International Journal of Agricultural Management and Development
Available online on: www.ijamad.iaurasht.ac.ir
ISSN: 2159-5852 (Print)
ISSN:2159-5860 (Online)
Research Paper

Knowledge Commercialization in Agricultural Higher Education: A Two-Step Approach to Structural Equation Modeling

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Received: 17 August 2018,
Accepted: 29 April 2020

Abstract

The purpose of this study was to analyze knowledge commercialization in agricultural higher education of Khuzestan province. To end it a survey research method was applied. Faculty members of agricultural colleges of Khuzestan province, Iran including Shahid Chamran University, Ramin Agricultural and Natural Resources University, Islamic Azad University are considered as statistical of population of study (N=417). The main instrument of research was questionnaire which validity was determined by a panel of experts and also Cronbach's Alpha coefficient was used for determining of reliability (α=0.86). Based on regression analysis, effective researchers, effective relationship of university with industry and society, material and spiritual support of knowledge commercialization, government services, rules and regulation and parks and centers of science and technology development may well explain for 61.4 percent variations (R^2=0.614) in level of knowledge commercialization in agricultural higher education. The SEM indicated that the predictive positive effect of external factors (EF) and internal factors (IF) to knowledge commercialization (KC). Also government services (GS), economic stimulus (ES), rules and regulation (RR) and Parks and Centers of science and technology development (PC) have a significant impact on EF. The findings indicated effective researchers (ER), effective relationship of university with industry and society (ERU), material and spiritual support of knowledge commercialization in universities (MS), use of specialized consultants in the field of knowledge commercialization (SC) and research quality (RQ) also have a significant impact on IF. The findings showed that these nine construct (GS, ES, RR, PC, ER, ERU, MS, SC and RQ) determinants accounts for 73 percent of the variance in the KC. The results showed that mistrust between industry and university has first priority of barriers to knowledge commercialization in agricultural higher education.

Keywords:
Barriers; higher education; knowledge commercialization; structural equation modeling

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INTRODUCTION

In recent years, universities, research institutes, and enterprises, in many countries, have embarked on the development and commercialization of research achievements (Hosseinian et al., 2015).The role of universities in the socio-economic development of societies is highlighted by adding entrepreneurial missions to universities' educational and research missions. Therefore, many researchers and politicians in different countries, has recently been reviewed academic entrepreneurship and the commercialization of knowledge (Farsi Jahangir et al., 2014). Commercialization is the process of technology conversion to successful economic products. Commercialization of knowledge is a process that transforms knowledge generated into marketable products (Yadollahi Farsi & Kalathaie, 2012). In other words, commercialization begins when a business is created as a way to use modern scientific and technological advances, with the aim of responding to market demands through design, development, manufacturing, marketing, and subsequent efforts to improve the product (Mehta, 2008). Commercialization starts with the development of an idea, takes shape with the production of goods and the development-based services, and completes with the sale of goods and services to the end users (Pourfateh et al., 2017). By changing attitudes toward universities, they now play a role in addition to their traditional activities, education and research, in pursuit of new goals, including participation in the economic development of society (Nicola et al., 2006). In addition to teaching and research, universities are increasingly expected to take on technology transfer and commercialization as a part of their mission (Rasmussen et al., 2006). One of the main goals of policy makers in science and technology is how universities can influence the process of developing new products, and successful commercial outcomes to create value chain (Meigounpoory & Ahmadi, 2012). In the current competitive world, the university research commercialization process is remembered as one of the important factor in the technological innovation process and effective factors in development of knowledge economy (Meigounpoory & Ahmadi, 2012). Several researchers have investigated and identified the internal and external factors affecting the commercialization of knowledge. The most important internal factors identified include: Effective researchers, effective relationship of university with industry and society, material and spiritual support of knowledge commercialization in universities, use of specialized consultants in the field of knowledge commercialization and research quality (Ashrieh et al., 2016; Arasteh & Jahed, 2010; Bandarian, 2007; Debackere & Veugelers, 2005; Salami & Khatibi, 2015; Shin & Lemi, 2006).The most important external factors identified include: Government services, economic stimulus, rules and regulation and parks and centers of science and technology development (Masudian et al., 2013; Narayan & Hooper, 2010). Knowledge as the main competitive advantage in the world economy has very vital role in countries development (Nadirkhanlou et al, 2012). The commercialization of knowledge produced by the universities has created a major topic in today's public discussions and it generally causes the production of scientific results in universities (Erfan &Nadi, 2016). Commercialization of academic knowledge is increasingly seen as a potential economic development model, particularly for improving the capabilities and economic performance of regions (Baycan, 2013). In addition to teaching and research, universities are increasingly expected to take on technology transfer and commercialization as a part of their mission (Rasmussen et al., 2006). So it seems necessary for the universities, as the main institution of knowledge generation, to participate in national and regional economic development (Nadirkhanlou et al., 2012). Increasingly, the need for

