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Original Research

Knowledge Commercialization in Iran University of Medical Sciences: Faculty Members' Viewpoints

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Abstract

Knowledge commercialization is one of the requirements of success in the modern economy. Universities and, accordingly, their faculty members play a crucial role in knowledge production and commercialization. The main purpose of the current study is to identify and review the factors influencing knowledge commercialization in the Iran University of Medical Sciences from the viewpoints of the faculty members. A cross-sectional descriptive survey was conducted on 267 randomly selected faculty members of the Iran University of Medical Sciences in line with the purpose of the study. The face validity of the scale was evaluated by seeking the opinions of five Medical Library and Information Science faculty members. The reliability of the scale was also confirmed by achieving Cronbach's alpha test coefficient equal to 0.86. The data analysis was done using the SPSS software, version 21, descriptive statistics, and the Friedman test. Managerial requirements (M=7.71, SD=±25.69) were revealed as the most influential factor in knowledge commercialization. The cultural requirements (M=6.56, SD=+-2.82) showed the least effect. Employing experienced professional staff, faculty members' problem-solving skills and knowledge and their research morale, supporting and equipping the involved bodies, developing a purposive, precise, and professional system for project evaluations, public financial and intellectual support, the inclusion of knowledge commercialization in the state's strategic planning, as well as the development of a research-centered and project-centered culture in the university, are among the most important components of knowledge commercialization. Furthermore, according to the Friedman test, the structural, managerial, legal, individual, cultural, and environmental factors seemingly significantly affect knowledge commercialization in the university. Paying attention to the requirements of knowledge management implementation, especially managerial requirements, is very important for successful knowledge commercialization in universities.

Keywords: Knowledge Commercialization, Research Commercialization, Iran University of Medical Sciences, Faculty Members.

Introduction

Universities and higher education institutions have gone through different periods since their inception. First-generation universities were established solely to educate students, second-generation universities are engaged in research and production of knowledge, and third-generation universities are entrepreneurial and product-oriented. In addition to producing science and training the human resources needed for development, third-generation universities also establish knowledge-based companies to commercialize science. The basic characteristics of third-generation universities include entrepreneurship, focus on economic aspects, and their efficiency and competitiveness compared to other academic generations. Third-generation universities that commercialize knowledge in practice become more efficient with activities such as patents, the development of knowledge-based companies, and science and technology parks (Dalmarco, Hulsink & Blois, 2018).

In the current era, the most sustainable economic growth in the world relates to a knowledge-oriented or knowledge-based economy. Universities, especially third-generation universities and knowledge-based companies, play a crucial role in economic growth within a knowledge-based economy. One of the success requirements in such an economy is knowledge commercialization (Sotirakou, 2004). Knowledge commercialization is the conversion and transfer of theoretical knowledge created in the universities into various business activities (Spilling, 2004). It also includes the efforts made to sell academic products or provide activities for making a profit, such as giving consultations, conducting applied research, and holding the applied educational programs (Vosough & Biralvand, 2016). The process of knowledge commercialization has two major elements: 1) research organizations (the universities and research centers); and 2) the users of the research results (including industries, venture capitalists, government, for-profit institutes, and so on). Accordingly, the fruitful marketing and commercialization of research results require complete understanding and identification of behavioral patterns of two parties involved in the knowledge production and commercialization process (Salamati, Vaezi, Memarpour & Rajabzadeh, 2016).

The commercialization of academic research has gained much importance during the two recent decades. UNESCO's universal declaration of Higher Education invites universities worldwide to an international convergence. It considers knowledge commercialization one of the universities' basic requirements to adapt to global trends (Papaconstantinou, 1997). On the one hand, the reduction of budgets allocated to the universities (Sotirakou, 2004), the increase in university and higher education admissions, concerns about the future jobs as well as the role of scientific knowledge and innovation in the development of new businesses are among the factors that identified the academics as one of the major factors in the economic and innovation development of countries (Salamati et al. 2016). Following Iran's 6th social and economic development plan for providing the necessary grounds for commercialization of research findings of the universities and research centers, the university administrators and policy-makers now understand its importance. They intend to move toward knowledge commercialization (ShamsAllahi & Yaghoubi, 2013).

