



**Prioritizing the effective factors of knowledge
commercialization with knowledge management approach**

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management approach**

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ABSTRACT

Commercialization of universities' research achievements is a complex activity which completes the chain of transforming idea of technology and leads to wealth creation, entrepreneurship and financial autonomy of universities. Also, knowledge management is one of these tools. Knowledge management is the process of creating value from intangible assets of organization. This intangible asset or knowledge is considered as an essential factor and vital source for organizations and future competitive advantages will be manifested in the form of organizations' capacity to manage knowledge. The purpose of present study was to prioritize factors affecting commercialization of knowledge with a knowledge management approach. This descriptive study is from survey type. In present study, inferential methods have been used to analyze quantitative data. Friedman test was also used to prioritize factors and confirmatory factor analysis (CFA) technique was utilized to determine the impact level of each affecting factor of knowledge commercialization.

Keywords: effective factors, knowledge commercialization, knowledge management



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1. INTRODUCTION

Commercialization is a process to make e knowledge, skills and invention produced in universities (research results in the form of methods, inventions, tools, processes, training courses, etc.) available and utilizable for organizations and society and research results means book, article, consultation, invention, education and so on, which utilizing them would make it possible to produce product, design and use of methods, processes, tools, develop human resources capabilities and provision of social services. The commercialization factors inve4stigated in present study include those conditions and characteristics of university environment which provide background, orientation and motivation necessary for commercialization of research findings. Given the lack of clarity of these factors and the relationships between them, it seems necessary to determine effective commercialization factors in commercializing research results and explain the relationship between these factors in order to help universities, researchers and decision makers in the field of research and technology to introduce research findings to social life environment and production of wealth from science, which the matter has been investigated in present study.

2. RESEARCH LITERATURE

Factors affecting knowledge commercialization with knowledge management approach

Investigation of theoretical foundations and existing literature showed commercialization factors affect attitudes, values and behavioral patterns of university and its stakeholders and the success or failure of universities in prediction of research results' commercialization can be addressed and studied in following categories:

Government forces

Government encourages innovation process (and commercialization) through providing infrastructure such as legal and public institutions. It can be mentioned to legal system of intellectual property, standardization institutions, financial support institutions, research infrastructures and ... as examples of government interventions



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in the process of creating and commercializing innovation and technology (Study Group of Strategic Management Faculty 2012).

Ratchford & Nichols (2010) have addressed some examples of government interventions in the process of creating and commercializing innovation and technology. In their study, they showed that governments and executive agents can utilize from research to make life better for humans and solve their problems.

According to Glatz, governments should support researches and apply their results and there should be close relations between governments and researchers (Sabaghian.2009).

Economic forces and market

The effect of world-class knowledge-based economy on many of the world's major universities has made university education as one of the largest sources of university capital to generate revenue (Feldman, 2007, p, 52-53).

According to Brachman (2006), "Lisbon Declaration¹" is an example of a comprehensive economic movement signed by heads of states and EU governments. Lisbon Declaration obliged EU governments to enjoy from knowledge-based economy by 2010 (Feldman,2007).

Financing required costs is also one of the most important and decisive factors in the research field. The share of research budget from gross national product (GNP) is considered as the main criterion for division of countries in the term of development. Measures such as discretion to fund research budgets, abolition of tax laws and regulations for more financial support for research and private sector investment in research should be considered in the economic dimension of research in addition to increasing research budget share of the country (Ghourchian & Shariati, 2009).

¹ Lisbon Strategy, also known as the Lisbon Agenda or Lisbon Process, was an action and development plan devised in 2000, for the economy of the European Union between 2000 and 2010. A pivotal role in its formulation was played by the Portuguese economist Maria João Rodrigues. Its aim was to make the EU "the most competitive and dynamic knowledge-based economy in the world capable of sustainable economic growth with more and better jobs and greater social cohesion", by 2010.[1] It was set out by the European Council in Lisbon in March 2000. By 2010, most of its goals were not achieved. It has been succeeded by the Europe 2020 strategy.



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Market is also affected by a variety of factors such as social, legal, political, value, competitive and technological factors. It is necessary for universities to identify and recognize these factors in order to communicate successfully and effectively with the market.

