Study of Technology Transfer Barriers in Industry of Ceramic Production and Prioritized Barriers by AHP Case Study :(Apadana Ceram Company)

Vahid Hassanlu[1*], Mohsen mardani[2], Mahsa Alikhani[3]

[1]Faculty of Management, Islamic Azad University, North Tehran Branch, Tehran, Iran
(PhD Student in Industrial Management, Islamic Azad University, Tehran, Iran)

[2] Member of Young Researches Club, PhD Student in Industrial Management, Islamic Azad University, Tehran, Iran

[3]Faculty of Management, Islamic Azad University, Central Tehran Branch, Tehran, Iran

ABSTRACT

Ceramic industry is one of the biggest and most effective industries in the world and it has a very important role in all markets in the future. The impact of this industry in economy, policy and development of all countries in the world is considerable and distinguished from two aspects. One is the role of ceramic-related technologies in developing of the country and increasing revenue and second is the critical role of these technologies in different parts of industry such as medicine, aviation, nuclear programs, automobile industry, etc. The promotion of technology transfer to developing countries has been a recurrent issue on the international economic agenda of the past three decades .This article studies the importance of technology transfer in ceramic industry and procedures and obstacles to overcome technological barriers and developing and applying offering methods for improving current conditions. The article was based on actual case studies of successful technology transfer events and a simple model of the technology transfer.

1. INTRODUCTION

Developed countries pay more attention to create & develop technologies and plan in all levels of technology management but developing counties have to turn to technology transfer to fill their gap with developed countries, because they are themselves unable to create technology .To achieve success in this field, they have to provide necessary infrastructure and manage technology transfer precisely (Akhavan. A.N., 2000).

Managing this process is important because it helps decision makers in all aspects of technology, techno ware, info ware, human ware and organ ware, so technology transfer could give suitable ground and infrastructure to absorb and localize new technologies and spread them (Eslami Bidgoli. S., 2006).

Incorrect limited and narrow perception of technology transfer could fail and defeat the transfer and confine.Achievements to just some useless machineries, catalogs, drawings and instructions transferred. (Haj Fathali. A., 2002).

With regard to the importance of this industry and its vital role for producing different products in different fields such as: automobile industry, aviation industry, medical industry,
nuclear industry, etc achieving to high standards for establishing and implementing, can give competitive advantageous for improving HI-TECH technologies and boosting the revenue stems from producing and selling the products from above industries. According to the recent statistics, there is not

a decent condition in this industry in Iran. There are a lot of barriers that prevent from achieving these goals and this paper focuses on four scopes in techno ware, human ware, info ware and organ ware.

The central focus of this paper is on understanding how developed countries and IRAN might best cooperate in order to facilitate the transfer of ceramic technologies. In order to understand what barriers exist to the technology transfer, it is necessary to outline the centrality of knowledge transfer.

2. LITERATURE REVIEW

2.1 Conceptual issues in technology transfer

There are 2 methods for development of technology. First endogenous development using internal resources and R & D; second technology transfer using external resources from out of organization (Ghanadi.M.F.2003).

In process of time and rapid pace of change in technology, no company or country is able to get all needed technologies, so transferring it from other countries/companies is unavoidable (Flannery W.T, A. 1994).

2.2 Components and elements of technology

Technology as the effective factor of production components such as raw materials is comprised of 4 elements as techno ware, human ware, info ware and organ ware (Kondo M., 2001).

Techno ware: Techno ware includes, tools, machinery, and physical equipment. It is the center of gravity for transforming inputs to outputs and is created & used by human (Kondo M., 2001).

Human ware: The section of technology that appears in human is called human ware and is the necessary ability for production operation. This element includes individual, genius, experience, skills, science, innovation, expertise, and values of human (Kondo M., 2001).

Info ware: This is the aspect of technology that has information basis and is named incarnation technology in documents.

Human generated it to use in techno ware and includes collection of information in different types such as documents, data, information, statistics, drawings, booklets, books and magazines (Kondo M., 2001).

Organ ware: An organization that has technology as an essential framework for production activity. Organ ware consists of organizing, management, networking, marketing, absorption, utilization & technology development systems. It is the key coordinator and controller of the 3 other elements (Kondo M., 2001).

Those 4 compartments of technology, cause natural resources and mid products be transformed to consumable or capital goods and services .Without those 4 parts, transformation is not possible. This could be specified with a mathematic formula (Tabatabaian. H., 2001).

