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Analyzing the structural fault model of cooperation dimensions in the supply chain (case study: SAIPA Automotive Group in Iran)

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Abstract

The dynamics of supply chains are increasing in response to changing business and technology environments, and cooperation is considered one of the primary and critical factors for the success of modern supply chains. This research aims to identify essential dimensions in the implementation of supply chain cooperation so that by managing them, cooperation can be effectively implemented in the supply chain of Saipa Automotive Group. This research is quantitative and applied. The statistical population of this research consists of university professors with at least ten years of work experience using the judgmental sampling method, and the sample size is equal to 10 people. The data collection process uses a researcher-made questionnaire, and data analysis is performed using the interpretive structural modeling method. In this model, the alignment of motivation was identified as the most critical variable, and by sharing costs, risks, and benefits among colleagues, the concept of motivation can be applied among companies. Also, by defining the mechanisms that share the profit fairly and proportionally to the partners' investment, the flow of motivation in the automotive industry chain will be facilitated.

Keywords: dimensions, supply chain cooperation, SAIPA group, interpretive structural model

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1- Introduction

Today, the supply chain is considered a platform for integrating and coordinating companies and coordinating material, information, and financial flows to use resources as the most logical way for organizations (Ivanov et al., 2017). Providing a platform where cooperation can be formed effectively and efficiently and make organizations successful requires knowing the primary and essential components involved in creating collaboration and seeing how each of these components influences. The necessity of supply chain cooperation leads to the formation of long-term commitments about technology sharing, integrated planning, and control systems, and also develops common goals and structural processes (Aliahmadi et al., 2015). In the discussion of cooperation, one should pay attention to all aspects, including its dimensions, components, drivers, enablers, resistances, obstacles, consequences, and benefits. Simchi -Levi et al. in 2004 considered the significant benefits of cooperation. Among the most important of them, we can mention increasing the added value of products, reducing the time required to introduce the product to the market, reducing the distribution time, increasing the quality, and improving the added value of an organization. Considering the numerous benefits of cooperation for the supply chain, this research aims to design an interpretive-structural model that shows the level of influence of variables about the dimensions and components of cooperation in the supply chain of Saipa Automotive Group.

2- Literature review

In 2018, Singh et al., in an article titled "Presenting a Framework for Supply Chain Cooperation", designed an interpretive structural model for cooperation. This model is designed in seven levels and with ten variables. At the seventh level, the only independent variable of the model is joint planning in order to implement plans. Also, in the first level, two variables of preparation and supply chain performance are considered dependent variables of the model.

In 2020, we and our colleagues conducted research entitled "How important are supply chain cooperation factors in supply chain finance?" An approach of financial service providers in China investigated the relationships between the dimensions of cooperation using a structural-interpretive model. In this model, eight variables were classified into three levels. Independent variables under top management support, trust, and IT infrastructure were placed at the bottom of the model. Three dependent variables, the collaborative performance system, information sharing, and motivational alignment, are at the top of the model.

The research's innovation is the presentation of an interpretative structural model for the dimensions of cooperation in the supply chain of Saipa Automobile Group. Compared to other studies, this model has seven variables and is classified into four levels.

3- Research methodology

This research is quantitative and applied. This research aims to interpret the structural modeling of the dimensions of cooperation in the supply chain. The statistical research community comprises university professors with at least 10 years of work experience and a degree in industrial engineering and management. Judgmental sampling method and sample size Considering that the ISM method is used, the number is 10 people (Gavinden et al., 2012). The data collection method uses a researcher-made questionnaire to determine the dimensions of cooperation in the supply chain. The data analysis is done with the help of the interpretative

structural modeling method. In this research, the validity of the questionnaires based on the meta-combination method and the reference of the articles, as well as the validity of the ISM models according to the approval of the experts and the research literature, have been examined in terms of reasonableness. Also, the reliability of ISM questionnaires and models has been checked according to the convergence and stability created by Boolean multiplication.

The ISM method is an interpretive structural method proposed by Agarwal in 2006 and presented in an article by Mohammadi et al. in 2015. In this method, after identifying the influential factors, the relationships between these factors and the way to achieve progress by these factors are investigated. Interpretive structural modeling is an interactive learning process that uses the interpretation of the opinions of a group of experts to determine the relationship between the concepts of a problem and creates a comprehensive structure of concepts. Also, the precedence, delay, and influence of variables on each other are examined in this method (Agarwal et al., 2007). The interpretive structural modeling method is carried out in 5 steps (Singh & Kant, 2008).

The first step: forming the structural self-interaction matrix (SSIM).

This matrix is formed to analyze the relationship between the elements, and to show the relationships between them, it consists of four symbols (V: one-way relationship from i to j, A: one-way relationship from j to i, X: two-way relationship from i to j and vice versa and O: there is no relation between i and j) is used.

