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Developing a model of factors affecting the technology management system using a structural-interpretive approach in the Ministry of Petroleum

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Abstract

Today, the importance of technology is confirmed in most global phenomena and its impact on issues affecting countries, organizations, and even various aspects of daily life. This study aimed to identify factors affecting the quality of the technology management system to develop an interactive model with a structural-interpretive approach in the Ministry of Oil companies. This study was conducted on 450 managers, officials, and experts of the five oil companies, 210 of whom were selected based on the purposive judgment method. The data were collected by a researcher-made questionnaire with 52 items based on the Likert scale technique and a standard ISM method questionnaire. The reliability of the first questionnaire was confirmed based on Cronbach's alpha test and composite reliability. An exploratory factor analysis approach was used to identify the factors, and the data were analyzed in Smart PLS software. In total, 16 factors were identified as influential factors regarding the quality of the technology management system based on the varimax rotation method by explaining 60.8% of the variance of the variables and separated into ten levels of importance. Finally, the structures of the interactive research model were determined after implementing the standard steps of the structural-interpretive modeling approach, which can be used according to each organization's priority levels and strategies to enforce improvement policies.

Keywords: Technology, technology management, exploratory factor analysis, structural-interpretive modeling
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1 Introduction

Technology and updates under the latest scientific achievements in technology at the national level are considered one of the most important factors and drivers of economic and social development. In addition, technology can be an essential actor in defining and redefining countries' relations in the global arena. Activists, academics, and governments have widely accepted the effect of technology as a source of competitive advantage for manufacturing industries. Technical knowledge and skills are prerequisites for competitiveness [6, 12]. Technology at the level of companies and organizations is one of the key components and the effective factors of progress and even survival of modern organizations. Technology plays a vital role in today's competitive economy, and global competition strategies

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are increasingly turning to technology, which has moved to very dynamic, high-speed, and turbulent environments. The rapid development of technology in recent years has affected certain areas of more than 30 management studies, including technology [25]. Economic growth, the expansion of information technology and the use of new technologies, and the need to increase competitiveness, especially for activities with a global field of action, the need for increasing attention to the category of technology and innovations to create a sustainable competitive advantage and maintaining survival in the field of competition is an undeniable issue. Technology management is one of the topics that has received much attention today. Sumanth believes that technology management will be the most important field in the coming years, and the seeds of such thinking have already been sown. Therefore, it is necessary to adopt new methods to evaluate the performance and abilities of managers who want to be more involved with technology management in the future [9]. Today, the definite impact of being up-to-date and properly managing any organization's technology in its continuous improvement and growth is logically accepted. According to the system thinking method, understanding and improving any system requires knowledge of the constituent factors and the direction of communication and interaction between the components. The first step in improving technology and planning for a more prosperous future is to know the current content and situation [10, 22, 17]. Finding the same, complete, single definition for technology is difficult. In scientific discussions, technology is defined as all knowledge, products, processes, tools, methods, and systems used in creating goods or providing services and is sometimes referred to briefly as the application of scientific knowledge to solve development problems or in a simpler form, the method of doing things. Webster's dictionary defines technology as a branch of knowledge that deals with applied, engineering, industrial, and artistic knowledge or using knowledge for a scientific end [21]. The technology comprises two Greek words, techne, and logia, where techne means art and skill and logia means science and knowledge. In the dictionary, technology refers to the knowledge of methods for growing, manufacturing, and processing something, especially making and using tools, devices, and machines [9]. [20], a famous professor of technology management in American universities, considers technology a wide range of activities and measures necessary to produce technical knowledge, materials, processes, and new products. The common feature of all definitions is to confirm that technology does not just include hardware and equipment and has different dimensions and components. Therefore, the discussion of technology management is one of the topics that has received attention today. Technology management was formed in the 1980s, and its field of study has more than 50 years of history. Research from the Institute of Electrical and Electronics Engineers (IEEE), in the Journal of Engineering Management in 2004 and the Journal of Technology Management Research in 2007, are shown in specific research [19]. Technology management has become a recognized field of study in the last 20 years with the emergence of specialized and professional organizations such as the International Association for Management of Technology (IAMOT), Portland International Center for Management of Engineering and Technology (PICMET), and European Institute for Technology and Innovation Management (EITIM) and the rapid increase in the number of publications and academic programs in the field in the late 80s [2, 19, 4]. Technology management is the management of a system that enables the creation, acquisition, and application of technology and includes the responsibility that places these activities in line with serving humanity and meeting customer needs. In addition, technology management means creating a mutual understanding between business and technology, recognizing the limitations of the strategic planning process, and using technology as part of the company's strategic planning process [7]. Technology management can be planned by analyzing situation curves, forecasting technological performance, and investing in research and development. Technology management maturity refers to an organization's perfection and effectiveness in identifying, developing, managing, and controlling its technological capabilities [18]. The existential philosophy of technology management is to create a match between the technology set and the goals and objectives of the organization and to make decisions about the issues related to the creation and use of technological assets and capabilities.

