TECHNOLOGY TRANSFER EFFECTIVENESS IN KNOWLEDGE-BASED CENTERS: PROVIDING A MODEL BASED ON KNOWLEDGE MANAGEMENT

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Abstract

The paper attempts to identify factors and variables affecting designing technology in knowledge-based centers in order to study their relations and, ultimately, to provide a model based on research data. To achieve this aim, technology transfer process capabilities, knowledge management, technology transfer effectiveness and constituting variables/indicators should be preliminarily and separately identified, and then the impact of knowledge management on capability of technology transfer process and its effectiveness should be measured in Iranian universities. The research method is descriptive of correlation type. In this research, using a simple stochastic method, 151 active people in technology transfer were selected from among Iranian knowledge-based centers. The data for the research were collected through questionnaires. Confirmed construct and factorial analysis were used to determine the validity, and for reliability, Chronbach alpha was employed. In order to study the relationship between research variables and to study hypotheses, the modeling of structural equations has been used with the help of SPSS and AMOS software. Findings indicate that knowledge management impacts on technology transfer effectiveness in knowledge-based centers. Likewise, knowledge management relates to technology transfer effectiveness via technology transfer capabilities. Studying the impact of each variable on technology transfer effectiveness indicates that knowledge capability followed by knowledge management and technological capabilities are the key factors and facilitators, and as a mitigating factor, organizational capability has the highest impact on technology transfer effectiveness.

Keywords: knowledge management, organizational capability, technological capability, knowledge capability, technology transfer

1. INTRODUCTION

Technology transfer is in fact the movement of technology from one point to another. For instance, technology can be transferred from one organization to another, from university to an organization and from one country to another (Reisman, 2005). Technology transfer is a dynamic, complicated and long-term process whose success owes to factors stemmed from other sources. Concerning high rate of failure in technology transfer projects (Guan, 2006), the most important challenges in the success of technology transfer projects is to identify these factors and their sources. According to Santer and Saparteau (2006), knowledge does not flow automatically from university to industry; rather it needs facilitating factors. Hence, it is important to analyze factors affecting technology design and transfer in universities and research centers. Therefore, identifying both special and general factors that impact on the success and effectiveness of technology transfer can mitigate technology transfer risks and can increase the success of technology transfer projects (Johnson, 1998; Harrington, 2005).

The main challenge for organizational decision makers is that they do not know how, needed
knowledge to resolve organizational problems in employees’ minds is developed. Research centers with technology transfer on their agenda are among those which should do their best to identify, fascinate and utilize their employees’ organizational knowledge effectively due to the scope and complexity of technology transfer processes. Knowledge management has a direct relationship with technology transfer effectiveness, and plays a mediating role in this regard. Knowledge management creates the necessary opportunity to improve factors related to technology transfer process and organizational performance; ultimately, acquiring competitive advantage.

The Present study attempts to identify organizational, relational, technological and knowledge factors which impact on technology transfer effectiveness in several Iranian universities and research centers. Likewise, the impact of knowledge management and technology transfer effectiveness in the surveyed population is measured.

In the present paper, factors related to technology transfer processes are called “capabilities”.

Concerning the aims of the research, one can point out the identification of factors related to technology transfer and constituting variables of technology transfer effectiveness in the studied centers. In the meantime, computing the amount of knowledge management impacts on technology transfer process and technology transfer effectiveness variables in such industries are, *inter alia*, the main aims of the present study.

2. LITERATURE REVIEW

Academic researches and transferring them to industry are highly respected in knowledge and technology management. Since early 1980, authors and policymakers have paid special attention to the relations between university and industry. Overall, technology transfer literature can be categorized into three main segments: a segment which studies technology transfer process factors, one for knowledge management and another one focusing on technology transfer effectiveness. In technology transfer process factors segment, all factors affecting technology transfer including organizational, relational, technological and knowledge factors are studied.

In literature, the importance of organizational structure in universities’ organizational performance is highlighted. Gopalakrishnan and Santro (2004) believe that organizational structure is an effective internal factor in knowledge acquisition and transfer from academic institutes. Siegel et al (2003) believe that lack of allocating sufficient resources to knowledge transfer initiatives by university, bureaucracy and inflexibility of university executive management are among the barriers of knowledge and technology transfer from university to industry (Siegel et al, 2003). Concerning organizational technological capability, Acha has introduced technological capability as technological know-how and necessary skills to identify, develop and utilize necessary techniques (Tsai, Keven, 2004).