scientific knowledge in the innovation process is reshaping the role of universities from teaching and research to engines of knowledge commercialization (Khan, 2017). In the past, universities and science centers only emphasized the educational process, but as a result of the changing needs of societies in the late nineteenth century, they also paid attention to the research process. This transformation is referred to as the "First Revolution" of universities. In the late twentieth century, universities embarked on a different mission for economic and social development, referred to as the Second Revolution. Entrepreneurship universities, in addition to education and research, took on the third mission of economic development (Etzkowitz, 2001). Today, universities have a greater responsibility in the research and application of research results in terms of generating income, general welfare, learning and participation and academic autonomy, and research findings are used as tools for extending the boundaries of knowledge. Also, knowledge and technology are two of the key factors in creating wealth, ability and knowledge of countries, and are considered as a powerful tool in national development. This is not possible except through academic entrepreneurship. One of the most important aspects of entrepreneurship at the university is entering the business domain, in other words, "knowledge commercialization" (Hassangholipour et al., 2012). Schulte (2004) believes that an entrepreneurial university is a university that must perform two tasks: first, they must teach future entrepreneurs to create business, and develop entrepreneurial spirit in students and in all areas. Secondly, it must act itself as an entrepreneur, become a business startup. Boehm and Hogan (2013) argue that knowledge is the core of economic development, and universities have a role to play in developing knowledge economy through knowledge-commercialization. Knowledge can be transferred to the market in various ways: education, research contracts, industrial consulting, joint ventures through the company's subsidiaries.

Ansari et al. (2016) showed that the highest ranking barriers to commercialization in agriculture were inappropriate perspectives and policy-making, financial-investment barriers, mistrust, and poor communication; the barriers related to the participation of the private sector were among the lowest ranking items. Pourezat et al. (2010) believe that, knowledge commercialization for the survival of universities is considered necessary. There are always some obstacles to the proper utilization of intellectual property produced at universities to development the commercialization of knowledge. Identifying and removing them is inevitable. Based on this research, "bureaucracy and non-flexibility of the university management system", and "weakness of communication and lack of communication networks among investors, industry activists and academics" have been identified as the most important barriers to knowledge commercialization at Tehran University.

Barnes et al. (2002) and Decter et al. (2007) concluded that mistrust between industry and university, the lack of attention of universities to the needs of society and industry were important barriers for knowledge commercialization. Pourfateh et al. (2017) indicated that factors affecting commercialization of agricultural innovation in Kermanshah Science and Technology Park included support of small and medium enterprise firms, relationship of parks with universities and research centers, and consequence of commercialization for agricultural sectors and research centers.

Yaakub et al. (2011) imply that agricultural based invention of university research should be considered as a significant tool for economic growth. They suggest that a case study and a quantitative analysis will be useful to further formulate propositions and to learn the agricultural based invention of university research. They believed that in Malaysia, most of the research and development in

agriculture are conducted at University Putra Malaysia (UPM). Noted as having commercial value, UPM have commercialized these inventions through licensing agreement, university start-up or joint venture collaboration. This is a normal strategy normally adopted by Malaysian universities.

Alizadeh et al. (2016) believed that Agricultural Higher Education Institutions (AHEI) in Iran include a wide range of universities, vocational and technical colleges (for example agriculture technical and vocational courses), and formal education (majority of agricultural universities in Iran). These institutions are controlled by a governmental or private system. In recent years, there has been a wide array of transformation-oriented initiatives to affect institutional changes including the definition of the purposes and goals of agricultural higher education, research policy, funding structure, quality assurance, and restructuring of the AHEI. Today's developing countries require promoting quality of human life and effective teaching and learning in HEI.

Considering the fact that the commercialization of knowledge is becoming a necessity and relative advantage in universities, it is necessary to identify the relevant factors in this field and to identify the appropriate model of knowledge commercialization. The aim of this study was to analyze knowledge commercialization in agricultural higher education of Khuzestan province.

METHODOLOGY

A survey research method was applied to achieve research objectives. The population of the study consisted of faculty members of agricultural colleges of Khuzestan province, Iran (Shahid Chamran University, Ramin Agricultural and Natural Resources University, Islamic Azad University) (N=417). The sample size was determined by the use of Cochran formula (n=105). The sampling method was stratified random sampling. The questionnaire was the main instrument to collect data. The validity was determined by a panel of experts consisting of faculty members in agricultural faculty of Shahid Chamran University. Cronbach's Alpha coefficient was 0.86. Descriptive statistics (frequencies, means, standard deviations) were used to describe analyzed data. To carry out of this study, a five-part questionnaire was developed. First section included items about demographic characteristics. Second part explained internal factors affecting knowledge commercialization in agricultural higher education by 18 statements. Part three indicated external factors affecting knowledge commercialization in agricultural higher education by 14 statements. Part four included items of knowledge commercialization. In the last part asked respondents to explain barriers affecting knowledge commercialization in agricultural higher education by 25 items. The scale used in part three to five was Likert scale (1=very low, 2=low, 3=average, 4= high, 5= very high). Factor analysis, regression, and structural equation modeling were used to analyze the data.

