

Zahedi, Amir Ehsan; Mirghfoori, Seyyed Habibollah; Abadi, Ali Morovati Sharif

Article

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*Corresponding author: Seyyed
Habibollah Mirghafoori management,
Yazd university, Iran (Islamic
Republic of)
E-mail: mirghafoori@yazd.ac.ir

Reviewing editor:
Lorenzo Ardito, Politecnico di Bari,
Italy

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MANAGEMENT | RESEARCH ARTICLE

An integrated map to developing the innovation and commercialization potential of Iranian knowledge-based companies

Amir Ehsan Zahedi¹, Seyyed Habibollah Mirghafoori^{1*} and Ali Morovati Sharif Abadi¹

Abstract: Innovation means the economic or social impact of the object on the market. Many inventions are being made and innumerable ideas are created; but among them, only a small number can affect the market, considered as new ideas and inventions. The rest of them disappear in various stages of their evolution, from the stage of idea to the market stage. Establishing knowledge-based companies in science and technology parks in order to commercialize ideas is one of the first serious work that has been done in the country to transform innovation into technology. The existence of an effective system for innovation and commercialization with respect to various types of specific resources required by the company to achieve sustainable competitive advantage is considered as a strategic choice. The purpose of this study is to develop an integrated map to developing the innovation and commercialization potential of knowledge-based companies in Iran. This study has been conducted using Strategic Options Development and Analysis (SODA) approach. The population consisted of experts in the field of knowledge-based companies. Using a theoretical sampling, 13 managers of knowledge-based companies in Tehran province were selected as participants in the research. Data were collected through semi-structured interview with general guidance. The final

ABOUT THE AUTHOR

Amir Ehsan Zahedi This research is part of our extensive study on designing development models for knowledge-based companies in Iran, which is presented in the form of a PhD thesis at Yazd university. The authors thank the cooperation and assistance of all who helped us in this research.

PUBLIC INTEREST STATEMENT

Innovation is one of the important features of today's organizations in the field of environmental changes, globalization and the profound change of consumer preferences and customer demands as a factor of business success, and a way of entering the global markets. Also commercialization and transmission of research findings to the industry and marketing are undoubtedly one of the most complex stages of innovation process. Experiences of different countries show that small and medium-sized enterprises (SMEs) play a key role in technology development, economic prosperity and employment. According to the most of the scholars, they are the foundation of knowledge-based economy. As a result, the present study intends to shed some light on innovation and commercialization in knowledge-based companies which is an essential issue. The results of this research can provide a comprehensive model for managers and innovators of knowledge-based companies to take action.

map drew and analyzed using Decision Explorer (DE) software. Accordingly, Human resources—Technology—Culture—Political factors—Financial and capital resources—Physical and structural resources, are key options in development of the innovation and commercialization potential of knowledge-based companies. By focusing on these options, the strategies have been developed for each of them to reinforce the key issues and to achieve the goals at the higher level.

Subjects: Business, Management and Accounting; Management of Technology & Innovation; Innovation Management

Keywords: innovation; commercialization; knowledge-based; strategic options development and analysis

1. Introduction

This question is constantly raised why a country has progressed, but the same country which has better conditions in terms of primary resources and productivity facilities has been lagging behind? What an important factor in the same situation cause success and progress of some (country-group-person) and backwardness and improper performance of some others? Creativity and innovation are the prerequisites for development and progress and excellence of an organization and society, and knowledge of it's techniques is an inevitable necessity for managers, students, researchers and those who are interested in this field (Taleb Bidokhti & Anvari, 2004). Innovation defined as output and productivity growth axis, the key driver of labor productivity growth, the main source of social flourishing, the key factor of industry dynamics both in terms of composition and organizing, and a decisive factor for economic success. Innovation helps organizations to gain competitive advantage in an uncertain environment and win rivals (Stefan & Bengtsson, 2017). Innovation in the long run affects on organization's performance and is the major factor in growth and development of business (Morshedloo, Alipoor, & Aabedi, 2015).

The manufacturing patents which are fails, unexpected problems that make a business operations unprofitable, factors that are ignored as neglected factors (such as technology transfer, etc.); And non-technological factors such as economic, political, social, and cultural factors; confirm the complexity of innovation path from the stage of “creating the object” to the stage of “market entry” (Stefan & Bengtsson, 2017).