Regarding relational capability, its role in innovation, new product development and time of introducing new products to market are studied (Jonker, 2006; Griffith, 2004). Adams, Fesfield (1991) and Rosenberg & Nelsen (1994) indicate that academic researches have important impacts on industrial productivity increase, and any increase in cooperation between university and industry would cause the transfer of academic implicit and explicit knowledge (Bekkers and Freita, 2008; Hong, 2008). With regard to knowledge capability, its role in the capacity of designing and utilizing new technology (Mu et al, 2010, Pertusa – Ortega et al, 2010; Bishop et al, 2011). Maglitta (1995) and Cole Gomolski (1997) assert that knowledge management is an effective way to improve the performance, the productivity, competitiveness, and techniques and processes of decision making, to distribute appropriate information in the organization, and to make us aware of the best patterns and successful experiences of other people. Concerning technology transfer effectiveness, Yuling Wang (2010), Carolina Lopez (2011) and Wi Wen Wu (2012) have studied the role of economic, qualitative, operational, learning, and HR in successful technology transfer.
2.1. Factors Affecting Technology Transfer

Technology transfer is a complicated and hard process which is not fruitful without investigation, and it may waste capitals and weaken technology (Asghari et al, 2013). Many authors emphasize that technology transfer is impacted by technology sending resource, technology receiver and the route and type of transferred technology and knowledge. To this end, efficient technology transfer requires a full understanding of capabilities of technology senders/receivers as well as other facilitating/limiting factors (Mu et al, 2010; Strachand and Everett, 2006). Technology transfer process enjoys some preventive and contingent factors that should be considered before taking in to account technology transfer models including awareness of needed radical factors to transfer technology and the factors of past technology transfer failures.

The necessary condition for technology transfer is to be aware of radical and effective factors. Technology transfer authorities should always be aware of main factors. These factors should be respected before technology transfer in order to achieve the benefits of technology for both technology resource and receiver. Concerning broad studies on technology transfer literature, affecting factors or capabilities in technology are identified and classified into four major measures as follows.

2.1.1. Organizational Capability

Organizational capability refers to innovating and reshaping internal resources (Hawawini, 2004). Structural organization of the university is a factor affecting new technology designing. Generally, organizational structure of a university should be homogeneous to new technology and respond its needs (Rouner, 2003; Trafdar, 2006).

To facilitate knowledge flow, research centers should design structures and systems by which one can generate, aggregate, integrate, disseminate, and manage the knowledge effectively. Chen and Huang (2007) and Pertusa – Ortega (2010) have determined the traits of organizational structure as the critical factors in affecting knowledge transfer process and innovation in companies. Most researches on organizational theory confirm that organizational structure plays a vital role in the capability of an organization to adapt, create and integrate knowledge and innovation in the organization.

Some authors claim that adaptation between organizational knowledge and structure to achieve flexibility and efficiency of competitive environments is very vital (Liao et al, 2010; Chen and Huang, 2007).

Siegel et al (2003) believe that academic executives in US universities should focus on five organizational and managerial factors in order to grow an entrepreneurship and commercialization climate. They include developing an awarding system to expand technology transfer cooperation, modifying the ways of employing personnel in technology transfer offices, devising flexible academic policies to facilitate academic technology transfer, devoting more resources to technology transfer, and removing cultural and informational barriers that prevent knowledge and technology transfer.

2.1.2. Relational Capability

Another factor affecting successful technology transfer less respected in the literature is the role of rivals, customers, supportive organizations and scientific centers. Overall, one can call it “organizational relational capability.” Such technology should have a right interaction with customers, suppliers and rivals.

In his research, Jonker (2006) introduced relational capability as the “ability of relationship”, and measured it by such metrics as relation with customers, rivals, suppliers, financial firms, technical/vocational organizations, research centers and universities. In another research by Ritter on German firms, he defined relational capability as interactions of an organization with customers, suppliers, rivals and research institutes.

The volume of relations between research institutes and industry would increase knowledge and technology transfer to companies. Intensity of relations between a company and knowledge suppliers or generators is very important for constant learning and is considered as the infrastructure of innovation process (Bramwell and Wolfe, 2008; Herrera et al, 2010). Mohnen and Hwario (2003) found that there is a positive relationship between introducing basic product...
innovations and reliance on research organizations (Fontana et al, 2006).

