



The Conceptual Framework for Commercialization of Research Findings in Iranian Universities

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Abstract

Changes in economic and social environments caused the traditional approach to universities and research centers as the producers of knowledge to be revised and a new approach to be configured. In this approach, the universities are more responsible for turning their research achievements into the factors of economic growth, prosperity and society wealth and should make more attempts to transfer and employ knowledge in economic, social and industrial areas so as to be interpreted as the commercialization of research results and accepted as one of the main missions and functions of universities besides the education and research. Lack of a comprehensive and integrated framework for the commercialization of research findings in universities was the salient issue identified in the literature. Presenting a conceptual model in response to the question “how to commercialize research results”, it is expected to solve a real problem of universities and it answers the theoretical gaps in this study field. This paper probes for a comprehensive conceptual framework with an exploratory study and comparative to identify the stages of commercialization process and most important factors which form the background to achieve commercialization and classification of factors on the basis of the characteristics of each component/ factor/ variable within a Tri-Category conceptual framework. With combination of variables and generation of the three dimensions of context, structure, content, and also the stages of commercialization process, the conceptual framework of this study was developed. Thus, the mentioned factors provide the conditions to facilitate commercialization process and provide its realization.

Keywords: Commercialization, commercialization process, commercialization conceptual framework, science and technology.

Introduction

In recent decades, the mission, goals and programs of the universities have had significant changes. In the past, universities were responsible only for the training but the first change in the university system in the late 19th century; the research issue was also added to the university functionalities¹. In the late 70s, in the USA, redefining the role of public research systems was raised pursuing the growth of anxiety over the decline in national competitive advantage and also over the increase of criticism about the universities due to strict attention to development of new technologies, and no attention to the process of making these technologies applied². The second academic revolution in the late twentieth century took place because of the emergence of science-based innovations, during which universities undertook the third mission means participation in economic development. In other words, in addition to education and research, the universities undertook the economic responsibility. The outcome of the second academic revolution is the generation of various forms of cooperation with industry and also efforts for commercialization of research consequences as a fundamental principle besides training and research. In the study done by Etzkowitz and

Leydesdorff, the adoption of commercialization functionality as one of the main roles of university has been interpreted by “The Academic Revolution”³.

Table-1
Expansion of University Mission¹

Training	Research	Entrepreneurship
Preservation and dissemination of knowledge	First academic revolution	Second Academic Revolution
New missions generate conflict of interest controversies	Two missions: teaching and research	Third mission: economic and social development; old missions continued

Considering recent trends and developments in many¹ countries, reforms are being done in order to increase the commercialization of universities’ research with public resources. These reforms include the change in academic systems and the change in research investment tools, and also creation of the structures and programs to support the commercialization activities. For example, reduction in public funding of research in US and also in European countries,

caused universities to begin activities in the commercial and business areas for providing financial resources. Shaping expectations about direct participation of universities in economic growth, universities being allowed to patent and creation of technology transferring offices are samples of improvements and modifications in commercialization process⁴.

Generally, the restrictions, the urgencies, and the commitments arising from changes in the economic and social environments cause the traditional approach to universities and research centers as producers and disseminators of knowledge to be reconsidered and a new approach to be formed. In this approach, the universities are more responsible for turning their own research achievements to the factors causing economic growth, social welfare and wealth. Universities encounter with the better challenge of responding to the community needs and expectations as the most important section of production and supply of knowledge.

