

Technology Transfer from University to Industry in Iran

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Abstract

This research focuses on the process of technology transfer from universities, as inventors of technologies, to companies, as users of them. It examines the mechanisms of technology transfer, the methods of establishing contact, incentives and barriers to technology transfer, the criteria used for evaluating the success of technology transfer, and the role of intermediary organizations. Additionally, company size is considered as it affects barriers and incentives for technology transfer and the criteria for evaluating success. The information obtained from 15 firms and 3 intermediary organizations in Iran indicate that, in addition to the initiatives taken by professors or companies to contact each other, intermediary organizations (including consortia and internship centers) and university units (including the liaison office and research centers) facilitate these contacts. From the perspective of companies, the major incentive for companies in transferring technology from universities was improving product quality. The ignorance of faculty members in understanding practical problems and the real world situation was a major barrier in the process of transferring technology. Some barriers and incentives were also found to be specific to the size of companies. Finally, gaining competitive advantage over competitors was the most important criterion that was used by companies to measure the success of transfer. This study produced a number of recommendations that will improve the technology transfer process.

Key words: University, Industry, Technology Transfer, Iran

1. Introduction

The relationship between university and industry has a long history, especially in developed countries. The increase in industrial competitiveness among countries at the end of the 19th century led to the creation of technical universities that were related to industrial needs. The main goals of these universities were to train the workforce, create situations for collaboration between university and industries, increase the level of education, and improve the local and national economy (Halsey, 1995; Mortazavi, 2002).

Most of the research in technology transfer deals with the transfer of technology from developed to developing countries. Some work has been done in exploring the processes of transfer of technology from university to industry. This work is, however, mainly focused on developed countries and almost non-existent in developing countries, especially in Middle Eastern countries. In this region, Iran is making fast progress in improving its university system and developing its technology.

In the last decade in Iran¹, efforts have been made to bring universities and industries together. This is evidenced by the emergence of intermediary organizations, such as liaison offices, research parks, and spin-off organizations. Also, the government supports initiatives by the Ministry of Science, Research, and Technology to organize conferences to bring together university professors and industry experts. Universities have a strong potential for research, innovation, and internal development, but they do not understand fully how to use this

¹ Historically, the first university with the new structure was established about 150 years ago, called “*Darolfonon*”. This university was involved in the fields of medicine, engineering, and military. Also it tried to establish contact with practical and industrial situations. Later, other similar universities were created. However, the lack of knowledge about the real needs of society caused a gap between university and industry (Qhasemzadeh, 1993).

potential and implement this ability. Additionally, industry has the perception that universities deal more with theories and do not understand practical problems.

The goal of technology transfer from university to industry, a collaborative process, is to benefit both the recipient company and the university (Daghfous and Hottenstein, 1997). Although to find this benefit still is one of the main issues in this collaboration (e.g. see: Swamidass and Vulasa 2009). There is no widely accepted definition of technology transfer. However, technology transfer usually consists of sharing knowledge between entities, such as university, industry, government, laboratories, or an intermediary third party. The various forms of technology include software, hardware, knowledge resting in people's minds, and written documents (Gerwin *et al.*, 1992). For the purpose of this study, we define technology transfer as a process by which the new knowledge moves from a university to a recipient organization. Only technology in the form of software and hardware will be considered for this study, as tracing the technology in people's mind and written documents present varying levels of difficulty.

This study considers the Iranian industry's perspective of the technology transfer process from university to industry. From a developing country perspective, very little is known about the technology transfer process, especially the mechanisms, barriers, and incentives of this process. The study will help to improve the understanding of the current process of technology transfer, while concentrating on the incentives and barriers to transferring technology from universities. The results and recommendations of the study will help universities and companies to improve the technology transfer process.

2. Methodology

This study is based on the sample collected from 15 companies and 3 intermediary organizations. The sample was collected from the city of Khorasan-e-Razavi and nearby areas. Khorasan-e-Razavi is a very important industrial region in Iran where most of the country's goods in the fields of food and car parts are manufactured. Companies located in this region are doing the majority of technology transfer relative to other provinces and can be considered as representative of Iranian companies. Two criteria were used to select the companies: i) companies that have transferred or at least tried to transfer the technology from university and ii) companies that have Iranian ownership.