[8] identified the key components affecting technology acquisition style to prioritize technology acquisition strategies, which were grouped into four groups: environmental factors, organizational technology, strategy, and organizational capability factors. [16] evaluated the effects of foresight in the management of technologies, expressed weaknesses, strengths, opportunities, and threats, and stated the features of foresight in other countries and its effects on technologies and the expansion of innovation. [13] studied the management of technologies in the gas company and showed that technology and innovation management activities, including identification, acquisition, exploitation, learning, protection, and technology selection, had a positive and significant effect on agility capabilities. [14] conducted organizational change management through a hierarchical scoring model. The pinnacle of innovation is new technologies that create new products and services. This paper aimed to draw important factors and perspectives in technology transfer to use hierarchical decision modeling to create a technology transfer score. [11] found that rapid development requires any business organization to develop appropriate technology and innovation management competencies as quickly as possible. The essential elements of technology management success are value orientation, system quality, management commitment, organizational factors, and competence. [24] stated that the Technology Management Com-

petency (TMC) approach consists of one or more competency processes. This study reviewed research to identify the fundamental concepts of technology management capabilities and technology platform management in the framework of technology platform ecosystems. [26] presented a framework to identify the main path of technology evolution while pointing out that technological innovation is a dynamic process that includes the life cycle of an idea from research to production. [15] concluded that the effective management of technology resources depends on the technology management system based on an evolutionary model of technology management system based on self-organization theory. The simulation results show that the evolution of each of the subsystems of the technology management system is affected by the growth rate of its knowledge, as well as the relationship and synergy between the subsystems. [5] investigated The Rural Technology Action Group (RUTAG) organizational aspects for developing and managing technology using the systems theory approach. [15] examined the relationship of technology management with product innovation through the possible role of technological capabilities. Testing the proposed hypotheses showed that technology management activities related to product innovation are not the same at different stages of technological capabilities. [23] investigated technology management practices in industries and institutions based on the five critical dimensions of the Gregorian process-based model. [1] conducted research among small to large companies in Malaysia and indicated that the relationship between technological capability and production performance is significant and positive. This study proved that there is a relationship between the variables. Therefore, the importance of technology and proper management of influential factors directly relates to increasing the role, importance, position, and intensity of influence of various industries and organizations. Iran's oil industry, with a history of more than a century, unique characteristics in economic, social, and political issues, and the most important economic drivers, has an important position. Therefore, all the efforts and plans made to improve the ability of various areas of this oil industry are valuable. The complex nature of activities related to multiple subsets of the oil industry and the concrete dependence of its processes on the use of different technologies require attention and investments in optimal management in all fields related to technology issues associated with this industry. Achieving these goals in the first steps requires knowing the factors affecting the quality of technology management in the oil industry and recognizing the nature of the interrelationships of the mentioned factors in terms of optimal decision-making and policies for successful and sustainable management. Therefore, the present study aimed to identify factors affecting the technology management system to provide an interactive model and prioritize improvement policies in the organizational environment of the subsidiaries of Iran's Ministry of Oil.

