is segmented into different levels.

To determine the relationships and level of the criteria, the access set and the prerequisite set for each criterion must be extracted from the received matrix. Each variable access set includes variables that can be accessed through this variable, and the prerequisite set includes variables through which this variable can be accessed. This is done using the access matrix. After determining the access and prerequisite set for each variable, the common elements in the access set and prerequisite for each variable are identified.

After determining these variables or variables, we remove them from the table and form the next table with the other remaining variables. In the second table, as in the first table, we specify the second level variable and continue to do so until the level of all variables is determined.

Step 6: Based on the relationships specified in the access matrix, a directional graph is drawn, and the compatible relationships are removed.

Previous research on ISM

ISM has been used in a number of studies, including Table 1 of the field of research of researchers who have used ISM in their research.

Table 1. Previous research on ISM

Row	research fellow	Field of application of interpretive structural modeling
1	Sakar et al,2007	Develop a balanced scorecard
2	Sakar et al,2008	Information technology empowerment in industry
3	Mohammad et al,2008	Supply chain agility modeling
4	Kumar et al,2009	Technology transfer in rural housing
5	Raj et al,2008	Capable of flexible manufacturing systems
6	Alawamble and Papul,2011	Risk modeling in a virtual organization
7	Wu et al,2015	Risk assessment in the offshore pipeline project
8	Rat [2] et al	Identify critical success factors in sustainable supply chain management
9	Abbas Zainab[3]	Obstacles to the green business model of the world's multinational corporations in the sector UK construction
10	Sindho[4]	Identify and analyze barriers to solar energy implementation in rural India
11	Jia et al[5]	Analysis of SSCM methods in mining and mineral industries
12	Jain[6]	Modeling and analysis of performance variables (flexible manufacturing system) FMS
13	Buzon[7] et al	Decreased mineral extraction: reverse logistics in the machinery industry in Brazil
14	Young2 et al	Factors affecting cost control in wind energy construction projects
15	Hee et al	Evaluate the risk transfer of the price chain in China
16	Kumar et al	CSR Problem Analysis in Supplier Selection Process

4- Research findings

Step 1: The criteria or elements considered (in this study the agility criteria of the supply chain) are listed (Table 2).

Table 2. Supply Chain Agility Criteria

Row	Criterion	Row	Criterion
1	Market change	13	Persons
2	Change in competitiveness	14	flexibility
3	Change in customer needs	15	Speed
4	Change in social needs	16	Solve liquidity problems including receipt of claims
5	Technology change	17	participation
6	Improve product quality	18	Timely delivery
7	Reduce product life	19	Reduce my Lead
8	Reduce production costs	20	Solve liquidity problems including receipt of claims
9	R&D innovation and development	21	Customer relationship
10	Increasing the number of suppliers	22	Information systems
11	Continuous assessments and point improvement points	23	Product basket management
12	responsiveness		

Step 2: Using the criteria or variables identified in the first step, a Contextual relation between them is defined according to each aspect of the criteria (Table 3).

Table 3. Self-interacting structural matrix

23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1		
o	o	o	v	o	o	o	o	o	o	a	o	a	o	o	o	o	o	v	v	v	v	x	**1**	Market change
o	o	o	o	o	o	o	v	o	o	o	o	o	o	o	o	o	o	o	o	o	x		2	Change in competitiveness
o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	v	o	o	o	o	x			3	Change in customer needs
a	x	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	x	x				4	Change in social needs
o	x	o	o	o	o	o	o	o	o	o	o	o	o	x	o	o	o	x					5	Technology change
o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	x	x						6	Improve product quality
o	o	o	o	o	o	o	v	o	o	o	o	o	o	o	o	x							7	Reduction of product life
o	a	a	o	a	a	o	o	a	o	o	o	o	o	o	x								8	Reduce production costs
o	o	o	o	o	o	o	v	o	o	o	o	o	o	x									9	Innovation and Development R&D
o	o	o	o	v	o	x	o	x	x	o	o	o	x										10	Increasing the number of suppliers
v	o	v	o	o	o	o	o	o	o	x	v	x											11	Continuous assessments and presentation of improvement points
o	o	o	v	v	o	o	o	o	o	a	x												12	responsiveness
v	o	v	o	o	o	o	o	o	o	x													13	Persons
o	o	o	o	a	o	x	v	o	x														14	flexibility
o	o	o	o	x	o	x	v	x															15	Speed
o	o	a	a	a	a	o	x																16	Solve liquidity problems including receipt of claims
o	o	o	o	v	o	x																	17	participation
o	o	o	o	x	x																		18	Timely delivery
o	o	o	o	x																			19	Reduce Lead Time
o	o	o	x																				20	Customer relationship
o	o	x																					21	Competence
o	x																						22	information systems
x																							23	Product basket management

Step 3: Structural Self-Interaction Matrix (SSIM) is developed for the indicators (Table 4).