Because of the lack of any one source containing the list of companies, information was obtained from four different sources: the university-society relations office, the internship office, industrial liaison offices, and the Ministry of Industries and Mines in Khorasan-e-Razavi. Based on these sources, 50 companies were listed. From this list, 30 Iranian-owned companies were selected. As a first step, the companies were contacted by telephone. The purpose and scope of research were explained and the confidentiality of answers was stressed. Of the 30 companies, 15 companies agreed to participate in this study and 15 did not participate. Five companies refused because of security reasons, four because of lack of time, three were not interested, and three showed an inability to answer questions. Companies were asked to identify a knowledgeable representative who was involved in the process of transferring technology and could serve as a contact person. These respondents were manufacturing directors, R&D managers, and, in two cases, company presidents. A detailed profile of the companies is given below:

2.1 Company Profiles

All companies in the study are Iranian owned and parent companies. Five companies in the sample were small with less than 100 employees, six companies were medium-sized with the number of employees ranging between 100 and 500, and four companies were large with more than 500 employees. Forty percent of these companies are less than 15 years old, 40 percent are between 15 and 30 years old, and 20 percent are more than 30 years old. Transfer took place at different stages of technology development. Of the 15 projects, seven took place at the research stage, five at the development stage, and three at the product stage. Information was also obtained on the technology that was transferred. As shown in Table 1, five of the technologies were in the field of hardware, and ten technologies were software related. The table gives further details about the age of the company, the number of employees, and the name of the technology.

Table 1- Company's age, size and the technology transferred

Small

Company	Technology	Age (numbers of years)	Number of Employees
1	Pressure Testing Technology	5	13
2	Technology to analyze the tension in steering axle	8	35
3	Software to examine the parameters that affect product planning	8	25
4	Technology for estimating the existence of oil inside the cylinder	6	48
5	Technology to analyze the temperature of formers	10	90

Medium

6	Technology for processing of steel metallographic image	16	260
7	System for data acquisition and analysis	10	180
8	Battery weld Diagnostics	18	230
9	Technology for minimizing the mold temperature	19	240
10	Product packaging	20	140
11	Design and producing car's cylinder (in metallurgy area)	23	450

Large

12	Software to analyze the dynamic forces on propeller shaft	15	800
13	Simulation modelling for producing car axle	30	1400
14	Fatigue measuring technology	38	1200
15	3D analysis of the tolerances technology	40	1800

This study also considers the role of intermediary organizations during the process of technology transfer. These organizations act as brokers between companies that have problems and attempt to find solutions from professors with new ideas. Three intermediary organizations agreed to participate in the study.

Both quantitative and qualitative data on the technology transfer projects were collected through a combination of personal interviews and a self-completed questionnaire. Two questionnaires were designed: the first was designed for companies, and the second, designed for intermediary organizations, was a modified version of the one for companies. The questionnaires were written first in English and then translated into Farsi.

To ensure accuracy in the questionnaire, three professionals who were familiar with the level of knowledge and vocabulary used in Iranian companies were consulted. Based on their recommendations, the Farsi translation of the questionnaires was slightly modified. For instance, there was no straight translation of the word commercialization. After describing the meaning of this word, an equivalent word used in Iranian industry was found. In order to check and improve the accuracy of the translation, the questionnaire was then translated back into English and any discrepancies were verified and corrected. The questionnaires were distributed in both languages to give respondents the option of using the language with which they were most comfortable.

Before arranging interviews with the respondents, the survey questionnaire was sent to companies and intermediary organizations by mail or fax. The purpose, focus, and scope of the study was explained at the start of each interview. During the interviews, respondents were asked to reflect on a most recent transfer project with which they were personally involved and to answer questions based on this project. Also, respondents had flexibility in answering questions. For instance, they could explain any issues that they thought were important or had a special function, or they could refuse to answer any questions. At the end of the interview session, respondents were requested to complete a structured questionnaire in the presence of the researcher. The average length of the interviews was 2 hours.

Quantitative questions in the questionnaire concentrated on incentives, barriers, and success criteria of the technology transfer process. All questions were analyzed using a 5-point Likert scale; on this scale a score of 1 indicated "not important," a score of 3 indicated "neither important nor unimportant," and a score of 5 indicated "very important." Each of these questions also included a space for respondents to state their own opinions. Qualitative questions inquired about the mechanisms of establishing contacts, intermediary organizations, and suggestions for improving the technology transfer process.