Customers and consumer orientation

Each organization's customers play an important role in increasing the commercialization of research results. Knowledge-based economy has made the circle of stakeholders and customers of higher education wider and more diverse (Ferasatkheh, 2010) and led the social response of higher education to be addressed to all audiences. Capital and customer satisfaction are two concepts used to explain role of customers in the success of business programs of universities. Knowledge available in the marketing channels and relationships with customers are the main subject of customer capital. Chen, Zhu & Xie (2004) have categorized customer capital in terms of marketing market intensity and customer loyalty.

Table (1), customer capital indicators

Fundamental capability	Creating and applying a customer database, customer service capabilities, and the ability to identify customer needs
Market intensity	Market share, potential market capability, sales units to customers, reputation and brand, creation of sales channels
Customer loyalty	Customer satisfaction, customer dissatisfaction, customer escape, investing in customer relationship

Competitors and Competitiveness

Competition between higher education institutes to attract students, research credits, altruistic helps, etc. is considered as an effective force in societies' development, especially in societies with a competitive economy. Porter (1990) argues that competitive advantage means values offered by company for customers, so that these



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values are higher than customer costs (Ghelichili, 2006 and Pacheco et al., 2017). In a competitive process, university should be considered as knowledge generator or center of the knowledge-based economy (Foroughi and Esfahani, 2012). The consequence of competitive era for university is a place for commercialization of knowledge so that they can grow their roots and leaves in the body of this entity (Feldman, 2007, pp.14-15).

Technological advances

Today, organizations involved in technological production are characterized by two major functions of producing new knowledge and commercializing it. Technology revolution is a force that not only forms the commercialization approach of universities, but also is a means to realize it. Growing use of computers and Internet as well as the importance of microchip technologies has encouraged universities to invest in these areas. Experts consider these technologies as commercialization platform for higher education. They introduce distance education as an objective example of universities' approach to close market values and commercialization processes (Feldman, 2007, p.66-67).

Plans, macro provisions and regulations

In this regard, one can refer to Iran's 20-year vision plan that describes Iran as a developed country with the first place in the field of economic, scientific and technological development in the region in an Islamic and revolutionary form with constructive and effective interaction in international relations. It can be also referred to the second principle of Islamic Republic of Iran's constitution for use of advanced human sciences and techniques and efforts to develop them. These cases are included in smaller provisions and regulations such as Articles 43, 45, 46 and 116 of Fourth Development Plan and Articles 16, 17 and 18 of Fifth Development Plan and ministries' development plans such as Fifth Development Plan for higher education and strategic plans of universities. It can be also referred to approval of the Law on Protection of Enterprises and Knowledge Based Organizations and Commercialization of Innovations and Inventions in 2010, especially Article 9 of this law (System of Laws and Legislations of the Islamic Parliament 2010).



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Venture Capital Funds

Venture capital is a type of funds that professional people offer to startups, innovative and upcoming companies through venture capital funds and with management assistance. These funds are usually corporations or cooperatives whose funds are funded by government, pension funds, foundations, companies, wealthy individuals, foreign investors or by themselves (Mostahsan & Bagheri, 2012).

Participation of these funds includes ongoing support and counseling and readiness for executive roles in addition to provide funding. Trusted companies such as Apple, Intel and Microsoft are among the most famous companies have used venture capital in their early development (Nuechterlein 2011).

Information and Communications Technology (ICT)

Information technology consists of collecting, organizing, storing and publishing information through computer and telecommunication tools (Turban, Rainer & Potter, 2005, p.9). In information society, wealth is acquired through information and its usage in agriculture, services and industry (Eliasson, Johansson & Taymaz , 2004).

Science and technology development parks and centers

Filling the gap between academia and industrial innovation is a new mission that governments have established development centers and technology parks to do this mission (Jalili, Mousakhani & Behboudi, 2011).

"Science and Technology Park is a professional and specialized institution that works to promote the level of innovation culture and increase interaction between companies participated in the park and industrial and commercial centers and science and technology institutes" (IRPHE, 2007, P.296).

Development center is also an institution that supports innovative startups companies in the field of technology knowledge through providing required services (IRPHE, 2007, P.303). Science and technology parks are a bridge between university and industry and the best place to grow technology (Radfar, Khamseh & Madani, 2009).