The second step: forming the initial acquisition matrix

In this step, using the 1-0 substitution rule, the SSIM matrix is converted into a 1-0 matrix. This matrix is called the primary achievement matrix (RM). The rule of 1-0 placement in the initial access matrix is as follows:

• If V is obtained in the relationship between two elements (i, j) in the self-interaction matrix, In the initial access matrix, the relationship between (i, j)Is placed with the number 1, and vice versa; the relationship between (j, i) is placed with the number 0.

• If A is obtained in the relationship between two elements (i, j) in the self-interaction matrix, In the initial access matrix, the relationship between (i, j) is placed with the number 0, and vice versa, the relationship between (j, i) is placed with the number 1.

• If X is obtained in the relationship between two elements (i, j) in the self-interaction matrix, In the initial access matrix, the relationship between (i, j)Is placed with the number 1, and vice versa, the relationship between (j, i) is placed with the number 1.

• If O is obtained in the relationship between two elements (i, j) in the self-interaction matrix, In the initial access matrix, the relationship between (i, j) is placed with the number 0, and vice versa, the relationship between (j, i) is placed with the number 0.

The third *step* is forming the revised achievement matrix (final achievement matrix)

According to the multiplicative property, if the element i leads to element j and element $j$leads to element k, then element I must also lead to element k.

Boolean's law for steady state:

$$M^* = M^K = M^{K+1}, K > 1 \quad (1)$$

In this way, some zero elements will also become 1, as shown in ($*1$).

The fourth step: is determining the level of criteria

Separating the system into different levels helps clarify each component's role and how they interact. At this stage, by obtaining the final achievement matrix to determine the level of criteria, the following three groups are identified:

Preceding set (prerequisite): Criteria placed in the column corresponding to a criterion in front of them 1; the set preceding that column is the criterion. In other words, the advanced set of each criterion includes the criteria that lead to or affect that criterion.

Achievable (Late) set: The criteria placed in the row corresponding to a criterion in front of them are 1; the later set is the criterion of that line. The latter set represents the criteria affected by a criterion or system component.

Shared set: The following table (share) column is obtained by obtaining the share of the previous two sets. The priority level is the first line where the share of two sets is equal to the attainable set. After determining the level, the criterion or criteria whose level has been determined is removed from the table, and this process is repeated until all the remaining variables are also determined. After determining the final level, the final form of the variables using the specified levels is drawn.

The fifth step: classification of criteria (MICMAC analysis)

In MICMAC analysis, the variables are divided into four categories according to the power of direction and dependence (which are extracted from the RM matrix):

- Independent variables: They have the power of direction and weak dependence. These variables are relatively unconnected to the system and have little or no connection.
- Dependent variables: They have low guiding power but strong dependence.
- Linking variables: These variables are called linking variables, and they have high driving power and dependence. These variables are non-static because any change in them can affect the system, and finally, the system's feedback can change these variables again.
- Key independent variables (driver): They have strong driving power but weak dependence. These variables act as the cornerstone of the model, and they should be emphasized to start the system working.

4- Research findings

In this section, ten university experts in related fields were consulted to complete the ISM questionnaires.

For ISM analysis, the structural interaction matrix (SSIM) is created first. Then, the primary achievement matrix (RM) must be formed. Finally, the modified achievement matrix is created. After forming this matrix, the level of criteria is determined.

After distributing the questionnaires and forming the structural interaction matrix, the initial achievement matrix was created as described in Table 1:

Table 1: Primary achievement matrix for collaboration dimensions

	Information and communication management	Resource planning in the production and logistics process	Coordination of goals and decisions	Technology and business development	Alignment of motivation	Performance evaluation in integrated processes	A combination of marketing and customer orientation
Information and communication management	1	0	1	0	0	1	1
Resource planning in the production and logistics process	0	1	1	0	0	1	1
Coordination of goals and decisions	1	1	1	0	1	0	1
Technology and business development	1	0	0	1	0	0	1
Alignment of motivation	1	0	1	0	1	0	1
Performance evaluation in integrated processes	0	0	0	0	1	1	0
A combination of marketing and customer orientation	0	0	0	1	0	0	1

According to the initial achievement matrix, a modified achievement matrix is created for the collaboration dimensions:

Table 2: Revised achievement matrix for collaboration dimensions

	Information and communication management	Resource planning in the production and logistics process	Coordination of goals and decisions	Technology and business development	motivational alignment	Performance evaluation in integrated processes	A combination of marketing and customer orientation	guidance
Information and communication management	1	*1	1	*1	*1	1	1	7
Resource planning in the production and logistics process	*1	1	1	*1	*1	1	1	7
Coordination of goals and decisions	1	1	1	*1	1	*1	1	7
Technology and business development	1	0	*1	1	0	*1	1	5
motivational alignment	1	*1	1	*1	1	*1	1	7
Performance evaluation in integrated processes	*1	0	*1	0	1	1	*1	5
A combination of marketing and customer orientation	*1	0	0	1	0	0	1	3
Dependency	7	4	6	6	5	6	7	

Determining the level of variables was done in several steps. These steps are indicated in the form of several tables.

