

Effective Determinants of Corporate Nano-Technopreneurship Process in Active Technological Knowledge Base Firms

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To Link this Article: <http://dx.doi.org/10.6007/IJAREMS/v2-i5/350> DOI:10.6007/IJAREMS/v2-i5/350

Published Online: September, 2013

Abstract

Although the age of nanotechnology in the world is almost half a century, but now it has become to an influential technology in different areas of industry. In recent decade, Nanotechnology becomes a technology which has competitive advantage for the world, with rapid growth in different fields of knowledge production and planning for commercialization the research achievements. In the mean time, achieving competitive advantage through the development of new products in the field of nanotechnology requires awareness of all active and talent people in this field of the concept of technological corporate-entrepreneurship. In this article, effective factors on the process of technological corporate-entrepreneurship in active technology companies in the field of nanotechnology in Iran are being evaluated and identified and eventually offered a new conceptual model of corporate technopreneurship process in active knowledge-based technological firms in nanotechnology area. The qualitative data was collected through interviews. The methodology is adapted from in-depth interviews with 12 academic experts and managers of technological firms, policymakers active in Nanotechnology industry until theoretical saturation state achieved. The gathered data was analyzed using axial and open coding methods. The results show that the effective determinant of corporate technopreneurship process in active knowledge-based nanotechnological firms includes of five main factors and 30 axial factors. The main factors are consisting of organizational, external, institutional and other new factors, i.e. technological and individual factors that are shown in new conceptual model of corporate technopreneurship process. The results of this paper can be used for the optimization of corporatenano-technopreneurship of active knowledge-based technological firms in all of world countries.

Keywords: Technopreneurship, Corporate technological entrepreneurship, Nanotechnology

Introduction

Forty years ago, Richard Feynman, a specialist in theoretical quantum and Nobel laureate, purposed this subject in his well-known lecture under title of *"There's a plenty of room at the bottom"* (1959). When he posited this issue, due to lack of appropriate tools, the scientists might not manipulate atoms and molecules (Feynman,1961). Term *"nano"* was brought by Norio Taniguchi, a professor in Tokyo University of Science in 1974. He used this term to describe making some accurate materials and devices in which their size variations are at nano-meter level (Taniguchi,1974). On early 1980s, Drexlergathered a group of university students in an association and preoccupied their thought by some ideas that he christened them as nanotechnology. In 1981, he presented his first scientific essay regarding molecular nanotechnology and published a book under title of *"Engine of Creation: The coming era of Nanotechnology"* in 1986. At present, several newly-established and leading enterprises are active in the field of development and commercialization of nanotechnologies throughout the world (Oriakhi,2004). Nanotechnology is considered as a preference and strategy for the world, due to the wide application and influence on most of the existing industries and preparation of ground for employing scholar youth and strong workforce (Nanotechnology monthly, Nano- headquarters, 2012). According to the predication made by US National Science Foundation (NSF) in 2001, the value of world markets for nanotechnology- base products is approximated about 1000 billion Dollars in 2015. A more optimistic expectation was also made by Lux Research Institution during 2006-2008 based on which, the value of world market for nanotechnology- based products will be estimated about 3100b\$ in 2015. This value for market size to nano-technological products by 2015 is approximately 10 times of the expected market value for biotechnological products up to 2015 and it is equal the value of Information and Communication Technology (ICT) products by this year (palmberg et al,2009). The predication made by Lux Research indicates that the value of nanotechnology products will be higher than ICT's and ten time of market value for biotechnological products. Figure (1) shows some predications that were excerpted from several sources.

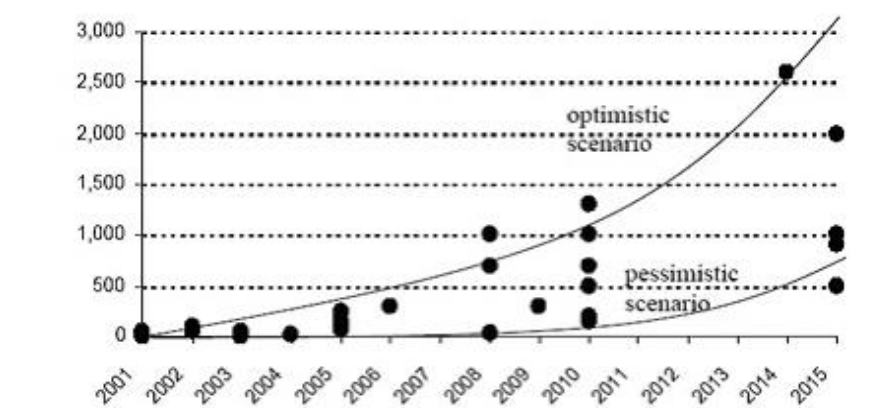


Fig. 1: Prediction for nanotechnology market (b\$), quoted from different sources (Lux Research)

Lux Research Institution and NSF have tried to classify their predictions based on the constituent subsystems of nanotechnology. This figure indicates that the maximum market share in nano-technological products respectively belong to nanodevices and non-biotechnology with approximately 420 and 415b\$. Materials and (nano) tools are also ranked at next positions with 145 and 50b\$. Compared to the conducted predictions for 2015, all these fields will be dramatically improved. For instance, nano- materials market will be

increased from 145b\$ to 340b\$. In these predictions, nano- tools have allotted the maximum market share. With respect to rate of world demand for workforce in the field of nanotechnology by 2015, if these figures are extracted based on experience in IT Sector then the other 2.5 workforce are also created per a manpower so that accordingly nanotechnology may have potential to create 5 million jobs by 2015 throughout the world including Iran and this signifies the higher rate of demand for nanotechnology base products and services. Thus, by considering the other factor namely supply, it could be found that there are a lot of entrepreneurial opportunities in this arena (OECD,STI working paper,2009). In addition to NSF, some of the foremost institutions have predicted nanotechnology market, which are given in Table- 1 (Roco & Bainbridge,2001).

