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Presenting a Suitable Model for Technology Transfer Process in the National Iranian Oil Industry

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Abstract *In this research after reviewing research literature and analysis of different models in order to transfer technology the phase-gate model was selected that is a process including different gates and phases. Based on this model, the interview framework was prepared for approving model and required date were collected using study of documents and semi-structured interview. After performing interviews and collecting data In this stage, it was determined that in the petroleum industry the phase-gate model is a process including 6 decision making phases and gates in three studied technology transfer projects. Research findings showed that analysis of technology transfer process projects in three studied cases as sample can be suitable solution in order to help managers in study of technology transfer process damages especially in the beginning and planning stage.*

Key words Technology transfer, phase-gate model, national industry of petroleum

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1. Introduction

Investing in the development of modern technologies has been identified from previous years by people like Jozef and Shompter and Robert Salo as drive motor of economic growth. By the present time, different models have been discussed in order to transfer technology and some of them are tested and implemented in some industries and industry areas that each are applied proportional to tested environment and the intended industry properties. Leonard Barten believes that technology transfer activity between two countries is flow of technology capabilities and believes that such activities provide modern knowledge and then customer's satisfaction is provided (Muhamed *et al*., 2012). Time is saved and finally customer's need is supplied (Sodhi, 2007). Many companies sustained a defeat due to presentation of suitable model for technology transfer in correct planning, lack of suitable support team and lack of evaluation process and correct prediction in transfer process.

Many companies cannot accomplish transfer process due to lack of careful planning, lack of appropriate supportive team and lack of assessment and prediction process. Study of many technology transfer projects in different industries showed that in many projects the technology transfer has been considered only as purchase project from foreign party and many important activities associated with technology transfer have not been considered during this process. Many studies conducted by scholars suggest that technology transfer is effective when internal factors related to will, suitable planning, presence of infrastructures required to technology transfer and external factors related to tendency of external technology investors and owners to invest in technology are observed (Robert and Berry,2001, Wong et al 2003., ,2004 and Phal,Cohen , Choi and Lee, Cheisa,.1994,Moo,1998.).

Different models are presented in order to technology transfer such as below cases: Robert & Berry, 1985, Afuah, 1988, Ford 1988, Model of Gilbert 1998. That each is investigated as summary.

Chiesa model: this pattern is composed from two phases. In the first phase, decision making is done between internal development, cooperation and technology purchase using a certain and standard table. High number of stars in this table indicates favorability of the intended method. For example, learning in cooperation is more than learning in the internal development and more than learning in the technology purchase (Panahi *et al.*2008).

Table 1. Phases of Chiesa's model

Acquisition methods			Factors
Purchase	Cooperation	Internal development	
★★★	★★	★	Time necessary for development
★	★★	★★★	proprietary rate of technology
★	★★★	★★	Learning
Variable	★★	★	Development cost
★★★	★★	★	Technical risk and familiarity with technology

If the result of the first phase is cooperation, Chiesa starts the second phase. In this phase, cooperation is analyzed in terms of three factor classes of cooperation purposes, cooperation content and typology of partners present in the analysis process and Chiesa provides requirements of cooperation success regarding state of each. So, each factor dictates some requirements. Then he studies each factor with regard to seven criteria including: effect on company resources, time horizon, controlling activities and resources, controlling results, risks, time and cost of starting cooperation and regression. Chiesa presented 13 cooperation methods in this pattern and finally these 13 methods are divided into 4 general classes in terms of mode of cooperation. *A-ownership:* one big institution completely possesses a little institution in order to achieve special and unique technology. *B-common investment:* two institutions share their resources by maintaining same or different share and a third institution is established with a determined aim formally**.** *C-Unity*: one institution shares its different resources with other institutions to achieve a common aim**.** *D-Outsourcing:* one company performs its technology activity through other companies and finally uses its output. Difference in these 4 classes of unity is in shared resources, resources ownership, management of common activities and how to use results of activities.

Robert & Berry: This model is not only associated to selection of the suitable methods to transfer technology but attends general methods of achieving technology including endogenous development. In this model, different strategies of obtaining technology in order to starting a modern technology are studied. Amount of familiarity of company with market on one hand and familiarity with technology on the other hand are two main factors for decision making bout the suitable method of achieving technology that is considered as a base in this model. These two factors are classified as:

There is fully identified base technology in the company (Abedini, 1997).

