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INTERPRETIVE STRUCTURAL MODELING OF KNOWLEDGE NETWORK IN CAR INDUSTRY' R&D CENTERS

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ABSTRACT

The current research has been done with the aim of knowledge network interpretive structural modeling in car industry's R&D centers. The key factors for implementing a knowledge network in car industry's R&D centers have been determined and then the final graphical model has been drawn by Interpretive Structural Modeling (ISM) approach.

The method of the current applied research includes a survey of experts and then the variables extracted through investigating research background, after that the MATLAB R2013 software is used for making compatible matrix as well as drawing graphical relations of the model by Interpretive Structural Modeling approach.

After studying related works & interviewing with under-studied firms' managers, interpretive structural modeling (ISM) & MICMAC analysis was used to generate a model for knowledge network.

Previous studies had not investigated the knowledge network in car industry's R&D centers; however, the present study implemented the knowledge network model in R&D Centers.

Keywords: Knowledge Network, Knowledge Management, Interpretive Structural Modeling, R&D Centers

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1. INTRODUCTION

Nowadays, knowledge networks are among the new efficient concepts in organizations for knowledge sharing process, which create knowledge interaction and communication among individuals with knowledge bases. This helps organizations use their internal and external knowledge resources in the form of a single logical network.

Network opinion refers to a form of organization with structural priorities regardless of its form as a mediator between market and hierarchy. According to Seufert et al. (1999), the dominant spirit on firms and research centers connected together through knowledge networks are hidden in knowledge flow of different knowledge bases.

Knowledge flow always moves inside knowledge networks from dense parts of knowledge to parts with low density and results in synergy and multiple knowledge creation in co-organizations which are connected to each other through knowledge networks. Knowledge is created, codified, categorized and stored in knowledge networks to use in whole organization for different applications. But, what is important for next step is mainstreaming knowledge in the veins of the organization as its blood. Knowledge networks help the knowledge flow in the organization body as blood in veins.

Knowledge networks should direct knowledge flow from different parts to its application place. However, one of the main challenges in knowledge networks is to encourage individuals to take effective and continuous actions in organization's knowledge sharing systems.

Many studies in Iranian organizations confirmed that the largest challenge for having successful knowledge-based management systems was low tendency of individuals for documenting and knowledge sharing. The issue of knowledge networks plays an important role for sharing individuals' knowledge in different R&D centers of car industry.

Since, knowledge networks are of the most efficient and the most effective solutions for knowledge sharing among individuals and knowledge bases; this research investigated the role of this issue as a tool for knowledge sharing and increasing the rate of knowledge flow in order to reproduce knowledge and also

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implement knowledge management in car industry so that reworks would be minimized.

The main question of this research is to determine the structure of car industry's R&D centers knowledge network. It also determines the constituting elements of car industry's R&D centers knowledge network. In this research, first, the effective variables are identified and then proper interpretive structural modelling is developed in knowledge network of R&D centers.

2. NECESSITY OF KNOWLEDGE NETWORKING IN CAR INDUSTRY'S R&D CENTERS

Currently, the primary issue in car industry is not knowledge sharing or absence of effective communication, information and knowledge among different parts of the industry. These kinds of knowledge are separately circulating in the body of each different R&D centers in the optimistic state and there are no related and integrated knowledge bases in different car industry's R&D centers so that knowledge sharing happens among various centers.

Formal structures of Iran's car industry do not present real flow of the knowledge. Besides formal organizational structures knowledge, informal networks are sharing and circulating knowledge; this has directed attentions of some managers to provide necessary guideline and planning for using this potential in order to increase knowledge flow rate and knowledge sharing (TAVALLAEE et al., 2012).

Managers of car industry should become more responsible towards using new ways and methods of knowledge management in car industry.

In the following items, the necessities of paying attention of car industry to knowledge networks are briefly stated;

- **Creating value added:** By implementing knowledge networks among R&D centers of car industry, value added is created for each centers.
- **Human resources:** Because of the rise in the age of the employees and experts of this industry and the resulting increase of the risk of knowledge and experience exit from the organization as well as necessity of using younger employees and transferring knowledge and experience of more

experienced employees to new employees, a mechanism is needed to provide knowledge and experience transfer from employees with high job experience to employees with low job experience in knowledge network.