2.1.3. Technological Capability

Walsh (2002) defined technological capability as technological inventions and being aware of technological future needs.

Santoro and Bierly (2006) assert that technology transfer would be increased if the technological capabilities of both sender and receptor are interrelated. Some authors believe that organizational capability to internalize external knowledge will be increased by learning methods like internal R&D, technology level, and technical training (Santoro and Bierly, 2006).

Overall, the common point in all definitions is the emphasis on developing, assimilating and utilizing technical skills in scientific inferences to create competitiveness in an organization (Tsai, Keven, 2004). In another research by Wang (2004) in Chinese high – tech, companies, the author used indicators such as investment in R&D, constant and high level in-service training, high capacity to employ elites by organization, high capacity to predict technological changes, the capability of utilizing new technologies in resolving internal problems and improving new technological standards to measure technologically capability of studied organizations.

2.1.4. Knowledge Capability

Knowledge capability is an important factor in knowledge and technology transfer. Knowledge capability is the ability of a company to recognize the value of new external information and to integrate it with internal organizational knowledge (Bishop et al. 2011; Kodama, 2008; Mu et al, 2010; Pertusa – Ortega et al, 2010).

Knowledge capability includes the abilities of acquiring and merging the knowledge and utilizing it in an organization. Innovation process in companies is the process of aggregation and generation of new knowledge. Its performance highly depends on the capacity of the company in using knowledge management and their human resources. Many authors believe that a company’s innovation capacity has a close association with its capability in acquiring advantages from knowledge and in integrating it with other elements of internal knowledge (Herrera, et al, 2010).

According to Hamel (1991), someone’s past experience would impact on the ability of knowledge sharing and new knowledge institutionalization. Cohen and Levinthal (1990) emphasize that past aggregative knowledge promotes both the capability of organizational current knowledge treasure, to integrate new knowledge with existing organizational knowledge, to use organizational knowledge for business purposes, to convert internal accumulated experience into applied business knowledge, to convert implicit and explicit knowledge into job procedures and norms, and to use current organizational knowledge to generate new knowledge to measure firms’ learning and knowledge (Chen and Huanj, 2009; Bishop et al, 2011; Deceter et al, 2007; Carayannis et al, 2000).

In their studies, some authors have considered company’s attraction capacity (technology level, training, T&D activities) and the existence of technology-related basic knowledge (technological knowledge, technical and organizational skills and receptor’s tacit knowledge) important for successful technology and knowledge transfer (Bishop et al, 2011; Kodama, 2008; Mu et al, 2010; Pertusa – Ortega et al, 2010).

2.2. Knowledge Management

Knowledge management is a new term with different definitions. US Center for Quality and Productivity defines it as strategies and processes to identify, acquire, and utilize knowledge (Monavvarian et al, 2013). Maglitta (1995) and Cole-Gomolski (1999) believe that knowledge management is an effective way to improve the performance, to increase the productivity and competition power, to distribute information in organization properly, to improve decision-making methods and processes, and to be aware of others’ successful patterns and experiences.

Daruch (2003) defined knowledge management as processes that generate knowledge and manage its sharing, dissemination and utilization inside the
organization. Davenport et al (1998) believe that knowledge management is to manage organizational knowledge through special and systematic processes to attain, organize, retain, use, share, and extend both implicit and explicit knowledge of employees to improve organizational performance and to generate value. Gupta et al (2000) believe that knowledge management is a process which helps organizations explore, organize, disseminate and transfer important information and necessary experiences for such activities as problem solving, dynamic learning, strategic planning and decision making. Knowledge management can effectively facilitate fast accessibility to commonly and properly needed knowledge for different tasks in order to improve decision making and to permit the dissemination and sharing of necessary knowledge and information in the organization (Bohlin, 1994; Davenport and Prusak, 1998).

2.3. Technology And Its Transfer

Technology is a tool or skill, a product or process, physical equipment or execution methods by which human’s capability increases. In operational terms, technology is technical knowledge that increases the capability of an organization to produce goods and services (Stock, 2000). Technology concept is like a bridge between science and new products (Asghari et al, 2013). Technology transfer is a process that allows technology transfers from one source to a receptor. The source can be the owner of technology like an organization or a country (Radosevik, 1999). Another specialist believes that technology transfer is from a location to another e.g. from an organization to another, from a university to an organization, or from one country to another (Reisman, 2005).