Despite the acceptance of commercialization as one of the universities' responsibilities, several evidences from all around the world indicate that although a large number of studies have been technically successful, a small percentage of them have achieved success in commercialization. Stevens' and Beverly's study shows that of all three thousand raw ideas, just an idea is successfully commercialized in Market⁵. The failure of a large majority of researches in commercialization process and also the necessity of researchers' acquaintance and those involved by commercialization activities require further study in this field. The review of literature shows that several studies have been conducted on commercialization as one of the important functions of universities, and each of them has investigated the commercialization issue of research findings from one aspect. Some studies have sought to analyze the factors influencing Commercialization⁶⁻¹³ and in other studies, the key success factors of Commercialization have been investigated¹⁴⁻¹⁹. In some other studies commercialization barriers have been investigated²⁰⁻²⁴. In another set of studies, the researchers focused on Commercialization process, activities and stages of Commercialization process are distinguished²⁵⁻³¹. In some studies, Commercialization practices and methods of making and commercialization mechanisms is considered³²⁻³⁴. The commercialization studies described in the literature, according to the researchers approach, fall generally into two broad categories of the content and process.

The lack of a comprehensive and integrated framework for commercialization of research findings in universities is the salient issue which has been identified in the literature. Thus, the answer to the question of "how science can be tied to the economy", or "how to commercialize the results of researches" can solve the main problem of universities by presentation of suitable framework and respond to the theoretical absences in the commercialization field. As mentioned, the main problem of study is "the absence of a comprehensive and practical framework for commercialization of research results and

findings" that could be used in universities and research centers. In other words, the main research question is "How can research findings be commercialized?"

Methodology

Experiences and comparative studies construct theories as a brief form which helps us perceive the nature of the study object. Considering research purpose and presentation of theoretical framework, the related literature to commercialization has been identified and analyzed with the comparative and exploratory approach. Recent changes in the mission, goals and programs of universities that lead to formation of commercial approach in universities and adopting this approach has also been investigated in Iranian universities (table 1). In order to achieve the research objectives and answer to research questions; the commercialization concepts of academic research results, have been studied from the point of view of different researches and then approaches and different models have been classified for doing of commercialization in the form of i. process approach and linear models, ii. content approach and functional models as well as the results of the comparative study which are based on the theoretical framework and have been indicated in table 2 and 3.

Conceptual Framework of Commercialization: The conceptual framework of management theory is to understand a topic or concept or strengthen the areas of study, and provide a structure that supports decision making and action³⁵. The present study identifies the main activities of commercialization process and factors affecting the commercialization of research findings and compares and integrates the results of previous studies, offers a comprehensive framework for the introduction of commercial activities and actions for commercialization and analyzes situations and conditions for the commercialization of research findings. Figure 1 shows the proposed framework.

For designing conceptual framework, this study utilizes the Tri-Category framework (3C) of co-structure, content and context. Forouzandeh and et al mentioned that the Tri-Category conceptual framework is a coherent framework that supports a better understanding and evaluation of a more effective strategic planning for the development of events and phenomena's organization³⁶. The Tri-Category framework is a logical model in the classification models and can be study and analysis all the concepts, events and organizational phenomena in three categories: context, co-structure and content³⁷; In other words, components and parameters in the effective commercialization of research findings have been classified and reviewed based on the Tri-Category model.

For the purpose of the structure Category, all elements of the physical and inhumane conditions of organization that regularity can be studied which includes templates, skins, body or scheme to make the physical and material, such as material resources,

finance and information. This is combined with a certain body part of the overall structural organization of the branch and the other are, in fact, the non-living factors. Content category or behavior, including organizational and human issues and human relations in organizations with behavioral norms, communication and certain patterns are interlinked and constitute the main content of the internal living environment. Context, as the third category is consider all conditions and environmental factors that have been inscribed on the organization and constitute an important platform of development, such as customers or clients, culture, markets, government agencies and other peripheral organization systems.

Ramifications of naming these Tri-Category framework, is the relationship between structural factors, behavioral and organizational context, so that any phenomenon or event cannot be taken out of the interaction of these three categories. In other words, the relationship between the three branches is unbreakable and inseparable of an intimate relationship in practice. The distinction between these three aspects of

organization is purely theatrical, and occurs in order to analyze and understand the concepts of organizational phenomena³⁷.