2 Method

This study was conducted on 450 managers, officials, supervisors, and experts of the five oil companies in Iran's northwest and southern oil regions, 210 of whom were selected based on the purposive judgment method. First, relevant items were designed in different functional areas of the technology management system to identify the factors related to the research topic and investigate the interactive relationships between the variables based on the study of previous studies. Then, influential factors on technology management performance were extracted using the Exploratory Factor Analysis (EFA) approach. The interactive model of the desired factors was designed based on the structural-interpretive modeling (ISM) approach, and various statistical techniques, such as the structural equation approach and path analysis, were used to validate the model. The approach questionnaire (EFA) has 52 researcher-made items and is based on a 5-option Likert scale, and the standard comparative approach questionnaire (ISM) was used to design the model.

3 Findings

3.1 Exploratory factor analysis (EFA) approach

Sufficient sample size is one of the requirements for optimal implementation of factor analysis to identify factors. The sample quality index (KMO) was used to check the adequacy of the sample for factor analysis, which is between zero and 1, and the ideal state of this index is numbers above 0.7. The output of Bartlett's sphericity test was used to calculate the normalized chi-square to ensure the correlation of the variable. The significance level of Bartlett's test must be smaller than the first type error probability (0.05) to conclude that the correlation matrix of the variables is not the same, indicating a relationship between the variables. The KMO index and Bartlett's Chi statistic, the degree of statistics were 0.742, 2620.062, and 1326, respectively. Further, the significance level of Bartlett's test was 0.000.

Factor analysis was performed on the research data after ensuring the appropriateness of statistical sample indicators. The final set of variables was extracted to build the scale after creating a set of preliminary variables in the factor analysis by rotation (Table 1).

Table 1: Number of confirmed factors and the total explained variance of factors affecting the quality of TMS

Factors	Eigenvalues of extraction factors with rotation			Factors	Eigenvalues of extraction factors with rotation		
	Total	Percentage of variance	The cumulative percentage		Total	Percentage of variance	The cumulative percentage
C1	7.1	13.8	13.7	**C9**	1.5	2.9	43.1
C2	2.5	4.9	18.7	**C10**	1.4	2.8	45.9
C3	2.1	4.1	22.8	**C11**	1.4	2.7	48.7
C4	2.0	3.8	26.7	**C12**	1.3	2.6	51.3
C5	1.8	3.5	30.3	**C13**	1.3	2.5	53.9
C6	1.7	4.3	33.7	**C14**	1.3	2.5	56.4
C7	1.7	2.3	37.0	**C15**	1.1	2.2	58.6
C8	1.6	3.2	40.2	**C16**	1.1	2.1	60.8

Eigenvalues with at least one value are large and identified factors. In this method, the predicted variance value of the variables is used as a criterion for choosing the number of factors. A total of 16 variables were identified as influential factors based on the adequacy of the cumulative variance explanation, which explained 60.8% of the variance of the factors affecting the quality of the technology management system. In addition, the relationship between the items of the factor analysis method questionnaire (52 questions) was examined by explaining the factors based on the common load of the variables (r^2). Questions with a shared load of less than 0.4 do not have much effect in measuring the primary factors in factor analysis and should be removed from the analysis process. Therefore, the common loadings obtained fluctuated between 0.513 and 0.761; thus, all items remained in the study.

After this stage, the factor loadings of each of the variables were calculated. Thus, the varimax rotation method was used to uniquely distribute the components in the subset of factors. Varimax is the most common orthogonal rotation method in factor analysis that minimizes the complexity of components by increasing large loadings and decreasing small loadings within each component (column) and simplifying the columns of the factor load matrix. In each factor, large loadings increase and small loadings decrease, so each factor has only a few variables with significant loadings and many with small (or zero) loadings. Therefore, factor loadings are distributed so that each group of variables measures exactly one factor. Table 2 shows the values of the factor loadings and the factor related to each component after rotating the matrix of the components using the varimax method.