Previous studies in knowledge commercialization were often aimed to introduce the concepts of knowledge commercialization and its prerequisites (Radfar, Khamseh & Madani, 2009), to identify the influential factors (Aghajani, Hosseini & Sarvari Ashliki 2015), challenges, and the barriers to the knowledge commercialization process (Pourezzat, Gholipour & Nadirkhanlou, 2010; Pourezzat & Heidari, 2011; Vosough & Biralvand, 2016), and to develop relevant conceptual models (Hafezi, Ekrami, Ghoorchian & Sarmadi, 2015; Mastery

Frahani, Nyazazari & Shlehi, 2015; Salamati et al. 2016).) According to the literature, the factors influencing knowledge commercialization in the universities are classified into four main categories: managerial, structural, environmental, and legal. Each of these main categories is subdivided into several sub-categories. The extent to which these factors can influence knowledge commercialization varies in different universities (Khayatmoghadam & Rastgar, 2015).

Some studies identified the challenges and barriers to knowledge commercialization and knowledge transfer from the university to the industry in Iran and classified them into four major cultural, structural and political, and legal barriers. Cultural barriers include the opposition of some academics to the commercial transfer of knowledge, lack of freedom of action for academics to involve in business activities, different attitudes of academics and industry practitioners, the reluctance of the national system toward innovation, non-competitive academic atmosphere, mutual distrust between university and industry, and lack of a strategic view to transferring knowledge and technology from university to industry (Vosough & Biralvand, 2016).

The existence of parent companies and non-development of new companies, insufficient relationship between industry and university, low investment for the development of new technologies and the resulting financial problems, inadequate professional competencies of graduates, and the weakness of the education system are mentioned as some of the structural barriers to knowledge commercialization. The legal-political barriers include weakness in intellectual property protection laws, the dependence of the university on governmental budgets, lack of knowledge of universities about the needs priorities of the business sector, and insufficient share of researchers in knowledge commercialization revenues (Pourezzat et al. 2010; Vosough & Biralvand, 2016). Most former studies are mainly done in non-medical universities. No research was found investigating the facilitators of and barriers to knowledge commercialization in medical universities and institutions of higher education to be taken as examples for the Iran University of Medical Sciences.

According to the Times Higher Education's (THE) World University Rankings in 2019, Iran University of Medical Sciences ranked 15th among the national universities of medical sciences and 201-250 among top Asian universities (International deputy, 2019). One of the ranking indicators relates to the universities' research income from industry and commerce, or in other words, the extent of knowledge commercialization. Iran University of Medical Sciences uses two strategies for knowledge commercialization: Conducting university-industry projects and establishing knowledge-based companies. University-industry projects are those projects in which the companies from the health industry, like pharmaceutical or medical equipment companies, request the university to conduct their required research projects while sponsoring the project. The second strategy of the Iran University of Medical Sciences is to establish knowledge-based companies. These companies are usually well-supported by the government and regarded as the major centers for developing and implementing research and innovative ideas of academics. The faculty members and students are among the important elements of knowledge commercialization who can produce and commercialize their experience and knowledge (ShamsAllahi & Yaghoubi, 2013). Therefore, it is crucial to seek their viewpoints on the effective factors and facilitators in knowledge commercialization. Identifying the effective factors, facilitators, and challenges of knowledge commercialization from the faculty members' perspective at the Iran University of Medical Sciences can improve and facilitate the flow of knowledge and technology from this university to the industry.

The present study seeks to investigate how to improve the transfer of knowledge and technology from the Iran University of Medical Sciences to the industry by identifying the cultural, structural, environmental, managerial, individual, legal, and political requirements and

challenges of knowledge commercialization in view of the faculty members. Identifying and prioritizing these factors and difficulties of knowledge commercialization may provide a ground to direct the Iran University of Medical Sciences (IUMS) research findings to the target markets.

Research Methods

This is a descriptive cross-sectional survey. The study population was 910 faculty members of the Iran University of Medical Sciences during the 2019-2020 academic year. The sample size was estimated as 269 faculty members using the Krejcie-Morgan table. A simple random sampling method was used to select the participants.

