

## **ASSESSMENT OF THE SUCCESS RATE OF THE TECHNOLOGY TRANSFER PROCESS IN THE OIL AND GAS INDUSTRY AND SELECTION OF THE MOST APPROPRIATE METHOD FOR TECHNOLOGY TRANSFER USING AHP TECHNIQUE (CASE STUDY: NATIONAL IRANIAN SOUTH OIL COMPANY)**

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### **ABSTRACT**

The importance of technology and its role as the main factor affecting the industrial and economic development is clear for developing countries. Today, companies in developing countries use different methods- such as transfer of new technologies- to narrow the gap with developed countries in the field of technology. By this, they have been able to somewhat reduce their [technological] distance from developed countries. However, in some cases, they have faced difficulties due to ineffectiveness of technology. Technology transfer is possible through different methods which are determined with regard to the role of technology transferor and technology transferee. Here, the challenge is that if the imported technology is not selected properly and not transferred from the right path, it will cause an irreparable damage. The process of technology transfer is consisted of six major phases. In case of successful application of all phases, the commercialization of transferred technology will be possible. These phases are: selection and acquisition, adaptation, absorption, application, development and diffusion. In this paper, it is tried to assess the success rate of technology transfer projects in National Iranian South Oil Company (NISOC) and finally specify the proper approach for the company to transfer technology based on priorities, using Analytical Hierarchy Process (AHP).

**Keywords:** *Technology, Technology Capability, Technology Transfer, Analytic Hierarchy Process (AHP)*

### **INTRODUCTION**

For years, technology was considered as a factor influencing all affairs of personal and social life. In recent years, this has become an important issue to discuss about the future of the nations and humanity. Developing countries tried to gain and improve their technologies to compensate for the backwardness and a better life; and developed countries did the same for gaining more power in international competition and maintaining their dominance. By studying the development history of developing countries, particularly in East Asia, you can see that through being on track to accelerate their development in expediting the removal of industrial sector problems, they have strengthened the foundation of technology in their country through the transfer of technology from other developed countries. And then, with creation of appropriate economic bases, they have sought to strengthen the academic and research centers. If, as a solution, developing countries want to acquire the scientific and technical knowledge necessary for economic development, without the use of existing knowledge that is the result of research conducted by researchers and scholars worldwide, this will be not only a difficult practice, but also causes irrational waste of forces and spending a huge amount of money. Furthermore, achieving such a solution during the time when developed countries predict abundant amounts in their annual budget to access the new technologies is not possible. The technology transfer is the best option to reduce the technology gap between developed and developing countries. Successful technology transfer requires knowing the industry's goals, sources of technology, how to innovate and transfer, transfer methods, affecting factors, how to absorb and how to develop it. Each of these indicators is based on its

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own specific expertise. Without the use of experts in technology transfer and technology management principles, the transfer does not occur or the related technology transfer is carried out as partial and half-baked

### **LITERATURE REVIEW**

Technology is a systematic knowledge used in the production of a product or provision of a service in the industry, agriculture or commerce, and installation or maintenance of an industrial plant or equipment, or in the management of an industrial company (WIPO, 2010). Innovation is also the conversion of knowledge and ideas into new or improved products, processes or services to gain a competitive advantage (Microsoft Corporation, 2007). Technology is as all knowledge, products, processes, tools, methods, and systems that are used to produce goods or services. One of the fields of technology management application that requires holistic view and introspection is the technology transfer. Today, industrialization is deeply dependent on the technology transfer. In today's world, there is a direct relationship between technology development and the economic, social, political and cultural life of a nation, so that it can be said that the technology is a key factor for the creation of wealth, power and wisdom for the nations and is seen as a powerful means of national development. For this reason, at the international level, the military conflicts have been replaced with technological-economic wars. Thus, adoption of technology development strategies in various sectors of the economy of any country is a key component of the economic reconstruction and development of that country. Without it, achieving goals such as economic self-sufficiency, national development and the improvement of living standards is impossible. Technology transfer is the adoption and use of technology in a place other than the place of its origin. In other words, a process that causes the flow of technology from the source to the receiver is called technology transfer. Technology transfer is a complex and difficult process. Purchase and transfer of technology with necessary study and assessment is not only helpful, but also it may lead to the weakening of national technology, in addition to wasting the money and time. Technology transfer must be viewed or looked at as a process through which imported technology is acquired, in a way that not only is used for the production of products, but also becomes a platform for the creation of new technologies. Technology transfer is taken place in two ways: vertical transfer and horizontal transfer. In the vertical transfer or R & D transfer, technical information and applied research findings are transferred to the phase of engineering design and development, and then enters into the production process with technology commercialization. In the horizontal transfer, the technology is transferred from one level of capability in a country to the same level of capability in another place. In this situation, the higher the level of technology transferee (receiver), the lower the cost of technology transfer and its absorption is more effectively realized. In the following table, the nature and meaning of technology transfer at any level and its cost are specified compared with other levels.