The questionnaire for intermediary organizations included only qualitative questions. These questions concentrated on methods of establishing contact, factors that acted as inhibitors, criteria for measuring the level of success, the issue of intellectual property rights, and suggestions for improving the process of technology transfer.

3. Collaborative mechanisms of establishing a link between university and industry

Several collaborative mechanisms have been used to establish links between universities and industry with varying success. These mechanisms are both proactive and reactive. They include direct professor-company links, intermediary organizations, contract research, exchange programs, industrial or university liaison offices, research centers, and spin-off Companies (Gerwin *et al.*, 1992; Rahil, 1994; Baldwin, 1986; Jones-Evans, 1998; Clarysse *et al.*, 2002; Markman *et al.*, 2005). The success of a technology transfer often depends on the method that is applied to bring together university professors and interested companies.

In this study, one of the qualitative questions asked was the different kind of mechanisms used for transferring technology. As shown in Table 2, the companies used three channels for creating a relationship and transferring technology from the university.

Table 2 - Mechanisms of Establishing Links

Mechanisms	Number of Companies Using these Mechanisms	Percentage of Total
Direct link between professors and company <ul style="list-style-type: none"> • Company approaches a professor (7) • Professor initiates a contact (2) 	9	60
Company approaches university <ul style="list-style-type: none"> • Research center in the university (2) • Liaison officer in the university (1) 	3	20
Intermediary organization initiates contacts	3	20

3.1 Direct Link between professors and company

As the results in Table 2 show, a direct link between the professor and the company was found to be most popular mechanism of establishing the contact; 60 percent of the companies in the sample used a direct link to professors. Companies that used this approach explained that the most important reason for doing so was the lack of bureaucracy. Companies were more proactive than universities in initiating contacts. In seven projects, companies established contact with professors, while just two professors initiated the contact with the companies. Most of these contacts were created on the basis of previous relationships or familiarity with professors and their profession. These familiarities came from various contacts. For instance, graduate students who worked at companies were one of the most important sources of initiating contact between companies and professors. In some cases, they consulted their professors for advice, so this became a good way for starting contact. Also, the reputation of professors and their colleagues were other ways in which this familiarity was established. The majority of respondents (80 percent) recognized the potential existing in universities and showed interest in continuing a relationship with professors, even after technology transfer. They also mentioned that professors showed a lack of interest in initiating and continuing the relationship. Lack of incentives and competition was given as one of the reasons that professors showed this lack of interest.

3.2 Company approaches university

Liaison offices act as a link between industry and a university, giving information to a university about the needs and problems of industry and, on the other hand, supplying information for industry about the potentials of recent technologies that have been developed in a university. In this study, all of the respondents agreed that liaison offices are not proactive enough in promoting the university inventions to industry; their main focus seems to be on introducing apprentices to companies. When companies approached the university, the liaison office mainly provided relevant information about the capabilities of professors and the projects on which they were working. Liaison offices also introduced the company to the relevant professor or a research center located on a campus of the university. Companies could also directly contact a research center.

In this study of companies, one contacted a professor through the liaison office and two companies directly contacted a research center in the university. The relationship through the liaison office of the respondent was initiated with the apprenticeship of some students working at the company, and it continued until the technology was transferred. In the research center mode, representatives of the company went to the labs and evaluated the quality and the stage of the project. Members of both university and company worked together in the lab, under the control and observation of the center, and jointly planned the technology transfer.

3.3 *Intermediary organizations*

Three companies in the sample transferred technology through intermediary organizations. An intermediary organization acts as a broker between the professors with inventions and companies looking for solutions. Further, the role of this organization can also include providing further support for development, patenting, and finding markets for the technology. These organizations come in different forms, namely internship centers, consortia, or technology parks. Internship centers are more popular for establishing university industry contacts than research consortia or parks. These three forms are described below:

3.3.1 *Internship Centers*

These centers are established to improve the level of university-industry cooperation and to utilize university professors in finding solutions for industry problems. These centers are normally supported and initiated by industry. The center will contact companies asking for projects which they would like universities to undertake. These projects are prioritized and announced to universities. Interested professors may contact the companies to clarify technical specifications and come to a mutual agreement before signing a contract. The internship center supervises this process. Three respondents who used this mechanism found these centers to be efficient, successful, and increasing in popularity. They found that the process enables professors to become more familiar with problems in the real world by having better communication with companies. On the other hand, some respondents were skeptical about the performance of these centers. They preferred a direct link with the universities rather than going through internship centers because they found the centers to be inefficient. For instance, they emphasized that saving time and reducing risk are the important reasons for companies to use this mechanism. In their opinion, intermediary organizations did not usually achieve these goals or, if they did, the success was achieved only for short-term projects. However, most of them believed that these problems exist because the concept of these organizations is new in Iran. So with the passing of time and promoting and expanding the functions of these organizations to companies and universities, strong relationships and greater efficiencies in use can be achieved between universities and companies.