Fully identified base Market is the current market of the company.

Modern and identified technology: Technology has not previously existed in the company but there was awareness about it.

Unknown and modern technology: technology has not existed previously and is unknown.

Modern and unknown market: there has not been a market for technology product by the present time and should be created by the company or market should be previously existed but there is not enough information about it in the company.

Ford's Model: like two other models, general methods of technology acquisition are attended in this model. Factors which are attended in this model for decision making about the suitable method of achieving technology are: relative ability of organization in the intended technology, necessity of rapid achieving to the intended technology, necessity of technology ownership inside the organization, technology position in the life cycle curve, effect of the strategic competition of technology and in fact the method proposed by this model is a combination of the technology transfer methods and development (Mirzaei, 2010).

Gilbert's Model: The technology transfer methods are divided into 4 classes:

A) Inactive Methods: methods are included in this class in which receiver obtains the intended technology as inactive under special condition like *turnkey* method.

B) Cooperation methods: methods are included in this class in which technology transferee and transferor play active role like providing common business unit

C) Anti-competition methods: this class includes methods that required technology is acquired with the satisfaction of technology owner like industrial espionage or adverse engineering.

D) General methods: required knowledge or skill is obtained through participating in training periods or seminars and training periods, visiting expeditions etc.

Two main factors of tendency and ability of technology receiver that supplying requirements of technology owner and control of technology owner on mode of using technology by the receiver have fundamental role in selection of the above methods (Saghari, 2011).

The most suitable model in the technology transfer process: As mentioned, one of the most important barriers in the decision making process about selection of the technology transfer projects is lack of a suitable model that can satisfies the used condition. In this section, it is tried to discuss properties of the above model using a modern pattern in order to achieve the used model in the research text.

Reasons of selecting model

Holistic in regarding different stages of technology transfer process: since technology development planning depends economic development planning system and in fact is considered as one of the its subsections so it is necessary to make decision in this area based on needs of national economy development program. For this purpose, observing below remarks is of fundamental terms of maintain relation and continuity of technology development with requirements of economic development.

A) Technology planning is in line with supplying national development planning purposes.

B) Although military technology transfer development planning system depends national development is planning but in terms of observing synergy properties of technology development planning, above plans is attributed as cooperation axle of large plans of national development.

C) Set of technologies required by each economic section is determined based on priorities of section so that supply method of each is determined.

D) Although in the phase of determining technology needs each economic section proposes its needs based on a certain perspective, but selection is performed based on national perspectives in the phase of selecting technology transfer phase Nonaka,2004) Aside from necessity of attending macroeconomic policies of country in making decision about selection of technology transfer projects , the main variables of decision making should include four main principles of technology transfer process and finally it should include the related decision making criteria based on different phases of transfer from identification of needs to the phase of absorbed technologies development(Linsu,1998).

- Recognition of technology nature: In selecting the suitable model for the technology transfer process , a model should be used that has enough recognition from the technology transfer nature that this subject connects the mentioned model to technology life models and models of technology type (Fagerberg and Godinho, 2005). In the discussion of technology life, object is maturity amount and its acceptance level in the global markets and although technology maturity and market approach are two different categories, acceptance condition of one product in market also depends to the purchase power of consumer in addition to the minimum acceptable price of good and no product and production method cannot be present in the market without observing t above condition and the reason is that increasing development of relationships and gradual removal custom tariffs of in countries. So it is observed that economic utilization from technology specially depends modern technologies, innovation, operating speed to making results economic and finally selection of technology family. Also the mentioned model should attend applicant's need and technology suppliers (Lambe and Spekman, 1997). In effective methods without direct referring to the companies that deliver technology, it is tried to transfer technology by the recognition of specialist in the attended area and performing the suitable management. This decreases technology costs significantly. So it should be tried maintain legal benefits of supplier in each project in the form of trade-production contract so that transferee obtains more readiness for technology transfer and

quality of common product or service should be found relied on full training of transferee. Observing this strategy in the model to change technology transfer contract to common economic cooperation contract is an effective action in decreasing transfer costs and the main factor in the recognition of the suitable supplier of the technology (Jagoda *et al.*, 2008). Of other properties of the better selected model is that it should be valid in performing significant comparison of technology transfer projects. One of the important difficulties in decision making of transfer projects is significant comparison of projects. Projects that often have different condition and even different nature. Project necessity and its importance is determined based on policies and programs of the applicant country institution and its practicality is realized after assuring that all main principles of the process are present (Kumar *et al*.,2007).