As mentioned, in order to designing conceptual framework for the commercialization of research be utilizing the Tri-Category model. Also, reviewing the literature depict process and content approaches for commercialization. Accordingly, for realizing the commercialization, it is assumed that the commercialization process and underlying factors should be specified for using in commercialization decision making. Hence, the core of framework is commercialization process that phases and the activities of various stages identified from the literature and shown in table 2. Also, the most influential factors on the commercialization were obtained with referring to previous studies and they were classified according to the characteristics of each component / variable in terms of Tri-Category model' dimensions (table 3). Research conceptual framework takes shape by combination of the three categorized variables and creation of three factors (context, structure and content), as well as commercialization process. Thus, the mentioned factors provide condition and underlay that facilitate commercialization process and commercialization realize (figure 1).

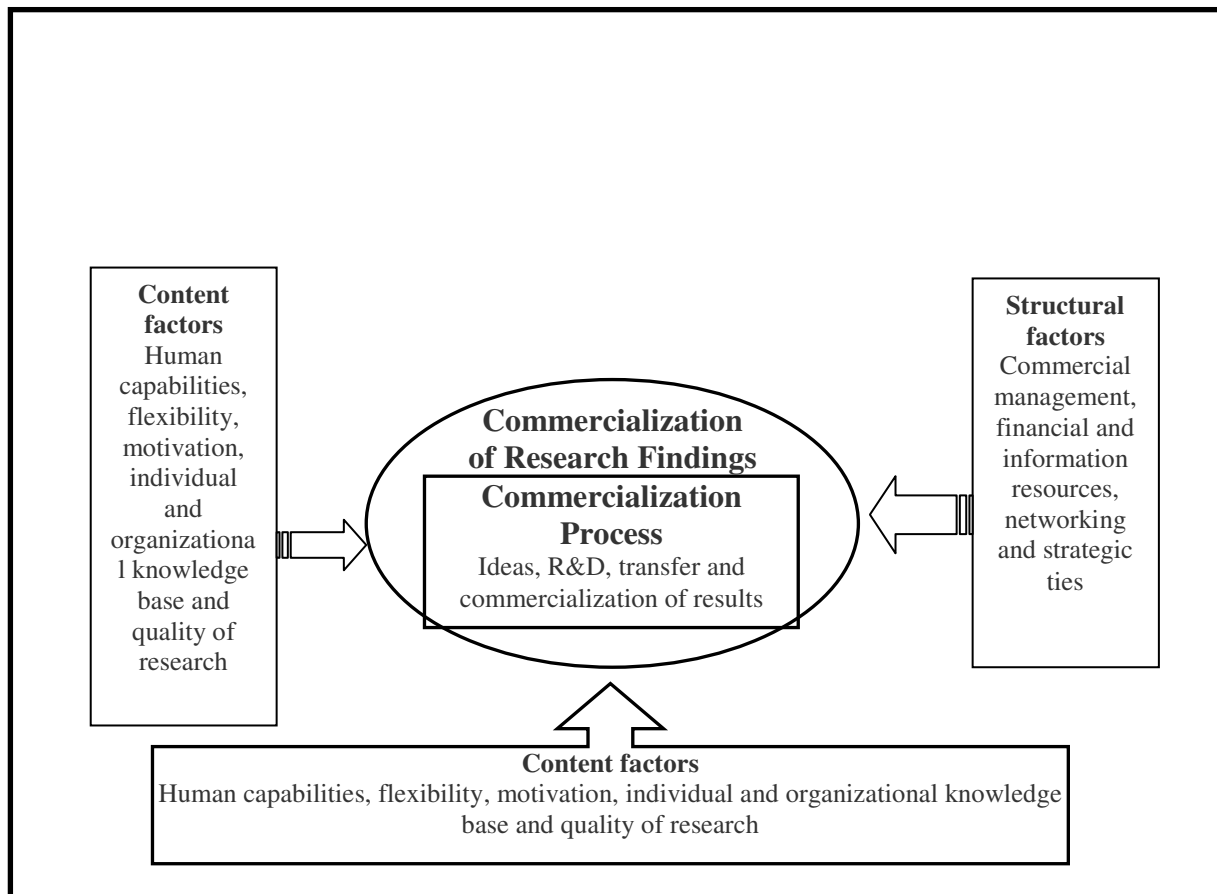


Figure-1
 Conceptual framework for commercializing research results and findings

Results and Discussion

Generally, dimensions and components of framework for commercialization of research results and findings contain both process and content dimensions that are described in the following two sections, forming the conceptual framework.

The process dimension of conceptual framework: One aspect of the proposed framework is based on the study that aims to answer the question of what steps the commercialization process and what activities and actions must be done in each step. Study and review of existing models in the literature have been following results. The Goldsmith Model^{38,39} illustrates the entire stages of commercialization process, from the first idea, through development, creation and start-up of a spin-off company and then the exit strategy for the inventor and investors. A 'check list' rather than a 'block diagram' type of model, describes concurrent 'streams' of technical, market and business activity, each stream conforming to six sequential stages: Investigation; Feasibility; Development; Introduction; Growth; and Maturity. In addition, these streams are broken into three sequential phases: the Concept Phase; Development Phase and Commercial Phase. The model is intended to be followed as a series of sequential steps, working from top to bottom and left to right; the process does not advance from one Stage to the next, or from one Phase to the next, until the technical, business and market issues dominating that stage have been sufficiently addressed and resolved.