- **Integration level being less:** Due to being separated from different units of car industry's R&D centers around the country, solutions which deal with new managerial tools have less integration level. It is hoped that these solutions have proper integration level through implementing knowledge networks among these structures.
- **Imbalance in knowledge & information flow:** Due to high geographical dispersion of R&D centers, there is no proper balance in knowledge & information flow in these centers.
- **Separated implementation of knowledge management:** In recent years, knowledge management despite its importance has been ignored from senior managers' point of view, which costs significant amount of money. With macro and strategic perspective, if these solutions are performed correctly with integrated programs and accurate strategies they will result in formation of a strong knowledge network, which causes a synergy in car industry.
- **Global competition:** Car industry practice in the international level and compete with other international firms. Therefore, it should be able to use knowledge of its experts to the highest level for attendance in international competition level and taking international markets in different countries. But, because of inability for optimum and accurate usage of managerial new tools it could not use its experts' knowledge and experience optimally to create competitive advantage for itself through increasing productivity and decreasing finished-price of its products. Iran car industry should pay attention to knowledge management since it has essential role on globalization of Iranian organizations & industries.
- **Sharing successful activities:** The possibility of the best activities & experiences circulation throughout the network and their transition to different units of car industry will be provided through implementing network knowledge.

3. KNOWLEDGE NETWORKS

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Main function of knowledge network is to acquire and share knowledge and makes it accessible inside and outside the organization (TAVALLAEE et al., 2012). According to Easton (1992) an approach to network is to consider it as a set of communicative units (EASTON, 1992). The proccess of network implementation is related to a complex network of activities, institutions and diffusion (KLIMASAUSKIENE, 2003).

Networking can help organizations find essential knowledge and use them for successful innovation performing (SEUFERT et al., 1999). The process of knowledge sharing is knowledge distribution inside the organization among employees and even outside of the organization. Knowledge sharing is one of the main factors in organization success because it can result in knlowledge expansion to those parts of the organization which are able to explore it.

Knowledge sharing results in idea sharing. Knowledge network is a good solution for exchanging individual and group knowledge. So, creating group knowledge network can be a good solution for facilitating knowledge exchange and availability. Infrastructures of IT and computer networks are the most important infrastructures of knowledge network implementation (MONGE et al., 1998; TAVALLAEE et al., 1998).

Researchers know knowledge network as a key factor for understanding the process of knowledge creation. Therefore, relations among people in the knowledge network facilitate knowledge creation. Since, knowledge is placed in the existing relations of knowledge network, as communication gets stronger, the density of knowledge in network increases and higher volume of knowledge is included within the network.

Also, knowledge network increases the chance of collaboration; this results in sharing and integration of different mental models (JAYRAMA; AYVARI, 2005). Individual knowledge which is circulating through the knowledge network can result in knowledge application in the body of R&D centers. This will cause to transfer the individual knowledge to group & organizational network. Individual knowledge is the knowledge which has been embedded in people and the organization tries to transfer it to groups and organizational network in the context of knowledge network

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to be embedded in the organization; it results in creation of value added for the organization.

According to what has been said, network can be defined as follow: a complex of main members who share a set of information, resources, etc. in a unique system or do common activities while their emphasis is on facilitating information expansion & relating organization & various individuals to each other in regional, local, national and international level in the form of a specific program for example due to the activity field, the geographic location, and the organizational affiliation and for definite or indefinite period of time, a set of information or resources and so on (CHINSOMBOON, 2000).

Knowledge-oriented relations among individuals, organizational bases & organizations, based on knowledge, are the new and applied achievements in the field of knowledge management.

Previous researches associated with knowledge sharing often need to implement communicative and interactive processes due to implicit nature of the main part of knowledge (iceberg metaphor). Explicit knowledge is codifying and categorizing easily and is transferable and shareable indirectly through different communicative and informative technologies; but implicit knowledge is complicated and is transferable through informal networks and interactions among people. Not only do these networks indicate relations among members but also they are essential for knowledge creation and sharing process (JAYRAMA; AYVARI, 2005).