In most cases, technology transfer requires physical processes related to knowledge (physical elements such as digital components) as well as know-how or advanced skills on installments. Knowledge is divided into two implicit and explicit categories (Nonka and Takeuch, 2001). Explicit knowledge refers to detailed plans, designs, diagrams, attributes, etc. Therefore, information is transferred more easily by technological support (Antonelli, 1997) while implicit (tacit) knowledge is hardly devised and is not basically devised in organization. Implicit knowledge was coined by Ploanyi in 1967. Antoneli (1997) asserted that since IT has a limited capacity for implicit knowledge transfer, we generally use it to transfer explicit knowledge. By using knowledge management, organizations are able to create an environment where one can regularly identify implicit knowledge, and where explicit knowledge is transferred more easily and rapidly with the help of IT tools.

2.4. Technology Transfer Effectiveness

To identify important factors in technology transfer effectiveness, the relevant literature was initially reviewed, and then these important factors were extracted in Iranian elites’ views. In a research by Wang (2004) in Taiwanese companies, technology transfer effectiveness was measured. In this research, the amount of aims achievement was already determined (Wang, 2004). In another research, Stock (2001) introduced operational effectiveness and economic effectiveness to measure technology transfer effectiveness.

In his study on Croatian firms, Shaojie (2006) measured technology transfer effectiveness through three factors: “receptor’s technical knowledge learning”, “dependency of receptor to sender in order to conduct the operations” and “using transferred technology on other projects to improve the operations”.

In most technology transfer projects in Iran, technical aspects and, to a lesser extent, organizational aspects are considered more (Movahedi, 2003) while the role of knowledge management in technology transfer process is not respected. Therefore, the present paper studies the impact of knowledge management on knowledge capability and technology transfer effectiveness in knowledge-based centers and manufacturing companies.

2.5. Technology Transfer And Its Experiences In Iran

In the present research, numerous doctoral and M.A theses are studied in the field of technology transfer in different Iranian organizations, and those closer to the research title were finally gathered. The most important barriers in successful technology transfer in Iranian organizations are “lack of specialized manpower, serious managerial
problems, disrespect to R&D, problems in cooperating with suppliers, disrespect to specialized training and retraining, lower attraction capacity, lack of motivations among personnel, and using license path in most technology transfer contracts (Movahedi, 2003).

### Table 1: Demographic distribution of respondents

<table>
<thead>
<tr>
<th>Job experience</th>
<th>The numbers of respondents</th>
<th>%</th>
<th>Aggregative percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 5 years</td>
<td>58</td>
<td>38.7</td>
<td>38.7</td>
</tr>
<tr>
<td>5 – 10 years</td>
<td>30</td>
<td>20.3</td>
<td>58.7</td>
</tr>
<tr>
<td>10 – 15 years</td>
<td>27</td>
<td>18.0</td>
<td>76.7</td>
</tr>
<tr>
<td>15 – 20 years</td>
<td>16</td>
<td>10.6</td>
<td>87.3</td>
</tr>
<tr>
<td>+20 years</td>
<td>20</td>
<td>12.6</td>
<td>100</td>
</tr>
<tr>
<td>Degree</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B.A.</td>
<td>7</td>
<td>4.7</td>
<td>4.7</td>
</tr>
<tr>
<td>M.A.</td>
<td>46</td>
<td>30.7</td>
<td>35.4</td>
</tr>
<tr>
<td>Ph.D.</td>
<td>95</td>
<td>63.2</td>
<td>98.6</td>
</tr>
<tr>
<td>Other</td>
<td>3</td>
<td>1.4</td>
<td>100</td>
</tr>
<tr>
<td>Scientific degree</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Researcher</td>
<td>45</td>
<td>29.8</td>
<td>29.8</td>
</tr>
<tr>
<td>Coach</td>
<td>8</td>
<td>5.3</td>
<td>35.1</td>
</tr>
<tr>
<td>Assistant prof.</td>
<td>78</td>
<td>51.7</td>
<td>86.8</td>
</tr>
<tr>
<td>Associate prof.</td>
<td>12</td>
<td>7.9</td>
<td>94.7</td>
</tr>
<tr>
<td>Professor</td>
<td>8</td>
<td>5.3</td>
<td>100</td>
</tr>
<tr>
<td>Educational field</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basic sciences</td>
<td>5</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Engineering and technical</td>
<td>24</td>
<td>16.0</td>
<td>19</td>
</tr>
<tr>
<td>Liberal arts</td>
<td>106</td>
<td>71.2</td>
<td>90.3</td>
</tr>
<tr>
<td>Other</td>
<td>16</td>
<td>10.0</td>
<td>100</td>
</tr>
<tr>
<td>The number of scientific papers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less than 10</td>
<td>83</td>
<td>55.3</td>
<td>55.3</td>
</tr>
<tr>
<td>10 – 20</td>
<td>27</td>
<td>18.3</td>
<td>73.3</td>
</tr>
<tr>
<td>20 – 30</td>
<td>12</td>
<td>8</td>
<td>81.3</td>
</tr>
<tr>
<td>Over than 30</td>
<td>29</td>
<td>18.7</td>
<td>100</td>
</tr>
</tbody>
</table>

