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Investigating the Reasons of Failure or Lack of Success in Commercializing the Products of Knowledge-Based Companies, the Case Study of Knowledge – Based Companies in the Field of Nanotechnology

Amir Farahani

Student of M.A Technology Management (MOT), South Tehran branch, Islamic Azad University, Tehran, Iran

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ABSTRACT

At the same time with the changes of late 20th century, a new mission was defined for universities and industries in the age of the knowledge-based economy, which required them to teach, investigate and produce the knowledge as well as "economic development"; which leads to the creation of knowledge-based companies. Accordingly by creation of the knowledge-based companies, these companies face to an extremely wide range of stakeholders, ranging from huge state apparatuses to the small private firms. One of the most important missions of these companies for economic development is the transformation of knowledge into the product and commercializing it. This has led companies to change their structure and function in a way that can accelerate the process of converting the idea into a product and commercializing it. In the present study, we tried to identify the intra-organizational difficulties of this section, by evaluating the pathology related to the failure reasons of the products commercializing in the knowledge-based companies of the nanotechnology field. The results showed that six dimensions are involved in the commercialization of knowledge-based products in the field of nanotechnology; which are respectively as follows: Rules and approvals, technical specifications, financial and economic specifications, market specifications.

Keywords: *products commercialization, knowledge-based companies, nanotechnology.*

I. INTRODUCTION

The study of the role and function of the university in the economic development of various societies represents great changes that faced the world to a new phase of development called knowledge-based economy. Based on these developments, in the late 20th century, a new mission was defined for universities and enterprises in the age of knowledge-based economy. Today, the importance of commercializing products in order to transform ideas and innovations into competitive products in the market is undeniable. Also, to move towards the economic development of knowledge-base economy, which is one of the major policies of the country. The research and science production

system is as the reservoir and the basic center of knowledge and also potential sources of ideas, that these ideas must become the products required by the society and market.

One of the major areas of science and technology is the commercialization and successful entry to the market. Attention to the subject of commercializationof ideas and the research results is essential and inevitable, which must be consideredby the managers along with rational decisions and explaining solutions, suitable for conditions of the research centers and knowledge-based companies. In the research organizations, without the commercialization of an achievement, the research has no meaning, because without access to the specific customers of an achievement, producing an idea or testing it, will be useless.Despite the importance of the commercialization of knowledge and technology, numerous evidencesof around the world shows that, in spite of the success of a large number of researches in technical terms, only a few of them had a successful commercialization, which indicates the complexity and the existence of various barriers to commercialization. In general, suggesting ideas, research, innovation and the technology based on itare valuable when it leads to creation of wealth. To turn the ideas into a successful and profitable business, they should be commercialized and commercialization as a nonlinear and complex process requires playing the role of actors and different factors with different abilities.

The purpose of this study is to investigate the reasons of failure or lack of success in commercializing the products of knowledge-based companies of the nanotechnology field.

II. Commercialization of the Product

History of commercialization

The commercialization of knowledge and technology has a long history. Technologies and knowledge resulted from scientific researches in the past, more limited than present, were commercialized after supply to the market. It seems that the beginning of the commercializing the knowledge and technology has taken place along with the discussions of cooperation between the university and industry in 1862.

Commercialization steps

The stages of commercialization in scientific sources are as follows:

- Creation of an idea
- Evaluating and screening an idea
- Making the idea practical
- Commercial analysis of commodity
- Market research and test market
- Technical and administrative aspects
- Commercialization

The Cooper model is one of the most famous commercialization models and is known as the stage-gate process model. In other words, the stage-gate process is an operational map to lead new product projects from the stage of its delivery to the market. The main feature of this model is to assign the developmental supports efficiently, since each process involves steps and inputs that specify the progress of the project. In this model, there are inputs that specify the progress of the project. Moreover in this model, the stage is where the action takes place in it, and the gate is also where the decision is made in order to continue or not continue the path of the development [1].

The main stages and decision points are as follows:

Stage 0: Suggesting ideas (first decision: screening the idea)

Stage 1: Initial review (second decision: secondary screening)

Stage 2: Detailed review (third decision: action for development)

Stage 3: Zero development (fourth decision: action for test)

Stage 4: Performing the test and validation (fifth decision: action for commercialization)

Stage 5: Industrial production and market entry; it should be noted that this model is more applicable fororganizations that produce and develop new products,although bydoing some reforms, also it can be used for research organizations to develop new technology.