These factors can be divided into two categories; Individual and group. The existence of these factors is incentives for knowledge sharing and their non-existence will impede from knowledge sharing (YORTCHI, 2010). Two researchers of this field have presented a framework which indicates general dimensions of knowledge sharing as follows (WANG; NOE, 2010):

- Organizational framework
- Individual & group characteristics
- Cultural features
- Personal features of HR
- Encouraging factors

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In this view, the cultural dimension has been considered as a subdivision of human, and organizational dimensions, individual, group characteristics and encouraging factors as subdivisions of human dimensions.

In this field, knowledge networks, as the most effective and efficient solution for knowledge sharing, have tools such as knowledge base, video conferences, multimedia e-mails, joint plaster boards group and applied sharing software, and so forth which have the duty of making knowledge communicable and intractable among people & different knowledge bases inside and outside of the organization and give the possibility of using internal & external knowledge resources seamlessly despite island being nature of the organization. Knowledge network is one infrastructures of knowledge management implementation which implementation reasons are knowledge effective flow, sharing and synergy through effective combination of knowledge bases of R&D centers.

As a result, it is expected that knowledge bases of interrelated firms to be expanded because expansion of knowledge bases for a firm results in expansion of knowledge bases for the other firms. These firms exchange the best solutions simultaneously which results in recreation of knowledge in the organization and creates the capabilities, based on new knowledge as well as causing to facilitate sharing and knowledge-based affairs of the interrelated firms in whole the network (JOHNSON, 2009).

According to existing definitions in valid scientific resources, knowledge networks are mainly focused on intra-organizational knowledge sharing and integration with external knowledge instead of mere concentration on knowledge creation. In fact, knowledge network concept is a response for the necessity of human center or pole existence as well as for knowing that what the employees know & what they get from the organization (EARL, 2001). Knowledge networks are tools for communicating between knowledge workers & experts of the organization in order to exchange knowledge for achieving predetermined specific aims. Knowledge network is a tool for knowledge dispersion & creation.

Since knowledge network has created organizations with the capability of access to knowledge, resources & technology, it has been identified as the main factor for achieving competitive achievements (JOHNSON, 2009). The flows of

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knowledge are other important features which indicate the knowledge network. Knowledge flows are mainly one-sided or two-sided (FREEMAN, 1991); (HARGADON, 1998); (NOOTEBOOM, 1999). The flows of knowledge are in relation with specific kind of agreements i.e. one-sided flow about issuing a license & two-sided flows about joint R&D (HARGADON, 1998).

4. RESEARCH METHODOLOGY

The method of current applied research is a quantitative method including surveys from experts and variables to be extracted through investigating research background and surveys from experts, then software of MATLAB R2013 b2 is used for making compatible matrix then graphic relations of the model are drawn by Interpretive Structural Modeling approach.