The required scale was developed based on the findings of Khayatmoghadam and Rastegar's (2015) study. Pourezzat and Haidari's (2019) analysis was also adopted for designing the items related to challenges of knowledge commercialization.

The whole scale consisted of three parts: A) demographic items: including seven items about the faculty members' workplace, sex, age, education, scientific rank, the field of study and work records, B) items related to knowledge commercialization requirements: 29 items in four general aspects; namely, managerial (Pourezzat et al. 2010), structural (Radfar et al. (2019), environmental and legal requirements (Papaconstantinou, 1997), and items on knowledge commercialization challenges (Mastery Frahani et al., 2015). The items were designed on a five-point Likert scale, ranging from 1 (very low) to 5 (very high). The face validity of the scale was determined by seeking the opinions of five professors in Medical Library and Information Science on the content and wording of the items. The scale distribution examined its reliability among 25 members of the research population, and Cronbach's alpha calculationended up with an alpha of 0.86 that proved acceptable.

The scale was distributed partly in person and partly by email to randomly selected 267 faculty members. If no reply was received, the scales were re-sent after two weeks. Of 269 scales sent, 193 were completed and returned. Several 69 scales were also distributed in person among the faculty members due to a lack of access to the email addresses of the relevant faculty members. Finally, 267 scales were filled out and returned. The data analysis was done using SPSS software, version 21, running the descriptive statistics (frequency distribution, mean, frequency percentage, and standard deviation) and inferential statistical techniques such as the co-variance and the Freidman Test.

Results

Of 267 participants, almost all participants except four were aged above 30. There was an almost equal distribution of participants by age over 30, i.e., about 30% for each age group of 30-40, 40-50, and over 50. There was also a parallel distribution by gender, including males (51%) and females (49%). About half of the participants (49.4%) were Assistant Professors, 30% of the participants were Lecturers, and 20.6% were Associate Professors. Most of them had more than 17 years of work experience as academics. In addition, 69.29% of the participants were from medicine. The least number of the participants were from the Faculty of Technology (1.50%) and the Faculty of Iranian Traditional Medicine (1.50%).

The factors influencing knowledge commercialization in Iran University of Medical Sciences

As shown in Table 1, managerial requirements (M=25.69, SD=±7.71) and individual requirements (M±SD=4/69+-16.90) proved to have the highest effect while cultural requirements (M±SD =6.56+-2.82) had the minimum impact on knowledge commercialization, according to the faculty members' viewpoints.

The sub-components of each requirement for implementing knowledge commercialization are elaborated in detail.

Table 1
The factors influencing knowledge commercialization from members' viewpoint

Variable	Frequency	Min.	Max.	Mean	Standard deviation	Rank mean
Legal requirements	267	4	20	9.72	3.94	3.01
Environmental requirements	267	4	19	8.8	3.30	2.61
Managerial requirements	267	11	45	25.69	7.71	5.84
Structural requirements	267	5	17	9.69	3.26	3.10
Cultural requirements	267	3	14	6.56	2.82	1.49
Individual requirements	267	7	31	16.90	4.69	4.94

Legal requirements for knowledge commercialization

According to Table 2, "clear rules about the ownership of intellectual property rights" (M±SD= 2.50+-1.12) showed the highest effect, and "rules, processes, and policies facilitating the knowledge commercialization in the university" (M±SD=2.31+-1.09) showed the least. The significance level of the Friedman test in examining the effects of the legal requirements on knowledge commercialization is 0.018, which is less than the standard significance level (P<0.05). This shows that the legal requirements significantly affect knowledge commercialization from the faculty members' viewpoint.

Table 2
Legal requirements in knowledge commercialization from faculty members' viewpoint

Components	Frequency	Min.	Max.	Mean	Standard deviation	Rank average	Sig.
Clear rules about the ownership of intellectual property ownership	267	1	5	2.50	1.12	2.60	0.018
Tax exemption to motivate the investors	267	1	5	2.46	1.22	2.58	
By-law motivating knowledge commercialization for researchers	267	1	5	2.44	1.	2.46	
Rules, processes, and policies facilitating the knowledge commercialization in the university	267	1	5	2.31	1.09	2.36	

Environmental requirements for knowledge commercialization

According to Table 3, "the government’s financial and intellectual support for universities, academic researchers and industry sector to foster and attract new and innovative ideas" (M±SD =2.34+-1.09) was the most effective, and "providing a suitable environment for competitive thought and scientific communication at national, international and regional levels" (M±SD =2.03+-0.98) was least effective. The level of significance of the Friedman test in examining the effects of the environmental requirements on knowledge commercialization was 0.001, which was less than the level of standard significance (P<0.05). This shows that the faculty members believe environmental requirements significantly affect knowledge commercialization.