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Explaining the problem

Commercialization of research results and its effective knowledge commercialization factors: commercialization means the process of introducing goods or services to commercial trading cycle (IRPHE, 2013) and commercialization of research results is transfer of an idea, method, tool, skill, technical knowledge of intellectual property, discovery or invention of scientific research implemented in academic sector (with or without partners) to an industrial environment which can lead to development or improvement of products or processes (Ktepe 2014). Universities play a role in obtaining legitimacy and revenue in response to market expectations and value creation for how researchers contribute to profit from commercialization of research results (MSRT, 2005).

Establishment and activity of vice president of science and technology, establishment of development centers and Science and technology parks, adoption of law on Protection of knowledge based enterprises and elite and researchers support laws are among other issues that increase the incentives of researchers to produce applied science and technology. Currently, universities face problems such as lack of financial resources, insufficient trust of customers and stakeholders about ability of universities to solve problem and meet the needs and multiplicity of competitors in production and supply of knowledge, methods, tools and processes required by organizations. They are trying to bring themselves closer to the generation of successful universities, namely Entrepreneur University. Commercialization of research findings which is the main feature of Entrepreneur University requires several prerequisites, specializations and factors. Meanwhile, external environmental factors (knowledge commercialization) play an important role in facilitating and motivating them.

commercialization of research results includes transfer of an idea, method, tool, skill, technical knowledge, intellectual property, discovery or invention resulting from scientific research implemented in academic sector (in partnership with or without partners) to an industrial environment which can lead to development or improvement of products or processes (Ktepe, 2004).



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Universities have placed their emphasis on responding to market expectations and producing value for customers in order to gain more legitimacy and more revenue. Science has entered marketing literature as a service or product since the topics of customer satisfaction and marketing of academic products to academic field were posed (Plewa & Quester, 2005; Nowotny, 2006). Transformation of knowledge into wealth becomes possible through formation of innovation process and production and sale of new products and by this, science becomes value, wealth and ultimately social welfare (Iran National Science Foundation, 2009). Production and service organizations are also dependent on environmental actors in production of science in order to provide their capabilities and resources and universities and their professional members are valuable resources for achieving this goal (Lin Lee & Hung 2006). University scholars coat a science-based cover to performance of industries by presenting the scientific fields of technology and bring them into the overflow of technological knowledge generated at university (Dietz & Bozeman, 2015). Iranian universities have no brilliant history of facing environment and its changes for many reasons. While the external environment has been heavily influenced by technological change, universities in the country have not shown much of their innovation in increasing funding sources, creation of information networks of new educational and research methods and scientific capabilities (Arasteh 2000). The survive environment of organizations is dynamic and constantly changing. Various environmental identities or more clearly, environment forces outside the organizations affect continuously affect them and control their behaviors. For this reason, no organization can be considered completely independent or self-governing. Arasteh et al (2000) have studied the effect of technological characteristics of produced product and market potential on commercialization of technology. The obtained results showed that the probability of technology commercialization would be higher if produced technologies have certain features of innovation in terms of generality, simplicity and flexibility, having potential customers, having a desirable market. Karlsson (2004) has also considered three environmental factors of private sector capital availability, ownership rules of research results and government programs effective in the success of research commercialization. Therefore, the



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purpose of present study was to prioritize effective factors of knowledge commercialization with knowledge management approach.

Questions of present study

1. How to prioritize knowledge commercialization factors with knowledge management approach?
2. What have been the effects of demographic factors and commercialization experience on determining effective commercialization factors in research results' commercialization?

3. METHODOLOGY

Present study is an applied one in the term of its purposes and a combined survey study in the term of data gathering method, because qualitative tools of interview and quantitative tools of questionnaires were used to gather required data. The statistical population of present study included senior managers and research and technology directors and faculty members of the technical and professional university and senior managers and managers related to research and technology of manufacturing and service organizations associated with this university. In interview section, the statistical population also included other experts in the field of scientific and executive related to the subject of present study and with effective compilations or executive history in commercializing research results in addition to above mentioned population.

The statistical population of present study was 521 individuals. Among them, 156 individuals were selected as sample size using Cochran formula and sample modification. Purposeful sampling method was used in qualitative section of the study to conduct a semi-structured interview and gather required data.