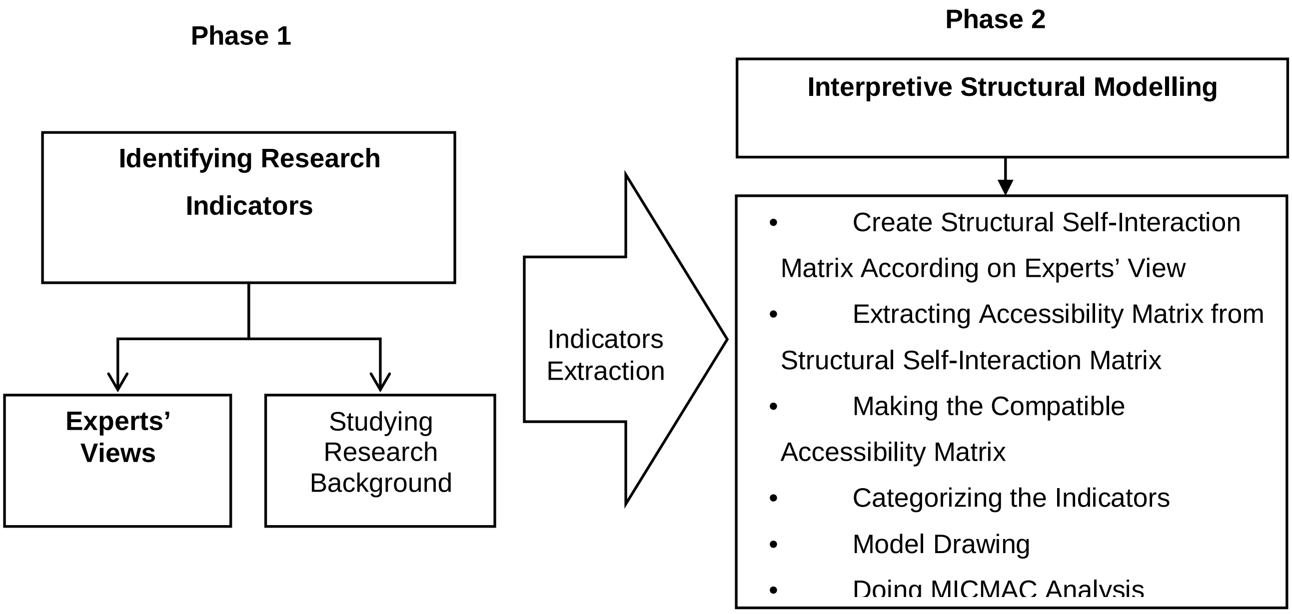

Figure 1: Research Plan

This research has been done in two main phases:

First phase: Identifying and extracting indicators; in this phase in addition, research literature investigation criteria have been identified and its indicators have been determined through surveying from industrial and academic experts. Interpretive Structural Modeling starts by providing a list from variables which are related to the subject or issue. These variables have been resulted from investigating literature, interviewing with experts or though questionnaires.

Second Phase: Determining relationship between variables & their types (modeling); In this phase the questionnaire of determining relationship for

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Interpretive Structural Modeling method completed by the experts. Then, by creating relations matrix and creating compatibility in relations matrix, ISM graph has been drawn as relations graphic modeling and different types of variables have been determined through MICMAC analysis.

The approach of Interpretive Structural Modeling has been used in this research which has been used for creating a qualitative-quantitative model as well as is an effective and efficient methodology for subject in which qualitative variables have mutual effect on each other in different levels of importance. (RUIZ-BENITEZ; CAMBRA-FIERRO, 2011).

Through using this technique we can find relations between qualitative variables of the issue (RUIZ-BENITEZ; CAMBRA-FIERRO, 2011).This model makes it possible to organize a set of various & interrelated factors in a comprehensive organized model as well as to explain the complicated pattern of conceptual relations among a set of variables by using some main concepts of the graph theory.

This method is interpretive because judgments of a group of people determine whether there is any relationship between these elements or not. ISM is a tool for integrating perception of different participatory groups & is used while trying to apply a coherent and systematic thinking on a complicated under-study discussion. Also, this is both interpretive and structural which means it decides which variable to use and how they are linked together.

According to the experts' judgment, it extracts a general structure from a set of variables according to communication and as well as it is a modeling technique which displays variables specific relations and a general structure in a graphic model. Interpretive structural modeling process consists of six basic steps.

First step: Achieving structural self-interaction matrix; this is the matrix to the dimension of variables which variables are brought in its first column and row respectively. The pairwise relations of variables are specifying through notations. Self-interaction matrix is formed by discussions and ideas of experts group (THAKKAR; DESHMUKH; GUPTA; SHANKAR, 2007).

This matrix indicates interaction between model elements. Each of experts fills out a questionnaire through which the type of the relations between the two variables can be identified.

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Table 1: Conceptual relations in formation of structural self-interaction matrix

Notation	Notation Definition
V	i causes to j(row causes to j)
A	j causes to i(column causes to row)
X	Bilateral relations of i&j
O	No valid relation

Source: Thakkar, Deshmukh, Gupta and Shankar, (2007)

As it has been referred, this matrix is completed through filled questionnaires by experts according to table 2. Resulted information has been collected by structural imperative modeling method and the final self-interaction matrix is formed. For determining the type of suggested relations, viewpoints of experts based on managerial different techniques such as brain storming, nominal group technique & so on is used. For determining the relation type notations in table 2 can be used.