Table 1

An Abstract From Predictions Of World Markets For Nanotechnology Based Products (Million\$)

	2015	2014	2013	2012	2011	2010	2009
Lux Research (2006 – 2008)	3100	2600	-	-	-	-	-
BBC (2008)	-	-	-	-	27	-	-
Scientifica (2008)	1500	-	-	263	-	-	-
RNCOS (2006)	-	-	-	-	-	1000	-
Wintergreen (2004)	750	-	-	-	-	-	-
MRI (2002)	-	-	-	-	-	148	-
Evolution capital (2001)	-	-	-	-	-	700	-
US National Science Foundation (NSF) (2001)	1000	-	-	-	-	-	-
The existing information on predications for Private Markets, Nanotechnology Market Forecast to 2013							

Currently, according to index of number of published reliable ISI essays, Iran is ranked in ninth position with publishing 3011 papers in the world (Nano Headquarters, 2012). Among them, acquiring of competitive advantages in nanotechnological field requires being aware of corporate nanotechnopreneurship in this area and creation of wealth by means of capacity of knowledge base enterprises. Whereas many researchers and active entrepreneurs in nanotechnology field are academicians and university graduates and with respect to novelty of corporate nanotechnological entrepreneurship, being informed about corporate nanotechnological entrepreneurship process may highly affect on activities of SMEs which are active in this field (Phillip H. Phan,2004). Given that corporate nanotechnological entrepreneurship is taken into consideration as one of the most important strategies to maintain competitive advantage of knowledge based enterprises and with respect to failure high rate in technology based projects in many enterprises, it is crucially important to identify the restrictive and accelerating factors for attraction and developing technology. Therefore, with respect to the existing lack of researches in this regard in Iran, having information about the effective factors on nanotechnological entrepreneurship process in studies in this field is one of the major challenges before researchers, policy- makers, and nanotechnology entrepreneurs. This paper seeks for giving answer to this major question that what factors may affect on corporate nanotechnological entrepreneurship in active technological knowledge based SMEs in the field of nanotechnology. To respond this problem, we have dealt with expressing the results and finding which derived from analysis of the collected data

from studied experts by means of interview method after review the subject literature and interpretation of methodology.

Theoretical Bases and Research History

Review Literature of Technopreneurship

Technopreneurship is one of the important subjects in entrepreneurship topic that may play important role in creation of competitive advantage in various enterprises and organizations. Technopreneurship is innovative application of technical science and knowledge individually or by a group of persons, who create and manage a business and take it financial risk in order to achieve their goals and perspectives. The engineers possess high technical skills in this regard but they often enjoy few skills in business and in terms of entrepreneurial thinking (Prodan, 2007). Its main role which it plays in reconstruction and economic growth is one of the reasons for this purpose. Technology based entrepreneurship is necessary for which technology base industries are being developed promptly and they are substituted by traditional industries and this change and knowledge base activities may be occasionally interpreted as great as industrial revolution. Today, it is completely clear that according to a report from OECD, development of technology play an essential role in economic growth and development and technology- oriented industries may play ever- increasing and major role in international trade. While emerging technopreneurship may cause ever- growing appearance of knowledge based SMEs (Dahlstrand, 2007). Dorf, R.C., & Byers (2005) define technopreneurship as a leadership style of business including identifying extremely technological economic opportunities with high capacity for growth, collection of resources like expert manpower and capital, rapid growth and remarkable risk management by means of decision making skills. Technology base businesses exploit from major advancements in science and engineering to provide better products and services for customers.

Definitions of Technopreneurship

technopreneurship is a latent concept that is placed in the core of many important subjects and it includes some topics about setup and growth in enterprises, development of regional economy, election of appropriate shareholders to acquire ideas for market and training of managers, engineers, and scientists. Technopreneurship comprises of identifying modern technologies and even creation of technological opportunities by presentation of commercial products and services (Blanco, 2007). technopreneurship is to invest in a project that gathers and mobilizes expert members with heterogeneous assets, which are related to advancement in scientific and technological knowledge, in order to create and acquire value for an enterprise. technopreneurship is used equally in the newly formed and established enterprises and at the same time to the any extent technopreneurship is necessary for growth, discrimination and competitive advantage in enterprises and at national level (Bailetti, 2012). Concept of "technopreneurship" as a strategy for maintenance and excellence of sustainable parameters of competitive advantages in organizations and businesses has drawn researchers' attention (Tajeddini, 2010).