2.6. **General Model And Hypotheses**

In the model provided in the theoretical literature, the sequence of technology transfer is addressed more while the capabilities of technology sender (university), technology receptor (industry), knowledge management and its role on technology transfer from university to industry are not considered.

The conceptual model provide in the present study constitutes dependent variables (technology transfer effectiveness) and independent variables (knowledge management, organizational, relational, and technological and knowledge capabilities). Figure 1 indicates research conceptual model along with the elements of each part. To study the relationship between the impacts of knowledge management on organizational and knowledge capabilities and technology transfer effectiveness, the above mentioned indicators were initially devised by referring to elites’ opinions as well as reviewing the relevant literature. In this vein, technology transfer indicators are categorized in four aspects. Different aspects of technology transfer capabilities, its constituents and sources are depicted in Appendix 1. Knowledge management constituents, technology transfer effectiveness and its resources are outlined in Appendix 2.

Concerning the above-mentioned points and the aims discussed earlier, the following hypotheses are provided:

**H1.** There is a positive and significant relationship between knowledge management and technology transfer capabilities in knowledge-based centers.

**H2.** There is a positive and significant relationship between technology transfer capabilities and technology transfer effectiveness in knowledge-based centers.

**H3.** There is a positive and significant relationship between knowledge management and technology transfer capabilities and technology transfer effectiveness in knowledge-based centers.
3. METHODOLOGY

3.1. Research Proposal

In the present study, important factors in measuring technology transfer process capabilities and technology transfer effectiveness in Iranian universities under study are identified by precise and multilateral reviewing of technology transfer literature, organizational structure literature, knowledge management, interviews with academic elites, authors and managers of technology transfer projects and knowledge management skillful authors in two separated steps. To achieve this aim, the relevant literature was broadly and precisely reviewed, and then a preliminary questionnaire was devised in three separate parts based on existing indicators in the literature.

The first part of the questionnaire was devoted to questions on organizational, relational, technological and knowledge capability in universities while the second part covered questions on knowledge management and the third part consisted of questions on technology transfer effectiveness. Likert five-scale spectrum was utilized to devise the questions from very low to very high. This questionnaire which was based on relevant literature was submitted to 20 academic elites as well as technology transfer authors and knowledge management researchers. After face-to-face interviews and concluding their opinions, some questions were deleted and some others that had interferences were merged, and indicators related to organizational, technological, and technology transfer effectiveness factors in Iranian industries were added to the preliminary questionnaire.

Likewise, the clarity of questions in each part and their relevance to knowledge management and capabilities as well as technology transfer effectiveness in universities under study was confirmed by elites and authors.

In the second step, the revised questionnaire with the results of the first step was devised in three separate steps and submitted to 20 technology transfer project managers, senior experts, authors and faculty members of the universities, and surveyed manufacturing industries. In this step and in addition to questionnaire, semi-structured interviews with project managers were conducted, and their experiences on knowledge management and technology transfer were gathered and recorded. In these interviews, special points as well as their suggestions/needs to accelerate technology transfer process and the role of knowledge management in improving technology transfer process were all determined. The questionnaire was severally evaluated and revised in terms of validity and reliability. According to Iranian elites, all three parts enjoy proper validity. Chronbach’s alpha was also measured to compute internal compatibility with confidence level. Table 2 depicts the reliability of the questionnaire after modifications. As observed, all values are greater than 0.7 (acceptable level). Thus, responses to all three parts of the questionnaire are reliable (Gallivan, 2005).