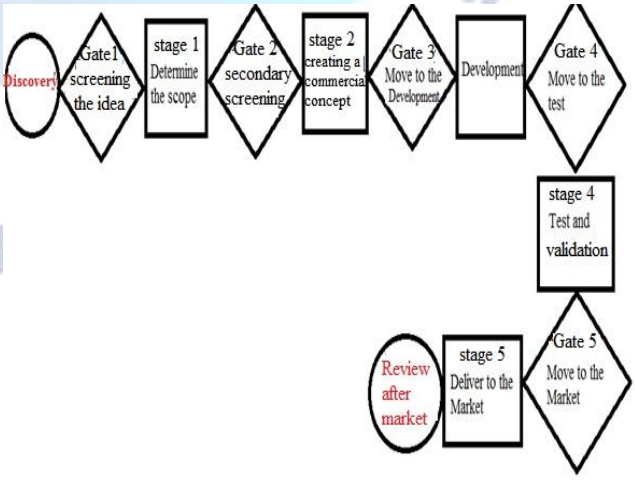

Figure 1: Cooper model [2]

III. NANOTECHNOLOGY

Nanotechnology is a field of applied knowledge and technology that embraces extensive quiries. The main subject of it, is to restrain the material or devices in sizes less than one micrometer, usually about 1 to 100 nanometers [3].

In fact, nanotechnology is thecomprehension and employmentof new properties of materials and systems in this dimension that show new physical effects, mainly influenced by the dominance of quantum properties on the classical properties. Nanotechnology, as the fourth wave of the industrial revolution, is a massive phenomenon that has spread in every scientific trend and is one of the modern technologies that is developing as quickly as possible.

Despite of many definitions for nanotechnology, the following definitions cover all of the items:

1- Development of technology and research at atomic level, molecular or macromolecular surfaces at a scale of 1 to 100 nm.
2- Creating and using structures and tools and systems that have new properties and functions due to their small size or their medium limit.
3- Ability of control or manipulate in atomic levels [2].

In this part of the present study, we tried to identify the factors influencing the success of technology commercialization from previous researches.

Technology commercialization

To define the commercialization of technology, first the technology must be defined. Therefore, in this part of the research, first the concept of technology will be defined and then the commercialization of technology will be introduced. Tariq Khalil has defined the technology as the whole knowledge, products, processes, tools, methods and systems used to create goods or provide services. In the general definition of the commercialization process, it is implied that the commercialization of technology is a defined process includes the transfer of knowledge and technology from a person or group to another person or group in order to use it in the system, process, product or the method of doing the work. This definition describes the concept of technology commercialization very close to the technology transfer. Some also define the technology commercialization as a process in which a technology is presented to the market, in the form of a product, service, or a new process. The process of technology commercialization embraces all activities from the emergence of ideas to the product design, test of prototype, manufacturing and marketing. Moreover, commercialization of technology can be viewed as the transfer of an idea or innovation and nowadays, commercialization has become one of the main segments of the innovation process. In general, the process of technical innovation can be divided into three distinct stages included as suggesting ideas, technology development and eventually commercializing it. The researcher must first create and develop an idea that has enough market potential, from different possible sources. This idea turns into the desired technology at the development stage. Once a marketable achievement is obtained, the commercialization phase begins. From the perspective of the innovation process, the technology should extend from its supplier to the industries and companies that are applying for it, in order to:

1- To avoid no use accumulation of technology in the universities, the research institutes and the companies capable of producing technology.
2- To increase the technology foundation of industries and companies as well as their ability of competitiveness in the global markets. Injecting better and newer technology into the local companies is one of the key levers to turn them from low performance companies into the world-class companies. This is especially important for small and medium companies which are not able to set up the research and development units.
3- By the commercialization of technologies, their development costs are compensated, and the possibility of investing in better and more advanced technologies will be obtained for the technology providers. These factors and some other factors have attracted the attention of the researchers to the issue of commercializing research findings.

Despite the acceptance of the commercialization issue by the researchers, numerous evidences from around the world imply that although many researches have been technically successful, but only a small percentage of them have achieved to success in the field of commercialization. This

shows the complexity of the commercialization process.

The process of technology commercialization is not a simple and linear process, but a complex process which is affected by a variety of factors such as infrastructure, business, technological, social, political, historical, and so on. Each of these factors, on one hand can be the reason of success for commercialization and on the other hand, prevent the success of commercialization. In the complex process of commercialization, many actors with variable abilities play a role. This process requires skills such as product development, market evaluation, market strategies, management of financial resources, engineering and production management, accounting, and so on.