What is gleaned from the careful consideration of innovation process characteristics is that the innovation process, especially in context of presenting an object to the market, is a vague, unstable, irregular, and unpredictable process, and never has a smooth path (Plagnol, Rowley, Martin, & Livesey, 2009). Therefore, the commercialization of knowledge and technology is an important part of innovation process, and no technology and product can enter the market without caring this part. On the other hand, the decision to commercialize new technology also has a close connection with the characteristics of innovation system in which the company operates (Plagnol et al., 2009).

The issue of innovation and commercialization in knowledge-based companies is more and more essential. In economics, we face two types of economics: the physical economy and the knowledge economy. The physical economy has always been regarded because is touchable, while today making ideas and commercializing that ideas, which is the knowledge economy, is the main source of income for advanced countries (Danesh Fard, 2016). It is necessary in Iran, that the importance of knowledge-based companies be understood and supported. Knowledge-based company means individual or group thinking and creativity force, and by no means should be equivalent to a factory structure. The corporations and knowledge-based companies of the world never have a factory and production line, but unfortunately, in our country still looks at the knowledge-based issue as a production and product line (Pakzad, Nezemi, &

Khatibi, 2015). being knowledge-based means creating more creativity and making business models that have not existed before (Sanoubar, Salmani, & Tajvidi, 2012).

while more than 2000 knowledge-based companies are active in the country, contribution of the knowledge-based companies in the country's Gross Domestic Product is less than half a percent (Soltani, 2016).

The lack of an integrated map that can guide the practice of these companies in the path of innovation and commercialization and facilitates their effectiveness, is obvious. Indeed, innovation and commercialization defined as the process of ownership, breeding and development of ideas with complementary knowledge; creation, build and production of marketable goods in the market. Therefore, the process of innovation and commercialization embraces all activities from the emergence of ideas to product design, prototype testing, manufacturing, and marketing. This process can be divided into two stages: 1—Planning, 2—Implementation.

In the planning stage, the appropriate map and strategies for success in the process of innovation and commercialization should be identified and in the implementation stage, the process according to the identified map and strategies (identified in previous stage) should be implemented (Yadollahi Farsi & Kalathaei, 2012). In fact, each company must provide a strategic plan before entering to the innovation and commercialization process. This encourages systematic thinking and provides the scene for a possible marketing plan (Yadollahi Farsi & Kalathaei, 2012).

Therefore, having an integrated map that can comprehensively cover the entire process of innovation and the factors affecting it, and can present strategies for key factors of success, is a solution for a knowledge-based.

According to what was said, this research pursues two major goals:

- (1) –Designing an integrated map to developing the innovation and commercialization potential of knowledge-based companies.
- (2) –Presenting strategies for developing the innovation and commercialization potential of knowledge-based companies.

The results of this research can provide strategies and practical applications for managers and innovators of knowledge-based companies, and guidelines of future studies for researchers of this field.

2. Review of literature

2.1. Innovation and commercialization

First it is necessary to explain the concept of innovation and commercialization.

Innovation from the Schumpeter's perspective can be a new product or service, a new production process, a new structure, or a new administrative system that can be applied to an organization or business (Bowen, Rostami, & Steel, 2010). Today's definition of innovation is it's introduction as a key element in the entrepreneurial process, which lies in the definition of Drucker and many entrepreneurship researchers and theorists endorse this idea (Henderson & Robertson, 2000). Drucker considers innovation as an action that is dedicated to the entrepreneur. By doing so, the entrepreneur provides new valuable resources or richness of existing resources which will increase the potential of value. In fact, innovation is a process by which the entrepreneurs turn opportunities into marketable ideas and through this tool, they can accelerate the changes (Hitt & Ireland, 2000). Innovation is a way of thinking and acting, which is essential for survival and profitability of organization (Gibson & Naquin, 2011). Wiig defines organizational innovation as a process in which the acquisition or generation of creative idea and it's processing into the product, services, and

new methods of operation are carried out. Kerr and Gagliardi argue that innovation and creativity are the most important factor in human development in all areas, so in today's highly competitive environment, innovation is an important factor in survival of organizations (Gunday, Ulusoy, Kilic, & Alpan, 2011).

On the other hand the master key of today's world is value creation. The strategy of entering the modern business world is technology, and master key of technology is commercialization and value added coming from that (DeGeeter, 2004). Commercialization is the process of transforming new technologies into commercially successful products and incorporating various arrays of important technical, commercial and financial processes that converts new technology to useful products or services. In other words, the commercialization of research findings is a connectivity loop of technology and market and focuses on the end rings of value chain (Gans & Stern, 2003). Since marketing of a product can guarantee success and survival of the organization, commercialization of technical knowledge has been considered as a critical factor (Bandarian, 2013). In research organizations without commercialization, researches are not meaningful. because without access to specific customers of a product, research activities will not be successful (Olsen & Poly, 2008).