$TCC = TB_t * HB_h * IB_i * OB_o$
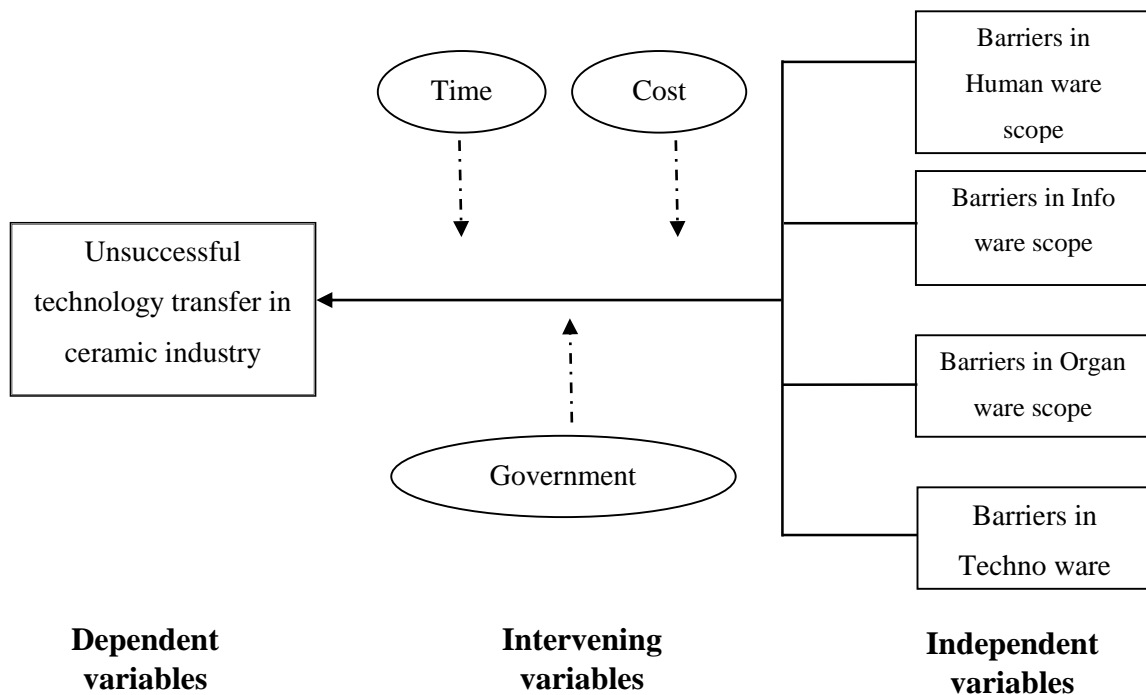T: techno ware
H: Human ware
I: Info ware
O: organ ware
TCC: technology contribution coefficient

2.2 conceptual model

The model of barriers of technology transfer is illustrated in the below figure.

Figure 1: Conceptual model of the research

| Dependent variables | Intervening variables | Independent variables |

In addition of these barriers, the cost of technology transfer, the time of doing this process, the time duration of implementation, and the government policies are influenceable factors that are mentioned as intervening factors. Barriers in each scope are identified and accumulated by ways such as study, field research, questionnaires, and interviews with experts and the results are analyzed by statistical methods.

3) Methodology and experimental research

This research is done in a society that is included of 30 of experts and managers of Apadana Sararm Corporation. Because of the low number of studied society no special sampling way is used. For gathering information, the ways studying documents, interview and questionnaire are used. The first questionnaire is comprised of 5 open questions about the barriers in technology transfer that are answered by managers and experts. The barriers that are identified are 6 barriers in human ware scope, 8 barriers in techno ware scope, 5 barriers in info ware scope, 7 barriers in organ ware scope, and four barriers in intervening variable scope. Then for determining the accuracy of these factors the second questionnaire with 30 questions are used and for quantifying these information the Likert Scale is used. In this questionnaire the items that give the score below the average are eliminated. In the third questionnaire for prioritizing these factors the Paired Comparison Analysis method is used. 30 persons are answered to the first questionnaire, 27 persons to the second analysis, and 24 persons are answered to the third questionnaire. For testing these identified factors the One Sample Test method is used and finally for determining the weight of each factor the Analytic Hierarchy Process (AHP) is used.