Definition of Corporate Entrepreneurship

Vesper purposes three main factors about corporate entrepreneurship including new strategic orientation, initiative from infrastructural layers, and creation of an independent business. Kuratko posits five distinct internal factors which support from corporate entrepreneurship in terms of meaning including top manager's support from corporate

entrepreneurship, bonus (reward) and accessibility to resources, organizational structure and boundaries, risk taking and access to time. After several decades from emerging entrepreneurship, this issue has entered into many intellectual and scientific branches and achieved a higher position. Technopreneurship and corporate entrepreneurship trends are some of the relevant fields. Recently, the overlapping of these two trends as a novel concept has been drawn attention by thinkers as corporate technopreneurship. The activities relating to corporate technopreneurship, particularly in terms of technological innovation, play very important role in developed economies and similarly they are considered as important for improving performance and economic revival of knowledge base SMEs since despite of the conducted studies on corporate entrepreneurship and technopreneurship, very limited number of these studies may found in which they put the cross point of these trends as the axis for their activity (Peng and Zhang,2008).

Definitions of Corporate Technopreneurship

Corporate technopreneurship is an intra- organizational process in which a technological entrepreneur or group of them create and manage an enterprise by research, development, innovation, and technology where this process is followed by venture (risk taking). Generally, technological entrepreneurs possess high technological knowledge but they are deprived from necessary skills of business, management for survival, and achievement in technological enterprises since it is requires acquiring a lot of financial experiences and data when an enterprise is established. When the enterprise grows, it needs to employ other experts from technological entrepreneurs' networks as well as other institutions during this process. Corporate technopreneurship may include production techniques and new procedures. Technological leadership tendency has been considered important to establish entrepreneurship. Techniques and technology are deemed as some part of corporate innovation. Corporate technopreneurship process is mainly related to technological innovations where technology may be utilized as a system of theoretical and operational knowledge and skills by enterprises for development, production, and delivery of their products and services so that it could be defined and embodied in personnel, materials, facilities, equipment, and physical procedures and processes. Antonici and Prodan consider corporate technopreneurship as a process inside an organization in which technological entrepreneurs or some groups of them tend to establish and manage R&D, innovation and technology base enterprises that are followed by risk. In general from their viewpoint, technological entrepreneurs possess a lot of technical knowledge but they lack of entrepreneurial necessary skills for management, duration, and success in organizations and this has led to reduced efficiency in technology base organizations and enterprises (Antonici&Prodan,2007). On the other hand, some thinkers believe in the existing effective relationship among corporate entrepreneurship and improved performance of organization while some others argue that there is a complicated relation among corporate entrepreneurship and improved performance. Nevertheless, rate of performance is not at the expected level and many enterprises, which have adapted corporate technopreneurship strategies, were failed (Peng and Zhang,2008). Technopreneurship will be placed in the development path when the relationship among micro and macro factors is being addressed between technological opportunities and entrepreneurial performance. In a study conducted by Petti and Zhang (2011), corporate technopreneurship is included in a system of internal entrepreneurial processes and the related strategic capabilities respectively including indentifying discover, and creation of technological opportunities and development of values

that enable innovative business models to exploit from these opportunities. More clearly, it is to search for opportunities and budgeting for investment and covers entrepreneurial tendency. Knowledge management covers capacity for attraction and management the relevant change to innovation of business model and incorporates dynamic capability that is aimed at creation of competitive advantage in organizational environment.

Nano -Technopreneurship

Development in technopreneurship in nanotechnology is in Early stage and it is done like a project, including financial sponsorship for active technopreneurship specialized association in nanotechnology field by US National Collegiate Inventors and Innovators Alliance (NCIIA) over three courses by focusing on design and development of new products and through emphasis on technopreneurship elements such as designer team, determination of marketing criterion, design optimization, on time arrival at market, cost analysis of life cycle, databases, the registered inventions, security and moral principles, which are granted for technopreneurship projects in the field of nanotechnology (Christopher C. Ibeh,2009). Whereas subject of employment in nanotechnology field is related to different products and the processes in which they are produces, many changes in technology field correspond to creative inventions and ideas derived from the mind that belongs to a person or a small group of people (Foster at al,2005). Study on investment in active newly- established enterprises in nanotechnological field shows it us that venture investors may affect on position of an enterprise and at the same time given this point that level of invention in an enterprise is a factor for determination of investment level and interaction among the given enterprise and investors (Tyler Wry,2013). In the nanotechnology field, inventors are active in some defined certain places like universities and governmental laboratories and enterprises so an entrepreneur in nanotechnological field should pay attention to finding the needed base in his/ her enterprise by considering inventors' attitude for this reason technopreneurship is preferred in nanotechnological field since nanotechnology revolution is simultaneously developing throughout the world at international level (Johnson, M.A,2009). In this field, an entrepreneur knows this well that high- techs always leads to job and new opportunities so this point should be considered that nanotechnology is changing the world and such a change may be only exerted in technopreneurshipprocess in this regard (Louis Hornyak,2008). In Table (2) a summary of corporate technopreneurship process is given.