## **AN INTRODUCTION TO THE MODEL AND TECHNIQUES USED IN THE STUDY**

### **a) Model Of The Technology Transfer Process**

Model of the technology transfer process has six general phases: The first phase, technology selection and acquisition: is a process of selecting technology from among existing technologies, conducting negotiations and concluding a contract to acquire it. The second phase, adaptation of imported technology: is a process of precise linkage of imported technology with the projects' needs, resource and situation of the country. The third phase, the absorption of imported technology: is a process of the full awareness of the receiver of technology (transferee) of all components of the acquired technology. The fourth phase, the use of transferred technology: is a process of utilizing the acquired technology. The fifth phase, the development of imported technology: is a process in which the technology is developed for better and newer processes and products using the knowledge gained from technology adaptation, absorption and application, experience, skills and internal research findings. The sixth phase, dissemination of imported technology: is a process of deepening and expanding the components of the

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acquired technology in the country. This model was used to answer the main questions and sub-questions of the research.

#### **b) Analytical Hierarchy Process (AHP) Technique**

The technique of Analytical Hierarchy Process (AHP) is used to answer the second research main question. It is usually used for decision making with multiple criteria. This technique makes it possible to formulate the problem based on hierarchy and also provides taking into account the various quantitative and qualitative criteria while dealing with the problem [problem assessment].

This technique involves different options in decision-making and has the possibility of conducting a sensitivity analysis on the main criteria and sub- criteria. This technique is based on paired comparison which facilitates the judgment and calculations and shows the extent of compatibility and incompatibility of the decision.

### **OBJECTIVES AND RESEARCH QUESTIONS**

The purpose of this study was to measure the success of the technology transfer process in NIDSC and to determine the most appropriate method of technology transfer with regard to the importance of each phases of transfer process using the technique of Analytical Hierarchy Process (AHP).

#### **A) The Main Research Questions Are :**

1. What is the success rate of the imported technology transfer process in the technology transfer projects?
2. What are the most appropriate methods of technology transfer in the oil and gas industry based on the order of priority?

#### **B) Secondary Research Questions Are :**

1. What is the success rate of the phase of technology selection and acquisition in the imported technology transfer process?
2. What is the success rate of the phase of technology adaptation in the imported technology transfer process?
3. What is the success rate of the phase of technology absorption in the imported technology transfer process?
4. What is the success rate of the phase of technology application in the imported technology transfer process?
5. What is the success rate of the phase of technology development in the imported technology transfer process?
6. What is the success rate of the phase of technology dissemination in the imported technology transfer process?

### **METHODOLOGY**

This study is an applied research in terms of the purpose and is survey in terms of the method used. The questionnaire is a tool used to obtain the data.

### **INDICATORS USED FOR RESEARCH**

According to the model of technology transfer process, the indicators in Table 1 were used for designing the questionnaire in order to collect data for the first research question and also sub-questions. Experts confirmed the validity and the score of 0.86 obtained using Cronbach's alpha test confirms its validity.

### **STATISTICAL POPULATION**

The statistical population of this research is consisted of middle and senior managers and experts of National Iranian South Oil Company with BA and MA degrees and work experience of more than eight.

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But due to limited number of experts, the complete enumeration method was used (Table1) and experts were weighted.

**Table 1: Descriptive Parameters Of Respondents**

Row	Educational level	Number	The average work experience
1	BA Degree	25	18
2	MA Degree	11	10

**METHOD OF DATA ANALYSIS**

Two methods were used to analyze the research data:

**The Method Of Statistical Analysis**

In this method, data is collected and summarized using statistical indicators. In other words, for descriptive analysis, the collected data are first summarized through developing a frequency distribution table and then displayed on the graph. Finally, they are summarized using other statistical indicators.