Different definitions of commercialization are presented. In Heritage dictionary, commercialization means using business methods to gain profit and productivity. Several definitions, such as "the introduction of a product or service in market for profit", "the process of transforming something into business", are almost the synonyms that can be found for commercialization (Kumar & Jain, 2003).

2.2. Innovation management and it's actors

What is important in the history of innovation studies is that innovation was considered as a random phenomenon for a long time; hence, its management was also not attended. Schumpeter is one of the first to focus on this phenomenon (Gunday et al., 2011).

A systematic approach to innovation and it's management although began around the turn of the 1960's, but flourished in the 1990's. The systematic insight of innovation and importance of places with economic advantage has made fundamental changes in analysis of economic and technological changes as well as policy studies. In this approach, firms are not independent innovators, but their innovation heavily depends on a set of institutional structures of knowledge production (research organizations and universities), an effective learning culture, knowledge disseminating organizations (schools and universities), government policies, and others firms that interact with each other. Also innovation is an inter-connected set includes various business, financial, organizational, technological, and scientific activities (Röd, 2016).

In other words, innovation was initially thought as a individual phenomenon, and each organization can offer new ideas or products based on it's innovators, and surpasses it's rivals. There was no doubt that intense competition requires that each organization hides it's research and information and minimizes publication possibility of them before releasing a product or a new idea (Stefan & Bengtsson, 2017). In such a space, the idea of innovation system was introduced. By reducing the role and importance of individual actors in innovation, this idea claimed that innovation is not an individual phenomenon, but rather it is a process that consists of several subprocesses and occurs when all of a new idea, a new device or a new market, operate in a coherent manner. In this regard, innovation is not an individual activity and can not be understood solely by independent decision making at the level of an individual or firm. In return it is a collective activity, resulting in complex interactions between the various institutions and relationships between them; continuous interactions that create the idea and apply it in the form of soft and hard technologies. Innovation is a system output that starts with the creation of an idea and ends with it's commercialization (Röd, 2016).

In other words, until commercialization does not take place, innovation does not appear. therefore in this research, commercialization along with innovation as a complementary phenomenon has been questioned. In fact, considering commercialization as the last stage of the process of developing a new product indicates a narrow view of the commercialization issue. This kind of thinking means that we are basically considering commercialization as the natural extension of the R&D process and always in the stage of entry into the market, commercialization reaching its highest level. The problem of such a view is the lack of comprehension.

From the most important features of systematic thinking these can be noted: attention to knowledge and innovation as an endogenous variable and analysis the factors affecting it; a holistic and systematic approach to innovation and attempts to analyze the small roots of this phenomenon; analysis of innovation in its broad sense, including innovation in product and process as well as organizational and technological innovation; emphasis on the role of institutions and all actors in the system and policies or targeted actions in determining the rate and direction of innovation; providing a coherent and integrated framework in policy making; modeling a complex concept, such as innovation and the system of transformation idea into product.

From the most important advantages of this view these can be noted: according to this approach, innovation efforts are linked to other macro policies of the country (such as educational policies, monetary policies, etc.), and this systemic look into the policy making process makes it possible to identify and resolve the existing weaknesses and inconsistencies by the proper understanding of the innovation system; also one of the highlights in the innovation system is the strong link between the university and industry and the emphasis on intermediary institutions and the identification of missing circles; as well as since the innovation system helps to the targeted researches with adaptation to the real needs of the country and the economic situation and so the researches will be converted to the technology and the market, so it can be a good solution to solve the problems of producing firms in the countries (Bawen et al., 2010). Therefore, this research has been based on this thinking.

2.3. Innovation strategies

It should be noted that some efforts have been made on the basis of systematic thinking designing innovation and commercialization strategies.

According to Mintzberg, strategies are patterns of the past and plans for the future. In other words, a strategy is a program that determines how resources, products, processes, and systems are arranged for companies to adapt to their environment for the development of competitive advantages (Stefan & Bengtsson, 2017). Lendel and Varmus (2011) also defined the innovation strategy as follows: a predefined, applied, and gradual design, to manage the allocation of resources to various types of innovation for achieving overall strategic goals, and a decision guidance framework for industries and companies about that at what time should eliminate the past with the best way, or changing the company's strategy and goals for focusing on the future business (Lendel & Varmus, 2011). Guan and others (2009) also claimed that improving performance requires a proper and robust selection of innovation strategies (Guan et al., 2009). Lu (2010) believes that such strategies are critical to continue flourishing of industries in today's world with increasing uncertainty (Lu, 2010). In this regard, researchers have presented various categories of business innovation strategies that has been shown in Table 1.