Table 2

Definitions of Corporate Technopreneurship

Researchers	Year	Dimensions and Definition
Tyler Wry	2013	Study on investment in active newly- established enterprises in nanotechnological field where venture investors may affect on position of an enterprise
<u>Bailetti</u>	2012	Technological investment is implemented in a project where expert personnel with heterogeneous assets are related to achievement in scientific and technological knowledge. It requires competitive distinction and advantage for growth in enterprises and at national level.
Petti & Zhang	2011	Organizations should be able to provide resources from foreign networks as a competitive lever to maintain competitive advantage

		Conflict in environmental chaos, importance of external factors and organizational performance
Peng & Zhang	2008	<p>To acquire advantage from emerging business opportunities and securing them, enterprises should take flexible and innovative strategies so that to be able to adapt to a competitive and insecure environment as well as customers' variable demands.</p> <p>Corporate technopreneurship is an important strategy for investigation of researchers and adaption it by enterprises. While the rate of performance is at the expected level. Some enterprises, which have taken corporate technopreneurship strategies, were failed. As a result, the relationship among corporate technopreneurship and performance has been drawn attention by researchers since based on the view from experts, the relationship among this phenomenon and performance is assumed more complicated that it considered.</p>
Peng et al	2008	Control and supervision of a unit over corporate technopreneurship and its performance may positively affect on it but acquisitive and merged managements and supervisions may be negatively related to this phenomenon
Antoncic & Prodan	2007	<p>Corporate technopreneurship is an intra- organizational process in which a person or a technological entrepreneur group create and manage an enterprise by research and development, innovation, and technology.</p> <p>Similarly, this process includes a high risk. Technological entrepreneurs have usually high technical knowledge but they lack business and managerial skills. To solve this problem, the group should gather some personnel with other needed specialties by using the existing networks as well.</p>
Menzel et al	2007	<p>Converting active engineers, particularly in R&D field, into corporate entrepreneurs in great organizations</p> <p>Engineers are the expert workforce in organizations that play important role in creation and development of innovation in organizations.</p> <p>Engineers should be able to establish positive interaction with other sectors like marketing, R&D, foreign providers, and services supplies. Innovation is not related only to technical knowledge (know- how) and it requires social knowledge so that innovations to be significant. Thus, in parallel with technical innovations, social innovations should also form.</p>

The basic theoretical framework of this paper as shown in fig.4 that is extracted by (Petti & Zhang, 2011) conceptual framework.

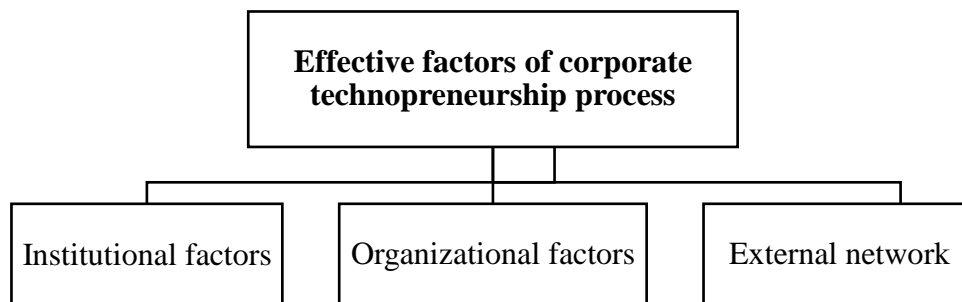


Fig 3: Research model of effective factors on corporate technopreneurship, Petti & Zhang (2011)

Methodology

Qualitative analysis

In order to identify the key effective factors on corporate technopreneurship in this paper that may affect on active knowledge based SMEs in the field of nanotechnology, qualitative analysis method was adopted. The method of determination of sample size was used at interview stage based on snowball sampling technique and continued up to saturation while the rationale of adequacy for the collected data is purposed as the adequacy limit for data. Given this objective some interviews were conducted with the presence of Twelve academic managers and professors who were knowledgeable to corporate technopreneurship over active enterprises in nano- field and after doing Twelfth interview, researcher concluded that information of interviewees were iterative and came to the saturation level and for this reason, it did not require continuing interviews. The following table shows demographic description from interviewees.

Table 3

Statistical Sample Of Interviewees Of Effective Determinants Of Corporate Technopreneurship process In Active Knowledge Base Technological Firms In The Field Of Nanotechnology

Interviewees	Female	Male
Members of academic fellowship from universities	2	3
Graduates	2	2
Directors of Enterprises	-	3

Then by using dimensional- inductive coding technique, the main and axial effective factors of corporate technopreneurship were derived to present a new conceptual model of corporate technopreneurship in active technological enterprises in the field of nanotechnology. The derived results from interview are also given in the following table.