One of the examples of the formation of an early internship center is in the city of Khorasan-e-Razavi. This internship office is sponsored by Sapco representing Iran Khodro, the largest automobile manufacture in Iran. Formed in 1999, the office acts as mediator between universities and companies that produce car parts. It helps to create a relationship between these parties in transferring technology, solving company problems, and improving the quality of company products. The internship office has contacts with more than seven universities and conducts projects in different fields, which include machinery, metallurgy, electronic and computer, management, and environment.

3.3.2 *Research Consortia*

“A consortium connotes a co-operative research effort among companies, universities, industries and/or government, typically aimed at helping the participants maintain their leadership position or gain an edge over their international competitors in a particular industry.” (Kumar and Magun, 1995). In a consortium, the focus is on pre-competitive research that will improve and give advantages to all its members, especially smaller companies with scarcer resources (Daghous, 1997). A university as a participant can cooperate with a number of companies in various areas. Companies pay a membership fee to participate and gain access to research results. University researchers use the company’s financial support and gain benefit from the built-in feedback that provides direction to their work.

The concept of consortia is relatively new in Iran and, therefore, the few consortia that exist are mainly in the food industry. The relationship among Iranian companies is not strong, mainly due to great concern with secrecy issues. Companies are mainly interested in using new results of research for their own financial benefit.

One representative from Iran Saffron Research Consortium was included in our research. This consortium, established in 2001 by the Saffron board, has 12 saffron producer companies as members. Members with similar problems meet to define a project. The Saffron research consortium contacts a university where they think

professors have the expertise to solve the problem. The respondent found the process of dealing with the university to be bureaucratic and time consuming.

3.3.3 Technology Parks

Like consortia and internship centers, one of the objectives of technology parks is to bring together university and industry. A technology park can include incubators, government research centers, and pilot plants. An example, Khorasan Science and Technology Park (KSTP), is described below.

Five years ago, KSTP started its activities in different fields such as materials, electronics, agriculture, and biotechnology. It is located in Khorasan-e-Razavi city in Khorasan province and is under the auspices of the Ministry of Science, Research, and Technology. The current structure of the research park includes two incubator centers, a government research center for technology development, three pilot plants in the food industry, and chemical and mechanical workshops. One of the objectives of this park is to create and develop relationships with universities to support its tenant companies. To this end, under the auspices of KSTP, an incubator is being set up at Ferdowsi University in Mashad. This will help in bringing university technology to companies. For companies to have entry into the park is they must:

- have existing or planned relationships with the Ferdowsi University and/or Islamic Azad University of Mashad,
- provide work experience to university students,
- participate in co-operative education programs,
- share research facilities,
- undertake joint research projects, and
- become a partner with a university member in applying for collaborative research funding (www.kstp.ir).

A member of the science board of this park answered our questions about their activities. This respondent described a technology that was transferred from an Iranian university to an Iranian company in which KSTP acted as an intermediary. This technology was about the design and production of a device that was used in the company's laboratory. The respondent mentioned that in this process the company presented their requirement and KSTP, after considering the type of project, approached the university. He believed this relationship was not completely successful because they faced some problems during the implementation phase, although the research phase was conducted well. He explained that professors were eager to find advantages for the university by conducting the project but were not at all concerned about the company's satisfaction. Company satisfaction is a major criteria for KSTP in measuring the success of technology transfer. He considered the main barriers in this transfer to be the university bureaucracy and the different goals held by the university and industry.

4. Benefits for industry through technology transfer

Löf and Broström (2006) surveyed 400 companies and found that accessing new research and developing new products are the two most important reasons for companies to coordinate with universities. Other researchers have identified a number of other benefits (Mortazavi, 2002; Lee, 1997; Daghou, 1997; Rahil, 1994) that companies can gain by collaborating with universities. These benefits are summarized below:

- Accessing required experts and consultants and, through this collaboration, firms may also find a unique solution for problems.
- Finding the required information and upgrading their knowledge in relation with new science and technology; this can improve the quality of products and the process of producing goods.
- Expanding the use of research in practical situations and motivating creativity for R&D.