Cranach's alpha method was used calculate reliability of questionnaire, which the amount of 0.9641 was obtained. The calculated Cranach's alpha coefficient for different sections of questionnaire indicates its proper reliability (Table, 2).



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Table (2), Cranach's alpha coefficient for all sections of the questionnaire

Section	Variables	Number of questions	total items	Cranach Alpha amount	Total reliability
First: Experience	Commercialization experience	11	11	0.87	0.87
Second: Effective components on knowledge commercialization based on knowledge management	Government forces	5	59	0.70	0.94
	Economic forces or market	6		0.66	
	Customers and Customer Orientation	8		0.74	
	Competitors and Competitiveness	5		0.75	
	Technological advancements	4		0.72	
	Plans, laws and regulations	6		0.81	
	Understanding and believing in religious teachings	5		0.88	
	Venture Capital Funds	4		.077	
	Science and technology development parks and centers	7		0.82	



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	Information and Communications Technology (ICT)	5		0.83	
	Education	4		0.75	

Ad Hoc method was used to analyze data obtained from interviews with 15 researchers and research directors and technology related to the commercialization of research results at a technical and professional university or in organizations under research and production contracting contract with this university. Production of meaning by Ad Hoc method is the most common form of interviewing analysis to produce meanings, because it simultaneously utilizes other approaches to analyze data from interview, such as tabulation, classification of meanings, and structuring of meanings through quotations and interpretation of meanings (Kvale, 1996).

Inferential methods were used to analyze quantitative data. Friedman test was used to prioritize factors and confirmatory factor analysis used to determine the effect of each factor of knowledge commercialization.

factors	Items	Frequency
Government forces	Government policies and orientations in relation to research and technology	8
	Encouraging inventors and entrepreneurs and paying attention to privatization	3
	Establishing a vice president Science and Technology Assistant, Support Fund for Researchers and ...	5
	Establish a technology department along with research disruptions in universities and other organizations	4
Economic forces	Having knowledge-centered economy	5
	relative growth of a knowledge-based, multi-product and oil-independent economy	7



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Customers	Customer satisfaction and responsiveness to them	4
	Having a position among government agencies	3
	History and reputation of university among employers and customers	6
Competitors and Competitiveness	Competition of companies with each other on the level and type of their knowledge	4
	Creating a new product or improving quality of previous products with competitive advantage	5
	Create a safe and healthy environment for competition	6
Technological advancements	Establishing laboratory and workshop facilities, advanced equipment, establishing site for testing products and similar in the university and industry .to complete research chain	3
Plans, laws and regulations	Faculty Promotion Regulations	4
	Macro national laws and regulations	4
	Development plans	4
	existence of major supportive laws and observing them	8
	Optimizing laws to encourage research and business activities of organizations in order to .become knowledge oriented	5
	Utilizing from legal capacity of fourth development plan and commercialization laws	4
Belief in religious teachings	Recognition, Belief and observation of religious teachings	3
	Familiarity and belief in teachings of Qur'an and Hadith and Islam	3
Venture Capital Funds	Full funding of university and industry from researchers	6



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	Many risky-taking supports and investments in a legal context	4
	Use of financial and equipment providers	3
	Venture-makers and entrepreneurs who are aware of commercialization and entrepreneurship	7
Science and technology development parks and centers	Activities of knowledge-based corporations, parks and centers of science and technology development	4
	importance of parks and development centers as infrastructures of knowledge economy of the country	3
	Observing laws and regulations regarding the activities of parks and centers for development of science and technology	4
Information and Communications Technology (ICT)	Strong and continuous interactions between faculty members and managers and organizations in the field of information and communication technology	3
Information and Communications Technology (ICT)	Creation of information and communication infrastructure	4
Information and Communications Technology (ICT)	Use of IT capabilities	6
Education	Having a research-centered and problem solving-based education system	4
	Train negotiation and communication skills to faculty members	3
	Training entrepreneurship and commercialization skills	2
	Training how to market and attract foreign capital	4



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FINDINGS

4. How is prioritization of knowledge commercialization factors?

In present study, Friedman test was used to prioritize effective commercialization factors in commercializing the research results. The test determines rank of components in addition to determining the rating for each component. According to the results obtained from Friedman test, it can be argued with confidence level of 0.99 that effective commercialization factors of commercializing research findings were prioritized, because significance level was less than 0.01. The factors have been presented in Table (6) based on importance and extent of their effect on commercialization of research results.