In order to indicate barriers to knowledge commercialization in agricultural colleges of Khuzestan province, factor analysis was conducted. To determine the appropriateness of data and measure the homogeneity of variables entered to the analysis, the Kaiser-Meyer-Olkin (KMO) and Bartlett' Test of Sphericity (BTS) were applied. Eigenvalue was used to determine the number of factors. Eigenvalue is the relative contribution of each factor of total variance of all the research variables. It means that the more eigenvalues for a factor, the more contribution it has in explaining total variance and the less eigenvalues for a factor, the less contribution it has in explaining total variance (Eshraghi Samani, 2017). Varimax method was used for factor rotation to a clearer separation of factors. Varimax method is the finest method to achieve a simple orthogonal structure (Eshraghi Samani, 2017). In this method, the correlation between the factors is so insignificant that it can be ignored. Varimax method increases large loads and reduce small loads

in each factor, so that each factor only has a few limited variables with large loads and has much variables with small loads (or zero) in return (Eshraghi Samani, 2017; Kline, 2004; Field, 2009). Structural Equation Modeling (SEM) was used to test for the direct, indirect and mediating effects of the external factors and internal factors variables in the prediction of knowledge commercialization. According to Hair et al. (2010), it is appropriate to adopt a two-step approach for SEM: first, assessment of the measurement model; second, assessment of the structural model.

RESULTS AND DISCUSSION

Demographic characteristics of respondents

The results showed that 81.9 percent of respondents were male and 18.1 percent of the respondents were female. Additionally, the results showed that 84.7 percent of respondents had a PhD degree and 15.3 percent have MSc degree. Results showed that the mean age of the respondents was 41.3 years. The findings further show that the respondents' average work experience was 10.4 years.

Knowledge commercialization level in agriculture based on the process of commercialization of academic research model (PCARM)

Based on the PCARM a series of steps such as idea processing, idea evaluation, idea development, business analysis and technology introduction, commercialization and outcome measurement should be designed to ensure that the commercialization of academic research is done systematically (Sharifi et al., 2015). Based on the results the level of idea processing, idea evaluation, idea development and commercialization and outcome measurement were low. Also the level of business analysis and technology introduction was very low (Table 1).

Idea processing in agricultural colleges

For analyzing idea processing in agricultural colleges of Khuzestan province were used varieties of dimensions. These dimensions include: 1) idea processing in the university is based on previous conceptual studies, 2) idea processing in the university is purposeful, 3) idea at the university are screened and prioritized and 4) each idea is referred to its own technology field. Based on the results the mean and standard deviation of each items were (M=1.962, SD=0.934), (M=2.371, SD=1.089), (M=2.610, SD=0.781) and (M=1.989, SD=0.892) respectively. The level of all items was low.

Idea evaluation in agricultural colleges

The dimensions of idea evaluation in agricultural colleges include: 1) at the university, each idea is assessed in its own technology field, 2) at the university, the external environment of each idea is evaluated, 3) at the university, an evaluation of the market for each idea is done, 4) at the university, an evaluation of the risk for each idea is done and 5) at the university, an evaluation of the required resources for each idea is done. Based on the results the mean and standard deviation of each items were (M=2.089, SD=0.897), (M=2.021, SD=0.912), (M=1.989, SD=1.993), (M=1.896, SD=1.993) and (M=2.008, SD=0.912) respectively. The level of all items was low.

Idea development in agricultural colleges

The dimensions of idea development in agricultural colleges include: 1) at the university, after the previous evaluation, ideas are approved, 2) after the approve of the idea, a strategic plan is developed and 3) the ideas are developed and the findings are presented as research results. Based on the results the mean and standard deviation of each items were (M=1.912, SD=0.981), (M=1.814, SD=0.992) and (M=1.934, SD=1.012) respectively. The level of all items was low.

Business analysis and technology introduction

For analyzing business analysis and technology introduction in agricultural colleges

of Khuzestan province were used varieties of dimensions. These dimensions include 1) technical, economical and market assessments by experts, 2) preparing the technological package, 3) delivery technology to market and 4) design a business model. Based on the results the mean and standard deviation of each items were (M=1.812, SD=0.997), (M=1.491, SD=0.916), (M=1.971, SD=1.128) and (M=1.822, SD=0.915) respectively. The level of all items was very low.

Commercialization and outcome measurement

The dimensions of commercialization and outcome measurement in agricultural colleges include: 1) commercialization through knowledge based company, 2) concluding commercial contracts, 3) sell of intellectual property if required by applicants, and 4) evaluating the process of commercialization for university and researchers. Based on the results the mean and standard deviation of each items were (M=1.971, SD=0.925), (M=1.892, SD=0.812), (M=2.016, SD=1.017) and (M=1.613, SD=1.014) respectively. The level of all items was low.