Table 2: Questionnaire and KMO statistic

<table>
<thead>
<tr>
<th>Technology transfer capabilities</th>
<th>The quantity of constituents</th>
<th>Chronbach’s alpha</th>
<th>KM O</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology transfer capability</td>
<td>4</td>
<td>0.82</td>
<td>0.7</td>
</tr>
<tr>
<td>Organizational capability</td>
<td>4</td>
<td>0.80</td>
<td>0.7</td>
</tr>
<tr>
<td>Relational capability</td>
<td>6</td>
<td>0.88</td>
<td>0.8</td>
</tr>
<tr>
<td>Knowledge capability</td>
<td>4</td>
<td>0.81</td>
<td>0.7</td>
</tr>
</tbody>
</table>

Figure 1: Research conceptual model

Technology transfer process capabilities

Knowledge management

Organizational capability

Relational capability

Technological capability

Knowledge capability

Transfer effectiveness

Table 2: Questionnaire and KMO statistic

<table>
<thead>
<tr>
<th>Technology transfer capabilities</th>
<th>The quantity of constituents</th>
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<tr>
<td>Organizational capability</td>
<td>4</td>
<td>0.80</td>
<td>0.7</td>
</tr>
<tr>
<td>Relational capability</td>
<td>6</td>
<td>0.88</td>
<td>0.8</td>
</tr>
<tr>
<td>Knowledge capability</td>
<td>4</td>
<td>0.81</td>
<td>0.7</td>
</tr>
</tbody>
</table>
Research population consists of Iranian universities and research centers with technology transfer experience. Four universities and research centers were randomly selected from them. After devising the questionnaire and initial sampling, confirming the reliability and validity of the questionnaire and final modifications, 500 questionnaires were distributed among researchers and faculty members of which 168 (34%) were returned. 17 of the returned questionnaires were omitted due to information deficiencies and, ultimately, 151 questionnaires were used to analyze data.

However, efforts were made to respect the condition of at least 10 questionnaires for each studied variable (Gullivan, 2005) in order to use path analysis technique for data analysis. Furthermore, KMO\(^1\) estimates shown in Table 2 indicate that sample volume adequacy. Table 1 shows the demographic distribution of collected samples.

### 3.2. Introducing Organizational Capability, Knowledge Capability And Technology Transfer Effectiveness Indicators

After concluding the relevant literature on technology transfer capabilities, knowledge management and technology transfer effectiveness (2.1 – 2.4), some indicators were extracted to measure technology transfer process capabilities, knowledge management and technology transfer effectiveness in Iranian universities. After being evaluated and revised by elites, there were totally 18 indicators for technology transfer capabilities (4 indicators for organizational capability, 6 for relational capability, 4 for technological capability and 4 for knowledge capability), 10 for knowledge management and 5 for technology transfer effectiveness in Iranian universities.

### 4. DATA ANALYSIS

To test the above-mentioned hypotheses, structural equation modeling in AMOS software is used. Figure 2 shows the model which fits the standardized ratios to test the 1st hypothesis. In below figures, variables like TTE, KM, OC, RC, KC and TC indicate technology transfer effectiveness, knowledge management, organizational capability, relational capability, knowledge capability and technological capability, respectively. Before interpreting the model coefficients and understanding the relations among variables, it is initially necessary to assure good fitness model. In this model, the value of \(\chi^2/df\) is computed as 1.51. Values less than 3 show proper fitness of the model. In the meantime, the value of RMSEA is 0.51. Since in statistical contexts, 0.08 value as cutting point is introduced as a benchmark for model fitness (Iacobucci, 2010) and values greater than 0.08 show model weakness, one can say that based on this benchmark, model fitness is not proper. In the meantime, desired rates for GFI, AGFI and CFI are greater than 0.9 which are 0.910, 0.902 and 0.931, respectively in the studied model. Table 3 outlines the statistics for good to fit model and other models.

Represented indicators show that on the whole this is a suitable model properly regenerating empirical data.
H2.4. knowledge capability has a positive and significant relationship with technology transfer effectiveness.

H2.5. technology transfer capabilities have a positive and significant relationship with technology transfer effectiveness.