IV. Investigating Failure Factors in the Commercialization of a Product Using Previous Researches

By reviewing previous studies in the evaluation field of the success of the technology commercialization, these studies can be classified into threegeneral categories. In one category, the factors affecting the commercialization of technology are mainly from the perspective of technology or the product of technology. The other category is the researches, which by the perspective of the company that commercializes the technology, mainly focus on identifying of the factors influencing the success of the technology commercialization. But most of the relevant researches are in the category where the factors influencing the success of thetechnology commercialization, from the perspective of both key factors meaning the technology and the company that commercializes the technology, have been identified.

Various components affecting the success of technology commercialization have been derived from previous researches which are presented in Table (1). Derived components, according to the thematic literature, especially take advantage of the strategic evaluation modelof the commercial potential and assessment model of commercialization readiness.so they are categorized in four dimensions. These dimensions include:

1. Technical specifications
2. Financial specifications
3. Market specifications
4. Rules and approvals

The studies listed in Table (1) include researches that have been published since 2000 and later; and have emphasized the factors affecting the commercialization success. In this regard, the researches that focused only on the factors affecting the technology transfer or new product development (NPD); were eliminated from the current study.

Table 1. Components affected the success of the technology commercialization along with their references.

Row	Dimensions	Components	Relevant references
1	Technical specifications	Technical feasibility of technology	[23,16,6,5,30]
2		Prominent security advantages of technology	[23,28,29,30,33]
3		Research and development capabilities (R & D)	[19,21,22,25]
4		Technological level of technology	[30,26]
5		reception ability of transparent patent	[23,17,30]
6		Low complexity in the use of new technology by potential customers	[6,5,7]
7		The acceptability and adaptability of the new technology by current used methods and processes	[6,30]
8		The possibility of launching technology in small scale	[6,23]
9		Being fully innovative and initiated technology or technology product	[23,17,30]
10		The availability of the required technical resources including of equipment, facilities and raw materials for the development of technology	[16,5,22]
11		Business technology company having specialized and experienced human power for commercialization	[27,26,5,32]
12		Safety of technology or technology product for usage of end users	[6,22]
13		The ability of the commercialization team to implement a plan	[29,26,30]
14		Previous technical experience of commercialization	[30,27]

15	Financial and economic specifications	Economic feasibility of development and commercialization of technology	[6,5,16]
16		The expected profitability of technology	[25,22,33]
17		The costs of technology development (the costs of changing the process, operations and support)	[26,25,22]
18		Proper pricing for technology or technology product	[5,16]
19		Financial supports of the government and private investors	[28,27,24,19,5,33]
20	Market specifications	Identifying the current and urgent requirements of market	[18,23]
21		Compatibility of the technology with the market requirement	[16,6,25]
22		The potential of technology for growth and penetrating in the market	[23,21,25]
23		Using the effective methods for marketing and selling the technology product	[16,28]
24		Having the sustainable competitive advantage for the company that commercializes the technology	[22,23,39]
25		Having partners and common treaties	[29,5,32]
26		Required time for transferring technology to the market (commercialization speed)	[25,23,17,31]
27		Target customers and end users for technology or technology product	[18,25]
28		The availability of the target market	[5,23]
29		The growing of the target market	[30]
30		Performing a competitive analysis	[17,22]
31		Having distinct advantages compared to the competitors' products	[23,30]
32		Social benefits and effects of the technology or technology product	[16]
33		The technology attractiveness by the technology product in the view of customers and end users	[5,6]
34	Rules and approvals	The existence of supportive laws that affect commercialization and acceptance of the technology in the market	[16,21,22]
35		Awareness of the standards that technology has to meet them in order to enter the market	[21,22]
36		The existence of cultural fit for technology or technology product	[6]
37		Protection of intellectual capital	[22,16,5,23]
38		Simplicity and facility of licensing (authorizing) the technology	[23,30]

V. Research Methodology

The purpose of scientific method is to discover and express the reality. The research in terms of methodology is, applying the scientific methodsin order to solve a problem or answer a question. Choosing the appropriate research method depends on the subject and the nature of the research andexecution facilities; andthe purpose of the research is the precise access to the answers of the research questions. For valid verification of the research conclusions, an appropriate method should be used in it; as the wrong choice leads to inaccurate conclusions. In this section, first the research method, society and statistical sample have been investigated, and then the method of data collection, desk research and conclusions are expressed. The present research is applicable in terms of the research purpose due to investigate the reasons of failure in commercializing the products of knowledge-based companies in the field of nanotechnology.