Table 1

Knowledge Commercialization level in Agriculture based on the Process of Commercialization of Academic Research Model (PCARM)

PCARM steps	Items	Mean	SD	Mean of each step	Situation
Idea processing	Idea processing in the university is based on previous conceptual studies.	1.96	0.93	2.23	Low
	Idea processing in the university is purposeful.	2.37	1.08		
	Idea at the university are screened and prioritized.	2.61	0.78		
Idea evaluation	Each idea is referred to its own technology field.	1.99	0.89	2.00	Low
	At the university, each idea is assessed in its own technology field.	2.09	0.89		
	At the university, the external environment of each idea is evaluated.	2.02	0.91		
	At the university, an evaluation of the market for each idea is done.	1.99	1.99		
	At the university, an evaluation of the risk for each idea is done.	1.89	0.990		
	At the university, an evaluation of the required resources for each idea is done.	2.01	0.91		
Idea development	At the university, after the previous evaluation, ideas are approved.	1.91	0.98	1.89	Low
	After the approve of the idea, a strategic plan is developed.	1.814	0.99		
	The ideas are developed and the findings are presented as research results.	1.934	1.01		
Business analysis and technology introduction	Technical, economical and market assessments by experts.	1.812	0.99	1.77	Very Low
	Preparing the technological package	1.491	0.92		
	Delivery technology to market	1.97	1.13		
	Design a business model	1.82	0.92		
Commercialization and outcome measurement	Commercialization through knowledge based company	1.97	0.925	1.87	Low
	Concluding commercial contracts	1.892	0.82		
	Sell of intellectual property if required by applicants	2.016	1.017		
	Evaluating the process of commercialization for university and researchers	1.613	1.014		

Priority barriers of knowledge commercialization in agriculture

Table 2 shows that mistrust between industry and university has first priority of barriers, because of having the lowest CV (CV=0.214), The lack of attention of universities to the needs of society and industry (CV=0.222), The lack of constructive communication between industry, university and government (CV=0.231), Academic research is not a problem-centered issue (CV=0.232), respectively have allocated priorities from second to fourth. In addition, Inadequate support for technology parks (CV=0.343), International economic sanctions (CV=0.346), Inadequate understanding of the internal and external market structure (CV=0.352), and the bureaucratic structure is tangled and complex (CV0.378) with the highest CV have allocated last priorities to themselves.

Table 2
Priority Barriers of Knowledge Commercialization in Agriculture

Barriers	Mean	SD	CV
Mistrust between industry and university	4.729	1.012	0.214
The lack of attention of universities to the needs of society and industry	4.126	0.916	0.222
The lack of constructive communication between industry, university and government	4.684	1.082	0.231
Academic research is not a problem-centered issue	4.297	0.997	0.232
Lack of financial resources in the field of research commercialization	3.886	0.917	0.236
Lack of training related to commercialization	4.129	0.995	0.241
Lack of supportive laws and regulations for the commercialization of knowledge	4.824	1.182	0.245
Cultural difference between university and industry	4.795	1.194	0.249
Lack of Entrepreneurship in Universities	4.240	1.094	0.258
The lack of education of risky, creative and entrepreneurial individuals	4.154	1.109	0.267
The long process of knowledge commercialization	3.655	1.016	0.278
The low motivation of the faculty members in the field of knowledge commercialization	3.612	1.015	0.281
Lack of strategic plan in the industry	3.074	0.916	0.298
Lack of competition among faculty members in the field of knowledge commercialization	3.629	1.085	0.299
Changing research approaches by changing managers in the industry	3.189	0.995	0.312
Problems and barriers to the export of commercial products	2.902	0.914	0.315
Lack of tax incentives	2.991	0.954	0.319
Absence of sufficient training for companies	3.595	1.154	0.321
The lack of industry awareness of the nature of academic research	3.375	1.124	0.333
Existence of relationships rather than criteria and expertise in assigning research projects	3.125	1.053	0.337
Inadequate capital institutions, especially risky ones	3.316	1.134	0.342
Inadequate support for technology parks	3.073	1.054	0.343
International economic sanctions	2.931	1.014	0.346
Inadequate understanding of the internal and external market structure	2.932	1.032	0.352
The bureaucratic structure is tangled and complex	2.444	0.924	0.378

Factor analysis

KMO was 0.719 and BTS was 1045.129 (p<0.01), indicating that the data were appropriate for factor analysis. In this study, five factors with eigenvalues greater than 1 were extracted which totally explained 74.891 percent of total factors variance and the rest was related to factors which have not recognized in this analysis or its eigenvalues has been less than 1 (Table 3). According to obtained eigenvalues in Table 3, first factor with eigenvalue of 5.562 had the greatest effect (31.563%) and the final (fifth) factor with eigenvalue of 1.954 had the least effect in explaining total variance. After reviewing the items related to each factor and its factor load, then factors were named as: 1) The lack of interaction between the university, industry and society, 2) Legal and supportive Barriers, 3) Economic and cultural barriers, 4) Structural barriers, and 5) Motivational barriers (Table 4).

The results showed that mistrust between industry and university has first priority of barriers. Also the lack of attention of universities to the needs of society and industry, the lack of constructive communication between industry, university and government, respectively have allocated priorities from second to fourth. Based on the results of factor analysis five factors with eigenvalues greater than 1 were extracted which totally explained 74.891 percent of total factors variance. After reviewing the items related to each factor and its factor load, then factors were named as: 1) The lack of interaction between the university, industry and society, 2) Legal and Supportive Barriers, 3) Economic and cultural barriers, 4) Structural barriers, and 5) Motivational barriers.

Internal and external factors affecting knowledge commercialization in agricultural higher education.