Table (6), prioritization of knowledge commercialization factors with the separation of three main factors

Factors	Variable (sub factors)	Frequency of respondents	Average rank	Chi-square test	Freedom degree	Significance level
	Customers, Customer Orientation	162	8.13	223.99	10	0.00
	Education		7.47			0.00
	ICT		7.11			0.00
	Technological advancements		6.63			0.00
	Economic forces or market		6.30			0.00
	Science and technology development parks and centers		5.81			0.00



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Commercialization factors	Venture Capital Funds		5.47			0.00
	Government forces		5.13			0.00
	Understanding and believing in religious teachings		5.12			0.00
	Plans, laws and regulations		4.47			0.00
	Competitors and Competitiveness		4.36			0.00

Question 4: what have been the effects of demographic factors and commercialization experience on determining effective commercialization factors in research results' commercialization?

One-way variance analysis in statistical analyzes related to the impact of gender, education, academic rank, income, employment status, country, final degree, academic experience, field of study, current position and work experience of respondents and determining the factors of commercialization research results indicated that there is no significant difference between respondents' opinions with respect to these variables.

Out of a total of 162 individuals of statistical sample of present study, 49 individuals (30.2%) stated that they have had a history of commercializing research results and 113 individuals (69.8%) stated that they have had no history of commercializing research results. . Also, most people with commercialization experience (89%) in many activities have had limited commercialization experience at the levels of never, once and twice.

Investigating the effect of research results' commercialization history on determining effective factors of commercialization research results showed that there is no significant difference between respondents with experience of research results'



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commercialization and respondents without this experience in the term of determining commercialization factors.

- It is recommended to seriously utilize from Legal capacity, such as law protecting corporations and knowledge-based institutions, commercialization of innovations and inventions and similar cases.

9. Financial and tax facilities can be assigned to pilot design protocols, testing and optimization of knowledge-based products, as well as establishing knowledge based companies with expert evaluations.

10. Media plans should be prepared and implemented to raise the awareness of academics, researchers, entrepreneurs, economic activists, policymakers, legislators and other stakeholders and stakeholders on various aspects of intellectual property rights.

11. Training courses should be organized to improve information literacy of members of the university in order to access needed scientific and technical information and to communicate with researchers and officials from other organizations.

12. It is recommended to researchers interested in studying related subjects of present study to conduct the subject of present study in other knowledge-based organizations as well as in manufacturing and service organizations of the country and examine the obtained results in order to investigate its generalizability and compare viewpoint of productive and service community of the country with the viewpoint of scientific and academic community.

4. CONCLUSION

The results obtained from quantitative study showed that all commercialization factors have effect on commercialization of research results at a confidence level higher than 99%. Confirmatory factor analysis indicated the effectiveness of all commercialization factors with factor load (beta coefficient) between 0.47 and 0.80 at significant level of 0.001.

The highest factor load (0.80) was related to customer and customer orientation of university and the least factor (0.47) was related to competitor and competitiveness.

Concluding the results obtained from interviews about effective commercialization



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factors in the commercialization of research results showed that all factors confirmed in the quantitative study have been also confirmed by experts participating in the interviews. Some of these factors such as education, laws and macro plans, government forces and venture capital funds were more emphasized compared with other factors and more items were extracted from them in interviews. With concluding quantitative and qualitative findings, effective external factors of commercializing research results were obtained with following priorities:

- Customers and customer orientation with a rating of 8.13 and factor load of 0.80
- Education with a rating of 7.47 and factor load of 0.75
- Technological advances with a rating of 6.63 and factor load of 0.63
- Economic forces and market with a rating of 6.30 and factor load of 0.62
- Science and technology development parks and centers market with a rating of 5.81 and factor load of 0.56
- Venture capital funds with a rating of 5.47 and factor load of 0.55
- Government forces with a rating of 5.13 and factor load of 0.54
- Familiarity and belief in religious teachings with a rating of 5.12 and factor load of 0.52
- Laws and macro plans with a rating of 4.47 and factor load of 0.48
- Competitors and competitive factors with a rating of 4.36 and factor load of 0.47