For determining the validity of the questionnaires, the experts' opinions are used and after modification in some questions the questionnaires are distributed between persons. The reliability of these questionnaires are tested by Cronbach's Alpha method. The results of these tests for the second questionnaire in the main scopes (Organ ware, Info ware, Techno ware, human ware) and intervening variables (Time, Cost, Government) are mentioned in the below tables:

Table 1: Cronbach's Alpha for main variables

Reliability Statistics

Cronbach's Alpha	N of Items
0.909	26

Table 2: Cronbach's Alpha for intervening variables

Reliability Statistics

Cronbach's Alpha	N of Items
0.823	**4**

Since the result of this test for both main and intervening variables are more than 0.7, the reliability of the questionnaires are approved.

3.1) the One Sample Test

After doing survey and complementation of questionnaires, the accuracy of identified factors in organ ware, info ware, human ware, techno ware scopes and intervening variables, since the number of sample is low and the standard deviation of it is indistinctive, is determined by one sample test. Because of using 5 point Likert scale, the number 3 is defined as the acceptance limit.

Hypothesis one

H0: there is no meaningful relation between human ware and failure in technology transfer.

H1: there is a meaningful relation between human ware and failure in technology transfer.

Table 3: the results of one sample test for human ware scope

One-Sample Test

	Test Value = 3					
	T	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Xh1	4.027	26	.000	.85185	.4171	1.2866
Xh2	10.071	26	.000	1.29630	1.0317	1.5609
Xh3	7.687	26	.000	1.11111	.8140	1.4082
Xh4	2.696	26	.012	.62963	.1495	1.1097
Xh5	4.328	26	.000	.77778	.4084	1.1471
Xh6	5.048	26	.000	.77778	.4611	1.0945
H	**8.976**	**5**	**.000**	**.90742**	**.6476**	**1.1673**

The results for human ware scope are approved for all these six variables.

Hypothesis two
⎧ H0: there is no meaningful relation between techno ware and failure in technology transfer.
⎨
⎩ H1: there is a meaningful relation between techno ware and failure in technology transfer.

Table 4: the results of one sample test for techno ware scope

One-Sample Test

	Test Value = 3					
	T	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Xt7	4.734	26	.000	.74074	.4191	1.0624
Xt8	.708	26	.485	.18519	-.3527	.7231
Xt9	4.163	26	.000	.66667	.3375	.9958
Xt10	1.551	26	.133	.29630	-.0965	.6891
Xt11	.515	26	.611	.11111	-.3323	.5545
Xt12	1.786	26	.086	.40741	-.0614	.8762
Xt13	2.749	26	.011	.55556	.1402	.9709
Xt14	2.508	26	.019	.40741	.0736	.7413
T	**5.342**	**7**	**.001**	**.42130**	**.2348**	**.6078**

According to the results all these eight barriers have meaningful relation with failure in technology transfer.

Hypothesis three
⎧ H0: there is no meaningful relation between info ware and failure in technology transfer
⎨
⎩ H1: there is a meaningful relation between info ware and failure in technology transfer

Table 5: the results of one sample test for info ware scope

One-Sample Test

	Test Value = 3					
	T	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Xi15	12.313	26	.000	1.62963	1.3576	1.9017

	T	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Xi16	-2.762	26	.010	-.51852	-.9044	-.1326
Xi17	.328	26	.746	.07407	-.3905	.5386
Xi18	-5.597	26	.000	-1.07407	-1.4685	-.6796
Xi19	3.092	26	.005	.55556	.1862	.9249
I	**.287**	**4**	**.788**	**.13316**	**-1.1551**	**1.4214**

According to the results three factors (Xi15, Xi17, and Xi19) are considered as barriers in technology transfer.

Hypothesis four ⌐ H0: there is no meaningful relation between organ ware and failure in technology transfer

H1: there is a meaningful relation between organ ware and failure in technology transfer

Table 6: the results of one sample test for organ ware scope

One-Sample Test

	Test Value = 3					
	T	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Xo20	9.037	26	.000	1.18519	.9156	1.4548
Xo21	5.199	26	.000	.62963	.3807	.8786
Xo22	11.171	26	.000	1.33333	1.0880	1.5787
Xo23	7.081	26	.000	1.00000	.7097	1.2903
Xo24	6.735	26	.000	1.07407	.7463	1.4019
Xo25	.157	26	.876	.03704	-.4472	.5213
Xo26	7.126	26	.000	.92593	.6588	1.1930
O	**8.996**	**12**	**.000**	**.84900**	**.6434**	**1.0546**

According to the results all these seven factors are approved.