Table 4. Achievement matrices.

23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	Variable
0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1
0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	3
0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	4
0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	5
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	6
0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	7
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	8
0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	9
0	0	0	0	1	0	1	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	10
1	0	1	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	1	11
0	0	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	12
1	0	1	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	1	13
0	0	0	0	0	0	1	1	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	14
0	0	0	0	1	0	1	1	1	0	0	0	0	1	0	1	0	0	0	0	0	0	0	15
0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16
0	0	0	0	1	0	1	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	17
0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	18
0	0	0	0	1	1	0	1	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	19
0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20
0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	21
0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0	0	0	22
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	23

Step 4: The access matrix is developed using its interactive structural matrix, and this matrix is checked for compatibility (Table 5).

Table 5. Access matrix after adaptation

23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	Variable
0	1*	0	1	0	0	0	1*	0	0	0	0	0	0	1*	1*	0	0	1	1	1	1	1	**1**
0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	**2**
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	**3**
0	1	0	0	0	0	0	1*	0	0	0	0	0	0	1*	1*	0	0	1	1	0	0	0	**4**

0	1	0	0	0	0	0	1*	0	0	0	0	0	0	1	1*	0	0	1	1	0	0	0	**5**
0	0	0	0	0	0	0	1*	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	**6**
0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	**7**
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	**8**
0	1*	0	0	0	0	0	1	0	0	0	0	0	0	1	1*	0	0	1	1*	0	0	0	**9**
0	0	0	0	1	1*	1	1*	1	1	0	0	0	1	0	1*	0	0	0	0	0	0	0	**10**
1	1*	1	1*	1*	1*	1*	1*	1*	1*	1	1	1	1*	1*	1*	0	0	1*	1*	1*	1*	1	**11**
0	0	0	1	1	1*	1*	1*	1*	1*	0	1	0	1*	0	1*	0	0	0	0	0	0	0	**12**
1	1*	1	1*	1*	1*	1*	1*	1*	1*	1	1	1	1*	1*	1*	0	0	1*	1*	1*	1*	1	**13**
0	0	0	0	1*	1*	1	1	1*	1	0	0	0	1	0	1*	0	0	0	0	0	0	0	**14**
0	0	0	0	1	1*	1	1	1	1*	0	0	0	1	0	1	0	0	0	0	0	0	0	**15**
0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**16**
0	0	0	0	1	1*	1	1*	1	1	0	0	0	1	0	1*	0	0	0	0	0	0	0	**17**
0	0	0	0	1	1	1*	1	1*	1*	0	0	0	1*	0	1	0	0	0	0	0	0	0	**18**

Step 5: The access matrix in step 4 is segmented into different levels (Table 6).

Table 6. Summary of results in level determination

Level	Subscribe	Prerequisites	Access	Variable
3	{1}	{1,11,13}	{1,2,3,4,5,8,9,16,20,22}	**1**
2	{2}	{1,2,11,13}	{2,16}	**2**
2	{3}	{1,3,11,13}	{3,8}	**3**
2	{4,5,9,22}	{1,4,5,9,11,13,22,23}	{4,5,8,9,16,22}	**4**
2	{4,5,9,22}	{1,4,5,9,11,13,22,23}	{4,5,8,9,16,22}	**5**
2	{6,7}	{6,7}	{6,7,16}	**6**
2	{6,7}	{6,7}	{6,7,16}	**7**
1	{8}	{1,3,4,5,8,9,10,11,12,13,14,15,17,18,19,21,22,23}	{8}	**8**
2	{4,5,9,22}	{1,4,5,9,11,13,22,23}	{4,5,8,9,16,22}	**9**
2	{10,14,15,17,18, 19}	{10,11,12,13,14,15,17,18,19}	{8,10,14,15,16,17,18,19}	**10**
4	{11,13}	{11,13}	{1,2,3,4,5,8,9,10,11,12,13,14,15,16,17,18, 19,20,2	**11**

			1,22,23}	
3	{12}	{11,12,13}	{8,10,12,14,15,16,17,18,19,20}	**12**
4	{11,13}	{11,13}	{1,2,3,4,5,8,9,10,11,12,13,14,15,16,17,18, 19,20,2 1,22,23}	**13**
2	{10,14,15,17, 18, 19}	{10,11,12,13,14,15,17,18,19}	{8,10,14,15,16,17,18,19}	**14**
2	{10,14,15,17, 18, 19}	{10,11,12,13,14,15,17,18,19}	{8,10,14,15,16,17,18,19}	**15**
1	{16}	{1,2,4,5,6,7,9,10,11,12,13,14,15,16,17,18, 19,20,2 1,22,23}	{16}	**16**
2	{10,14,15,17, 18, 19}	{10,11,12,13,14,15,17,18,19}	{8,10,14,15,16,17,18,19}	**17**