According to the results of present study, having advanced technologies creates opportunity of conducting technology-based research and creation of new technologies and these technologies are needed by industrial and service customers. Razavi & Moeini (1999) conducted a study on the activities of research and technology centers and concluded that first priorities of these centers was to select and implement research projects according to country's technological needs (67.6%) and the needs of industry customers (21%), respectively. This finding is in consistent with the results of present study. Other finding in the study of commercialization factors was the effect of education component, including education system of higher education system and organizational education on improving research results' commercialization. In this regard, the finding of Alan



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Lowe (2002) is in consistent with the results of present study. According to Alan Lowe's study, knowledge of knowledge inventors plays an important role in the development of technology by academic inventors.

According to the results of present study, government forces (0.54), economic forces (0.62) and technological advances (0.63) are factors affecting research results' commercialization. In this regard, results of study conducted by Grady (2002) are in consistent with the results of present study. According to Grady's study, environmental factors including institutional and market support have effect on entrepreneurial and business behaviors of researchers. Also, the study conducted by Feldman (2007) is in consistent with the results of present study. The results obtained from this study indicated the impact of government pressures, economic pressures and technology pressure on research commercialization. It should be noted that Feldman's study has been conducted on University of New Mexico with the aim of explaining the impact of collaboration culture and transformation of university values and the mentioned finding was one of the sub-findings of this study.

According to the results of present study, venture capital funds, development centers and science and technology parks are factors affecting research results' commercialization. In this regard, finding of study conducted by Allen Consulting Group (2004) in Australia- which indicated the effect of factors such as availability of venture capital funds and presence of local businesses with strong capacity to receive technology in commercializing research results- is in consistent with the results of present study.

According to the findings of present study, one of the most important factors affecting research results' commercialization is customers and attention to their demands and needs and in contrast, competitors and attention to them are the least important factors affecting research results' commercialization. From viewpoint of experts, both factors are important in the growth and survival of independent organizations (Hutt & Speh, 2007). On the other hand, competition between higher education institutions to attract students, faculty members, research credit and other similar cases are considered highly effective in commercializing research, especially in societies with competitive economy. Competitive forces imposed to higher



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education make higher education decision-makers to re-evaluate their values and missions and business efforts can be seen as a powerful tool for their victory in the field of competition (Feldman, 2007).

The problem why customers are more important than competitors in Iranian society and technical universities from the viewpoint of respondents of present study is a question that requires scrutiny and careful investigation. According to Feldman (2007), it can be said that Iran's society has not yet entered in the field of competition and attention to financial and decision-making autonomy, especially its academic community.

Due to the fact that factor of competitors and competitiveness have gained a score higher than mean value in present study as like other factors as well as confirmatory factor analysis indicated the effect of this factor on research results'

commercialization, therefore it can be said that the academic community of Iran and the technical and professional university are at the beginning of their path in the term of paying attention to competitors and competitive ability and the growth and survival of this factor has not been significant yet. Hence, it cannot be still considered as an effective factor of research results' commercialization by universities.

Another interesting and important finding was the role of familiarity with religious teachings related to application of science in life and scientific belief in them for commercialization of research results. From viewpoint of respondents, this factor was placed in a higher rank (0.52) compared with competition factors (0.47) and macro policies and regulations (0.48) in the term of effectiveness in applying knowledge and commercializing research results. No research was found on the effect of religious and religious factors on research results' commercialization.

Other important finding was the role of Information and Communication Technology (ICT), which ranked third among external factors affecting research results' commercialization. This finding reflects the attention of academics to information and communication technologies and their entry into information age.



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This factor has played an important role in facilitating business and scientific relations through collapse of boundaries between industry and academia, between countries and between researchers, employers and customers.

Also, this factor contributed to creation of a competitive environment and speed of science based products and supply of these products through increasing customer bargaining power, customization, producer power, expansion of distribution networks and other similar cases.

Several researches and experts such as Eliasson et al (2004) and Tarben et al (2005) have emphasized on the positive effect of information and communication technology on research and research affairs, internal communication and commercialization, advertising and marketing, which is in consistent with the findings of present study.

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