- Ability to use qualitative variables: Usually the most important factor of decision making models inefficiency is conformity to the real condition resulted from conversion of qualitative variable to quantitative ones. In order to solve problem, it is necessary to use linguistics variables to decrease negative effects of conversion of qualitative variable to quantitative ones using the fuzzy logic and improve quality of above variables interaction. As was mentioned, one of the main reasons of lack of success of the technology transfer projects is lack of realism that possibility of performing project. So if feasibility distributions are used to convert qualitative variables, higher confidence coefficient is obtained) Cooper, 2008).

A flexible model in conformity with the real technical and economic condition of country: Undoubtedly, model flexibility in conformity with the real condition of decision making environment is unavoidable that two min policies are regarded to facilitate it: First, fuzzy feasibility component should be attended as possible as in using qualitative variables to remove usual shortage of projects feasibility studies and second in order to assure the correct function of model, model should be tested in case studies. About the mentioned model, this action has been performed in Canada and positive results are presented and finally model conformity with the real condition is provided for the attended organization in a reciprocating process (Huot and Carrington, 2006). So decision making model in the technology transfer process should have a multiple-stage structure so that necessary validity in performing comparisons is provided. With regard to the mentioned contents about favorable properties of the mentioned model and the studied industry namely Iranian Oil Industry, the phase-gate model is selected due to the most conformity with the discussed condition and properties. With regard to above subjects, one comprehensive model is necessary to analyze and study technology transfer in different industries. The phase-gate model is one of the modern models in the technology transfer processes that are used for the first time by Jagouda *et al.* in 2005 and recently in industry of the Canada. Results indicate that technology transfer projects are not effective unless they provide institution growth. Author states that the technology transfer process should be only regarded as content of marketing strategies content and not as isolating from technology projects (Jagoda and Ramanathan, 2005).

2. Methodology of research

In this research 3 studied cases were used to present the technology transfer (TT) experience in national Iranian petroleum industry. According to Jagoda study (2010) the case study strategy is very effective when research involves why and how questions. Case studies have gained considerable acceptance in business research over the recent years, particularly as a selection method to examine some phenomena in real life settings.

This research considered transfer of 3 technologies namely drilling rig between Baker Company and electric utility company, Demercaptanization or DMP process between VIINUS Company and petroleum industry research institute and reservoir studies technology between Statoil and research institute. They were selected because they were close to study time, were presenting new technology process in oil products and pieces, and were presenting high quality products and observing environmental considerations and also importance of the transferred technologies. The first technology transfer project was started since 1993 and domestic party stated that it enter into a contract if manufacturing process is performed inside. The contract was canceled due to sanctions imposed by America after 12 years of cooperation. Then they continued their activity for some years by providing an internal consortium agreement but the agreement was canceled again due to lack of enough equipment and new technology.

Some next years an agreement was signed with French and it was canceled because sanctions were imposed and foreign party did not obligate to supply equipment's and now it is prorogated. The second project was started in 2001 and finished in 2012. The third project was started since 2001and was completed successfully in 2004. The transfer of intended technologies provides ability for domestic party to manufacture and use that technology for a while after completion of transfer. This research was performed by 12 persons of the national oil industry managers in cooperation with researchers in a 9 months period and type of this quantitative research was applied.

The mentioned companies, that their activity axle is oil and gas products, are famous from expert's perspective for having regulated policies and new and top management methods. In this project we focused on TT performed by these technologies and analyze it by Stage-gate model.3 projects of drilling rig between Baker company and electric utility company, Demercaptanization or DMP process between VIINUS company and oil industry research institute and reservoir studies technology between Statoil and research institute were selected to perform this research because they are close to the time of study, present high quality products and observe environmental considerations, present new technology process in oil products and also these transferred technologies are important. The mentioned projects provide a comprehensive insight into advantages and disadvantages of the TT process. To gather information documents of the projects and semi structured interview with top managers involved in projects were considered.