In addition to the last four hypothesis the relation between four factors (time, cost, sanction, and government) and failure of technology transfer are examined and the accuracy of all these factors are confirmed.

Table 7: The table of mean, standard deviation and standard error mean of government.

One-Sample Statistics

	N	Mean	Std. Deviation	Std. Error Mean
G	27	3.4074	1.08342	.20850

Table 8: The table of results for one sample test of the intervening variable government

One-Sample Test

	Test Value = 3					
	T	Df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
G	1.954	26	.062	.40741	2÷-.021	.8360

Table 9: The table of results for one sample test of the intervening variable sanction

One-Sample Test

	Test Value = 3					
	T	Df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
I	12.748	26	.000	1.66667	1.3979	1.9354

Table 10: The table of results for one sample test of the intervening variable time

One-Sample Test

	Test Value = 3					
	t	Df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
T	3.547	26	.002	.70370	.2959	1.1115

Table 11: The table of results for one sample test of the intervening variable cost

One-Sample Test

	Test Value = 3					
	t	Df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
C	1.070	26	.294	.25926	-.2386	.7571

3.2) prioritizing the barriers by using the AHP method

We use the AHP method for prioritizing the barriers in each scope. For determining the weight of each of these barriers we use the paired comparison analysis method by using the formula $\frac{N(N-1)}{2}$. In each scope a questionnaire is designed for doing these comparisons and then these barriers are prioritized by AHP method.

Table 12: The paired comparison analysis matrix of human ware scope

Human ware	Xh1	Xh2	Xh3	Xh4	Xh5	Xh6
Xh1	1.00	0.38	0.50	1.65	0.25	2.07
Xh2	2.63	1.00	1.32	2.90	0.72	4.62
Xh3	2.00	0.76	1.00	1.47	0.57	2.16
Xh4	0.61	0.34	0.68	1.00	0.46	2.85
Xh5	4.00	1.35	1.75	2.17	1.00	3.30
Xh6	0.48	0.22	0.46	0.35	0.30	1.00
Add of columns	10.72	4.09	5.72	9.54	3.30	16.00

Table 13: AHP calculations of human ware scope

Human ware	Xh1	Xh2	Xh3	Xh4	Xh5	Xh6	Mean of row
Xh1	0.09	0.09	0.09	0.17	0.08	0.13	0.109

Xh2	0.25	0.24	0.23	0.30	0.22	0.29	0.255
Xh3	0.19	0.19	0.17	0.15	0.17	0.14	0.168
Xh4	0.06	0.08	0.12	0.10	0.14	0.18	0.114
Xh5	0.37	0.34	0.31	0.23	0.30	0.21	0.293
Xh6	0.05	0.05	0.08	0.04	0.09	0.06	0.062
Add of columns	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**

Table 14: Priority of barriers in human ware scope

Human ware		
1	Lack of expert and acquainted persons to product ceramics inside the country (xh5)	0.293
2	Lack of expert consultants as contracting with manufacturers (xh2)	0.255
3	Lack of expert consultants as selecting and purchasing machineries (xh3)	0.168
4	Sending unexperienced persons as expert consultants from manufacturers (xh4)	0.114
5	Lack of an expert consultants team in technology transfer (xh1)	0.109
6	Lack of skilled consultants of financial elements (xh6)	0.062

Table 15: The paired comparison analysis matrix of techno ware scope

Techno ware	Xt7	Xt8	Xt9	Xt10	Xt11	Xt12	Xt13	Xt14
Xt7	1.00	4.85	1.76	1.89	4.04	3.67	4.26	1.17
Xt8	0.21	1.00	0.27	0.29	0.83	0.63	0.35	0.19
Xt9	0.57	3.70	1.00	1.20	3.69	1.81	3.07	0.57