**Analysis Method Based On Expert Judgment**

Using the judgment of experts for the data analysis, is one of the most important decision- making methods in those research that the use of their results is very important; and a possible error or high percentage of error in other methods of analysis in these studies may reduce the validity of the results. This method was used in this study in order to analyze data and research questions. This method is used to analyze the information of research questions and to use in paired comparisons (when AHP technique is used), and eventually is used to provide solutions to problems.

There are numerous suitable methods for technology transfer, but the most important of which include employing foreign researchers, reverse engineering, foreign direct investment, consortium, turnkey, and partnership (or mutual cooperation).

These methods are based on analysis of the data obtained.

**Table 2: Indicators And Dimensions Of Technology Transfer Process Used In Research**

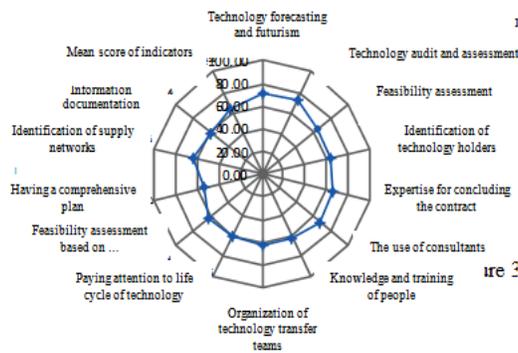
Dimensions of transfer process	Number	Indicators
Selection and acquisition	1	Imported technology forecasting and foresight
	2	Technology audits and assessment compatible with existing models (Standards)
	3	Feasibility assessments based on the objectives and strategies of the organization
	4	Systematic identification of technology holders
	5	Enough and necessary expertise in order to conclude the technology transfer contracts
	6	Enjoying consultants and research centers
	7	Sufficient knowledge and training for the people who deal with technology transfer
	8	Organization of the technology transfer teams compatible with type and method of transfer
	9	Paying attention to the survival curve of the imported technology
	10	Feasibility assessment based on the national objectives and priorities
	11	Having a comprehensive plan for technology transfer
	12	Identifying the networks of suppliers and supply chain of imported technology

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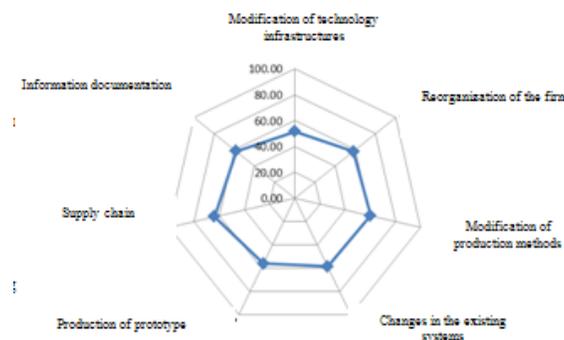
	13	Documentation of information at the end of the selection and acquisition phase
Adaptation	14	Modification of the imported technology infrastructure
	15	Organization designing and its reorganization compatible with the imported technology
	16	Modification of production methods and construction techniques compatible with the imported technology
	17	Modifications of existing systems to fit the imported technology
	18	Producing a prototype product, testing, and applying required modifications according to available resources
	19	Selection of a suppliers network with imported technology
	20	Documentation at the end of the adaptation phase
Acquisition	21	Full review of the documents delivered by the technology transferor
	22	Training the manpower receiving the technology
	23	Making reforms in the research in infrastructure
	24	Communication with and application of research organizations
	25	Using the opportunity to operationally cooperate with manpower transferring the technology
	26	Documentation at the end of the absorption phase
Application	27	Preliminary and detailed design of the workshop and factory, installation and operation of them
	28	Designing and establishment of different systems (planning and production control, warehousing, maintenance, etc.), employment and labor organization
	29	bidding and concluding contracts with contractors
	30	Identification of the technology supply market
	31	Concluding contract(s) with contractors in order to supply equipment
	32	Establishment and operation of systems designed
	33	Test operation and fixing the defects and bottlenecks
	34	Product commercialization by imported technology
	35	Documentation in the application phase
Development and Improvement	36	Continuous study of the technology survival curve in the world
	37	Examining the capability of the nation in the field of technology development
	38	Product improvement through conducting research on process improvement
	39	Developing a suitable program to improve technology
	40	Using customer feedback for the improvement purpose
	41	Innovation in designing and producing new products according to customer needs
	42	Improved product commercialization
	43	Systematic documentation of information at the end of development phase
Dissemination	44	Dissemination of technological achievements and encouraging the researchers
	45	Presentation of findings of technology to other rings of the chain
	46	Dissemination of technology information in journals, conferences and etc.
	47	Spread of imported technology through transfer between firms
	48	Transfer of imported technology to other countries
	49	Documentation of information at the end of the development phase and systematic improvement