As Table 6 shows, variables 16 and 8 (solving the liquidity problem, including collecting receivables and reducing production costs) are at the first level.
Variables: 2-3-4-5-6-7-9-9-10-14-15-15 17-18-19-20-21-22 (changes in competitiveness, changes in customer needs, changes in social needs, changes in Technology, improving product quality, reducing product life, innovation and R&D development, increasing the number of suppliers, flexibility, speed, participation, timely delivery, reducing lead time, customer relationship, competence, information systems) are in the second level.
Variables 23, 12 and 1 (market, product portfolio management, accountability) are in the third level.
Variables 11 and 13 (continuous assessments and presentation of improvement points and individuals) are at the fourth and final level of the model.
Step 6: Based on the relationships specified in the access matrix, a directional graph is drawn, and the compatibility relationships are removed. As can be seen in the presented model, solving the liquidity problem and reducing production costs is in the first level and is the most dependent variable. In the next section, we examine the conductivity and dependency of supply chain agility variables.

MICMAC analysis

In MICMAC analysis, variables are divided into four categories according to the Driving power and Dependence power. The stimulus of each factor is by adding the entry of a matrix corresponding to the line of that factor. In other words, the stimulus power of a factor is the numerical sum of the factors that affect this factor. The factor itself is also considered. The dependence of each factor is obtained from the numerical sum of the columns related to that factor. In other words, the dependence of each factor is the numerical sum of all the factors that help to achieve this factor.
Table (7) calculates the conductivity and dependence of the variables. The first category includes Autonomous variables that have weak guidance and dependency. These variables are relatively unrelated to the system and have poor communication with the system. In this study, the variables of change in competitiveness, change in customer needs, improvement of product quality, reduction of product life, customer relationship, competency and product portfolio management are included in this category. Dependent variables are the second category that have low conductivity but high dependency.
In the Sina pharmaceutical company, reducing the cost of production and solving the liquidity problem is among the receivables in this category. The third group of variables is Linkage variables that have high conductivity and dependency. These variables are non-static, because any change in them can affect the system, and eventually system feedback can change these variables again. In this study, changes in common needs, changes in technology, innovation and development of R&D, increase in the number of suppliers, flexibility, speed, participation, timely delivery, information systems, reduction of Lead Time, are among these categories. The fourth category includes independent variables that have strong guiding power but poor dependence. These groups are the fundamental part of the model, and to start the system, they must be emphasized in the first place. Individual variables and continuous assessments and presentation of improvement points, market change, accountability is among these categories.

Table 7. of the power of guidance and dependence of variables

23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	Variable
7	6	3	2	8	8	8	1	8	8	21	10	21	8	6	1	3	3	6	6	2	2	10	Driving power
3	8	3	5	9	9	9	21	9	9	2	3	2	9	8	18	2	2	8	8	4	4	3	Dependence power