Second step: achieving accessibility matrix; accessibility matrix can be achieved through converting notations of Structural Self-Interaction Matrix relations to zero and one. These rules have been shown in table 3.

Table 2: conversion of conceptual relations to numbers

Conceptual notation	i to j	j to i
V	1	0
A	0	1
X	1	1
O	0	0

Source: Thakkar, Deshmukh, Gupta and Shankar (2007)

Third step: Compatibility of Accessibility Matrix; in this step the transitive state among factors should be investigated; if ***i*** causes **j** & **j** causes **k,** then **i** must cause **k** (110). Huang et.al have used mathematical rules for adaptation so that, Accessibility Matrix they have exponentiated to k+1 and K>1. Of course, the operation of matrix exponentiation must be according to Boolean logic. For achieving the final compatible matrix M-file coding structure in MATLAB R2013b version is done.

Fourth Step: determining levels of variables; in order to determine the level & priority of variables accessibility set and prerequisite set for each variable are determined. Accessibility set of each variable includes variables which can be achieved through this variable and prerequisite set includes variables through which

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these variables can be achieved. Then, intersection of accessibility and prerequisite sets for all factors are determined and factors will be considered as high level if accessibility set is equal to intersection set of those factors. To achieve to other levels, previous levels should be separated from the matrix and process to be repeated. After re-determining the levels, the achieved matrix is settled respectively. The new matrix is called cone matrix (THAKKAR; DESHMUKH; GUPTA; SHANKAR, 2007).

Fifth step: drawing graphs; at first, the criteria are sorted by levels and according to achieved priority from up to down. Then structural model is drawing through nodes and lines according to the achieved matrix from categorized received matrix by levels. If there is any relation between ***i*** to ***j,*** it will be shown by an arrow from ***i*** to ***j.*** (THAKKAR; DESHMUKH; GUPTA; SHANKAR, 2007).

Sixth step: MICMAC analysis (Figure 2); in this part, model variables are analyzed and are categorized by two criteria; influence and dependence to determine that which variable has the most significant effect on the others. In the following, also, it is identified by interpreting variables that what the dependency of each of the model's variables is like.

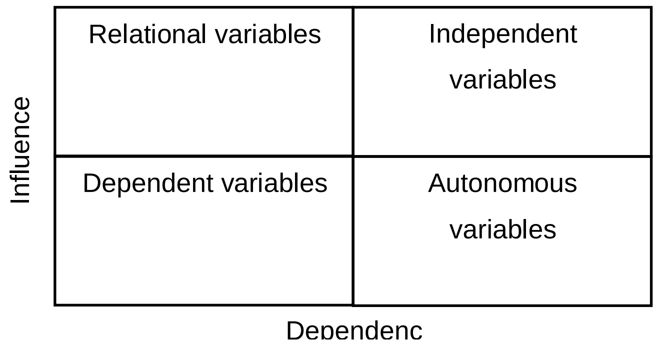

Figure 2: MICMAC interpretation

The aim of this analysis is identifying and analyzing influence and dependency of the variables. In this analysis all variables are divided to 4 categories by influence and dependency power.

- Autonomous variables which have weak influence and dependence. These variables are partly unlinked to the system as well as have less and weak communication with the system.

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- Dependent variables which have weak influence and strong dependency.
- Relational variables which have strong influence and dependency. These variables are dynamic because any changes in them can affect the system as well as system feedback may change them too.
- Independent variables which have strong influence & weak dependency (RAVI; SHANKAR; TAIWARI, 2005).

5. DATA ANALYSIS & FINDINGS

After studying related research, 25 variables have been identified. According to a survey from experts of this field in car industry's R&D centers, 12 main variables have been identified in designing the knowledge network pattern of car industry according to table 4.