**SUMMARY OF FINDINGS**

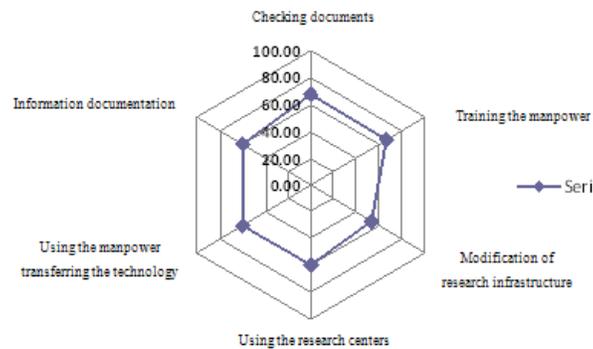
Summary of findings of the research sub-questions. Results of the indicators of the research six dimensions are shown in the figures 1 to 6.



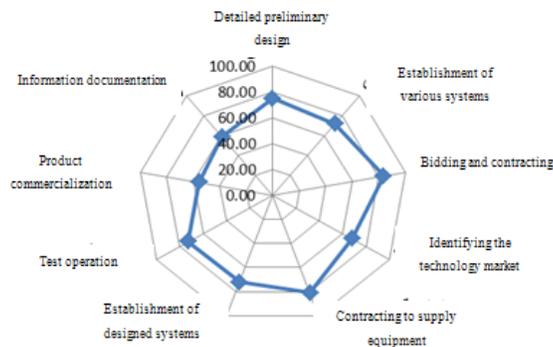
**Figure 1: Success Rate Of Indicators Of Selection And Acquisition Phase**



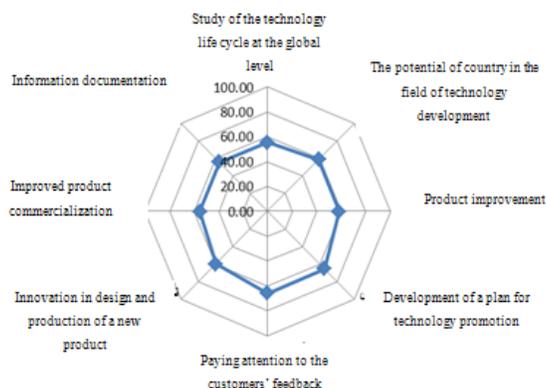
**Figure 2: Success Rate Of Indicators Of Adaptation Phase**



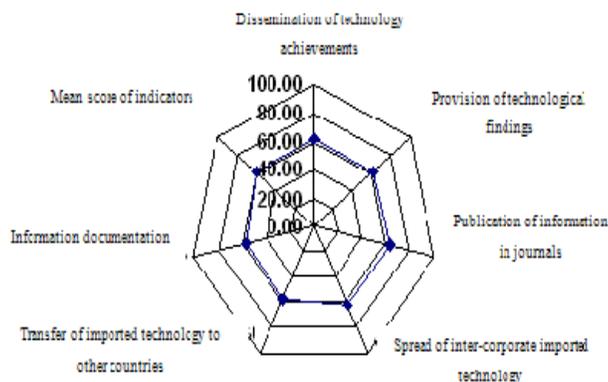
**Figure 3: The Success Rate Of Acquisition Phase**