Table 2: Factor load and factors related to factor analysis questions

Factor	**Factor Loud**	**Ques**	**Factor**	**Factor Loud**	**Ques**	**Factor**	**Factor Loud**	**Ques**	**Factor**	**Factor Loud**	**Ques**
$C8$	0.618	40	$C11$	0.482	27	$C7$	0.413	14	$C4$	0.428	1
$C7$	0.623	41	$C14$	0.473	28	$C2$	0.445	15	$C3$	0.441	2
$C12$	0.471	42	$C5$	0.522	29	$C5$	0.459	16	$C8$	0.428	3
$C9$	0.593	43	$C15$	0.435	30	$C10$	0.445	17	$C8$	0.531	4
$C14$	0.531	44	$C6$	0.512	31	$C12$	0.443	18	$C11$	0.416	5
$C1$	0.429	45	$C14$	0.514	32	$C9$	0.531	19	$C10$	0.552	6
$C3$	0.544	46	$C2$	0.479	33	$C7$	0.550	20	$C16$	0.478	7
$C14$	0.611	47	$C10$	0.549	34	$C11$	0.488	21	$C15$	0.564	8
$C16$	0.473	48	$C13$	0.617	35	$C14$	0.619	22	$C6$	0.530	9
$C10$	0.520	49	$C5$	0.567	36	$C1$	0.473	23	$C3$	0.493	10
$C15$	0.527	50	$C12$	0.441	37	$C10$	0.452	24	$C13$	0.465	11
$C4$	0.559	51	$C2$	0.504	38	$C64$	0.20	25	$C1$	0.466	12
$C10$	0.448	52	$C4$	0.466	39	$C9$	0.498	26	$C16$	0.545	13

The size of the factor loadings of all the items is above 0.3, which shows the power of proper connection between the apparent variables and the factors related to each category. Therefore, the 16 identified factors are named according to the themes related to the items of each factor according to Table 3 in the following order.

Interpretive Structural Modeling (ISM): Warfield developed this approach through mathematics, computers, and experts' participation in designing large and complex systems. In this method, the direction of the complex relationships between the elements of a system is checked. Thus, the complexity between the elements is overcome by analyzing the effect of one element on other elements. Different elements are structured in the form of a comprehensive systematic model. The structural-interpretive modeling method transforms vague and weak mental models into explicit, well-defined models useful for many purposes [3].

At this stage, the factors and variables based on the exploratory factor analysis approach have been the basis of

Table 3: The labels of the extracted factors

Factor	Factor Label	Factor	Factor Label
C1	Improving the capability of human resources	C9	Maintaining efficient human resources
C2	Improving the level of technological competence	C10	Research activities in technology
C3	Organizational technology strategy	C11	Adaptability to new technology
C4	Technological aristocracy	C12	The power of integrating technology
C5	The effect of political factors	C13	Adequacy of communication structures
C6	The ability to commercialize technology	C14	The legal structuring of technology preservation
C7	The ability to evaluate technology	C15	Mechanisms for updating current technologies
C8	The ability to predict technology	C16	Intercorporate cooperation

a survey of the research elite group of 75 people to implement the method (ISM). The steps can be explained in the following order.

4 Formation of structural self-interaction matrix (SSIM)

The 16 research factors were compared pairwise using the standard approach questionnaire (ISM) and the following relationships. Based on the rules of this approach, the effect of variable i on variable j with the letter (V), the effect of variable j on variable i with the letter (A), the two-way relationship with the letter (X) and the lack of relationship with the letter (O) were identified.

The frequency method (mode) was used to summarize opinions and form a self-interaction matrix based on the structural-interpretive modeling approach, and a structural self-interaction matrix (SSIM) was created by identifying the relationship between two factors.

5 Formation of primary access matrix

The primary access matrix was used according to the rules of the scientific approach to form the primary access matrix from the following relationships:

$$(i,j)=1 \quad (i,j)=1 \qquad X \qquad (i,j)=0 \quad (j,i)=1 \qquad V$$
$$(i,j)=0 \quad (i,j)=0 \qquad O \qquad (i,j)=1 \quad (j,i)=0 \qquad A$$

6 Formation of the final access matrix

The final access matrix was formed based on entering transferability and multiplicative relationships between factors to establish the internal consistency of the primary access matrix. If component a leads to component b and component b leads to component k, then it can be concluded that component a will also lead to component k. Finally, some zero numbers in the initial access matrix will become one after applying these relationships.