Table 3: Key variables of knowledge network pattern designation

No	Variable	Reference
1	National macro environment	(ZHOU; BROWN; DEV, 2009; PEREZ; PABLOS, 2003; MALHOTRA, 2003; REZAEEAN; DANAEEFARD; ZANKOEENEJAD, 2011; FARSHAD; KHODADADHOSEINI, 2006)
2	Industry environment	(ZHOU; BROWN; DEV, 2009; PEREZ; PABLOS, 2003; MALHOTRA, 2003; REZAEEAN; DANAEEFARD; ZANKOEENEJAD, 2011; FARSHAD; KHODADADHOSEINI, 2006)
3	Organizational Internal environment	(ANDREA; VON KROGH; SEUFERT, 2005)
4	Explicit knowledge	(MIRKAMALI; HOSEINGHOLINEJAD, 2010)
5	Implicit knowledge	(MIRKAMALI; HOSEINGHOLINEJAD, 2010)
6	Organizational culture	(ZAHRA; NEUBAUM; LARRAÑETA, 2007; POURSERAJEAN; OLIA; SOLTANI, 2013; ALVANI; ZAREEMATIN; PASHAZADEH, 2009)
7	Social culture	(ZAHRA; NEUBAUM; LARRAÑETA, 2007; POURSERAJEAN; OLIA; SOLTANI, 2013; ALVANI; ZAREEMATIN; PASHAZADEH, 2009)
8	IT Software systems	(ZAHRA; NEUBAUM; LARRAÑETA, 2007; GHANI, 2009; ALIPOUR, 2014; PAHLEVANI; PIRAYESH; ALIPOUR; BASHKOH, 2010; FAZOLLAHI; NOUROZI, 2011)
9	IT & network hardware systems	(ZAHRA; NEUBAUM; LARRAÑETA, 2007; GHANI, 2009; PAHLEVANI; PIRAYESH; ALIPOUR; BASHKOH, 2010; FAZOLLAHI; NOUROZI, 2011)
10	Managerial mechanisms	(ASKARANY; SMITH; YAZDIFAR, 2007; LIN, 2008; PALMIÉ; 2012; TAGHIZADEH; ZEAEE, 2013; HASAANZADEH; TEYMORITABEE, 2015)
11	Structural mechanisms	(PAHLEVANI; PIRAYESH; ALIPOUR; BASHKOH, 2010; ALVANI; ZAREEMATIN; PASHAZADEH, 2009; SHAHBANDZADEH; HASSANNIAZI, 2014)
12	Relational mechanisms	(FIGALLO; RHINE, 2002; PAHLEVANI; PIRAYESH; ALIPOUR; BASHKOH, 2010; ALVANI; ZAREEMATIN; PASHAZADEH, 2009; ALIPOUR, 2014; MOZAFARI; SAADAT, 2009; KAZEMI; VAHIDIMOTLAGH; VAHIDIMOTLAGH, 2015)

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Performing 6 steps of Interpretive Structural Modeling

First step is achieving Structural Self Interaction Matrix Table 5. In this research, the Structural Self Interaction Matrix has been achieved under the supervision of 9 industrial and academic experts.

Table 4: Structural Self Interaction Matrix

Variable	National Macro Environment	Industry Environment	Organizational Internal Environment	Explicit Knowledge	Implicit knowledge	Individual culture	Organizational culture	IT Software systems	IT & Network Hardware systems	Managerial mechanisms	Structural mechanisms	Relational mechanisms
1		V	V	O	O	O	V	O	V	V	O	V
2			V	V	V	O	V	O	V	V	V	V
3				V	V	X	V	V	V	V	V	V
4					X	O	V	A	O	V	V	X
5						V	A	A	O	X	V	A
6							A	O	O	V	O	X
7								V	O	X	V	V
8									V	A	A	X
9										O	O	O
10											V	V
11												V
12												

Second step is achieving the accessibility matrix which can be achieved through converting notation of Structural Self Interaction Matrix relations to 0 and 1. It has been shown in table 6.