To study the above hypotheses, each is fitted separately and good to fit statistics are shown in table 3 which shows proper fitness. In the meantime, fitness for each model and their significance is depicted in table 4. For instance, the result of model 2.3 fitness in table 4 indicates that there is a significant relationship between relational capability and technology transfer effectiveness. Standard ratio (correlation coefficient between hidden variables of relational capability and technology transfer effectiveness is estimated as 0.54 which shows a positive relationship between both variables. Since the significance value of this test is 0.11 which is less than 0.05, we conclude that the linear relationship between both variables is significant in 0.05 level (note that such estimation is achieved in the absence of other capabilities in the model). Concerning the results estimated in table 4, one can say that other technology transfer capabilities also have a significant relationship with technology transfer effectiveness (in the absence of other capabilities). Therefore, hypotheses H2.1 to H4 are supported.

H2.5 addresses the relationship between technology transfer capabilities and technology transfer effectiveness, and asks whether each technology transfer capability (if assumed being fixed) has any significant relationship with technology transfer effectiveness or not.

Good to fit statistics in the present model are shown in table 3 (model 2.5). Concerning standard ratios shown in table 4, one can say that technological, relational and knowledge capabilities have a significant relationship with technology transfer effectiveness. Additionally, no significant relationship is observed between organizational capability and technology transfer effectiveness in the attendance of other capabilities. To interpret such parameters, one can say that if relational and knowledge capabilities in two universities are identical, then we expect more technology transfer effectiveness in the university with higher organizational capability.
Ultimately, to study H3 which reads that knowledge management has a significant relationship with technology transfer effectiveness through technology transfer capabilities; the model devised in figure 3 is used. Its good to fit statistics has admirable fitness.

Table 3: Good to fit indices in fitted model

<table>
<thead>
<tr>
<th>Model</th>
<th>X2/ df</th>
<th>RMS EA</th>
<th>RM R</th>
<th>GFI</th>
<th>AGFI</th>
<th>CFI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model 1</td>
<td>1.5</td>
<td>0.051</td>
<td>0.0</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
</tr>
<tr>
<td>Model 2</td>
<td>RC 6</td>
<td>RM 0.049</td>
<td>0.36</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
</tr>
<tr>
<td></td>
<td>TC 9</td>
<td>RM 0.057</td>
<td>0.36</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
</tr>
<tr>
<td></td>
<td>OC 0</td>
<td>RM 0.048</td>
<td>0.36</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
</tr>
<tr>
<td></td>
<td>KC 2.4</td>
<td>RM 0.063</td>
<td>0.36</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
</tr>
<tr>
<td></td>
<td>Total 7</td>
<td>RM 0.066</td>
<td>0.36</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
</tr>
<tr>
<td>Model 3</td>
<td>1.5</td>
<td>0.056</td>
<td>0.0</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
</tr>
</tbody>
</table>

Desired value: <3 <0.08 <0.05 >0.0 >0.0 >0.0

Table 4: The estimation of path ratio and its significance in fitted models

<table>
<thead>
<tr>
<th>Model</th>
<th>RC</th>
<th>TC</th>
<th>OC</th>
<th>KC</th>
<th>KM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model 1</td>
<td>KM 0.006</td>
<td>0.83</td>
<td>KM 0.016</td>
<td>0.79</td>
<td>KM 0.008</td>
</tr>
<tr>
<td>Model 2</td>
<td>TTE 0.11</td>
<td>0.54</td>
<td>TTE 0.009</td>
<td>0.57</td>
<td>TTE 0.24</td>
</tr>
<tr>
<td></td>
<td>TTE 0.045</td>
<td>0.33</td>
<td>TTE 0.037</td>
<td>0.28</td>
<td>TTE 0.355</td>
</tr>
<tr>
<td></td>
<td>TTE 0.361</td>
<td>0.19</td>
<td>TTE 0.210</td>
<td>0.24</td>
<td>TTE 0.029</td>
</tr>
</tbody>
</table>

Figure 3: The relations between knowledge management and technology transfer process capabilities and technology transfer effectiveness

In the fitted model, the direct impact by knowledge management on technology transfer effectiveness is estimated as 0.41 (significant in level 0.05) and the indirect impact is estimated as 0.20 (significant in level 0.05). The overall by knowledge management on technology transfer effectiveness shown in table 4 (model 3) is estimated as 0.61 (significant in level 0.05). Therefore, one can say that knowledge management relates to technology transfer effectiveness indirectly via technology transfer capabilities.