7 Determining the level of research factors

Each factor's output and input sets are determined, with the number one in the row of each factor forming the output set. In addition, number one in the column of each criterion is placed to determine the input set. The equality of the members of the output and joint sets (input and output), related to each factor in each iteration of the calculation, indicates the level of that factor in the model. According to the ISM approach principles, each model level's determined factors should be removed from the review process in the subsequent iterations of calculations (Table 4).

8 Model design based on ISM

The interactive model of the research factors is divided into ten levels, in which the influence of factors increases with decreasing height in the model. Therefore, the final diagram of the research is designed based on the levels of each extracted variable according to Figure 1 in the following order.

MICMAC analysis: Variables are divided according to the values of two indicators of the power of influence and the degree of dependence in the four areas of the diagram with the titles of autonomous, dependent, linked,

Table 4: Determining the levels of extracted factors in the research model

Iteration	Factor	Output set	Input set	Common collection	Level
First	C1	1, 2, 3, 4, 6, 7, 10, 11, 12, 15, 16	1	1	
	C2	2, 3, 4, 6, 8, 11, 12, 15, 16	1, 2, 3, 5, 6, 7, 8, 9, 10, 12, 16	2, 3, 6, 8, 12, 16	
	C3	2, 3, 4, 6, 7, 8, 10, 11, 12, 13, 15, 16	1, 2, 3, 5, 6, 7, 8, 9, 10, 12, 15, 16	2, 3, 6, 7, 8, 10, 12, 15, 16	
	C4	4, 6, 8, 10, 11	1, 2, 3, 4, 5, 7, 8, 9, 10, 12, 13, 16	4, 8, 10	
	C5	2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 16	5	5	
	C6	2, 3, 6, 11, 13, 15, 16	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 13, 15, 16	2, 3, 6, 13, 15, 16	
	C7	2, 3, 4, 6, 7, 8, 10, 11, 12	1, 3, 5, 7, 8, 9, 10, 13, 16	3, 7, 8, 10	
	C8	2, 3, 4, 6, 7, 8, 10, 11, 12	2, 3, 4, 5, 7, 8, 9, 10, 12, 13, 16	2, 3, 4, 7, 8, 10, 12	
	C9	2, 3, 4, 6, 7, 8, 9, 10, 11, 12, 15, 16	5, 9	9	
	C10	2, 3, 4, 6, 7, 8, 10, 11, 12, 13, 15, 16	1, 3, 4, 5, 7, 8, 9, 10, 12, 13, 16	3, 4, 7, 8, 10, 12, 13, 16	
	C11	11	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 16	11	1
	C12	2, 3, 4, 6, 8, 10, 11, 12, 15, 16	1, 2, 3, 5, 7, 8, 9, 10, 12, 13, 16	2, 3, 8, 10, 12, 16	
	C13	4, 6, 7, 8, 10, 11, 12, 13, 15, 16	3, 5, 6, 10, 13	6, 10, 13	
	C14	14	14	14	1
	C15	3, 6, 15	1, 2, 3, 5, 6, 9, 10, 12, 13, 15, 16	3, 6, 15	1
	C16	2, 3, 4, 6, 7, 8, 10, 11, 12, 15, 16	1, 2, 3, 5, 6, 9, 10, 12, 13, 16	2, 3, 6, 10, 12, 16	
Second	C6	2, 3, 6, 13, 16	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 13, 16	2, 3, 6, 13, 16	2
Third	C4	4, 8, 10	1, 2, 3, 4, 5, 7, 8, 9, 10, 12, 13, 16	4, 8, 10	3
	C8	2, 3, 4, 7, 8, 10, 12	2, 3, 4, 5, 7, 8, 9, 10, 12, 13, 16	2, 3, 4, 7, 8, 10, 12	3
Fourth	C2	2, 3, 12, 16	1, 2, 3, 5, 7, 9, 10, 12, 16	2, 3, 12, 16	4
	C12	2, 3, 10, 12, 16	1, 2, 3, 5, 7, 9, 10, 12, 13, 16	2, 3, 10, 12, 16	4
Fifth	C7	3, 7, 10	1, 3, 5, 7, 9, 10, 13, 16	3, 7, 10	5
	C10	3, 7, 10, 13, 16	1, 3, 5, 7, 9, 10, 13, 16	3, 7, 10, 13, 16	5
Sixth	C16	3, 16	1, 3, 5, 9, 13, 16	3, 16	6
Seventh	C13	13	3, 5, 13	13	7
Eighth	C3	3	1, 3, 5, 9	3	8
Ninth	C1	1	1	1	9
	C9	9	5, 9	9	9
Tenth	C5	5	5	5	10