Table 5: accessibility matrix

Variable	National Macro Environment	Industry Environment	Organizational Internal Environment	Explicit Knowledge	Implicit knowledge	Individual culture	Organizational culture	IT Software systems	IT & network hardware systems	Managerial mechanisms	Structural mechanisms	Relational mechanisms
1	1	1	1	0	0	0	1	0	1	1	0	1
2	0	1	1	1	1	0	1	0	1	1	1	1
3	0	0	1	1	1	1	1	1	1	1	1	1
4	0	0	0	1	1	0	1	0	0	1	1	1
5	0	0	0	1	1	1	0	0	0	1	1	0
6	0	0	1	0	0	1	0	0	0	1	0	1
7	0	0	0	0	1	1	1	1	0	1	1	1
8	0	0	0	1	1	0	0	1	1	0	0	1
9	0	0	0	0	0	0	0	0	1	0	0	0

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10	0	0	0	0	1	0	1	1	0	1	1	1
11	0	0	0	0	0	0	0	1	0	0	1	1
12	0	0	0	1	1	1	0	1	0	0	0	1

Third Step is making the accessibility matrix compatible so that in this step it should be noted that if it is achieved from A to B then from B to C; as a result, it can be achieved from A to C directly (THAKKAR; DESHMUKH; GUPTA; SHANKAR, 2007). The matrix of the table (6) is multiplied to itself to some extent that product is equal to last step matrix; so the compatible matrix is achieved. In this step MATLAB R2013b software has been used for computing (its source code of computation has been attached). In table 7 compatible resulted matrix of this software has been shown.

Table 6: Final compatible matrix

Variable	National Macro Environment	Industry Environment	Organizational Internal Environment	Explicit Knowledge	Implicit knowledge	Individual culture	Organizational culture	IT Software systems	IT & network hardware systems	Managerial mechanisms	Structural mechanisms	Relational mechanisms
1	1	1	1	1	1	1	1	1	1	1	1	1
2	0	1	1	1	1	1	1	1	1	1	1	1
3	0	0	1	1	1	1	1	1	1	1	1	1
4	0	0	1	1	1	1	1	1	1	1	1	1
5	0	0	1	1	1	1	1	1	1	1	1	1
6	0	0	1	1	1	1	1	1	1	1	1	1
7	0	0	1	1	1	1	1	1	1	1	1	1
8	0	0	1	1	1	1	1	1	1	1	1	1
9	0	0	0	0	0	0	0	0	1	0	0	0
10	0	0	1	1	1	1	1	1	1	1	1	1
11	0	0	1	1	1	1	1	1	1	1	1	1
12	0	0	1	1	1	1	1	1	1	1	1	1

Forth step in determining the level of variables. Each level is identified when intersection of accessibility and prerequisite sets is equal to accessibility set. Accessibility set is equal to the row in front of each criterion and prerequisite set is equal to the column in front of each criterion.

After determination of the higher level variable, this variable is deleted from the variables' list, and then this should be done for other variables until each variable is placed in its specific level. The level numbers are equal to the numbers of repetitions. In this research, the level numbers were equal to 4. The final result of determining levels of variables has been shown in table 8.

Table 7 levels of model variables

Model level	variables
1	9
2	3,4,5,6,7,8,10,11,12

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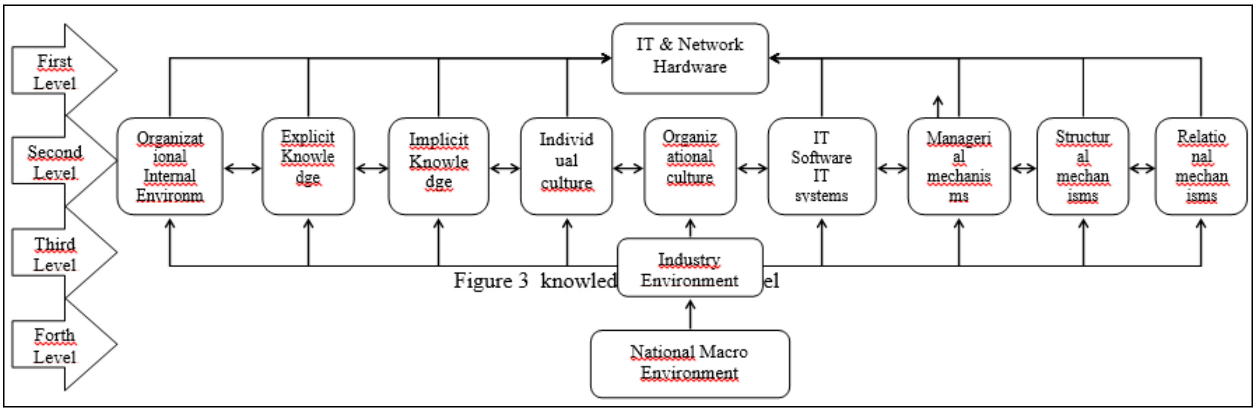
3	2
4	1