Internal factors affecting knowledge commercialization in agricultural higher education

As can be seen in Table 5, most important internal factors affecting knowledge commercialization in agricultural higher education of Khuzestan province were: effective researchers (M=4.21, SD=0.98), effective relationship of university with industry and society (M=4.18, SD=0.97), material and spiritual support of knowledge commercialization (M=4.12, SD=0.98) and use of specialized consultants in the field of knowledge commercialization (M=4.11, SD= 1.03). Based on the results, having an experience with the industry, has the most important, in effective researchers. Overall, the average rating for the effective researchers is equal to 4.21 from 5. Also in the effective relationship of university with industry and society, the results suggest that familiarization and training of researchers in the direction of commercialization has the highest importance. In general, the average rating of factors associated with effective relationship of university with industry and society is equal to 4.18 out of 5.From the studied experts' point of view about material and spiritual support of knowledge commercialization, the spiritual encouragement and motivation has the highest importance. Generally, average rating of the importance of material and spiritual support of knowledge commercialization is equal to 4.12 out of 5.

External factors affecting knowledge commercialization in agricultural higher education

As can be seen in Table 6, most important external factors affecting knowledge commercialization in agricultural higher education of Khuzestan province were government services (M=4.34, SD= 1.04), economic stimulus (M=4.18, SD= 1.01), rules and regulation (M=4.14, SD= 0.99) and parks and centers of science and technology development (M=4.09, SD= 1.02). Based on the results, improving government policies and orientations in research and technology, has the most important, in government services. Overall, the average rating for the government services is equal to 4.34 from 5.

Table 3
Extracted Factors with Eigenvalues, Variance Percent and the Cumulative Variance

Factors	Eigenvalue	Variance (%)	Cumulative percent of variance
The lack of interaction between the university, industry and society,	5.562	31.563	31.563
Legal and Supportive Barriers,	4.197	23.716	55.279
Economic and cultural barriers,	3.519	10.408	65.687
Structural barriers	2.183	5.463	71.15
Motivational barriers.	1.954	3.741	74.891

Table 4
Items Loaded to Each Factors and Related Factor Load

Factor name	items	Factor load
The lack of interaction between the university, industry and society	The lack of attention of universities to the needs of society and industry	0.741
	Mistrust between industry and university	0.739
	The long process of knowledge commercialization	0.719
	The lack of constructive communication between industry, university and government	0.691
	The lack of education of risky, creative and entrepreneurial individuals	0.616
Legal and Supportive Barriers	Academic research is not a problem-centered issue	0.701
	Lack of strategic plan in the industry	0.816
	Changing research approaches by changing managers in the industry	0.708
	Lack of supportive laws and regulations for the commercialization of knowledge	0.692
	Problems and barriers to the export of commercial products	0.609
	Lack of tax incentives	0.764
	Absence of sufficient training for companies	0.708
	Lack of training related to commercialization	0.691
	Lack of financial resources in the field of research commercialization	0.801
	Inadequate capital institutions, especially risky ones	0.712
	Inadequate support for technology parks	0.591
	International economic sanctions	0.701
Economic and cultural barriers	Cultural difference between university and industry	0.618
	Lack of Entrepreneurship in Universities	0.591
	The lack of industry awareness of the nature of academic research	0.705
	Existence of relationships rather than criteria and expertise in assigning research projects	0.617
	Inadequate understanding of the internal and external market structure	0.817
Structural barriers	The bureaucratic structure is tangled and complex	0.595
	Lack of competition among faculty members in the field of knowledge commercialization	0.722
Motivational barriers	The low motivation of the faculty members in the field of knowledge commercialization	0.732

Table 5
The Prioritization of Internal Factors Affecting Knowledge Commercialization in Agricultural Higher Education

Items	Mean	SD	Rank
Effective Researchers (ER)	4.21	0.98	
Having an experience relationship with the industry	4.32	1.06	1
High interest and motivation to conduct research	4.27	1.04	2
Interested in commercializing knowledge	4.17	0.98	3
Having a commercialization research experience	4.09	0.91	4
Effective Relationship of University with Industry and Society (ERU)	4.18	0.97	
Familiarization and training of researchers in the direction of commercialization	4.29	1.11	1
Carrying out the research needed by the industry and society	4.25	1.07	2
Development of R & D center in the universities	4.21	1.08	3
Development of technical and vocational activities and emphasis on skills at the university	4.01	0.97	4
Material and Spiritual support of Knowledge Commercialization in Universities (MS)	4.12	0.98	
Spiritual encouragement and motivation	4.22	1.08	1
Holding national and international exhibitions and presenting achievements	4.17	1.07	2
Financial support from inventors and innovators in universities	4.13	1.12	3
Emphasis on the commercialization of knowledge in the topics of the lesson	3.97	1.17	4
Use of Specialized Consultants in the field of Knowledge Commercialization (SC)	4.11	1.03	
Understanding and communicating university management with knowledgeable and effective people in the industry	4.18	1.01	1
Professional consultancy services by knowledgeable people in the field of commercialization of knowledge to the university faculty members	4.10	1.07	2
Use of expert advisers to strengthen university-industry communication at joint meetings	4.05	1.04	3
Research Quality (RQ)	4.07	1.11	
Having a large-scale program in research and technology	4.11	1.12	1
Having budgets for testing and industrialization	4.08	1.13	2
Define university projects based on industry needs	4.03	1.09	3

Also in the economic stimulus, the results suggest that knowledge-centered economy has the highest importance. In general, the average rating of factors associated with economic stimulus is equal to 4.18 out of 5. From the studied experts' point of view about rules and regulation, the improving rules and regulations in macro-scale about commercialization of knowledge has the highest importance. Generally, average rating of the rules and regulation is equal to 4.14 out of 5.Based on the results, development of knowledge-based companies in science and technology parks, has the most important, in parks and centers of science and technology development. Overall, the average rating for this item is equal to 4.09 from 5.