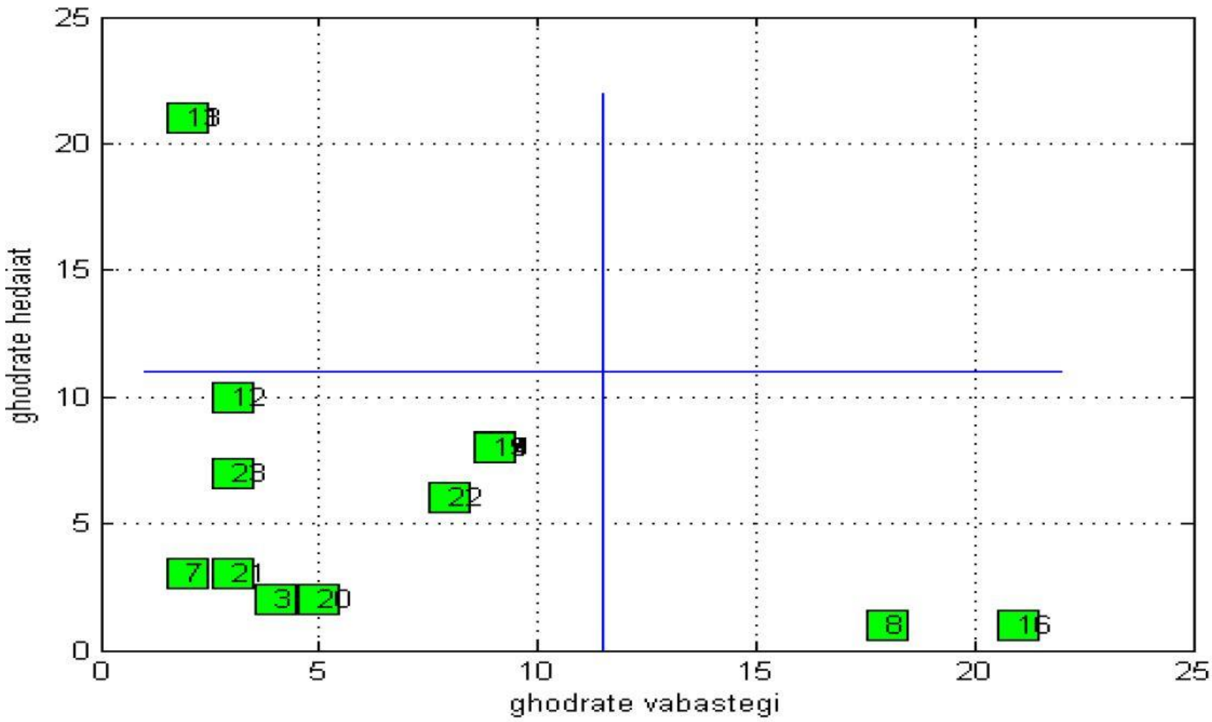

Figure 1. The degree of correlation and dependence of variables

The figure 1 and table 7 show the area of each variable. 4 regions are equally equal, but in the analysis of variables whose dependence and guidance value are above 8, we have considered a lot. In this form, the variables that have the same coordinates are placed on top of each other.

Conclusion

This research has identified and prioritized the factors affecting the agility of the supply chain of Sina Pharmaceutical Company using multi-criteria decision-making methods. The statistical population of the study is Sina Pharmaceutical Company. In this research, two library and field methods have been used to collect data. The library method was used to refer to books, dissertations, publications and libraries of the University and the National Library of Iran and information centers to achieve the latest achievements of studies and research and complete the research literature and review theoretical issues related to the subject. Finally, field studies in the pharmaceutical industry were conducted to investigate the relationship between these factors and model analysis. In the field study section, a questionnaire was designed, which examines the effect of factors and the relationship between factors in order to model ISM. After collecting information, using MATLAB software, the agility modeling of suppliers in the supply chain with ISM technique was discussed. After examining the relationships and drawing the model of the table and the power dependency chart and the driving power, it was formed. In order to determine the category of variables in MICMAC analysis, the variables were divided into four categories according to the driving power and dependence power. The first term includes independent variables that have weak driving power and dependency power. These variables are relatively unrelated to the system and have poor communication with the system. In this study, the variables of change in competitiveness, change in customer needs, improvement of product quality, reduction of product life, customer relationship, competence are in this category. Dependent variables are the second category that have low conductivity but high dependency. In Sina Pharmaceutical Company, reducing production costs and solving liquidity problems, including receipt of receivables, are in this category. The third group of variables are connected variables that have high conductivity and high dependence. These variables are non-static, because any change in them can affect the system, and eventually system feedback can change these variables again. In this study, changes in social needs, changes in technology, innovation and development of R&D, increasing the number of suppliers, flexibility, speed, participation, timely delivery, information systems, reducing Lead Time, are among these categories. The fourth category includes independent variables that have strong guiding power but poor dependence. These groups re the fundamental part of the model, and to start the system, they must be emphasized in the first place. Individual variables and continuous assessments and presentation of improvement points, market change, accountability is among these categories.

Suggestions

Practical suggestions

1- With proper and accurate planning based on sales forecast and need for quantity and time, determine the materials and reduce lead times.

2- By providing cheap and quality raw materials, production costs will be reduced.

3- By carefully controlling the materials and using experienced people, he refused to use low-quality and low-quality raw materials.

4- By hiring experienced and talented people, he predicted the market and customer conditions.

5- By determining the appropriate criteria for selecting suppliers, evaluate more suppliers and select the most suitable suppliers with the existing criteria.

6- Increase flexibility and speed in production by monitoring evaluations and continuously improving existing problems.

Suggestions for future research

1- In future research, it is possible to prioritize agility criteria using fuzzy hierarchical analysis technique.

2- In future research, it is possible to model supply chain risk modeling using interpretive structural modeling technique.

3- In future research, it is possible to prioritize different suppliers using the Topsis Bohr technique, which is the basis for prioritizing the agility criteria of the supply chain.

4- In future research, agile modeling of supply chain can be done in different statistical community and its results can be compared with the results of this research.

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