Table 3: Determination of the first level in the dimensions of supply chain cooperation

Dimensions	Available collection	Advanced collection	sharing	Level
Information and communication management	1.2.3.4.5.6.7	1.2.3.4.5.6.7	1.2.3.4.5.6.7	1
Resource planning in the production and logistics process	1.2.3.4.5.6.7	1.2.3.5	1.2.3.5	1
Coordination of goals and decisions	1.2.3.4.5.6.7	1.2.3.4.5.6	1.2.3.4.5.6	1
Technology and business development	1.3.4.6.7	1.2.3.4.5.7	1.3.4.7	
motivational alignment	1.2.3.4.5.6.7	1.2.3.5.6	1.2.3.5.6	
Performance evaluation in integrated processes	1.3.5.6.7	1.2.3.4.5.6	1.3.5.6	
A combination of marketing and customer orientation	1.4.7	1.2.3.4.5.6.7	1.4.7	1

Table 4: Determination of the second level in the dimensions of supply chain cooperation

Dimensions	Available collection	Advanced collection	sharing	Level
Technology and business development	4.6	4.5	4	
motivational alignment	4.5.6	5.6	5.6	
Performance evaluation in integrated processes	5.6	4.5.6	5.6	2

Table 5: Determination of the third level in the dimensions of supply chain cooperation

Dimensions	Available collection	Advanced collection	sharing	Level
Technology and business development	4	4.5	4	3
motivational alignment	4.5	5	5	

Table 6: Determination of the fourth level in the dimensions of supply chain cooperation

Dimensions	Available collection	Advanced collection	sharing	Level
motivational alignment	5	5	5	4

Finally, by forming the attainable set and the advanced set and calculating their share in several steps, the final model was drawn:

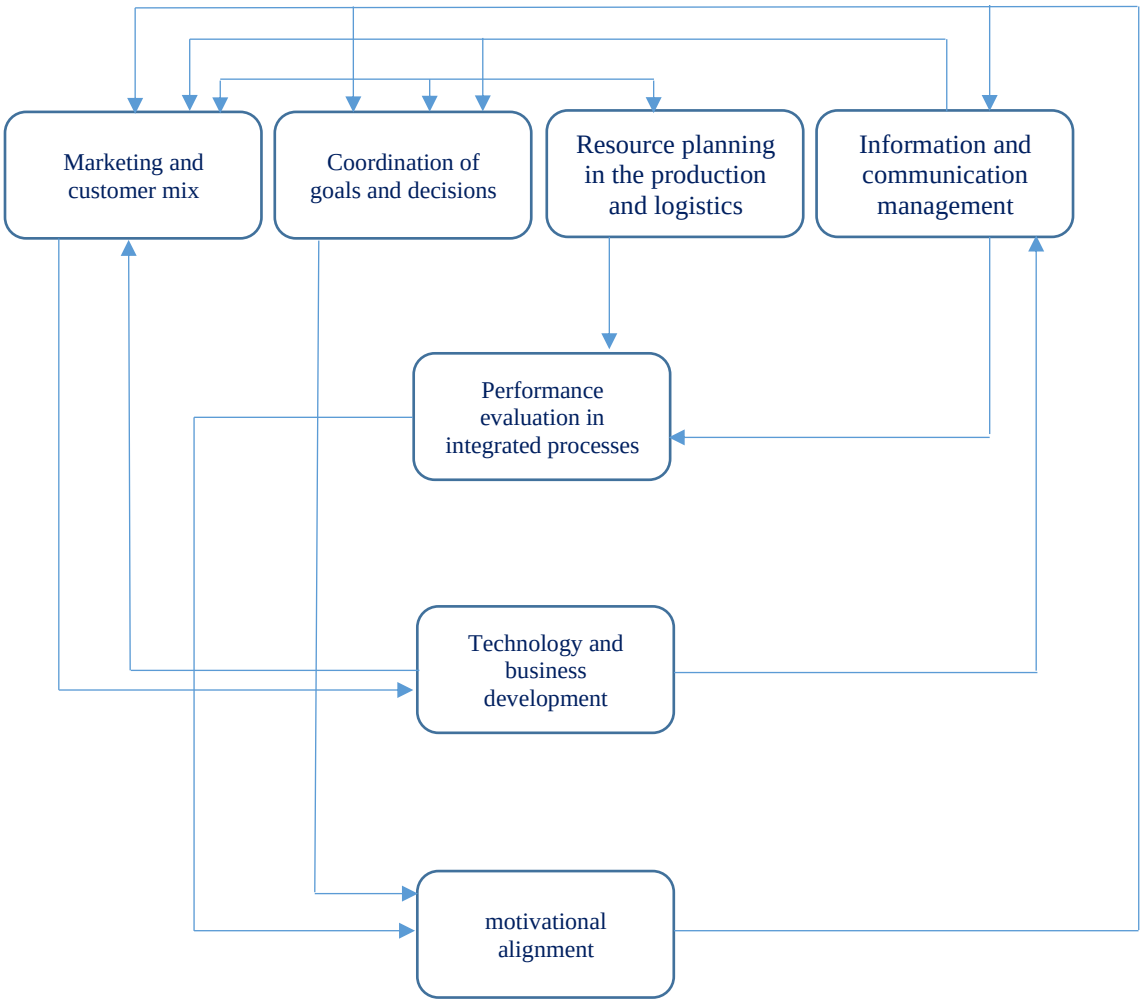

Figure 1: Model of cooperation dimensions in the supply chain

5- Conclusion

In this research, structural-interpretive modeling was done in the context of the dimensions of supply chain cooperation. For this purpose, a structural interactive matrix, primary achievement matrix, and modified achievement matrix were created, and the criteria level was determined. Finally, the final model was drawn by forming the achievable and the advanced sets and calculating their share in several steps. The levels of the variables are ordered from low to high based on influence. In terms of appearance, the lowest level in the model has the most influence and the most minor influence, and when the variables of this level change, the system undergoes changes, and the most significant number related to the levels is assigned to them. They are also known as independent variables in the model. On the other hand, in terms of appearance, the highest level in the model has the most minor influence and the most influence and occupies the lowest number related to the levels. It is also known as the dependent variable in the model.

In the cooperation dimensions model section, seven main categories were included in the model as follows:

The motivation alignment variable, as the main independent and influential variable at the bottom of the model, is at level four. This variable affects "information and communication management" and "mixed marketing and customer orientation" and has a reciprocal relationship with the variable "coordination of goals and decisions". The variable "Technology and Business Development" has three places and has a reciprocal relationship with the variable "Marketing and Customer Orientation" and has an effect on "Information and Communication Management." The variable of performance evaluation in integrated processes is placed at the level of two and affects the alignment of motivation and is also affected by the two variables "information and communication management" and "resource planning in the production and logistics process". Finally, the variables "information and communication management," resource planning in the production and logistics process, "coordination of goals and decisions," and "mixed marketing and customer orientation" are located as dependent variables and at the top of the model, at level one. Dependent variables at the third level have also established relationships like this:

"Information and communication management" has a reciprocal relationship with the variable "coordination of goals and decisions"; it affects performance evaluation variables in integrated and "mixed marketing and customer-oriented" processes, and it is among the variables of "technology and business development" "work" and alignment of motivation takes effect. The resource planning variable in the production and logistics process is reciprocal with the "coordination of goals and decisions" variable. It affects performance evaluation variables in integrated processes and "mixed marketing and customer orientation." The variable "coordination of goals and decisions" has established a mutual relationship with the variables of "information and communication management," resource planning in the production and logistics process, and alignment of motivation and affects the "mix of marketing and customer orientation." The variable "mixed marketing and customer orientation" has a mutual relationship with the variable "technology and business development" and is affected by all the variables in the system except performance evaluation in integrated processes.

The following provides practical suggestions related to managing and improving the independent (key) variables of the model so that with their changes, other variables undergo changes, and finally, changes and improvements are made for the dependent variables of the model. In the dimension model of supply chain cooperation, the motivation alignment variable was identified as an effective variable.

The processes of sharing costs, risks, and benefits among colleagues in the supply chain can effectively apply the concept of motivation among companies. Also, by managing the mentioned processes, it is possible to set incentive plans and programs. By carrying out successful partnerships in the supply chain, which is associated with the fair sharing of profits and losses, and the successful results of these partnerships can be evaluated quantitatively for colleagues, it is possible to align the motivation as well as to continue. This cooperation was promising throughout the chain. Also, by defining the mechanisms that share the profit fairly and in proportion to the amount of investment and risk tolerance of each partner, it is possible to help establish a more effective flow of motivation in the automotive industry chain.

Other future researchers are suggested to carry out research related to the identified key variable of the model, i.e., motivation alignment, to identify the level of influence of each factor in the automotive industry's supply chain.

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