The major defect of the efforts made to explain the strategies of innovation is the generalization and the lack of attention to key success factors in the innovation and commercialization process, so in this research attempts to reach practical and applied strategies for progress by focusing on key options.

2.4. Knowledge-based companies

The issue of innovation and commercialization in knowledge-based companies is felt to be more and more urgent and given the specific requirements of these companies, it is necessary to

Table 1. The most important categories of innovation strategies

Source	Innovation strategies
Miles and Snow	Leading, conservative, analytical and reactive
Friman	Opportunistic, aggressive, defensive, affiliated or reticent, imitation, traditional
Dwyer and Mellor	Defensive strategy, distinctive product strategy, technical offensive strategy, risk strategy, conservative strategy
Gilbert	Reaction innovation strategy and lead innovation strategy
Veugelers and Cassiman	A prerequisite for innovation, the purchase of innovation and hybrid strategies
Parnell and others	Progressive, defensive, analytical, reactive, equilibrium
Masini	pioneer, imitator
Akman and Yilmaz	Aggressive, analytical, conservative, futuristic, leading and risky
Guan et al. (2009)	Leading, imitator, defensive, technology importer

carefully examine their features in designing a suitable map. Knowledge-based companies are one of a variety of small and medium-sized enterprises (SMEs).

Until the early 1960's, the major attention of managerial issues was paid to large companies, but in recent years, SMEs have been recognized as the engine of economic growth in country's economic development. According to a study, SMEs have different definitions in different countries. According to EU standards, an SME defined with a staff number less than 250 people and an it's annual turnover should be less than 40 million euro. The most important feature and advantage of these firms, in addition to being more fluid and having the ability to adapt to changing environmental conditions, is their competitive and innovative status (Hsu, Chang, & Luo, 2017).

Today, in most countries, SMEs are playing a role in various aspects of social, industrial production, and services (Chen & Zhou, 2017). Enhancement of market changes has led to the need for more innovation and consequently innovation programs in SMEs. These firms should always think about market-based changes in order not to go out from the scene of competition (Karimi & Rahmani, 2015). Governments must also provide working and activity conditions for SMEs, and attracting technology-based companies through science and technology parks by creating a suitable environment. For this reason, companies located in science and technology parks are called knowledge-based companies because they have a set of skills, abilities, competencies and specialist, which bring creativity and innovation in these companies at the peak. (Rosenbusch, Brinckmann, & Bausch, 2011).

In a knowledge-based economy, knowledge-based companies play an important role in economic growth. The knowledge-based companies and institutes are private companies or foundations which are formed in order to synergy science and wealth, knowledge-based economy development, realization of scientific and economic objectives and commercialization of research and development in the field of superior and highly value added technologies specially in related to the software production (Chen et al., 2017). In knowledge-based companies, economic growth and job creation will be done according to the capacity of innovation. This means that R&D achievements are continuously transformed through investment into product, process, or modern system, and as a result, they are the important factors in innovation and exploitation of technology in national economy (Elahyari Fard & Abasi, 2011).

Knowledge-based companies refer to firms that hire university graduates and it's main texture is formed by experts, and the main source of their income is knowledge, instead of natural resources, capital or non-productive labor. In general, the wealth generation in these firms is done through

the use of internal capabilities of individuals (peopleware). It does not exclude the role of software and hardware, but the role of peopleware in creating, growing and surviving these firms is central.

The criteria for distinguishing knowledge-based industries from other industries are as follows:

- (1) The ratio of specialist staff to total employees has a large difference with other industries.
- (2) The growth rate of specialist staff is higher than other employees.
- (3) The faculty members of the university participate in the management of the firm.
- (4) The technology life cycle is long at the early stages and after the growth stage, it is short and in any case, the rate of change in technology is higher than other industries.
- (5) A much larger budget than other industries for research and development is allocated.
- (6) There is a special ability to use technology for the rapid growth of the firm.
- (7) Industry development relies on the development of technology, not on capital or hardware.
- (8) Their competitive advantage is innovation in technology.
- (9) Conquer new markets by presenting products with new technologies
- (10) Does not rely on manual or semi-automatic methods (Estiri & Moshiri, 2009).