Regression analysis

Based on regression analysis, effective researchers, effective relationship of university with industry and society, material and spiritual support of knowledge commercialization, government services, rules and regulation and parks and centers of science and technology development may well explain for 61.4 percent changes (R2=0.614) in level of knowledge commercialization in agricultural higher education (Table 7).

Table 6

The Prioritization of External Factors Affecting Knowledge Commercialization in Agricultural Higher Education

Items	Mean	SD	Rank
Government Services (GS)	4.34	1.04	
Improving government policies and orientations in research and technology	4.41	1.02	1
Encourage inventors and entrepreneurs and pay attention to commercialization in national programs	4.36	1.03	2
Development of a support fund for researchers and inventors	4.31	1.04	3
Developing motivational programs and strengthening the spirit of commercialization of knowledge in society by the government	4.28	1.02	4
Economic Stimulus (ES)	4.18	1.01	
Knowledge-centered economy	4.24	1.03	1
The relative growth of the knowledge-based economy, multi-product and non-oil	4.19	0.99	2
Developing the export of knowledge based products	4.11	0.96	3
Rules and Regulation (RR)	4.14	0.99	
Improving rules and regulations in macro-scale about commercialization of knowledge	4.19	1.03	1
Having supportive laws and following them	4.16	1.02	2
Optimizing laws to encourage research and commercialization	4.12	0.99	3
Use the legal capacity of development programs and commercialization laws	4.08	1.02	4
Parks and centers of science and technology development (PC)	4.09	1.02	
Development of knowledge-based companies in science and technology parks	4.21	0.99	1
Material and spiritual support from knowledge-based companies in science and technology parks	4.09	0.98	2
Acting on laws and regulations in the field of science and technology parks	3.98	1.01	3

Table 7

Regression analysis between dependent and independent variables

Independent variables	B	SE B	Beta	t- value	*p*-value
Effective researchers	1.141	2.762	0.719	3.761**	0.001
Effective relationship of university with industry and society	0.945	2.092	0.693	4.915**	0.003
Material and spiritual support of knowledge commercialization	1.391	1.082	0.981	3.773**	0.000
Government services	1.003	0.961	0.482	4.972**	0.008
Rules and regulation	2.007	1.008	0.569	3.451**	0.000
Parks and centers of science and technology development	2.981	2.791	0.591	1.982*	0.023
Constant	3.65`	8.791	0.891	5.962**	0.000

**p<0.01, *p<0.05

Based on Table 7, we can see that the predictor variables of effective researchers, effective relationship of university with industry and society, material and spiritual support of knowledge commercialization and governmental services are significant because their p <0.01.In consideration to Variance Inflation Factor (VIF), we can argue about co-linearity statistics. If VIF is less than 10, co-linearity will not be significant. According to results, it is considered amount of co-linearity is less than 10 for predictor variable in the last stage of regression analysis. Considering to quantity of beta (ß) can be arbitrated ratio and proportion predictor variables in explanation of dependent variable.

Structural equation modeling

Structural Equation Modeling (SEM) was used to test for the direct, indirect and mediating effects of the EF (GS, ES, RR, PC) and IF (ER, ERU, MS, SC, RO) variables in the prediction of KC. The results of confirmatory factor analysis showed the initial measurement model to provide an acceptable fit for the data (X^2=612.593; X^2/df =2.62; GFI=0.98; TLI=0.96; CFI =0.94; IFI=0.95; RMSEA=0.068). Therefore, the measurement model provided a reasonable fit (Table 8). Thus, the hypothesized model was judged suitable for the SEM.

Convergent validity

A first condition for convergent validity is that the standardized factor loadings should all be significant (t-value > 1.96) with a value of more than 0.50 (Hair et al, 2010). The results in Table 5 show the t-value for the factor loadings to all exceed 7.31(p < 0.01) and the standardized factor loading to all have values greater than 0.519. This shows good convergent validity for the constructs (GS, ES, RR, PC, ER, ERU, MS, SC, RQ and KC) of this study (Table 9).

Construct Reliability (CR): For the composite or construct reliability to be adequate, a value of CR=0.70 or higher is recommended (Nunnally & Bernstein, 1994). As shown in Table 10, all of the constructs had construct reliabilities which were greater than the recommended 0.70. The results also show the AVE estimate for all of the constructs to be above or close to the recommended threshold of 0.50 (Nunnally & Bernstein, 1994). This shows good composite or construct reliability for the constructs of this study.

Discriminant validity: According to Fornell and Larcker (1981), if the square root of the AVE estimate for each construct is greater than the correlation between that and all of the other constructs in the model, then discriminant validity is demonstrated. As shown in Table 8, the square root of each AVE is greater than its correlations with the other constructs. This means that the indicators have more in common with the construct that they are associated with the other constructs. Thus, discriminant validity has been demonstrated for the constructs in the measurement model.