Xt10	0.53	3.45	0.83	1.00	2.69	2.02	1.17	0.44
Xt11	0.25	1.20	0.27	0.37	1.00	0.72	0.52	0.18
Xt12	0.27	1.59	0.55	0.50	1.39	1.00	0.59	0.32
Xt13	0.23	2.86	0.33	0.85	1.92	1.69	1.00	0.31
Xt14	0.85	5.26	1.75	2.27	5.56	3.13	3.23	1.00
Add of columns	**3.91**	**23.91**	**6.77**	**8.37**	**21.12**	**14.67**	**14.19**	**4.18**

Table 16: AHP calculations of techno ware scope

Techno ware	Xt7	Xt8	Xt9	Xt10	Xt11	Xt12	Xt13	Xt14	Mean of row
Xt7	0.26	0.20	0.26	0.23	0.19	0.25	0.30	0.28	0.25
Xt8	0.05	0.04	0.04	0.03	0.04	0.04	0.02	0.05	0.04
Xt9	0.15	0.15	0.15	0.14	0.17	0.12	0.22	0.14	0.16
Xt10	0.14	0.14	0.12	0.12	0.13	0.14	0.08	0.11	0.12
Xt11	0.06	0.05	0.04	0.04	0.05	0.05	0.04	0.04	0.05
Xt12	0.07	0.07	0.08	0.06	0.07	0.07	0.04	0.08	0.07
Xt13	0.06	0.12	0.05	0.10	0.09	0.12	0.07	0.07	0.09
Xt14	0.22	0.22	0.26	0.27	0.26	0.21	0.23	0.24	0.24
Add of columns	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**

Table 17: Priority of barriers in techno ware scope

	Techno ware	
1	Lack of proper materials in the time of starting up machineries (xt7)	0.25
2	Inconsistency of equipment because of brokers for acquiring them (xt14)	.024

3	Difficulties because of the closeness of production process to other industries (xt9)	0.16
4	Lack of spare parts and increasing the repair cost as the result (xt10)	0.12
5	Increasing maintenance cost because of increasing the time of starting up (xt13)	0.09
6	Lack of required machineries inside the country (xt12)	0.07
7	Inappropriate shipment ways of machineries (xt11)	0.05
8	Inappropriate place of factory (xt8)	0.04

Table 18: The paired comparison analysis matrix of info ware scope

Info ware	Xi15	Xi17	Xi19
Xi15	1.00	5.06	5.64
Xi17	0.20	1.00	2.07
Xi19	0.18	0.48	1.00
Add of columns	1.37	6.54	8.71

Table 19: AHP calculations of info ware scope

Info ware	Xi15	Xi17	Xi19	Mean of rows
Xi15	0.73	0.77	0.65	0.72
Xi17	0.14	0.15	0.24	0.18
Xi19	0.13	0.07	0.11	0.11
Add of columns	1.00	1.00	1.00	1.00

Table 20: Priority of barriers in info ware scope

	Info ware	
1	Lack of justification plan (xi15)	0.72
2	Sending uncompleted documents for installing machineries (xi17)	0.18
3	Sending plans and documents in contrast of the project requirements (x	0.11

Table 21: The paired comparison analysis matrix of organ ware scope

Organ ware	Xo20	Xo21	Xo22	Xo23	Xo24	Xo25	Xo26
Xo20	1.00	3.24	0.48	0.27	0.72	3.93	5.43
Xo21	0.31	1.00	1.26	2.16	6.23	2.82	3.16
Xo22	2.08	0.79	1.00	3.38	0.19	0.18	0.29
Xo23	3.70	0.46	0.29	1.00	1.09	0.69	0.27
Xo24	1.39	0.16	5.26	0.91	1.00	0.40	2.016
Xo25	0.25	0.35	5.55	1.44	2.5	1.00	0.33
Xo26	0.18	0.31	3.44	3.70	0.46	3.03	1.00
Add of columns	**8.91**	**6.31**	**17.28**	**12.86**	**12.19**	**12.05**	**12.64**

Table 22: AHP calculations of info ware scope

Organ ware	Xo20	Xo21	Xo22	Xo23	Xo24	Xo25	Xo26	Mean of rows
Xo20	0.11	0.51	0.27	0.02	0.59	0.32	0.42	0.28
Xo21	0.034	0.15	0.072	0.16	0.51	0.23	0.25	0.2
Xo22	0.23	0.125	0.057	0.26	0.015	0.014	0.022	0.103
Xo23	0.41	0.072	0.016	0.077	0.089	0.057	0.021	0.106
Xo24	0.15	0.025	0.3	0.07	0.082	0.033	0.17	0.118
Xo25	0.028	0.055	0.32	0.11	0.2	0.082	0.026	0.117
Xo26	0.02	0.049	0.19	0.28	0.037	0.25	0.079	0.129
Add of columns	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**