- Developing dynamic capability, i.e., the ability to develop new products and processes and to identify new markets and the capability to develop business plans.
- Getting access to university resources, such as skills and facilities that include hardware, software, and special equipment.
- Achieving reputation, prestige, and improvement in the company's image.
- Sharing the cost and risk of the project with universities.
- Selecting future employees through assessing the potential of current students and recruiting the good students.

In this study, respondent were asked to rate, on a scale of 1 to 5, the extent of benefits which they perceive from establishing contact with universities to receive the technology required for their companies. Here 1 represents no benefit at all and 5 represents extreme benefit. The average rating of their responses by company size, as well as overall, is shown in Table 3.

Respondents believed that getting the technology from universities would improve the quality of their products. They considered this benefit especially important, as they anticipate that Iran will join the World Trade Organization (WTO). Companies understand that to compete in the global market, improving the quality of the products is important. Furthermore, companies believe that finding the required information to upgrade knowledge and solve problems is a second major reason for cooperation with universities. As Table 3 shows, for more than half of the items average scores of significant and rank above 3.5. This shows that Iranian companies believe they have received benefits by establishing contact with universities.

On further examining the incentives by size of companies, it was found that the motive for all companies in establishing contact with universities was improving the quality of products. However, for large companies finding the required information to upgrade knowledge was more important than for small and medium-sized companies. On the other hand, small companies stressed accessing required experts and consultants, and major incentives for medium-sized companies in gaining access to university resources were facilities and expensive instruments . Probably this difference can be explained by the fact that large companies already have enough internal experts; in contrast small and medium-sized companies have a need to upgrade their knowledge. Also, as Table 3 shows, in six items small and medium companies had higher scores out of eight items than the large companies. Thus it seems that small and medium-sized companies achieve more benefits by creating relationships with universities.

Table 3 - Average Scores on Incentives for Small, Medium-Sized, and Large Companies

Benefits	Small	Medium-Sized	Large	Overall
Access to required experts and consultants	4.2	3.66	3	3.66**
Access to university resources not available to us	3.4	4.16	3.25	3.66**
Find the required information, upgrade knowledge, and solve the particular problem	3.4	3.66	4.25	3.73**
Gain advantage by sharing the risk of research and reducing the cost	2.6	2.67	2	2.46

Achieve reputation and prestige and improve the company's image	2.4	2	1.75	2.06
Improve the quality of products	4	4.5	4.75	4.4***
Increase the ability to create and develop new products	4	3.83	3	3.66
Lack of R&D staff in company	3.8	2.83	1.25	2.73

*** Significant at .001 level

**significant at .01 level

Respondents were also asked to list any other benefits that they gained by establishing contact with universities. The items mentioned included accelerating the innovation, a suitable price in comparison with other opportunities, and the exclusivity of technology in contrast with other competitors.

5 Barriers to Technology Transfer

While universities and companies gain benefits through collaboration with each other, studies have identified some barriers that exist during the technology transfer. These barriers, as described below, could exist because of differing goals between universities and industry, cultural differences, attitudinal barriers, information dissemination, organizational structure, and intellectual property rights.

Different Goals

Normally companies want to reduce the risks and costs and increase profits. Their focus is on clear and practical approaches for solving problems (Mortazavi, 2002). Further, companies emphasize short-term research for saving time and getting a better chance for accessing new market opportunities faster than other competitors (Mortazavi, 2002; Rahil, 1994). On the other hand, universities are interested in middle and long-term research with emphasis on accuracy and precision (Mortazavi, 2002; Rahil, 1994). Universities focus on basic research, discovering new sciences, and expanding the boundary of knowledge (Mortazavi, 2002). Different objectives between universities and companies can create a potential for conflict that causes resistance in the technology transfer process.

Cultural Difference

Daft (2004) defines culture as a set of "values, norms, guiding beliefs, and understanding." One of the barriers to the linkage between university and industry is the knowledge gap about each other's organizational cultures (Jones-Evans, 1998). Siegel *et al.* (2004) also states that universities and companies do not appreciate or perceive the culture and constraints of each other.