Table 8

Summary of Goodness of Fit Indices for the Measurement Model

Fit indices	X^2	*p*	X^2/df	GFI	CFI	TLI	IFI	RMSEA
Value in study	612.593	0.000	2.62	0.98	0.94	0.96	0.95	0.068
Suggest value	-	>0.05	<3	>0.80	>0.90	>0.90	>0.90	<0.08

Table 9
Results of Confirmatory Factor Analysis for the Measurement Model

Constructs		Indictors	Standardized factor loading	t- value	CR	AVE
EF	GS	GS_1	0.572	8.34**	0.89	0.561
		GS_2	0.651	7.31**		
		GS_3	0.712	10.12**		
		GS_4	0.693	9.59**		
	ES	ES_1	0.756	13.48**	0.83	0.673
		ES_2	0.519	11.92**		
		ES_3	0.798	10.32**		
	RR	RR_1	0.565	8.12**		
		RR_2	0.521	9.18**		
		RR_3	0.609	8.14**		
		RR_4	0.701	7.82**		
	PC	PC_1	0.634	10.39**	0.93	0.59
		PC_2	0.592	8.17**		
		PC_3	0.608	9.74**		
IF	ER	ER_1	0.812	14.23**	0.92	0.589
		ER_2	0.587	7.94		
		ER_3	0.734	9.35		
		ER_4	0.547	9.23		
	ERU	ERU_1	0.657	15.12**	0.87	0.612
		ERU_2	0.577	12.82		
		ERU_3	0.868	12.54		
		ERU_4	0.819	9.67		
	MS	MS_1	0.792	9.42**	0.95	0.597
		MS_2	0.826	10.23		
		MS_3	0.709	11.65		
		MS_4	0.892	9.98		
	SC	SC_1	0.819	8.16**	0.89	0.608
		SC_2	0.709	10.73		
		SC_3	0.779	11.54		
	RQ	RQ_1	0.817	9.75	0.87	0.609
		RQ_2	0.913	10.32		
		RQ_3	0.694	10.36		

Table 10
Means, SD and Correlations with Square Roots of the AVE

	Mean	SD	1	2	3	4	5	6	7	8	9
GS	4.34	1.21	0.85[a]								
ES	4.18	1.18	0.66	0.91[a]							
RR	4.14	1.34	0.61	0.72	0.83[a]						
PC	4.09	1.39	0.59	0.69	0.59	0.75[a]					
ER	4.21	0.98	0.77	0.83	0.78	0.51	0.82[a]				
ERU	4.18	0.97	0.72	0.86	0.72	0.63	0.79	0.76[a]			
MS	4.12	0.98	0.68	0.79	0.59	0.68	0.76	0.56	0.85[a]		
SC	4.11	1.03	0.75	0.78	0.78	0.57	0.81	0.52	0.72	0.83[a]	
RQ	4.07	1.11	0.82	0.88	0.69	0.62	0.78	0.59	0.79	0.78	0.79[a]

**p<0.01, a: The square roots of AVE estimates

Assessment of the structural model:

Once a satisfactory measurement model was obtained, the second step, involving SEM, was to test the structural model. The structural model includes the hypothesized relationships among constructs in the research model. The overall goodness of fit statistics showed that the structural model fits the data well. Having assessed the fit indices for the measurement model and the structural model, the estimated coefficients of the causal relationships among constructs were examined (Figure 1).

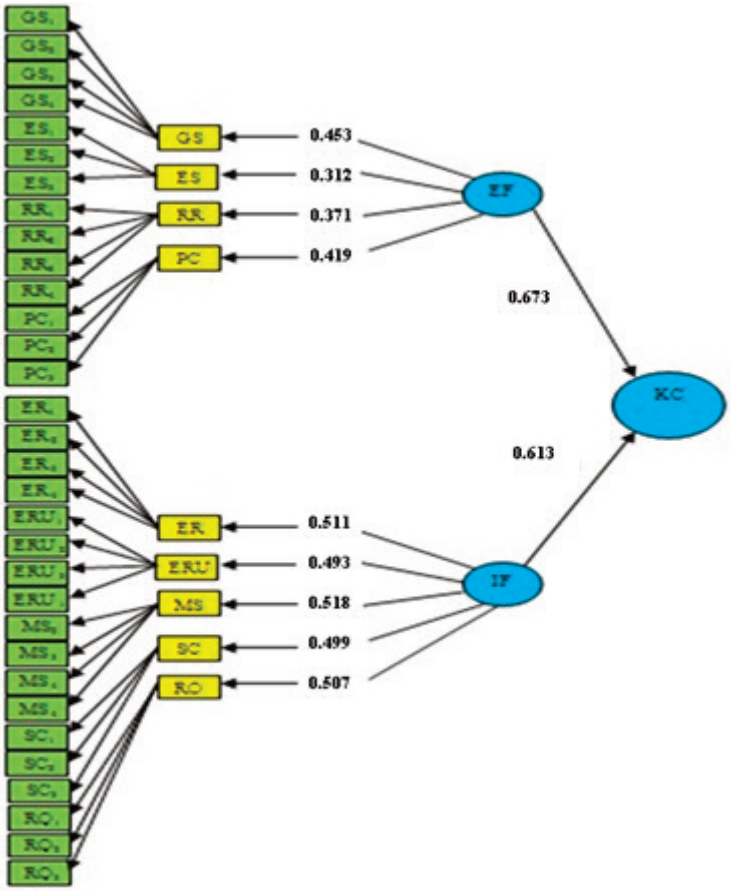

Figure 1. Path Model with standardized factor loadings

Table 11

The Effects of GS, ES, RR, PC, ER, ERU, MS, SC and RQ on KC.