Rothwell and Zagfeld⁴⁰ model is similar to Goldsmith's model as a 'block diagram' model, with the blocks describing the relationships between the components of the commercialization process and how they interact with each other. This model, like Goldsmith's model is sequential, but it places the technical 'stream' at the center of the process, its path to market influenced by emerging and evolving market needs on the one hand, and by the evolution of technology on the other. 'Business' issues are implied but not addressed specifically in this model and the detailed 'check lists' of technical, business and market factors is absent. Commercialization model of Cooper (1983)⁴¹ or the model 'stage-gate, separated the idea-market process to a sequence of steps and decision points. Ideas, review and initial screening of ideas, detailed review and re-screened in order to create a business, idea development; testing and validation of the idea, prototype, market entry are the commercialization steps that are mentioned in the above model. In this model, stage is where the action is taking place.

The other process models were reviewed in the literature is Jolly Model⁴² that the commercialization processes are imagination the idea and feasibility of commercialization, technology demonstration, and market entry and maintain position. As Jolly model to be used for commercialization of new technologies in developed countries where the necessary infrastructure is provided, So in order to take advantage of the model in developing countries, Yong - Duke Lee reforms such as setting

up a research and development (R & D), manufacturing location and infrastructure environments adds to commercialization. The models that are most relevant to the present study are three-level model Goktepe⁴³, University of British Columbia⁴⁴, Magnus⁴⁵ and Mehdi⁴⁶ model. In the Goktepe model, phases, steps and activities for the commercialization of university research findings are presented in three levels. The first level consists of idea generation, research and achieving results; Second level, transfer and commercialization activities, including dissemination of research findings, assessment findings, the legal protection of research findings, commercialization strategy formulation, and commercialization and monitoring to commercialization operations and third level of the model, the commercial exploitation of research findings and knowledge is transferred from the University.

British Columbia (BC) model includes the research, the transfer of the research results, ownership of the results were transferred by transferee, the exploitation of research results and inter-industry and university. The disclosure of research results, evaluation results, legal protection of research results, and the strategy formulation of the research to commercialization and monitoring of activities are performed in the BC model for commercialization. Generation and development of ideas and scientific research, documentation, presentation and disclosure of the results of research in the form of intellectual property, the commercialization strategy formulation, a company organized in the form of exploitation, production of semi-industrial, manufacturing and business strategy formulation are the steps which are expressed in the Magnus and Mehdi model.