University researchers focus on gaining knowledge while industries just want to find a quick profit through the researchers (Mortazavi, 2002). For instance, Jones-Evans (1998) explains that in many cases firms want to find the solution for their problem quickly, whereas universities would take a considerable period to identify the problem and find the range of solutions. Jones-Evans concludes that "universities tend to follow a model of action which is directed from supply to demand side whilst enterprises function according to a model directed from demand to supply side." These cultural differences could reduce the communication between the two parties and, hence, become a barrier.

Attitudinal Barriers

In his book, Robbins (2001) identifies attitude as “evaluation statements or judgments concerning objects, people, or events.” Siegel *et al.* (2004) describes the university members’ attitudes as “we will give a solution for your problems if you just give us money.” Jones-Evans (1998) believes that universities follow an open door policy to cooperate with all kind of industry and collaborating research, while industry’s perception depends on the “nature of link with the university and types of industry.”

Managers believe that faculty members are out of touch with practical problems and real world situations and they still live in “ivory towers” (Rahil, 1994; Jones-Evans, 1998). This attitude especially exists in low technology small and medium-sized enterprises, where the managers or owners do not normally have any previous academic experience (Jones-Evans, 1998). These conditions will reduce the trust in the ability of universities to do their tasks efficiently, and they will cause difficulty in the process of technology transfer.

Information Dissemination

Universities and firms differ in their approach to disseminating information. University members want to disseminate the research results in scientific journals as proof of their research abilities. Firms, however, want to keep results confidential and get patents for these results, because in the competitive market place controlling their information is an advantage to companies (Rahil, 1994; Jones-Evans, 1998). Thus the link with industry sometimes confines the free flow of information between universities and companies, and it also restricts their contributions to the wider economy.

Organizational Structure and Resources

The structure of universities and companies are different from each other, and this may create a barrier in the technology transfer process. For example, universities are more bureaucratic and they have an inflexible structure (Razi, 1998). But firms have a more flexible structure than universities, especially in private organizations (Mortazavi, 2002). Also according to the survey done by Siegel *et al.* (2004) universities wish to “follow rigid procedures that may not fit a particular situation.”

On the issue of resources, according to Jones-Evans (1998), a problem exists in universities at both institutional and individual levels. From the institutional level point of view, there is not enough funding, particularly internal financial support within the university, to improve the relation with industry. At the individual level, members of a faculty do not have enough time to establish contact with industry and collaborate in joint projects, in addition to their major duties in teaching the students of the university.

Intellectual Property Rights

One of the popular issues that is a barrier to performance in many of the joint projects is the ownership of intellectual property rights (Rahil, 1994). Interviewers in the Siegel *et al.* (2004) study explain that universities are “too aggressive in exercising intellectual property rights.” Gerwin *et al.* (1992) also states that “universities will set limitation[s] for potential recipients and inventors from coming to term by setting the rigid attitudes toward the possession of intellectual property rights.”

In general, all parties that cooperate in this process want to protect their own benefits, but often these benefits are in conflict with the other party.

Other barriers

In addition to the barriers just mentioned, some other barriers exist. These include lack of expertise in liaison offices, university policies, the reward system, a lack of communication, and a lack of academic training of company employees. Additionally, the small size of companies has been an impediment in transferring technology from university to industry (Gerwin *et al.* 1992; Jones-Evans, 1998; Razi, 1998). Because of the lack of communication, companies have a low awareness of the ability of university faculties and the kind of research they perform. On the other hand, universities have little information about industry needs (Rahil, 1994; Gerwin *et al.*

1992) and may not be able to communicate with company members beyond their academic discipline. The size of companies is viewed by some researchers (Cooper, 1997) as one of the barriers in transferring technology. Most small and medium-sized companies do not have enough resources to support or utilize university research. Researchers suggest that small companies, in order to survive and prosper, have one way to achieve those results: “get involved in partnership with universities” (Rahil, 1994).

In considering the importance of barriers from industry’s point of view, we asked companies to rate the factors having a negative effect on the technology transfer process. The average rating of their responses, shown both by company size as well as overall, is given in Table 4. Three variables found to be statistically significant are described below.