Table 4

Coding the effective factor on corporate technopreneurship process in Active knowledge based SMEs in nanotechnology industry

Axial Coding	Open Coding Concepts	Verbal Statement of Interviewees	Interview Code	Frequency
Organizational Factors	Organizational resources	The presence of organizational technology play an essential role in development of corporate entrepreneurship in active enterprises in nanotechnology. Financial and investment sources in active enterprises are some of the needed infrastructures for corporate technopreneurship in the field of nanotechnology	I ₁ , I ₅ , I ₆ , I ₇ , I ₈ , I ₁₀ , I ₃ , I ₂ , I ₉	9
	Organizational Infrastructures	Soft infrastructures including technology, space, and hard infrastructures comprise of places, R&D, and areas which seem necessary for development of corporate entrepreneurship	I ₂ , I ₃ , I ₄ , I ₅ , I ₈ , I ₉ , I ₁₀ , I ₁ , I ₆ , I ₇	10
	Organizational Strategy	Development strategy for new product and strategy of investment in corporate technopreneurship are effective on the field of nanotechnology, Market strategy and business strategy along with presentation on technopreneurship Business Model effect on active enterprises in nano field	I ₁ , I ₂ , I ₃ , I ₄ , I ₅ , I ₇ , I ₈ , I ₉ , I ₁₀	9
	Organizational Management	The knowledgeable management for commercialization and entrepreneurship process along with industrial experience in corporate technopreneurship process may play vital role in nanotechnological field	I ₁ , I ₂ , I ₃ , I ₄ , I ₅ , I ₈ , I ₉ , I ₁₀	8
	Knowledge Management	The presence of management for creation and distribution of knowledge inside an organization and its utilization and storage is highly important in corporate technopreneurship in nanotechnological field	I ₁ , I ₂ , I ₅ , I ₇ , I ₈ , I ₉ , I ₃ , I ₆ , I ₁₀	9
	Organizational Process	The existing certain processes including R&D process in corporate technopreneurship field concerning to nano and development process of new product may encourage personnel to technopreneurship in nano industry	I ₁ , I ₂ , I ₅ , I ₆ , I ₇ , I ₈ , I ₉	7

	Organizational Internal Networks	The specialized social networks and Social virtual networks may be effective in acceleration of corporate entrepreneurship process in nanotechnology	l ₁ ,l ₂ ,l ₅ ,l ₆ ,l ₇ ,l ₈ , l ₉	7
	Organizational History and Culture	Despite of organizational experience in technopreneurship field, the supportive organizational policies and social capital of technopreneurship will have better performance in nanotechnological field	l ₁ ,l ₂ ,l ₅ , l ₆ ,l ₈ ,l ₁₀ ,l ₇ , l ₉ ,	8
External Factors	Government	If some needed conditions and facilities are provided and the supportive role is played including customs and taxation rules for entrepreneurs and domestic products so that to reduce creation of risk for the new enterprise then corporate technopreneurship will be increased particularly manufacturing of new products and establishing new enterprises by entrepreneurs, researchers and technological practitioners.	l ₁ ,l ₂ ,l ₅ , l ₇ ,l ₉ , l ₆ ,l ₈ ,l ₁₀ l ₃ ,l ₄	10
	Market	International transactions, technology attraction coefficient and market demand regarding new products in nanotechnology, foreign market size, and distribution networks with market infrastructures and complementary technologies are considered as important and determinant factor in corporate technopreneurship in nanotechnological field.	l ₁ ,l ₂ ,l ₃ , l ₄ ,l ₅ , l ₆ ,l ₇ l ₈ , ,l ₉ , l ₁₀	10
	Capital	The presence of venture investors and the existing investment supportive fund as well as the rate of foreign investors' desire in plans and facilitation in burrow loan to technological manufacturers may play essential role in technopreneurship and creation of new enterprises.	l ₁ l ₂ ,l ₃ , l ₅ ,l ₆ ,l ₇ l ₈ l ₉ ,l ₁₀	9
	Organizations & Enterprises	Providers for raw materials, laboratory equipments, customer corporate and public and private organizations relating to nanotechnology like KAFA Co, NIOC, and Ministry of Industries influence in corporate technopreneurship task in nanotechnological field.	l ₁ ,l ₂ ,l ₃ ,l ₅ ,l ₆ ,l ₈ , l ₉ , l ₇	8

	Intellectual Ownership Registration Organizations	Intellectual ownership and trade brands and signs registration organization and international patent institutions make it possible to issue license(s) for commercialization of new products and or processes which are some effective factors on corporate technopreneurship in the field of nanotechnology.	l ₁ ,l ₂ ,l ₃ , l ₅ ,l ₆ ,l ₇ l ₈ l ₉ ,l ₁₀	9
	Standard and License Issuing Organization	National organization for issuance of permission whether public or private are some of effective and very important factors on growing corporate technopreneurship in nanotechnology out of which we can refer to Environmental Protection Organization (EPO), Ministry of Health & Medical Sciences, Ministry of Science, Researches & Technology, FDA and Ministry of Agriculture	l ₁ ,l ₂ ,l ₃ ,l ₄ , l ₅ ,l ₆ ,l ₇ ,l ₈ ,l ₉ ,l ₁₀	10
	Networks	Laboratory networks and clusters and associations of technology are one of the crucial factors in corporate technopreneurship.	l ₁ ,l ₂ ,l ₅ ,l ₆ ,l ₈ ,l ₃ , l ₇ ,l ₉ ,l ₁₀	9
Technological Factors	Technological Readiness Level (TRL)	High- Technology absorption factor is one of the effective factors on corporate technopreneurship in the field of nanotechnology. There are several TRL from idea to mass production and marketing level that effect on technopreneurship process of nano-tech. firms.	l ₁ ,l ₂ ,l ₅ ,l ₆ ,l ₈ ,l ₃ , l ₇ ,l ₉ ,l ₁₀	9
	Type of Technology	It is important that technology has low, medium or high tech. level for technological part of firms.	l ₁ , l ₂ ,l ₃ , l ₅ ,l ₇ ,l ₈ , l ₉ ,l ₁₀	8
Individual Factors	Demographic Features	Financial solvency and age of researcher play important role in creation of innovation and development of technopreneurship in enterprise	l ₁ ,l ₂ ,l ₃ ,l ₄ ,l ₆ ,l ₇ , l ₈ ,l ₉ ,l ₁₀	9
		Gender of researcher is evaluated as important in corporate technopreneurship in nanotechnology and most of technologists are males so factors of age and educations are effective.	l ₁ ,l ₂ ,l ₃ ,l ₄ , l ₅ ,l ₆ ,l ₇ ,l ₈ ,l ₉ ,l ₁₀	10
		Knowledge and lack of knowledge in technologist regarding processes and	l ₁ ,l ₂ ,l ₅ ,l ₆ ,l ₈ ,l ₉ , l ₁₀ , l ₃	8