Table 23: Priority of barriers in organ ware scope

	Organ ware	
1	Holding meetings by managers without skilled experts (xo21)	0.2008
2	Inappropriate decision making at the right time by management (xo20)	0.2852
3	Lack of appropriate organizational relations (xo26)	0.1292
4	Unsuitable reactions by managers to changes, crises, and sanctions (xo24)	0.1185
5	Uncooperative interactions by domestic companies (xo25)	0.1172
6	Misunderstanding of technology transfer knowledge by top managers (xo23)	0.1060
7	Lack of structured program at the beginning time of the project (xo22)	0.1030

Table 24: The paired comparison analysis matrix of four scopes

Four scopes of technology transfer	H	T	I	O
H	1.00	1.68	2.85	1.43
T	0.60	1.00	1.31	0.40
I	0.35	0.76	1.00	0.39
O	0.70	2.50	2.56	1.00
Add of columns	2.65	5.94	7.72	3.22

Table 25: AHP calculations of four scopes

Four scopes of technology transfer	H	T	I	O	Mean of rows
H	0.38	0.28	0.37	0.44	0.37
T	0.23	0.17	0.17	0.12	0.17
I	0.13	0.13	0.13	0.12	0.13
O	0.26	0.42	0.33	0.31	0.33
Add of columns	1.00	1.00	1.00	1.00	1.00

Table 26: Priority of barriers in four scopes

	Four scopes of technology transfer	
1	Human ware (H)	0.37
2	Organ ware (o)	0.33
3	Techno ware (T)	0.17
4	Info ware (I)	0.13

4) Results and conclusions

This research is done by the aim of determining and prioritizing the barriers of technology transfer in industry of ceramic production. For this purpose at the first step we have accumulated data and information of 30 experts in this industry, then analyzed these inputs by statistical methods and finally prioritized these barriers by the AHP method.

According to the calculations and analysis the priority is: human ware, organ ware, techno ware, and info ware.

There are some suggestions in each scope for improving the situation:

- In human ware scope applying of expert persons to the production process that are familiarize to the technology, using of skilled consultants in financial and commercial issues, using of expert persons in technology transfer process and applying of acquainted persons to financial elements can be useful and enhance the potential of the company for doing the technology transfer process in an efficient way.

- In organ ware scope selecting competent managers, allocating good resources at the time of budgeting, constant presence of management by a skilled team of consultant can be useful for improving the organization's ability in this field.

- In techno ware scope accessing to the materials in the testing time and starting up the machineries, eliminating brokers as buying machineries, accurate estimation of required spare parts, prevent of lasting technology transfer process can be enhance the efficiency of this phase.

- In Info ware scope existing of justification plan, feasibility plan, accurate and reasonable estimation of required capital and the duration of starting up are suggested for improving the productivity of this scope.

References

1. Akhavan. A. N. (2000), Transfer of Technology, Institute of Formation & Research Industries armaments, Tehran. (In Persian), pp. 23-35.

2. Eslami. S. R. (2001), Transfer International of Technology & its role in the Industrial development of OCDE, Report IMI, Tehran. (In Persian).pp.14-19.

3. Flannery W.T, A. (1994) Heuristic model of the technology transfer process in federal laboratories, technology management, No 1, pp. 94-100.

4. Eslami Bidgoli. S. (2006), Case Study: Process of Recycle bulbs, fluorescent, Report IMI, Tehran. (In Persian). Pp.7-9.

5. Haj Fathali. A. (2002), Development Technology, Evaluation Concepts & Process of Decision, University of Allameh Tabatabaei, Tehran. (In Persian).pp.5-9.

6. Ghanadi.M.F. (2003), Selection of Suitable solar Technology for Production electrical Energy, Report of Energy Center Research,Tehran.(in Persian).pp.2-3.

7. Kondo M,. (2001) Networking for technology acquisition and transfer; forum on management of technology, Vienna, Austria, pp.2-5

8. Tabatabaian. H. (2001), Transfer Technology require Approach total, Office Collaboration Technology, Tehran. (In Persian). Pp.7-12