According to the literature reviewed and summarized, we can form the core of the conceptual framework that is commercialization process and respond to one of the research questions and the phases and steps of commercialization process provided. Thus, the commercialization process started with the idea generation and doing scientific research on the idea, to achieve the results and findings, documentation, transfer of results and ended with supply to market.

The content dimension of the conceptual framework: Literature review and the results of previous studies can be creating more appropriate and realistic view to login to promote more commercialization of research in universities. As the experience of other countries shows that to achieve this goal is requiring a wider view, the set of conditions and factors should be considered and provided that affect commercialization process and the different needs. In other words, to successfully commercialize, the university sector must be developing capacity and capability for commercialization and transfer of research results; this requires the ability to reform research policy, institution-building, acquire expertise and skills, etc. On the other hand, the macroeconomic environment, political and legal conditions are favorable for the commercialization of and technology transfer and the industry sector is requiring specifications and capacities to obtain technology. In reviewing

the results of the mentioned studies, some factors, such as national innovation system (NIS), information systems, science parks, incubators and laboratories, technomarts, regulations and intellectual property law, access to financial resources, active and strong institutions for commercialization, culture of commercialization and organizational culture prevailing in the universities environment or research centers, Knowledge base and research quality, capacity to receive technology in the industries are commonly known as the main affecting factors in the technology transfer and commercialization of university research in various countries. Other studies, conducted in connection with the commercialization of research studies, have emphasized the above factors^{47,48}.

Conclusion

The Tri-Category conceptual model is coherent framework for the better understanding and analyzing the events and organizational entities; thus, for designing conceptual framework utilized the Tri-Category theory. Offered framework has two sections; the core of that contains commercialization process, phases, steps and various activities. The other section of framework is the most important influential factors on commercialization that acquired with referring to previous studies and also considers the characteristics of each factor/component/ variable then, they were classified based on the Tri-Category model' dimensions. Conceptual framework was developed by combination of the three variables and underlying three dimensions, the content, structure and context, as well as the commercialization process. Thus, the mentioned factors provide conditions for facilitating commercialization process and realization it. Commercialization of research results and findings is a variable its success dependent on these factors. The presented conceptual framework in this study helps to researchers in commercializing of results research. Review of the commercialization literature and classifying these studies in two category; process and content approaches and the combination of these two approaches is other results of this research. Generally, the main message and result of the paper is "Success in commercialization requires attention to the it's process as well as the factors and obstacles are affecting commercialization".