Determinant	Outcome	Path coefficient	t-value	Outcome	Path coefficient	t-value	R^2
GS	EF	0.453	4.56				
ES	EF	0.312	4.45				
RR	EF	0.371	3.76	KC	0.673	4.68	
PC	EF	0.419	3.85				
ER	IF	0.511	3.96				0.73
ERU	IF	0.493	3.80				
MS	IF	0.518	4.04	KC	0.613	4.11	
SC	IF	0.499	4.21				
RQ	IF	0.507	3.98				

From Table 11 and Figure 1, it can be seen that the predictive positive effect of EF to KC is supported (β=0.673, t-value=4.68, p<0.001). In addition, that is the IF has a positive effect on KC (β=0.613, t-value=4.11, p<0.001). Also GS, ES, RR and PC also have a significant impact on EF. The findings showed indicated ER, ERU, MS, SC and RQ also have a significant impact on IF. The findings showed that R2 for KC was 0.73. So that, these nine construct (GS, ES, RR, PC, ER, ERU, MS, SC and RQ) determinants accounts for 73 percent of the variance in the KC.

DISCUSSION AND CONCLUSION

Based on the PCARM a series of steps such as idea processing, idea evaluation, idea development, business analysis and technology introduction, commercialization and outcome measurement should be designed to ensure that the commercialization of academic research is done systematically. The idea processing requires the development of creative ideas and the creation of the necessary infrastructure in this field. In the idea evaluation phase, the usefulness of the idea and its social and economic acceptability is analyzed. In the process of developing the idea, identifying the necessary strategies to development the idea and formulating an action plan is considered and the resources and facilities needed are analyzed. In the process of business analysis, the basis for the commercialization of research findings is considered and, in the final stage, the necessary field for commercialization is provided and the results are evaluated.

Based on the results the level of idea processing, idea evaluation, idea development and commercialization and outcome measurement were low. Also the level of business analysis and technology introduction was very low. Given the unfavorable situation of knowledge commercialization in the agricultural sector, it is essential that relevant authorities(such as university presidents and university research and technology deputies) provide the necessary measures to develop the knowledge-commercialization infrastructure in this sector. According to the results, effective researchers, effective relationship of university with industry and society, material and spiritual support of knowledge commercialization, government services, rules and regulation and parks and centers of science and technology development may well explain for 61.4% changes (R^2=0.614) in level of knowledge commercialization in agricultural higher education. The some of this finding was supported by Bandarian, 2007; Debackere & Veugelers, 2005; Shin & Lemi, 2006.

Based on regression analysis, effective researchers, effective relationship of university with industry and society, material and spiritual support of knowledge commercialization, government services, rules and regulation and parks and centers of science and technology development may well explain for 61.4% changes (R^2=0.614) in level of knowledge commercialization in agricultural higher education. This finding was supported by Arasteh & Jahed, 2010; Ashrieh et al, 2016; Salami and Khatibi, 2015.The SEM indicated that the predictive positive effect of EF and IF to KC. Also GS, ES, RR and PC also have a significant impact on EF. The findings showed indicated ER, ERU, MS, SC and RQ also have a significant impact on IF. The findings showed that R2 for KC was 0.73. So that, these nine construct (GS, ES, RR, PC, ER, ERU, MS, SC and RQ) determinants accounts for 73% of the variance in the KC. The results showed that mistrust between industry and university has first priority of barriers. Also the lack of attention of universities to the needs of society and industry, the lack of constructive communication between industry, university and government, respectively have allocated priorities from second to fourth. The research results of Barnes et al. (2002) and Decter et al. (2007) support these results. Based on the results of factor analysis, five factors with eigenvalues greater than 1 were extracted which totally explained 74.891% of total factors variance.

After reviewing the items related to each factor and its factor load, then factors were named as: 1)the lack of interaction between the university, industry and society, 2) legal and supportive barriers, 3) economic and cultural barriers, 4)structural barriers, and 5)motivational barriers. The results of Debackere & Veugelers (2005) support these results.

ACKNOWLEDGEMENTS

This paper is part of research project that financial granted by Shoushtar Branch, Islamic Azad University. The author is grateful to the financial support of Shoushtar Branch, Islamic Azad University

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How to cite this article:
Ahmadinejad, M. (2020). Knowledge commercialization in agricultural higher education: A two-step approach to structural equation modeling. *International Journal of Agricultural Management and Development, 10*(2), 149-166.
URL: http://ijamad.iaurasht.ac.ir/article_673811_36e87779b7c4a664e1383e95b3158f89.pdf