Stage-gate approach was used to develop the search and conduct interview subjects in order to perform information collection process. These interviews were conducted for 45 minutes up to 2 hours during research. Three selected projects are very similar to each other functionally and are included in medium- sized companies group. According to oil technology transfer companies in developing countries like Iran the production of these companies reach to 10 million dollar annually and are referred as the biggest and most developed companies in country. One of the most important factors in conducting qualitative interview is flexibility.

Regarding that aim of this research is to present a comprehensive model in order to study projects in the technology transfer, method of qualitative research is to explain identification of cases available in stages and gates of the selected model. Also in order to ranking phases and gates of model in three intended cases, results obtained from interview were used. In result using inferential statistics is not necessary and descriptive statistics is used. Results obtained from interviews and study and conformity of studied models and phase-gate model created the below analytical structure of the below model:

Identification of the analytic Stage-gate model

This model has been used successfully to plan the development of new products in big industries. Stage-gate system is a management tool to develop the new product that is proposed by Cooper in late 1980 decade (Cooper, 2008). This model was currently used in management processes of new products development some years after being presented by Cooper. Jagoda and Ramantan presented a conceptual model for technology transfer management in order to develop the systematic achievement (Ramanatan and Jagod, 2005, Jagoda *et al*., 2010). Although the stage-gate process has been initially presented to develop the new product and it can be claimed that it is the best method in this area.

This method can be also used as a structured decision making tool in each investment and research project that observes all attitudes of the beneficiaries. This model is a practical framework composed of six stages and gates. Each stage or phase consists of a set of prescribed activities and duties and a technology transfer team is undertaken to gather, integrate and analyze the information. In each gate the go, kill, recycle or hold decisions are taken. The decisions may go back activities in order to be performed again or advance them to the next stage. This model allows organization to minimize the risk of their failure in technology transfer process. To use this model readily in the technology transfer projects, the model template is divided into three stages: start, planning and implementation. These stages are divided into three sectors in each stage based on key factors of the management team. The intended model has been shown schematically in figure 1 and then the mentioned cases in stages and gates are explained.

With regard to obtained information from interviews, it was concluded that model for three intended projects includes three general stages and 4 phases and gates that are presented in detail:

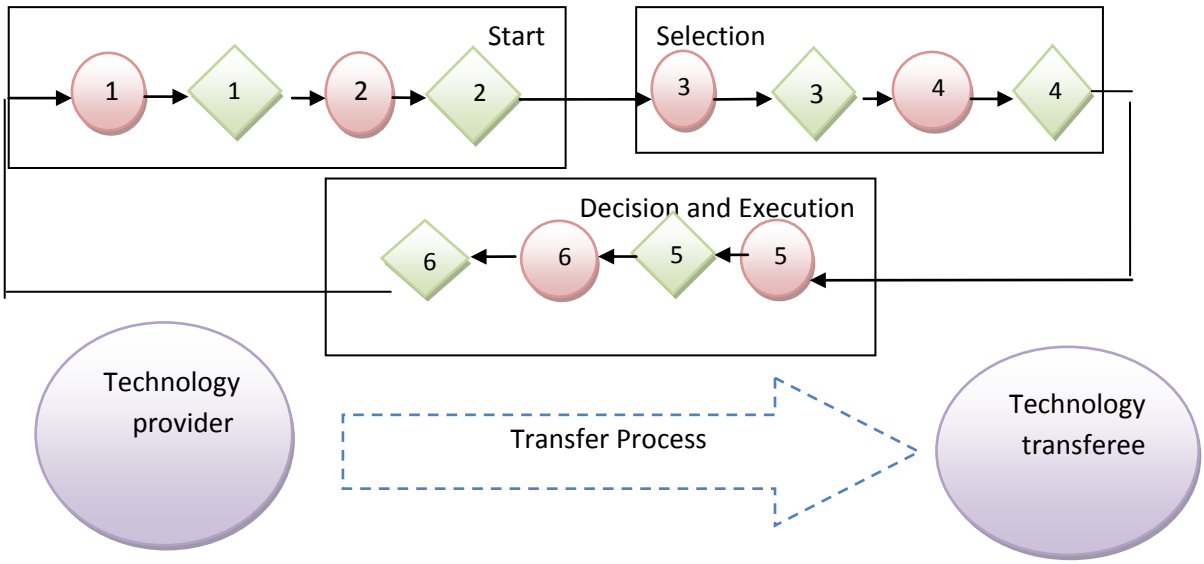

Figure 1. Phase-gate Model

Table 1-2. Summary of the stages and gates of the stage-gate model

Start stage	Planning stage	Implementation and assessment Stage
Stage1: opportunities spotting and identifying value enhancing technologies	Stage 3: Negotiation	Stage 5: Implementing technology transfer
Gate1: Confirmation of the identified technology	Gate 3: Finalizing and approving agreements	Gate 5: Implementation audit
Stage 2: Focused technology search	Stage 4: preparing of technology transfer project implementation plan	Stage 6: Assessment of technology transfer impact
Gate2: Confirmation of project	Gate 4: Approving implementation plan	Gate 6: Developing guidelines for post-technology transfer activities

The first stage (opportunity spotting and identifying value enhancing technologies): This stage is the starting point in each technology transfer project. In this stage the project team that in present research is a group of the technology transfer projects experts in petroleum industry evaluate the market tendency and direct it toward customer preferences and expectations, technological and economic feasibility or cost analysis, competitors preferences and government regulation in order to detect the potential technologies.

Gate 1 (confirmation of the identified technology): In this gate a top manager team evaluates the proposed proposal based on organization strategies and operational criteria. Also the financial feasibility of the proposal is evaluated in order to evaluation tools of the project.

Second stage (focused technology search): The strategic fitness, market attractiveness and technological leadership is considered. This study also includes technology specifications, financial costs of the project, project planning and business study.

Second gate (project confirmation): this gate is critical. An initial list of the technology providers is identified and determined based on technology strategy of the institute. The top managers stop project to return it back to the second stage if they were not satisfied about business examples. If they make a Go-decision the technology transfer committee is changed to a full technology transfer project team.

Third Stage (Negotiations): This stage is started when negotiations with the shortlisted suppliers is started. This process may continue until they reach agreement on issues related to payments while financial benefit of two parties is preserved. The competitive level of a project, business requirements and transparence of the purposes are considered. To manage the process better two transfer parties should be in frequent contact and communication.

Third gate (finalizing and approving agreements): This stage is completed once negotiations have reached a satisfactory level and details and terms of the agreement are approved by parties. Technology transfer team and top managers evaluate the comprehensives of the transfer agreement details, the appropriateness of the proposed mechanisms, and affordability of the payment amounts and time frames. If revisions are needed the project may have to go back to third stage.

Fourth stage: (preparing technology transfer project implementation plan): some purposes are determined for activities based on amount of access to customer and quality of the assessment system. Technology transfer steering team and transferor present the initial technology transfer plan.

Fourth gate (approving implementation plan): top managers' team and steering committee evaluate feasibility of the technology transfer implementation schedule and efficiency and adequacy of training. This review is conducted by results obtained from transferor. The technology transferee should be very careful and pay special attention in this stage since very irrecoverable difficulties will be developed in implementation stage if this stage is passed incomplete. Some or all activities exited from the stage 4 will be again returned back to the same stage to be implemented again or refined if requests of the top managers are not satisfied by technology transfer steering committee or results are not consistent with the standards. Also initial payment to transferor is performed in this gate.

Stage 5 (implementing technology transfer process): Technology transfer process implementation needs suitable and good project management. In case training is required the information transfer procedure should be immediately performed. Also it is necessary to consider the time those material, parts and services are provided to ensure the implementation of the intended programs.

Gate 5 (implementation audit): This stage is focused on gaining an understanding of barriers that prevent successful technology transfer. The top managers may develop an internal or external audit committee to gather reports related to presented trainings. This report may be focused on experience of implementation with critical factors like necessity of the presentation for both technology transferor and transferee, antonym experiences, preservation of the time frame integrity, cost imposition, training area and skill upgrading, produced information and information effectiveness.

Stage 6 (Technology transfer impact assessment): Evaluation of technology transfer projects is difficult since it is a complex process with multiple outcomes that could be emerged across the life of a project. Also it is very difficult to evaluate marginal profit of the technology transfer project. The enough precautions should be taken to evaluate the technology transfer projects effects from financial, technological, market and organizational using balanced score card.