References

1. Etzkowitz H., Research groups as quasi-firms': the invention of the entrepreneurial university, *Research Policy*, **32**, 109–121 (2003)
2. Siegel D.S., Waldman D.A., Atwater L.E., Link A.N., Commercial knowledge transfers from universities to firms: improving the effectiveness of university–industry collaboration, *Journal of High Technology Management Research*, **14**, 111–33 (2003)
3. Etzkowitz H. and Leydesdorff L., The dynamics of innovation: from National Systems and "Mode 2" to a Triple Helix of university– industry–government relations, *Research Policy*, **29**, 109–23 (2000)
4. Baldini N., Grimaldi R. and Sobrero M., Institutional changes and the commercialization of academic knowledge: A study of Italian universities' patenting activities between 1965 and 2002, *Research Policy*, **35**, 518–32 (2006)
5. Young T.A., Establishing a Technology Transfer Office". A handbook of best practices available in: [www.snitts.se/document /ipHandbook-Young_Establishing TTOs.pdf](http://www.snitts.se/document/ipHandbook-Young_Establishing_TTOs.pdf) (2007)
6. Industry Canada, People and Excellence: the Heart of Successful Commercialization, Volume II, Supporting Material, Ottawa, Industry Canada (2006)
7. Diane A.I. S &T Commercialization of Federal Research Laborites and University Research, Carleton University Eric Sport, School of Business, Canada (2004)
8. Bandarian R., Enablers of Commercialization in Research Organizations, Proceeding of International Management Conference, Sharif University of Technology, Iran (2005)
9. Salami R. and Mohammadi K., Mechanisms of technology transfer and commercialization of research at the University of trilateral cooperation, the Iranian government and industry, Proceedings of the ninth conference of Industries and Mines R & D Centers, 8 and 9 December, Tehran (2010)
10. Niknam M., Behboudi M. and Jalili N., Identify factors influencing the commercialization of research achievements; case study Islamic Tablighat Organization, Proceedings of the First International Conference on Management, *Innovation and Entrepreneurship, February Shiraz*, (2010)
11. Jalili N., Mousakhani M. and Behboudi M., Nationalized Model For Commercialization, Field Study in Iran, *Interdisciplinary Journal of Research in Business*, **1(4)**, 118-129 (2011)
12. Pourezzat A.A., Gholipour E. and Nadirkhanlu S., Identify and prioritize the factors affecting commercialization of science at universities, *Journal research, entrepreneurship*, **7**, 66-35 (2010-A)
13. Moghimi S.M., Sadiqzadeh A. and Jafarzadeh K.A., The effect of Environmental factors on the commercialization of ideas and research results, *Strategic Management Studies quartrary*, **2**, 113-126 (2010)
14. Andrew O. Martyniuk, Ravi K. Jain, Harry J. Stone, Critical success factors and barriers to technology transfer: case studies and implications, *International Journal of Technology Transfer and Commercialisation*, **2(3)**, 306-327 (2003)
15. ThanhHuyen T.T., A study of the key success factors for new technology commercialization, Master's thesis,