Table 3
Environmental requirements from faculty members' viewpoint

Components	frequency	min	max	mean	standard deviation	rank average	level of significance
The government's financial and intellectual support for universities, academic researchers, and for the industry sector to foster and attract new and innovative ideas	267	1	5	2.34	1.09	2.59	0.005
Attention to healthcare knowledge commercialization activities in the strategic planning of the country	267	1	5	2.31	1.00	2.78	
Offering new courses or holding workshops about knowledge commercialization in the university	267	1	5	2.19	1.18	2.40	
Providing a suitable environment for competitive thought and scientific communication at national, international, and regional levels	267	1	5	2.03	0.98	2.23	

Managerial requirements for knowledge commercialization

According to Table 4, "employing experienced professional staff in the university and research centers" (M±SD = 2.70+-1.12) showed the highest effect, and "developing a roadmap for the commercialization of academic research" (M±SD =2.03+-0.98) showed the least. The level of significance of the Friedman test in examining the effects of managerial requirements on knowledge commercialization was 0.001, which was less than the level of standard significance (P<0.05). This shows that the faculty members believe managerial requirements have a significant effect on knowledge commercialization.

Table 4
Managerial requirements for knowledge commercialization from faculty members' viewpoint

Components	frequency	min	max	mean	standard deviation	rank average	level of significance
Employing experienced professional staff in the university and research centers	267	1	5	2.70	1.12	7.41	0.001
The relative freedom of action for academics to involve in business and knowledge commercialization activities	267	1	5	2.57	1.19	6.60	
Explicit emphasis on academic entrepreneurship in universities and research centers' missions	267	1	4	2.37	0.91	6.46	
Reducing the extra bureaucracy and showing flexibility in the processes of knowledge commercialization	267	1	5	2.49	1.07	6.41	
Employing managers with strategic vision in research and executive affairs	267	1	5	2.37	1.11	6.13	
Encouraging the academics to conduct problem-based research	267	1	5	2.34	1.00	6.03	
Sharing the benefits of commercialization and innovation	267	1	5	2.30	1.12	5.74	

Components	frequency	min	max	mean	standard deviation	rank average	level of significance
with innovative researchers							
Presenting and using the research findings in the real context and reporting the results	267	1	5	2.25	0.9	5.55	
Financial support for venture capital funds such as research and technology funds via granting loan, credit, and financial facilities	267	1	4	2.15	0.78	5.52	
Increasing research competition and entrepreneurship among the universities	267	1	4	2.12	0.94	5.29	
Developing the roadmap for commercialization of academic researches	٢٦٧	1	4	2.03	0.98	4.85	

Structural requirements for knowledge commercialization in Iran University of Medical Sciences

According to Table 5, "supporting and equipping the involved bodies in research commercialization (industry liaison offices, development centers, and so on)" (M±SD = 2.2250+-0.82) showed the highest effect, and "establishing marketing and ordering centers for research results" (M±SD = 1.67+-0.76) showed the least. The level of significance of the Friedman test in examining the effect of managerial requirements on knowledge commercialization was 0.001, which revealed that the faculty members believe that the structural requirements have significant effects on knowledge commercialization.