Gate 6 (developing guidelines for post-technology transfer activities): The important decisions are made in this stage. In this stage the decision is taken whether to continue the use of available technology by improving profitability or try another technology transfer process. In this condition some guidelines are presented by top management to accelerate the future activities of the technology transfer by giving consultation to the technology transfer steering committee. These activities may include new technology transfer project, development of technology through internal research and development or applying a combination of both in partnership with technology transferor.

3. Discussion and conclusion

Step-threshold model was used in present study offered by Jagoda and Ramanatan in 2003 and 2005 to investigate the experience of technology transfer in oil national industry in this report. Based on Step-threshold model the key issues affecting on the success and failure of technology transfer in any step were determined. Technology transfer process as used by Jagoda and Ramanatan was investigated in all three projects ad in two steps. Companies which were parties to the contract and engaged in industrial affairs for more than two decades could identify the proper technology. The key issues related to allocated operations at the first steps of this model can be enumerated as follows:

1. Technology has not been identified as the first priority in oil industry, the development pattern for development in Iran oil industry has been based on exploitation and operation. Presence of this pattern was due to formational basics of oil industry in Iran and also the intense dependency of our country to oil industry. All managers (those who were interviewed) have emphasizes on this point as one of the main reasons for not developing of the technology in oil industry.

2. Internal provision industries are not able to attract transferred foreign technologies to oil industry. This problem was arisen due to lack of industrial substructures in internal industries and more important than that lack of effective communication between government and research and university centers and industry.

3. Intimate communication and continuous relationship among high ranking managers helps in better performance process of technology transfer team in the first step.

4. Intimate communication and continuous relationship among high ranking managers can cause sharing the information in different aspects. The experienced team members could identify and assess the outreach sources and fill the vacancy in the second step.

Having information and experiences in other technology transfer techniques and local market information and customers 'needs which are mainly from China, Korea and India help the receiver of the transfer to identify its required technology.

5. The above mentioned companies did not present a complete picture in the first step. Capital investment was done due to interest of internal party managers and authorities to obtain the technology as soon as possible and more market share and equally more interest which was not questioned and this hypothesis was replaced that new technology can produce new products with higher quality and thus initial costs are covered by more selling and many expenses were borne by internal party.

Comparing with the initial activities, planning step has been done with some weaknesses in abovementioned companies. Negotiations were made only on the prices and other key factors were ignored. Project team tried to accelerate transfer process and reach to implementation step. As mentioned in the model transfer process does not finish here and must undergo implementation and assessment steps as well. Regarding the obtained results from investigating three projects, following key issues were noted:

The results show that the receiver of technology transfer has not performed any intended evaluations in any of the projects regarding the effect of technology transfer in six steps. Evaluation of the effect of technology transfer must be assessed considering such cases as efficiency, privilege, upgraded skill and customer satisfaction so that we can benefit from its results for following technology transfer projects.

The receiver of technology transfer is not able to reach to its technological objectives in the sixth step which is due to installing and functioning of the machines in the fifth step in which investigation was not done properly and objectives were not tuned with the intended objectives.

Identifying the properties and dimensions of the selected project has been done successfully in most of the cases but the weakness is that there are no special standards and methods to perform the process of acquisition in the oil industry for example some of the projects confronted with problems in terms of contractual and legal processes with foreign party. In most of the projects all technology transfer acquisition routes were not considered perhaps due to lack of experience and insufficient familiarity with all technology transfer acquisition routes and lack of assessing other routes on the part of internal party. For this reason there are no indices to assess different routes in oil industry. In those projects done outside oil industry research center there is no indices for the involved individuals in technology transfer acquisition process including technology managers.

Step model: threshold creates a proper and ideal framework to plan and manage technology transfer projects. If the managers and programmers of technology transfer project follow the step model of threshold and perform the offered activities can reduce the obstacles to technology transfer to minimum and wherever possible the supporting equipment can prevent from existing problems. The above case study has provided remarkable and worthy viewpoints to promote technology transfer in oil industry which is covered by Iran national oil company. The factors for failures provide two critical points: first there is a critical need for programmers of technology transfer projects to develop sufficient skill to analyze technology regarding business and consequently market and customer expectation. Second when technology arrives to a new market there is a need for simultaneous attempts to develop the market to support technological attempts. A technology transfer project is not regarded as successful unless it is fruitful for the company and enhances its interest and causes the development of the company. In today business technology transfer is regarded as a combination of business and it is not just as a mere technology project.

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