	Researcher's Experience & Knowledge	trends may highly affect on corporate technopreneurship activities.		
		Knowledge and experience of technologist and his/ her knowledge and lack of knowledge about processes and trends and the fact that if researcher was active in commercialization by taking a certain strategy may highly influence in technopreneurship in nanotechnological field.	l ₂ ,l ₃ ,l ₅ ,l ₆ ,l ₇ ,l ₈ ,l ₉ ,l ₁₀	8
	Psychological Features	A person who never be disappointed in the case of failure and he/ she has an attribute to seek for success and never assign his/ her affairs to determined fate while possessing self-reliance at high level so such a person may succeed in this sense.	l ₁ ,l ₂ ,l ₃ ,l ₆ ,l ₇ ,l ₈ ,l ₉	7
	Entrepreneur's Motives	The researcher, who likes to be his/ her own boss, tends to corporate technopreneurship in nanotechnology field and creation of new enterprise. Desire to seeking and acquiring wealth in technologist and creation of interior capacity for bearing and taking risk may contribute technologist in commercialization of product and corporate technopreneurship in nanotechnological field	l ₁ ,l ₂ ,l ₃ ,l ₅ ,l ₇ ,l ₈ ,l ₉ ,l ₁₀	8
	Technologist Personal Networks	The researcher, who has access to investor for commercialization of findings of his/ her studies and to provider for the needed raw materials to commercialize research finding and or identifies customers of his/ her commercialized product may be more involved in commercialization activity of creation of new enterprise.	l ₂ ,l ₅ ,l ₆ ,l ₉ ,l ₁₀	5
	Individual Skills	Characteristics and ability of perceiving new concepts and creation of team work spirit in technologist and possessing leadership features are some of effective features on corporate technopreneurship in nanotechnological field.	l ₂ ,l ₃ ,l ₄ ,l ₆ ,l ₇ ,l ₈ ,l ₉ ,l ₁₀	8
	Academic Institutions	Public and private universities, Science & Technological Parks and academic researches centers for improving	l ₂ ,l ₃ ,l ₄ ,l ₆ ,l ₇ ,l ₈ ,l ₉ ,l ₁₀	8

Institutional Factors		corporate technopreneurship regarding design and development of new product as well as growth centers may be effective factors in this sense		
	Guild Institutes	Existence of educational and research institutes, science- technology headquarters and setup science-technology centers in science and technology parks may effect on nanotechnology corporate technological entrepreneurship process	l ₁ , l ₂ ,l ₃ , l ₅ ,l ₇ ,l ₈ , l ₉ ,l ₁₀ ,l ₆	9
	Counseling Centers	The existing entrepreneurship clinics, industrial counseling clinics and nano corridor may increase commercialization probability and establishment of new enterprises in nanotechnology.	l ₁ ,l ₃ ,l ₅ , ,l ₁₀ ,l ₂ l ₇ ,l ₈ ,l ₉	8
	Financial Sponsors Institutes for Technological development	The subject of capital and financial support is one of the important in design and development of new product in corporate technopreneurship especially in nanotechnology in which certain laboratory instruments are used where supportive fund for researchers and supporting fund for investment are some of these factors.	l ₁ ,l ₂ ,l ₅ ,l ₆ ,l ₈ ,l ₉ , l ₁₀	7
	Associations & Syndicates	Employer- employee guild associations, professors’ scientific mobilization (BASIJ), NGOs are some effective factors on corporate technopreneurship in nanotechnology.	l ₁ ,l ₃ , ,l ₄ ,l ₆ , l ₇ ,l ₈	6
	Public Institutions	Due to the importance of nanotechnology in daily life and its impacts on some governmental important institutions including science-technology deputy of the Presidency Center, Ministry of Science, Researches and Technology, Nanotechnology Development Strategic Headquarters, Ministry of Health & Medical Sciences, Elites National Foundation, and Intellectual ownership Registration Centers may affect crucially on corporate technopreneurship in nanotechnological field.	l ₁ ,l ₂ ,l ₃ ,l ₄ , l ₅ ,l ₆ ,l ₇ ,l ₈ ,l ₉ ,l ₁₀	10