**Figure 4: The Success Rate Of Indicators Of Application Phase**



**Figure 5: Success Rate Of The Indicators Of Development Phase**



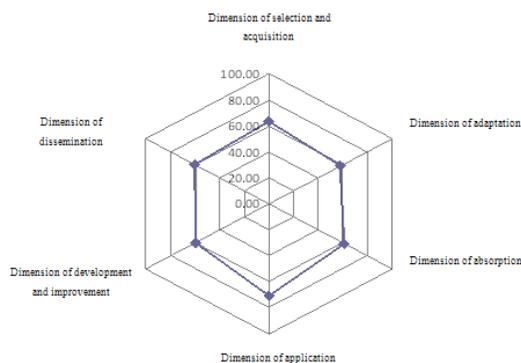
**Figure 6: Success Rate Of Indicators Of Dissemination Phase**

**Summary Of The Findings Of The Main Research Question**

**Question1** –What is the success rate of the imported technology transfer process in the technology transfer project?

**Table 3: The functionality of each of the indicators and technological 9 dimensions**

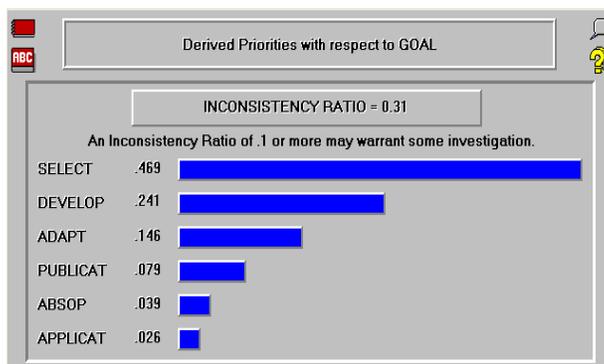
Phases of the technology transfer process	The success rate of each phase
Dimension of the selection and acquisition	63.45
Dimension of adaptation	58.04
Dimnsion of absorpction	60.93
Dimension of application	70.90
Dimension of development and improvement	59.22
Dimension of dissemination	60.51
The success rate of the technology transfer process	62.17



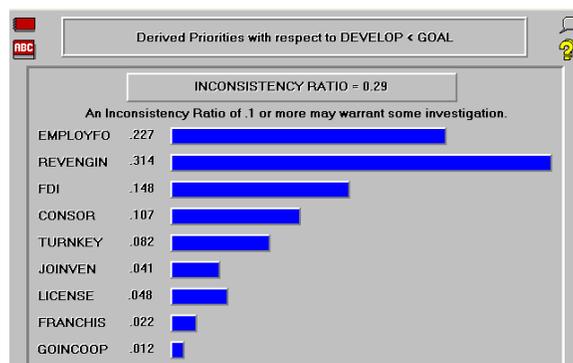
**Figure 7: Diagram Of The Success Rate Of Technology Transfer Phases**

The success rate for each phase of the process of technology transfer in NISOC and also the success rate of the whole process are shown in Table 3. With respect to the base 100, it could be stated that the average success rate of the transfer is 62.17 %.

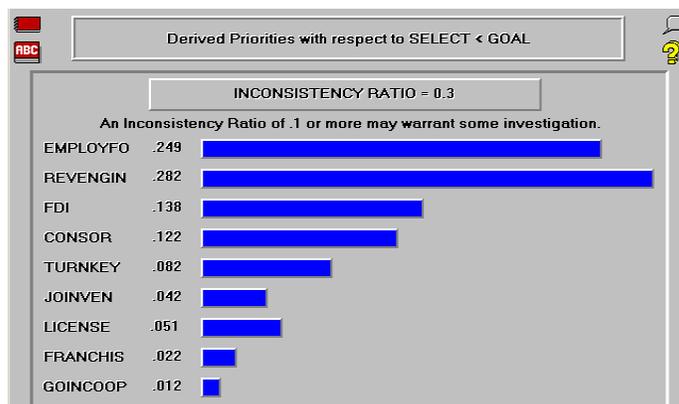
**Question2** –What are the most useful methods for technology transfer in NISOC in priority order?  
 In order to answer the second research question, multi-criteria decision making method was used while applying Analytical Hierarchy Analysis (AHA) and considering the preference of methods in different phases of the technology transfer process. The experts' opinions method was also used for weighting the paired comparison of methods. In order to perform AHP, Expert Choice was used. Figures 8 to 14 are as follows:



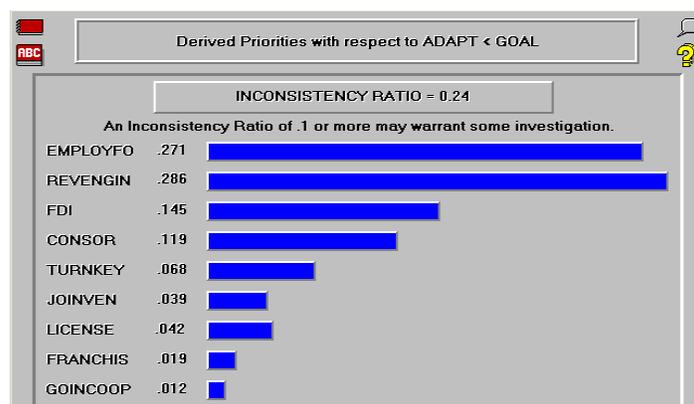
**Figure 8: Weight Percentage (Wt%) of The Phases Of Technology Transfer Relative to Each Other**



**Figure 9: Weight Percentage (Wt%) Of Different Methods of Technology Transfer With Respect To The Improvement And Development Dimension**



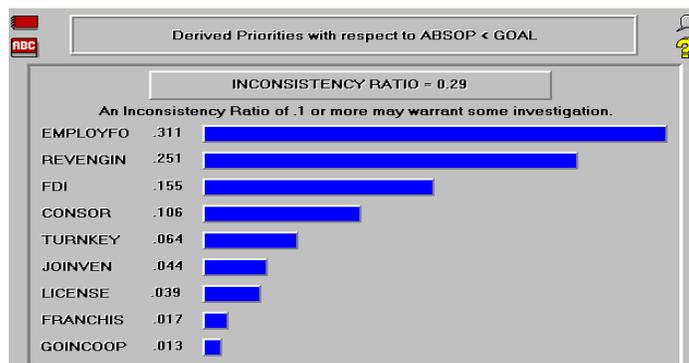
**Figure 10: Weight Percentage (Wt%) Of Different Methods Of Technology Transfer With Respect To The Selection And Acquisition Dimension**



**Figure 11: Weight Percentage (Wt%) Of Different Methods Of Technology Transfer With Respect To The Adaptation Dimension**



**Figure 12: Weight Percentage (Wt%) Of Different Methods Of Technology Transfer With Respect To The Publication Dimension**



**Figure 13: Weight Percentage (Wt%) Of Different Methods Of Technology Transfer With Respect To The Absorption Dimension**



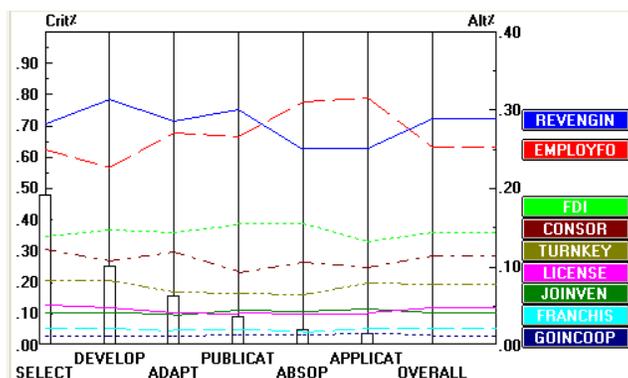
**Figure 14: Weight Percentage (Wt%) Of Different Methods Of Technology Transfer With Respect To The Application Dimension**

Figure 15 indicates the order of preference for the use of a variety of methods of technology transfer in NISOC. Also, the sensitivity analysis based on the performance, about order of preference of a variety of proper methods of technology transfer is shown in Figure 16.



**Figure 15: The Order Of Preference For The Use Of A Variety Of Methods Of Technology Transfer In NISOC**

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**Figure 16: The Sensitivity Analysis Based On The Performance About A Variety Of Proper Methods Of Technology Transfer**

**CONCLUSION**

**Results Analysis**

Analysis of secondary research questions:

Given the results obtained in the first sub- question at the selection and acquisition phase; technology audit and assessment and futurism are superior indicators. NISOC is somewhat superior to other organizations in terms of predicting the imported technologies. But this advantage can cause a challenge for the company due to the lack of a comprehensive transfer program and also failure to document the information. With a look at the opinions of experts and managers, it is found that despite the ability of foresight, this company must take major steps towards comprehensive planning for technology transfer.

Analysis of the results of the second research sub- question:

According to the results obtained in the second sub – question, the main problem in the phase of imported technology adaptation is the modification of infrastructures.