Table 5
Structural requirements for knowledge commercialization from faculty members' viewpoint

Components	frequency	min	max	mean	standard deviation	rank average	level of significance
Supporting and equipping the involved bodies in research commercialization (industry liaison offices, development centers, and so on)	267	1	4	2.22	0.82	3.57	0.001
Developing a purposive, precise and efficient system for research projects' evaluation	267	1	5	2.13	0.92	3.37	
Providing a suitable collaboration ground for industry managers in university and vice versa	267	1	4	1.84	0.79	2.83	
Extensive communications and networking among academics, industry activists, investors, and entrepreneurs	267	1	4	1.83	0.89	2.77	
Establishing marketing and ordering centers for the research results	267	1	4	1.67	0.76	2.46	

Cultural requirements for knowledge commercialization in Iran University of Medical Sciences

According to Table 6, "creating and developing a project-centered and research-centered culture in the university" (M±SD=2.30+-1.18) showed the highest effect, and "institutionalizing and creating a culture of knowledge commercialization in the academic environment" (M±SD = 2.01+-1.09) showed the least. The level of significance of the Friedman test in examining the

effect of managerial requirements on knowledge commercialization was 0.001, which was less than the level of standard significance (P<0/05). This shows that the faculty members believe that cultural requirements significantly affect knowledge commercialization.

Table 6
Cultural requirements for knowledge commercialization from faculty members' viewpoint

components	frequency	min	max	mean	standard deviation	rank average	level of significance
Creating and developing a project-centered and research-centered culture in the university	267	1	5	2.30	1.18	2.13	0.001
Motivating the academics to involve in knowledge commercialization	267	1	4	2.25	1.03	1.99	
Institutionalizing and creating a culture of knowledge commercialization in the academic environment	267	1	5	2.01	1.09	1.88	

Individual requirements for knowledge commercialization in Iran University of Medical Sciences

According to Table 7, "faculty members' inherent talent and their dynamic and creative ideas" (M±SD=3.13+-0.96) showed the highest effect, and "marketing skill and knowledge and business labor" (M±SD=1.90+-0.78) showed the least. The level of significance of the Friedman test in examining the effect of managerial requirements on knowledge commercialization was 0.001, which shows that the faculty members believe that individual requirements have significant effects on knowledge commercialization.

Table 7
Individual requirements for knowledge commercialization from faculty members' viewpoint

components	frequency	min	max	mean	standard deviation	rank average	level of significance
Faculty members' inherent talent and their dynamic and creative ideas	267	1	5	3.13	0.96	5.54	0.001
Faculty members' problem-solving skills, as well as their knowledge and research morale	267	1	5	3.01	1.14	5.22	
Entrepreneurship skills and knowledge	267	1	5	2.37	0.99	3.98	
Familiarity of faculty members with science and technology development centers and parks	267	1	5	2.25	0.90	3.76	
Familiarity of faculty members with industry and market priorities and issues	267	1	4	2.28	0.81	3.73	
Familiarity of faculty members with the by-law, law, and regulations of knowledge	267	1	4	1.95	0.82	2.97	

commercialization							
Marketing and business skills and knowledge	267	1	4	1.90	0.78	2.81	

Barriers to knowledge commercialization in Iran University of Medical Sciences

According to Table 8, "lack of communicative means between government, industry, and university" (M±SD=4.28+-0.69) showed the highest effect, and "lack of management and political independence in the university" (M±SD=3.40+-1.00) indicated the least effect. The level of significance of the Friedman test in examining the challenges of knowledge commercialization was 0.001, which was less than the level of standard significance (P<0.05), showing that the faculty members believed that the challenges mentioned in the study have significant effects on knowledge commercialization.

Table 8
Challenges of knowledge commercialization from faculty members' viewpoint

components	frequency	min	max	mean	standard deviation	rank average	level of significance
Lack of communicative links/channels between government, industry, and university	267	2	5	4.28	0.69	7.87	0.001
Lack of creative, risk-taking, and entrepreneurs	267	2	5	4.15	0.84	7.35	
Lack of industry research needs assessment and lack of academics' familiarity with the industry research needs	267	2	5	4.12	0.63	7.09	
Lack of professional and effective research teams among the faculty members	267	1	5	4.00	1.04	6.82	
Lack of motivation for knowledge commercialization in universities and research centers	267	1	5	3.91	1.02	6.71	
The prevailing culture in industry and university	267	2	5	4.03	0.71	6.64	
Lack of problem-oriented dissertations/projects and lack of using their results in the industry	267	1	5	3.91	0.98	6.64	
Lack of financial independence of the university	267	2	5	3.99	0.76	6.63	
Taking a long time to commercialize a scientific finding	267	1	5	3.75	1.29	6.21	
Mutual distrust between industry and university	267	2	5	3.78	1.02	6.00	
Lack of knowledge of academics about the positive consequences of the knowledge commercialization	267	2	5	3.62	1.02	5.41	
Lack of management and political independence in the university	267	2	5	3.40	1.00	4.65	