As a result, 30 open codes were identified in the framework of 5 axial codes, after conducting open and axial coding of the resultant data from interview with experts. These codes express

experts' comments regarding the effective factors on technopreneurship in the field of nanotechnology in Iran. Based on experts' view and similar to conceptual framework of Petti and Zhang, group of corporate and institutional factors affects on nanotechnological field in Iran but factor of foreign network was presented as a axial factor in model of Petti and Zhang where with respect to experts' comment, this factor was identified as some part of minor elements in branch of organizational, external, and individual factors. Similarly, some other groups were recognized under title of external, technological, and individual factors so that according to experts' emphasis, they made up separately groups III, IV, and V of effective factors. Although some dimensions from technological factors have been indentified in studies conducted by some researchers like Markman at al in (2005) and Lai, Tsai (2008) and Gibson(2009) this is not emphasized as a single factor. Table 4 shows the resultant findings from open coding and axial coding of data from interview with experts.

Table 4

Effective Determinants of Corporate Nano-Technopreneurshipprocess In Active Technological Knowledge Base Firms Extracted From Open Coding And Axial Coding

Open Coding Concepts	Axial Coding	Open Coding Concepts	Axial Coding
Technological Readiness Level (TRL)	Technological Factors	Corporate resources	Corporate Factors
Type of Technology		Organizational Internal Networks	
Demographic Features	Individual Factors	Corporate Infrastructures	
Personality Characteristics		Corporate Strategy	
Researcher's Experience & Knowledge		Organizational History and Culture	
Technologist Personal Networks		Corporate Management	
Psychological Features		Knowledge Management	
Entrepreneur's Motives		Organizational Process	
Individual Skills		Market	
Academic Institutions	Institutional Factors	Government	
Guild Institutes		Capital	
Counseling Centers		Intellectual Ownership Registration Organizations	
Financial Sponsor Institutes for Technological development		Organizations & Enterprises	
Associations & Syndicates		Standard and License Issuing Organization	
Public Institutions		Networks	

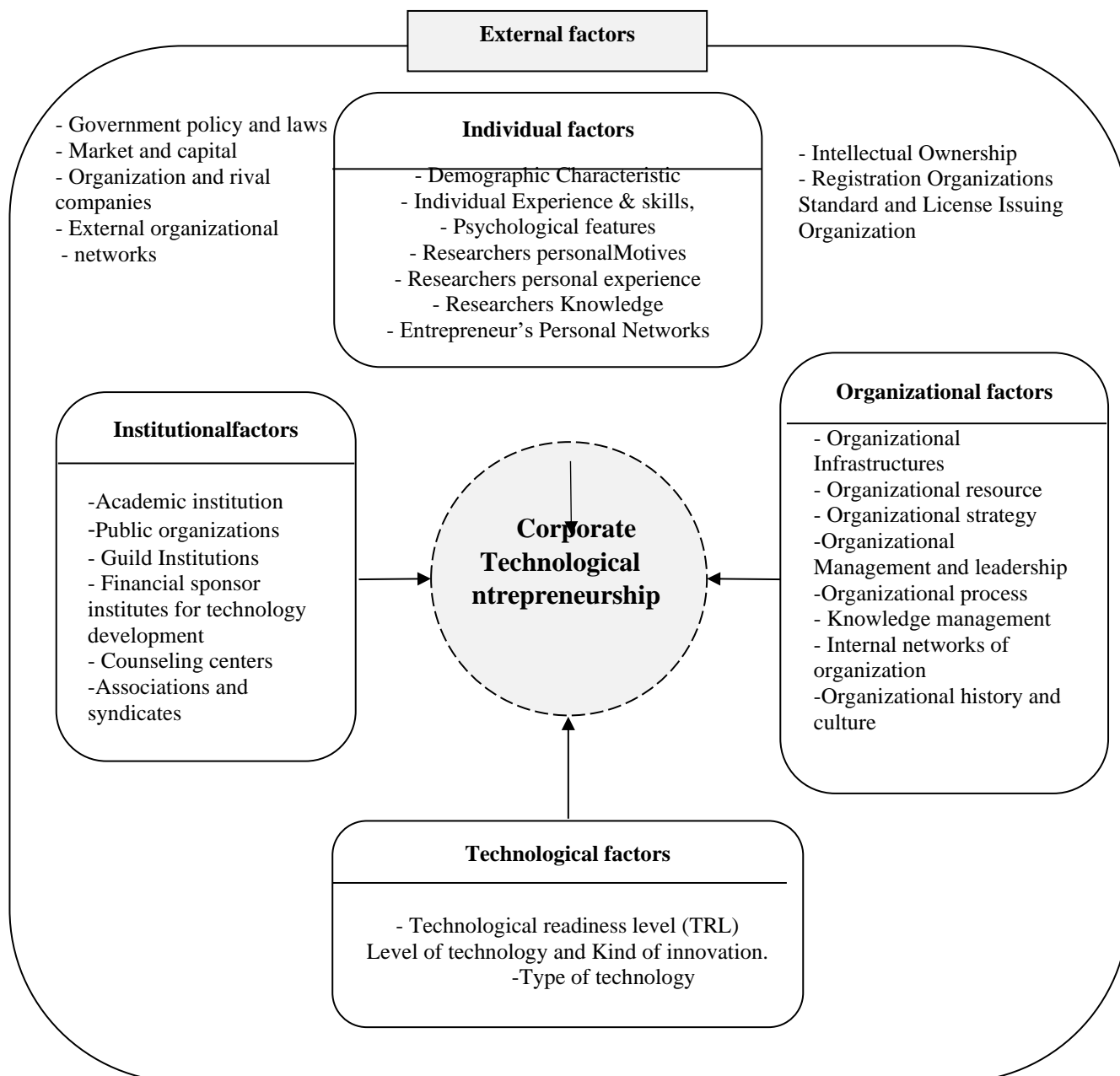
As it observed in Table 4, the effective determinants of corporate nano-technopreneurshipprocess consist of five main factor as organizational, external, individual, institutional, and technological factors that can effect on high technopreneurfirms in nanotechnology industry of developing countries (Like Iran). The organizational effective