A major barrier was that industry managers believed that faculty members were out of touch with practical problems and real world situations. The attitude of managers towards the members of faculty was found to be a major barrier in this relationship. All respondents believed that most university researchers do basic research rather than applied research. The second main barrier, according to respondents, was the lack of awareness of each other’s ability. The significant reason for this is the lack of contact between universities and industry. Without a specific network to present the needs of companies and the abilities of universities the gap between awareness of the two parties about each other’s abilities only widens. The inability of universities to commercialize research was the third significant barrier. Respondents felt that university members are out of touch with the real world; they further believed that professors do not place importance on research results. In other words, professors do not pay attention to the feedback that companies provide them.

On further examining the barriers by size of companies, it was found that the respondents from both large and medium-sized companies ranked the lack of awareness of each other’s abilities as the top barrier. Small companies ranked the lack of universities’ ability in commercializing research as the top barrier.

Table 4 - Average Scores on Barriers for Small, Medium-Sized, and Large Companies

	Barriers	Small	Medium-Sized	Large	Average
Different goals	University wanted to conduct research over a longer time frame than your time frame	2.8	2.66	2.25	2.6
	University did not pay attention to cost and budget	2.8	2.66	1.75	2.46
Cultural difference	University focuses on gaining knowledge in research with attention to details, while you want to quickly find more profit through the research	3.2	2.33	2.5	2.6
Attitudinal barriers	Faculty members seem to be out of touch with practical problems and real world situations	4.2	4.33	3.25	4***
	Lack of confidence in ability of professors and the result of research	1.8	3.16	3	2.66
Information dissemination	University wanted to disseminate the research result broadly and rapidly while you wanted to maintain secrecy	2.8	2.5	2	2.46

Organization structure	Different organization structure of university and your company. For instance, university is more bureaucratic; the processes of decision making, legal constraint, and policies are different	3.2	2.83	2.25	2.8
	Lack of funds and expertise for handling the transfer process in university	2.6	2.66	2.25	2.53
Intellectual property rights	University and company have a different view of the ownership of the intellectual property right	3.6	2.5	2	2.73
Other	Lack of awareness of each other's abilities	3.4	4.16	3.75	3.8***
	Extra funds and personnel requirement for utilizing university invention	3.6	2.66	1.5	2.66
	Lack of university's ability for commercialization of the research	4.4	3.66	2.75	3.66**
	University and professors usually delayed in delivery	3	2.83	3.25	3

*** Significant at .001 level

**significant at .01 level

6. Evaluation of success

One of the most important issues about the success of technology transfer is how we can evaluate it. It is necessary for firms and universities to use some criteria to evaluate and predict the success in the technology transfer process. Bennett (2002), in a United Nations report, concluded that a process of technology transfer is successful if it: i) is congruent with goals and strategies of companies, ii) is market oriented, iii) provides increase in profit, iv) creates and protects employment, and v) has an acceptable environmental impact. According to Martin *et al.* (1978), companies experiencing success in the process of transfer have ongoing and close relationships with the technology's transmitter.

Rahil (1994) measured success in terms of meeting technical specifications and financial gains. She found that establishing an ongoing relationship between university and firm is an important aspect of evaluating the project's success. Bennett (2002) emphasizes that success of technology transfer should be evaluated by the positive impact that it makes on the performance of the industrial and recipient part, not by the success of the technical implementation of the plan. Kuchinsky states that "success should be measured by the bottom-line dollar value of products and new businesses enabled by the technology that is transferred" (Foley, 1996). Kilduff and Blewett (1994) note that the success of technology transfer can be measured by answering "whether or not and how well the expectations were met" (Daghous, 1997).

In this study, respondents were asked to rate on a scale of 1 to 5 the importance of the following criteria in evaluating the success of technology transfer:

- established ongoing relation with university,
- positive impact on performance,
- new business enabled,

- gaining competitive advantage in contrast with other competitors,
- impact on profit,
- utilization of the technology by selling or by applying it in the company, and
- benefit for society.

As shown in Table 5, on an average for all companies, having a positive impact on performance and utilization of the new technology by selling it or by applying it in the company was found to be significant. Respondents mentioned that they consider the criterion of competitive advantage important because of the expectation that Iran would join the WTO. This criterion was ranked higher for small and medium-sized companies. A possible reason for this result is that Iran has more small and medium-sized companies than large companies, so competition is intense and high. Also, it was found that the utilization of new technology and the positive affect on performance were rated higher for large companies.