Discussion

Third-generation universities, with characteristics such as entrepreneurship, focus on economic aspects, efficiency, and competitiveness compared to other universities' generations to commercialize knowledge practically. To become an entrepreneur university and obtain maximum benefits from research and scientific potentials, most universities need to pursue and evaluate their knowledge commercialization more seriously. Knowledge commercialization

should be managed efficiently to achieve this goal, and the influencing factors need to be identified. Identification of these factors leads to developing policies and designing appropriate action plans to improve knowledge commercialization status in the universities. According to the present study results, six factors, including managerial, individual, legal, structural, environmental, and cultural requirements, influence knowledge commercialization in the Iran University of Medical Sciences. In the following section, each of these will be discussed briefly.

According to the results, the faculty members of Iran university of Medical Sciences believe that of 11 managerial requirements influencing the knowledge commercialization, "employing experienced professional staff in the university and research centers" and "relative freedom of action for academics to involve in business and knowledge commercialization activities" were the most influential factors. The results of this study are consistent with the findings of Beiranvand and Seif. Narimani & Vaezi (2017) and ShamsAllahi and Yaghoubi (2013). They also showed that managerial factors extensively affect knowledge efficiency and practicality of knowledge transfer and commercialization processes.

Individual requirements were found as the second influential factor influencing knowledge commercialization according to the viewpoints of faculty members. Of the six individual-related factors, the “faculty members’ inherent talent and dynamic and creative ideas" seemed to have the highest effect. Regarding the impact of individual requirements on the success of knowledge commercialization, the results of this study are consistent with those of Hajiketabi, Zohahfaghary, Goodarzi & Akhondi (2017), Pournaghi & Hejazi (2019), and Khayatmoghadam and Rastgar (2015). They also reported that the faculty members’ skill and knowledge in problem-solving, entrepreneurship, marketing, and business work, their research morale, inherent talent, dynamic and creative ideas, familiarity with the market and industry needs, priorities and different issues, familiarity with science and technology development centers and parks, and familiarity with knowledge commercialization laws, regulations, and by-laws are the most important individual factors influencing knowledge commercialization in the university.

Legal requirements were the third influential factor influencing the Iran University of Medical Sciences knowledge commercialization. Among its components, "clear rules about the ownership of intellectual property rights" showed the highest effect. The study results about the impact of legal requirements on the success of knowledge commercialization are consistent with results of studies by Hajiketabi et al. (2017), Pournaghi and Hejazi (2019) and Pourezzat and Heidari (2011). According to these studies, securing intellectual property rights by IP registration in knowledge-based companies and relevant legal institutions is very important before initiating knowledge transfer and commercialization. Therefore, the Iran University of Medical Sciences managers and policymakers are recommended to develop and execute clear regulations, policies, and procedures regarding the legal ownership of the intellectual property given facilitating, enhancing, and encouraging knowledge commercialization (e.g., by tax exemptions) in the university.

Regarding the effectiveness of structural requirements influencing knowledge commercialization, the results showed that, of the four factors, “supporting and equipping the involved bodies in research commercialization such as industry liaison offices, development centers, and so on” is viewed as the most important factor by the faculty members. Developing a structural ground via designing effective mechanisms and implementing commercialization strategies with a competitive approach constitute the initial foundation of the organization toward knowledge commercialization. Developing a purposive, precise and efficient system for research projects’ evaluations, extensive communications and networking among academics and industry activists, investors, and entrepreneurs, providing a suitable collaboration ground for industry managers in the university and vice versa, and establishing marketing and ordering

centers for the research results were among the other important structural factors identified as facilitating knowledge commercialization in the university.

In terms of the structural requirements, the results of this study are consistent with the findings of Biranvand and Seif (2018) and ShamsAllahi and Yaghoubi (2013). They concluded that among the indicators of knowledge commercialization, the economic and political indicators had the priority and the most significant impact on knowledge commercialization. According to these studies, quality of knowledge and research, human skills, and innovative substructures are the second priority for knowledge commercialization. Developing and encouraging the entrepreneurship and commercialization culture, processing research results for various purposes, and paying attention to the needs of the market and customers are other effective indicators mentioned by these studies, which are consistent with the findings of the current study.