Concerning the above points, path ratios in table 4, and studying each variable in technology transfer effectiveness, one can conclude that knowledge capability and knowledge management and, finally, technological capability have the highest impact on technology transfer effectiveness.

Regarding the fitted model, total impact of knowledge management on technology transfer effectiveness is estimated as 0.61 which is significant based on table 4 in significant level 0.05. Therefore, H3 is supported.
5. DISCUSSION

The conducted research indicates that technology transfer is a multilateral phenomenon in whose success many factors are involved. In this line, some factors are more important than others.

Development and progress of societies is the result of scientific and industrial development links. By linking university and research centers as the incumbents of scientific centers development to industry as the incumbent of industrial development, one can achieve very positive results in economic development that would lead the country to progress and dynamism constantly. Studying relevant literature indicates that all countries have acknowledged the role of technology and knowledge in economic growth, and that they have conducted broad initiatives to build a bridge between research and industry sections. Concerning research results that show direct impact by knowledge management on successful technology transfer, it is appropriate that domestic research center managers pay more attention to technology transfer and pave the ground for executing its processes and mechanisms. In the meantime, they should make technology transfer projects and projects easier and more suitable to facilitate technology transfer flow and to enhance researchers’ performance in technology transfer activities by devoting sufficient resources to such activities.

Likewise, managers at research centers should improve the capacity of technology designing through increasing specialists’ skill levels, training levels, devoting sufficient resources to research activities and proper organizational structure. Such initiatives not only promote knowledge and technical levels of technology receptors, but also make it possible for research centers to transfer concerned knowledge and technology in a shorter time and at lower costs.

6. CONCLUSION

Due to new technology generation and transfer, universities are seen as one of the largest resources to acquire technology in manufacturing industries. Hence, it is very important to study technology transfer from university to industry. Technology transfer is influenced by the traits of both technology sender and receptor.

Concerning the above discussion, the present study was conducted. Initially, variables affecting on technology transfer from universities and research centers to industry were identified and then the relationship between knowledge management and these variables and their impacts on successful technology transfer were evaluated. To this end, technology transfer literature was widely and precisely studied, and then technology transfer related factors called as technology transfer process capabilities like organizational, relational, and technological and knowledge capabilities were identified as the factors affecting on technology transfer. In the meantime, indicators to measure their impact on successful technology transfer were determined. In the provided model, the relations between research variables were studied by structural equation model. The findings indicated that knowledge management directly impacts on technology transfer effectiveness (41%) and its indirect impact is only through knowledge capability as a facilitator (33%) and organizational capability as a mitigating factor (-0.46%).

Furthermore, confirmatory factor analysis (CFA) findings indicated that in knowledge-based centers, indicators such as acquiring and disseminating specialists’ knowledge and experience, using individuals’ current knowledge and experiences, and developing and using employees’ knowledge in new situations impact more than other indicators on successful technology design and transfer. In knowledge capability, such indicators as experiences, technological know-how, skill levels, educational levels, and R&D activities impact on successful technology design, generate and transfer more than other indicators. On the one hand, in organizational capability, indicators like decentralization and granting more independence to authors and faculty members in relation to industry, lack of sufficient resources for technology transfer, improper organizational structure, lack of adopted regulations on how to protect intellectual properties, laws and rules governing technology transfer offices or research offices, and lack of experienced and specialized managers and personnel in these offices, dearth of internal laws on how to regulate authors’ contribution, and lack of a clear strategy as a set of guidelines for technology transfer management without any interference in training missions can weaken the performance of authors in technology transfer activities more than other organizational barriers.
Studying other important factors on technology transfer projects effectiveness such as environmental, cultural, technology transfer paths, technology nature and technology transfer contracts are, *inter alia*, considerable subjects for future researchers. One can study these factors in terms of their impact on successful technology transfer or identify new factors not mentioned in the literature but influential in technology transfer process from knowledge-based centers to Industry in the view of elites.

**APPENDICES**

Appendix 1: Constituents of technology transfer process capabilities and their sources

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Source</th>
</tr>
</thead>
</table>

Appendix 2: Constituents of knowledge management, technology transfer effectiveness and its sources

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Technology transfer</strong></td>
<td>Stock (2005), Reisman (2005), Shaoji (2006).</td>
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</tr>
</tbody>
</table>
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