Table 5 - Average Scores on Success Criteria for Small, Medium-Sized, and Large Companies

Criteria	Small	Medium-Sized	Large	Overall Average
Established ongoing relation with the university	3.2	2.5	3	2.86
Positive effect on performance	3.4	3.66	4	3.66**
New business enabled	2.8	2.66	2.75	2.73
Gaining competitive advantage in contrast with other competitors	4.2	4.16	3.5	4***
Impact on profit	3.8	3	3	3.26
Utilization of the new technology by selling it or by applying it in company	4	3.66	4	3.86**
Benefits for Iranian society	3.2	2.5	2.5	2.73

*** Significant at .001 level

**significant at .01 level

Other than these results, it does not seem that size is an influential factor in companies' choice of success criteria for evaluating the technology transfer process. Based on the qualitative answers from the respondents, it was evident that the companies do not have any formal process, such as forms and documents, to evaluate the success of projects.

7. Conclusions and Recommendations

During this study, we considered a developing country perspective on the transfer of technology processes from universities to industry. Fifteen companies and three intermediary organizations were selected. We collected data by interviewing representatives of each of these companies and organizations.

We discovered that the major incentive for companies to establish contact with universities was improving the quality of products. According to the companies, the unfamiliarity of faculty members with practical problems and real world situations, and the lack of awareness of each other's ability were the major barriers to relationships with universities. In most cases, the methods used for transferring knowledge for the proper use of technology were written documents and face-to-face conversation and presentation. Companies thought that gaining a competitive advantage in contrast with competitors, and utilization of the new technology by selling it or by applying it in a company were the most important criteria for measuring the success of the technology transfer process. Only a few companies wanted to work with intermediary organizations; most preferred to have direct contact with the university. In respondents' opinion these organizations are better for short-term projects only.

Respondents were also asked to give opinions on what the government, companies, and universities can do to improve the technology transfer process from universities to industry. Most of the respondents believed those university members mainly focus on theoretical, not practical, issues. This problem could be solved if universities revised their educational plan from theoretical to practical issues, especially in engineering. To carry out this principle, universities need to take a number of steps. They will need to change the syllabus and create new fields working in cooperation with industry. This will include defining the final projects of students according to industry needs, involving company engineers in the early stage of research, and using exchange programs that increase the familiarity of faculty members with problems faced by industry. For instance, three respondents suggested a change in the process of evaluating the professors in universities; they should be evaluated and promoted based on their ability to develop joint projects with industry.

Improved communication with universities as a means of increasing the awareness of each other's ability was recommended by respondents. One of the suggestions was to have more conferences that utilized participants from both industry and universities.

Respondents believed that universities should understand the importance of time and be responsible to deliver their research on time. On the other hand, companies ought to recognize the specific needs of universities.

Other suggestions from respondents included increasing the collaboration among universities, government, and companies and decreasing the bureaucracy that exists in universities. To improve the level of confidence in the ability of universities, respondents also suggested increasing the clarity of research contracts, increasing the familiarity of university members with commercialization problems, and improving the image of universities in implementing the complete projects.

Most of the respondents felt that the Iranian government should increase participation in creating the relationship between universities and industry. They believed that government ought to support small and medium-sized companies in term of the required funds for cooperation with universities. Additionally, a tax advantage by government to companies that collaborate with universities could increase the motivation of companies to establish this relationship. Government can also provide support by organizing exhibitions and conferences in which universities and industry participate

Companies are more proactive than universities; in most of the cases that we studied companies initiated the contact with universities. University liaison offices are well positioned to play a significant role as a bridge between universities and industry. As suggested by the respondents, this office should create a database that explains university expertise and company needs, working together with industry and government. It could also publish catalogs that emphasize the capabilities of the university and professors in technology transfer and establish a method of giving information about the university's inventions to alumni.

Intellectual property rights have an important role in establishing better links between university and industry and also in encouraging innovation. In general, either the inventor or the organization has the ownership of

intellectual property. While the focus on commercialization increases, researchers are more concerned with protection of research output than with intellectual property (Fulop and Couchman, 2006). Because of the importance of these issues, the World Intellectual Property Organization was formed in 1967 to create international policies to protect intellectual property (Ministry of Science research and Technology, 2001). The Iranian government has joined this organization, but the rules have yet to be fully implemented, especially the penalties for breaking rules. Further, individuals and organizations spend a great deal of time registering their innovation, because this process is very time consuming in Iran. They also do not have any guarantee that protects their innovation in spite of getting a patent. This situation is one of the factors that may hinder technology transfer.

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