Regarding the environmental requirements, the study showed that, of the four existing factors, "the government's financial and intellectual support for universities, researchers and industry sector to foster and attract new and innovative ideas" had the highest effect on knowledge commercialization according to the faculty members' viewpoints. In explaining the environmental requirements, it should be noted that the organization's environment consists of all factors that affect the organization's activities, and the organization has to comply and adapt to these factors to survive and grow. The external environment has caused today's businesses to face global competition, government policies, and economic uncertainty. The environmental factors influenced the universities' knowledge commercialization strategies too. Some of these factors, as identified by the study, include the government's financial and intellectual support, attention to healthcare knowledge commercialization activities in the strategic planning of the country, offering new courses or holding workshops about knowledge commercialization in the university, and providing a suitable environment for competitive thought and scientific communication at national, international and regional levels.

The findings of this study about the effects of environmental factors on the success of knowledge commercialization are consistent with the results of the studies by Hajiketabi et al. (2017) , Khayatmoghadam and Rastgar (2015), and Santoro and Bierly (2006). They concluded that providing the necessary substructure to attract innovative ideas and creating an appropriate ground and condition for scientific and intellectual communications are the main requirements for improving knowledge commercialization.

The cultural requirements showed the least effect on knowledge commercialization from the faculty members' viewpoint. Of the three factors, "creating and developing a research-centered and project-centered culture in the university" obtained the highest mean score, followed by "motivating the academics to involve in knowledge commercialization." The desirable and collective culture for supporting innovation and technology transfer results from effective management practices. There is a need to change the traditional culture that has developed at a university or a research center, and it is a long and complicated process. The generation and transfer of practical knowledge are beneficial when the scientists and researchers have a clear idea about their mission and tasks and are encouraged to do it while the necessary conditions for knowledge commercialization and transfer are available. Therefore, it is essential to promote and create a culture of knowledge commercialization, self-esteem, and hope among the students, faculty members, and personnel of the university and research organizations. In addition, it is necessary to create and develop a project-centered and research-centered culture in the university to motivate academics to involve in knowledge commercialization. The results of this study in terms of the effects of cultural requirements on the success of knowledge commercialization are consistent with the findings of Biranvand and Seif (2018), Pournaghi and Hejazi (2019), and Dalmarco, Hulsink and Blois (2018). They found that developing a

desirable culture for providing the required ground for knowledge commercialization is necessary to improve knowledge commercialization.

Finally, the study revealed that the most critical barriers to knowledge commercialization in the Iran University of Medical Sciences are as follows:

- lack of communicative links/channels between government, industry, and university
- lack of creative, risk-taking, and entrepreneur people
- lack of industry research needs assessment
- lack of academics' familiarity with the industry research needs, and lack of professional research teams among the faculty members
- lack of motivation for knowledge commercialization in universities and research centers

The results are consistent with the findings of Beiranvand et al. (2018). They showed that knowledge commercialization is not always easy and successful. Since commercialization activities may affect the educational and research activities of the university, there is a possibility of conflict and resistance to them.

Conclusion

The findings showed that managerial, legal, structural, environmental, and cultural factors are among the most important factors influencing knowledge commercialization in the Iran University of Medical Sciences from the viewpoint of faculty members.

The findings refer to the fact that as long as knowledge commercialization is not included in the missions and tasks of the university clearly and strictly, it might be overlooked and will not be effective. For knowledge commercialization to be one of the main activities of the university, it is necessary to consider its requirements and components and even consider it in allocating the annual research budget. In fact, for successful knowledge commercialization in the university, it is necessary to formulate and regulate law and regulations under the supervision of the university administration and with the cooperation of administrative specialists, lawyers, entrepreneurial academics, experts in the field of academic entrepreneurship and business development, and other relevant bodies. In addition, the necessary efforts and measures must be taken by the relevant divisions to remove the main managerial, individual, structural, legal, environmental, and cultural barriers to knowledge commercialization in the university.

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