Research variables

In this study, the failure reasons of knowledge-based companies are considered as the independent variable group of the research. Moreover, the commercialization in theknowledge-based companies is also the dependent variable.

Statistical population of the research

The statistical population refers to all individuals who have common traits in particular directions of research perspectives, and it is included in the conclusions of the desired research. The researcher must determine the framework of statistical population before the beginning of the research, so that he specifies his process of research and he can simply introduce it to the others.The statistical population is also called target population. According to spatial and

temporal realm,the statistical population of research mainly focused on the knowledge-based companies of the nanotechnology which produce the product in Tehran province.

Sampling method

Considering that there were ambiguities in the list of knowledge-based companies, the stratified random sampling created problems and limitations in conducting the research; therefore, the random sampling has been used in this research. Inthe study of the knowledge-based companies, individuals with different organizational levels participated in this research.

Statistical sample and sample size

Sample and sampling are one of the most important topics in the humanities statistics. On one hand, according to the extent of population orstudied subjects, the researcher has to implement the sampling. On the other hand, trust in the findings of a research is evaluated by the accuracy of its sampling. Since the statistical populationof this research is limited in the knowledge-based companies sector; therefore in this research, limited population sampling formula (equation 1) is used for sampling.

$$n = \frac{Nz^{2}_{a/2}pq}{\in^{2}(N-1)z^{2}_{a/2}pq} \quad (1)$$

In equation (1) there are:

p: Variable attribute ratio; p = 0/5

z: Normal variable of unit corresponding to the confidence level of 95%; za/2 = 1.96

∈: The amount of allowable error, ∈ = 0/08

N: the amount of statistical population, 900

In this way, “n” represents the appropriate number of the sample, which is obtained from the following equation:

$$n = \frac{900\times[1.96]^{2}\times0.5\times0.5}{(0.08)^{2}\times(900-1)+(1.96)^{2}\times0.5\times0.5} = 139.618 \approx 140 \quad (2)$$

In spite of the fact that 140 samples are adequate for the research, but 300 companies were selected from knowledge-based companies and 190 questionnaires were completed in person and by the telephone and internet.

Method of data collection

One of the most important stages of the researchis the gathering of information. Required information to conduct the researchcan be collected in different ways. There are various tools to obtain data including observation, interview, questionnaire, documents and etc. Each of these tools has some disadvantages and advantages that should be taken into consideration when using them, so that the credibility of the research is not undermined and on the other hand, the strengths of the tools are reinforced. Every researcher should choose one or several toolsaccording to the nature of the problem and the hypotheses. After acquiring necessary conditions for the validity of tools, the researcher has to use them in order to collect the data; so that finally, through the processing and analyzing of these data, he can judge about the hypotheses. The selection of the tools should be in a way that the researcher can defend his choice of tools and validate his research achievements through it.The most important methods of collecting data in this study are as follows.

Desk research

Through this type of study, the secondary data is obtained, that is examined by the researcher before the study begins. The sources of this data are: available data in the past documents, official statistics, non-official statistics and organizational documents. To gather the information corresponding to the literature of this research and theoretical discussions related to the subject, the method of desk research, English and Persian books and articles, theses and internet have been used.

Questionnaire: To collect data and information, a questionnaire is used for analysis.

VI. Conclusion

In spite of accepting the commercialization issue and its importance by the policy makers, researchers and innovators, the efforts of innovators and researchers mostly fail in the stage of technology commercialization and the research achievements. This represents the complexity of the commercialization process. In the successful commercialization of a technology, several factors are influential, including technical considerations, market issues and financial issues as well as legal and environmental issues. One of the main approaches to overcome the issues related to the commercialization of technologies, is to evaluate the success of their commercialization before they are implemented. In this regard, the present study attempts to investigate the reasons of failure in commercializing the products of knowledge-based companies of the nanotechnology field. The results of Table 1 show that these researches have employed various methods, consist of statistical

methods including structural equation modeling and logistic regression; multi-criteria decision methods including fuzzy analytic hierarchy process and analytic network process; and also classification and regression tree method, as one of the data mining methods, to determine preference weights of factors affecting the commercialization of technology.

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