factors on technological entrepreneurship process in active SMEs in nanotechnological field include eight dimensions as organizational sources, organizational infrastructures, organizational strategies, organizational management, knowledge management in organization, organizational processes, intra-organizational networks, at last history and culture of organization. External factors have seven dimensions including government, market, capital, organizations and enterprises, intellectual ownership registration organizations, standard and license issuing organization and networks. The institutional factors have six dimensions comprising of academic institutions, guild institutes, counseling centers, financial sponsor institutes for nanotechnology development, and governmental associations, syndicates and organizations. Individual factors have seven dimensions including demographic features, researcher's experience and knowledge, psychological features, motivation, personal skills, and technologist personal networks. And finally, technological factors comprise of two dimensions of technological readiness level (TRL) and type of technology.

Analysis and Conclusion

The results derived from the above table suggest that rather than confirmation of organizational and institutional factors in corporate technopreneurship process in nanotechnology, the interviewees have also emphasized on three other factors under title of external, technological, and individual factors. According to the comment of the interviewee expert(s), the effective organizational factors on corporate technopreneurship include organizational sources comprising of corporate technology, financial and capital sources, and Human Resources, organizational strategy including business strategy, strategy of product development and market strategy for design and development of new product and or new enterprise, organizational processes, knowledge management, organizational infrastructures, organizational internal networks, and intra-organizational institutions, which the results of these studies are necessary for corporate technopreneurship. The institutional factors like academic institutions, governmental organizations, and associations, syndicates, and guild agencies are considered as important and effective factors on corporate technopreneurship in the field of nano. A new conceptual framework is presented to identify the effective determinants of high technopreneurship process in active knowledge base firms in nanotechnology industry in Figure (4)

Fig 4: Conceptual framework of the effective key factors influencing in corporate technopreneurship in active knowledge base firms in nanotechnology industry



The new individual effective factors such as demographic features, personal experiences, psychological features, researcher's communication networks and technologist personal skills will effect on corporate technopreneurship in nanotechnology industry. Also external factors has a significant influence in corporate technopreneurship in active knowledge base SMEs in nano industry. These factors include external factors of business such as status of financial markets and foreign market size and market demand regarding nano products and standard and license issuing organizations and venture investors, investment supporting funds as well as market manpower, market providers, characteristics of industry, government's financial and supportive rules and policies concerning to corporate technopreneurship in the field of nanotechnology. It was characterized in this paper that technological factors extremely effect on corporate technopreneurship and product commercialization. The results from interview showed that corporate technopreneurship will be affected by technology development level in active knowledge base SMEs in the field of nanotechnology. One of the other important

findings derived from this study for active knowledge base SMEs in nanotechnology field is subject of networks, which has been purposed in as a main factor in the model of Zhang and Petti. Research results indicated that factors of networks are considered as personal networks, organizational internal networks, and networks outside the organization as minor factors and some of them as the major factors. In order to make sure of the given results in this study, the derived results are compared with findings from other studies done by researchers in Table 5.

Table 5

Comparison among results of this paper with other researchers' results

Axial factors	Compared to other researchers
Organizational Factors	Prodan, I. (2007), Bailetti, T. (2012), Zhang, G. (2008), Zhang, G(2008), Dorf, R.C., & Byers, T. H. (2005), Shane, S. Venkataraman, S. (2003), Kuratko, D.F., (1993), Tyler Wry, (2013)
Institutional Factors	Prodan, I. (2007), Petti, C., Zhang, Sh.(2011), Kuratko, D.F., (1993), Blanco, S. (2007)
External Factors	Worthington I. & Britton, C. (2006), Prodan, I. (2007), Bailetti, T. (2012), Zhang, G. (2008), Blanco, S. (2007)
Technological Factors	Prodan, I. (2007), Petti, C., Zhang, Sh.(2011)
Individual Factors	Prodan, I. (2007), Petti, C., Zhang, Sh.(2011)

Results of this paper indicate that five groups of organizational, external, individual, institutional, and technological factors effect on corporate technopreneurship in active knowledge base technological firms in nanotechnology industry. Since none of previous studies dealt with this subject concerning to nanotechnology in particular thus some of effective factors on corporate technopreneurship process in those active knowledge based SMEs which have been identified in nanotechnological field in Iran, have not been expressed by researchers. The results of this paper could be applied for high-technopreneurship process in nano technological firms all over the worlds.

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