Fifth step is drawing a graph, to sort criteria by levels and insert them in the final model. At the end, the relations between them according to the compatible matrix are identified. This final model of the research has been shown in figure 3.



Sixth step is MICMAC analysis (Figure 4) in which variables has been categorized to 4 by 2 influence and dependency power.

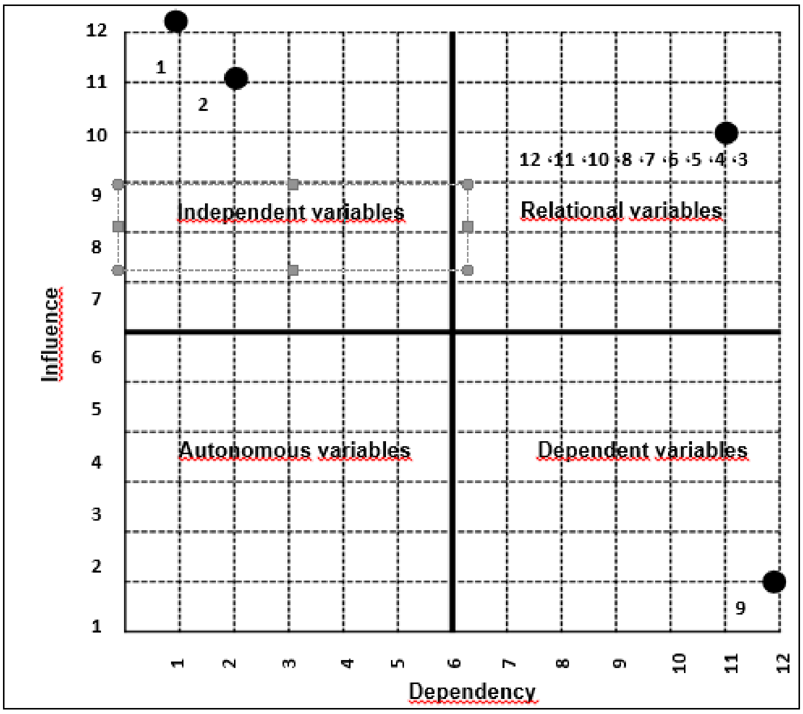


Figure 3: The diagram of influence & dependency power

To compute influence power sum of row's numbers for each variable and to compute dependency power sum of column's numbers for each variable is used which has been shown in table 9 based on variables.

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Table 8: the degree of variables influence & dependency power

Variables	1	2	3	4	5	6	7	8	9	10	11	12
influence power	12	11	10	10	10	10	10	10	1	10	10	10
dependency power	1	2	11	11	11	11	11	11	12	11	11	11

6. Conclusion

Identifying important and effective factors for creating knowledge network in R&D centers is very important. Thus, this research tries to identify important variables from other research for implementing knowledge network. As a result, 12 important and effective variables which had the most proportionality with the population and were considered more by managers and experts in car industry's R&D centers have been chosen.

Then, their relations and sequences have been obtained by ISM technique. Results have indicated that national macro environment variable is the cornerstone of the knowledge network in Iran car industry's R&D centers. It means that, this variable should be used and its potentials and capacities in national level should be considered for starting the knowledge network.

As a result, the field for the next variable i.e. industrial environment which considers existing potentials and capacities of the industry is provided; then all other variables; organizational internal, explicit knowledge, individual culture, organizational culture, managerial, structural and relational mechanisms are placed in the same level of importance.

IT and network hardware systems are the last ones which are as the context of installing knowledge networks in car industry's R&D centers as well as it can be called as backbone of the knowledge network in R&D centers which all configuration of the knowledge network is mounted on.

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