The principal policy of the imported technology adaptation requires that the variables effective in adaptation that are depending on the circumstances and the type of product are identified. Modifications can be made in product design, choice of network providers, capacity and combination of multiple alignments, machinery and equipment, as well as the composition and management of human resources and organizational structure. Due to the potential of the company, it is recommended to use human resources trained in the field of technology transfer.

Analysis of the results of the third research sub- question:

According to the results of the third research sub- question, a major problem in the absorption phase is related to the modifications in organizations' research infrastructure, as well as the relevance and application of research organizations. In this regard, NISOC should take effective steps in the field of industrial research required for the company's survival and take greater advantage of the research centers as well as operational experts who transfer the technology and treats this as an opportunity to grow and enhance their knowledge.

Analysis of the results of the research fourth sub-question:

According to the results obtained in the fourth sub-question of research, the strength of the company in the application phase is to identify the technology market and to conclude contracts with contractors for the supply of equipment. It has some problems in other cases, such as the commercialization of imported technology, planning and control, production, as well as identifying operational bottlenecks and documentation of information. In this field, it should take relevant measures to operate the imported technology.

Analysis of the results of the fifth sub-question:

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According to the results obtained in the fifth sub- question, in the development and improvement phase, the company has a comparative advantage in the field of developing a suitable program to enhance the technology and improve the use of technology in order to pave the way for the improvement of inputs from other development cases such as improved product commercialization and continuous study of technology survival curve in the world. But paying no attention to the technologies existed in the world which are often superior to the previous technologies in terms of energy consumption, time devoted and maintenance costs causes the loss of corporate assets and will also reduce the competitive advantage in the market economy. Therefore, NISOC should pay special attention to this case.

Analysis of the results of the sixth sub- question:

According to the results of the sixth sub- question, the greatest difficulty or problem in the phase of technology dissemination is the failure in the transfer of the imported technology to other countries.

Today, the technology importing countries not only benefit from imported technologies, but also they are trying to develop and transfer them to other countries. With strong support and years of experience, NISOC should try to make profit using its experience and technical knowledge. That ambition will be realized through efforts, wills and ambitions of senior managers as well as developing a detailed program.

### **Analysis Of The First Main Research Question**

According to the results, and based on the opinions of experts, the application phase has the highest score with the success rate of 70.97%, and the adaptation phase has the lowest score with the success rate of 58.04%. Figure 8 represents the score difference between application phase and adaptation with other phases.

Although none of the phases had a high level success rate except for the application phase, but due to fact that other phases had a success rate higher than 50 %, it can be said that the status of this company in this field is at the intermediate level, amenable to good. Based on systematic approach, any gap or failure in each of the phases of the process will have a negative impact on the success of the whole process. As can be seen, the application phase and the selection and acquisition phase had the greatest weight. The phase of selection is very important, because the process is based on it. Feasibility studies and technology assessment are done in this phase and the best way for technology transfer is also determined at this stage. If the success rate is low in this phase, and a right technology is not selected, technology transfer process will be practically incomplete or unsuccessful, even the other phases of the process are fully implemented. Success rate of 63.45% indicates a good background in this field, therefore, as already mentioned, with the formation of specialized teams and the use of experts and consultants; it is possible to take measures in the field of transferring an importing technology transfer with an open mind. Absorption and dissemination suggest that the in the case of proper implementation of the technology transfer process, there is the potential to localize the transferred technology for the company with development and research and take effective steps to reduce dependence on foreign countries. Also, due to the fact that the success rates of different phases are often around 60 %, it is hoped to transfer the technology properly and apply all transfer phases using the experts.

### **Analysis Of The Second Main Research Question**

After paired comparisons of the various methods of technology transfer using the Expert Choice, Figure 15 shows the priority order using a variety of methods for the technology transfer in NISOC. Reverse engineering method achieved the highest weight in many dimensions of technology transfer. Recruitment of foreign researchers gained the second weight score with a higher distance from direct investment. Then consortium, turnkey, licensing, joint venture, franchise and mutual cooperation gained the next scores, respectively. Because the majority of projects transferred to the NISOC necessarily require equipment that must be supplied from the outside, this classification is largely confirmed. Also, due to the specialized nature of the work, the weight obtained for the procedure of employing foreign researchers and its place in the second category is justifiable.

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