- National Cheng Kung university, Available at: <http://etds.lib.ncku.edu.tw...> (2009)
16. Radfar, R., Nezami, A. and madani, H., Commercialization the effect factor in economic and technology development, *Journal parks and incubators*, **20**, 33-40 (2009)
 17. Firoozmanesh M.R., Commercialization of research results in the hi tech, companies, Ninth Annual Conference on Community Research and Development of Industries and Mines, Tehran, Iran (2010)
 18. Swedish Institute for Growth Policy Studies, ITPS, Commercialization of Research Results in the united states, An overview of federal and academic technology transfer (2004)
 19. Braun M., Brown D., Graf G., Leroyer J., Sabisch H., Meissner D., Rouach D., Santi, P., Getting More Innovation from Public Research, European Commission, Enterprise Directorate General, P.4-6, <http://www.cordis.lu/innovationpolicy/studies/published.htm> (2000)
 20. Advisory Council on Science and Technology., Issues with Respect to Commercialization Canadian University Research, Project Number 98848, final report (1999)
 21. Biemans W.G. and Harmsen H., Overcoming the barriers to market –oriented product development, *Journal of Marketing Practice: Applied Marketing Science*, **1(2)**, 7-25 (1995)
 22. Bandarian R. and Ghabezi R., Advantages and challenges of commercializing research results research centers in the industry, *Journal parks and technology incubators*, **20**, 19-25 (2009)
 23. Pourezzat A.A., Gholipour E. and Nadirkhanlu S., Explanation of barriers to entrepreneurship and commercialization of university students in Tehran University, *Journal of Science and Technology Policy*, **4** the 2nd year, summer, 78-65 (2010 - B)
 24. Pourezzat A.A. and Heydari E., Identify and classification of knowledge commercialization challenges and barriers with using Q method, *Journal of Science and Technology Policy*, **1**, 49-62 (2011)
 25. Magnus K., Commercialization of Research Results in the United States, ITPS, Swedish Institute for Growth Policy Studies, P.14,15 , Accessed in www.itps.se (2004)
 26. DevrimGöktepe, Investigation of University Industry Technology Transfer Cases: A Conceptual and Methodological Approach, Division of Innovation-LTH Lund University (2004)
 27. Goldsmith H.R., A Model for Technology Commercialization, Mid-Continent Regional Technology Transfer Centre Affilliate's Conference, NASA Johnson Space Centre, Houston (1995)
 28. Goldsmith H.R., Model of Commercialization. Arkansas Small Business and Technology Development Center, Available from: <http://asbdc.ualr.edu/technology/commercialization/the.model.asp>. (2003)
 29. Jolly V.J ., Commercializing new technologies: getting from mind to market, Harward business school press, Online available at: <http://books.google.com/books> (1997)
 30. Cooper R.G., A process model for industrial new product development, *IEEE Transactions on Engineering Management*, EM-30, 2-11 (1983)
 31. Rothwell R. and Zegfeld W., Reindustrialization and Technology, London, Longmans (1985)
 32. University of British Colombia, commercialization procedures, University Industrial Liaison Office, Canada, Available at: http://www.Uilo.ubc.ca/researcher_commercialization.asp (2013)
 33. Bontoux, Thierry, Getting Technologies Such as Nanotechnology Out of the Universities, <http://www.azonano.com/details.asp?ArticleId=2548>. Accessed in: 2011-03-10 (2010)
 34. Amin Mozaffari F. and Shamsi L., The investigation of Commercialization of academic research methods and approaches; Case study Tabriz University. *Journal - Science and Technology Policy*, Third Year, **4**, 28-15 (2011)
 35. AbbasiEsfanjani H., Framework to support technological knowledge management, *Tadbir Magazine*, seventeenth year, March, **178**, 79-74 (2006)
 36. Forouzandeh D.L., Sarlak M.M., Pourezzat A.A. and Ghorbani A. , A Comprehensive Conceptual Framework for the E-Government Realization, *Australian Journal of Basic and Applied Sciences*, **6(8)**, 50-64 (2012)
 37. MirzaeiAhranjani H. and Amiri M., Developing a Three Dimensional Model for Analysis of Philosophical Bases and Fundamental SubStructures of Management Theories, Iran, *Journal of Management Knowledge*, 3-21 (2002)
 38. Goldsmith H.R., A Model for Technology Commercialization, Mid-Continent Regional Technology Transfer Centre Affilliate's Conference. NASA Johnson Space Centre, Houston (1995)
 39. Goldsmith H.R., Model of Commercialization, Arkansas Small Business and Technology Development Center, Available from: <http://asbdc.ualr.edu/technology/commercialization/the.model.asp>.(2003)
 40. Rothwell R. and W. Zegfeld, Reindustrialization and Technology, London, Longmans (1985)
 41. Cooper R.G., A process model for industrial new product development, *IEEE Transactions on Engineering Management*, EM-30, 2-11 (1983)

42. Jolly V.J., Commercializing new technologies: getting from mind to market, Harward business school press, Online available at: <http://books.google.com/books> (1997)
43. DevrimGöktepe, Investigation of University Industry Technology Transfer Cases: A Conceptual and Methodological Approach, Division of Innovation-LTH Lund University (2004)
44. University of British Colombia, “commercialization procedures” University Industrial Liaison Office, Canada. Available at: [http://www. Uilo.ubc.ca/researcher_commercialization.asp](http://www.Uilo.ubc.ca/researcher_commercialization.asp) (2013)
45. Magnus K., Commercialization of Research Results in the United States, ITPS, Swedish Institute for Growth Policy Studies, P.14,15 , Accessed in www.itps.se (2004)
46. Mahdi R., Development of a methodology for problem solving of commercialization of technology and research achievements, First International Conference on strategies and techniques of problem solving, Tehran (2007)
47. Allen Consulting Group, Building Effective Systems for the Commercialization of University Research, Prepared for Business Council of Australia and Australian Vice-Chancellors` committee (2004)
48. Fakour B., Conditions predisposing to promote the commercialization of university research, *Journal of Rahyaf, policies of national scientific research center*, 40, 54-46 (2007)