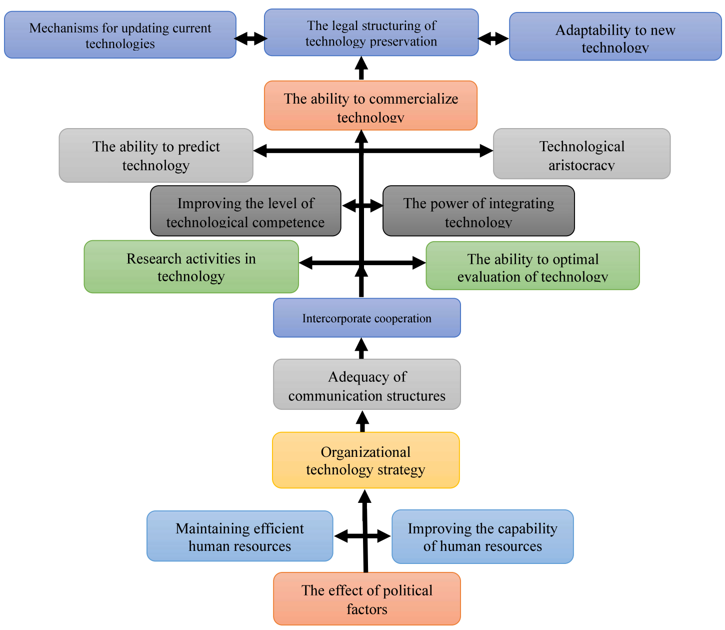

Figure 1: Variables affecting the establishment of the management system

and influence. Two indicators indicating the type of interrelationships of the elements are determined based on the influencing and effectiveness towards each other based on the number of numbers one in the row and column of each factor in the final access matrix. Therefore, the placement results of the research model structures in the areas of the MICMAC diagram are presented in Figure 2:

9 Goodness of fit

Validation of a model involves verifying the certainty of the existence and stable identification of the factors used in the model. The structural equation approach was used to examine the relationships between the hidden variables in the research algorithm and the observable variables or research items. The t-statistics and factor loadings of all

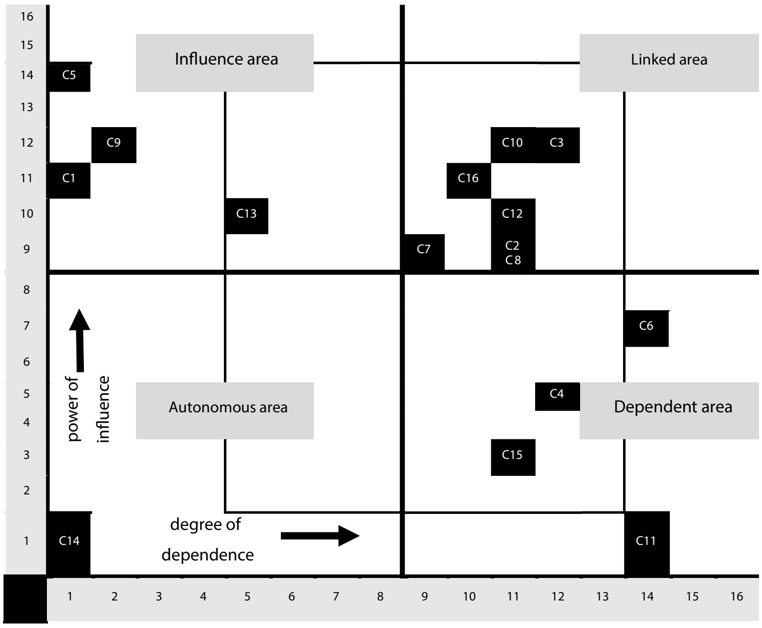

Figure 2: MICMAC diagram of research factors

observable variables were above acceptable levels. The diagnostic validity of the structures was measured with Average Variance Extracted (AVE), and the values of this index were above the proper level for all factors, and the diagnostic validity of the model structures was confirmed. The reliability of the research measurement tool was also checked by calculating Cronbach's alpha and composite reliability coefficients (CR). T-statistic values measure the significance of the communication path between the technology management system and research variables. The results of calculating the path coefficient or beta coefficient of the standardized regression obtained for the research variables are also in accordance with Table 5.

Table 5: Parameters for checking the goodness of fit

Factor	CR	α. Cbach	R Square	Path coefficient	T statistic	Factor	CR	α. Cbach	R Square	Path coefficient	T statistic
C1	0.67	0.71	0.33	0.58	7.20	C9	0.68	0.81	0.62.0	0.66	9.94
C2	0.64	0.79	0.58	0.63	8.61	C10	0.72	0.73	0.70	0.78	17.53
C3	0.66	0.74	0.62	0.56	8.42	C11	0.62	0.72	0.66	0.38	3.65
C4	0.68	0.71	0.56	0.37	2.88	C12	0.69	0.74	0.53	0.53	7.14
C5	0.70	0.88	0.54	0.59	6.56	C13	0.67	0.75	0.54	0.61	5.99
C6	0.69	0.82	0.53	0.57	6.80	C14	0.65	0.72	0.63	0.57	7.09
C7	0.73	0.76	0.58	0.65	8.58	C15	0.70	0.77	0.54	0.63	8.96
C8	0.60	0.76	0.66	0.59	9.35	C16	0.73	0.84	0.57	0.46	8.68

The t-statistics of all the paths related to improving the quality of the technology management system are significant in all the identified factors. On the other hand, the coefficient of the path of these relationships is positive and indicates a proper relationship.

10 Conclusion and Recommendations

This study was conducted to identify factors affecting the performance quality of the technology management system of the companies under the Ministry of Oil and design the interactive model of the desired variables based on the structural-interpretive approach. A total of 16 factors were identified based on predicting the variables' variance value. The labels of the extracted factors were attached based on two parameters of the technical examination of the items of each factor and the psychological principles governing the items. The path of the impact of the variables on the technology management system was through each of the main activities of the organization's technology management, and each of the factors affected the activities. Then, the research model was formed based on the structural-interpretive modeling approach to determine the importance level of the factors, and the validity of the research model was verified based on the structural equations approach and desired parameters. The research factors were arranged in ten model levels based on their importance and impact on the performance quality of the technology management system. Based on the opinion of the elite research group, the impact factor of political factors and especially cruel sanctions on the country's oil industry is placed at the lowest level of the model and has the most significant impact on other identified factors according to the principles of the approach (ISM). Political factors are also placed in the influence area based on the MICMAC diagram and should, therefore, be considered the most critical parameter to study. Thus, the interaction of the Ministries of Oil and Foreign Affairs of Iran for designing practical solutions to reduce the negative effects of the sanctions on the oil industry, especially in areas related to technology, is critical. Other vital solutions are identifying the potential of effective communication with international technology and reputable companies to create opportunities for information exchange and joint ventures. Other research variables were placed in different classes of the model according to their importance. The research model can guide in identifying areas needing more attention based on technology strategies in various organizations active in Iran's oil industry and related industries and determine the direction of appropriate policies. Pursuing new sciences and associated technologies and designing mechanisms to update information related to technological developments in the international field are requirements that require attention from senior managers. Continuous and targeted studies to diagnose and identify the strengths and weaknesses of the technology field and determine effective technologies in competitive advantages should be on the agenda of the planners of the companies under the Ministry of Oil. In addition, another effective solution is using domestic knowledge-based and innovative companies' capacities to cover technological gaps and neutralize the effects of sanctions. Activating the capabilities of research and development departments of oil companies to identify specific areas of technology for cooperation with scientific and research centers and technologies with commercialization potential has significant effects on upgrading the technology parameters of oil organizations. Creating working groups to examine the technological links of oil industry technologies with other industries and the feasibility of technological integration methods to develop new combined technologies is an effective method of exploiting hidden technological capabilities in increasing the speed of technology growth.

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