The most important features of the knowledge-based companies are presented in Table 2.

2.5. Elements of innovation and commercialization in knowledge-based companies

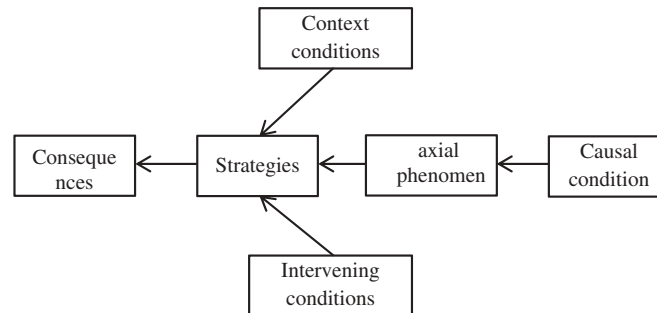
According to a research study by Mirghafoori and others (2018) a pattern contains six boxes about innovation and commercialization in knowledge-based companies designed in the following order:

- (1) Causal conditions: categories relating to the conditions affecting axial category which are necessary conditions but not sufficient to achieve consequences of applying strategies;
- (2) The axial phenomenon: the main category that can be related to other categories and appears frequently in the data;
- (3) Strategies: specific actions and interactions that result from the axial phenomenon;
- (4) Context conditions: specific conditions affecting strategies;
- (5) Intervening conditions: general conditions affecting strategies;
- (6) Consequences: outputs derived from strategies.

Table 2. Characteristics of the knowledge-based companies

Features	Brief description	
Idea-based	Knowledge based companies use their knowledge assets as competitive advantages, and their benefits are result of commercialization of new ideas and innovations	
Commercialization capability	Opportunity	Commercialization is a process that turns produced knowledge into marketable products in market
	Idea, creativity and innovation	
	Business plan	
	Permissions	
	Human Capital	
	Goods and services	
	Brand name	
	Competitive	
Competitiveness	Knowledge-based companies have important capabilities such as positive competition and generation and development, and are in line with the growing economy	

Figure 1. relationships between the boxes of the innovation and commercialization elements.



The relationships between the boxes presented in figure 1:

Based on these relationships, five theoretical propositions conducted as follows:

- (1) Financial and Capital Resources; Physical and Structural Resources; Human Resources; Technology; Culture; Political Factors; Cost; Supportive Factors; Novelty; Creativity; Idea generation; Assessment and Sifting Ideas; Ideas Development; Production and Operations; Design And engineering, and the emergence of innovation, are the causal conditions for entering the market (the axial phenomenon).
- (2) Knowledge-based economy, Industry, Research, Information and Knowledge, Skills and Experiences, Trust and Leadership, Interaction and Communication, Risk-taking and Intelligence, Support and Participation, Focus, Continuous Improvement, Flexibility, Policy and Administration, Equipping resources, Marketing, Commercialization strategies including: Leading strategy–Embossed strategy–Defensive strategy–Importer of technology–open innovation, Creative strategies include: Creativity techniques–Brainstorming–Modeling of nature–Innovation conditions–Creative environment–Talent Management Systems–Individual characteristics, Commercialization approaches include: Reaction Commercialization approach–Commercialization Assurance approach–Simultaneous commercialization approach–Commercialization approach in a novice company, Commercialization as part of business activities, are as action and interaction strategies that can lead to continuity and protection of getting to market.
- (3) Continuous changes around the world, Requirements, Program and plan, Innovation and Commercialization pattern, Innovation and Commercialization system, Innovation dimensions, Strategy including Strategy development–Strategy definition–Strategy selection–Strategic look–Strategic choices–Strategy necessity–The Strategic Business Plan–Strategic business, provide a general ground to take measures to keep entering to the market.
- (4) Innovation and Commercialization restrictions, Internal analysis, External analysis, Feasibility, Process characteristics, Feedback, provide a specific arrangements for taking measures to continue entering the market.
- (5) Entering the market and taken action and interaction strategies to maintain and sustain entering the market will follow consequences of Resilient economy, Profitability of society, Globalization, Business success, Entrepreneurship, Problem solving, Growth and Maturity, Competitive advantage, Value creation, and Innovation types (Mirghafoori et al., 2018).

2.6. Research background

In reviewing previous researches Hussein (1998) examined the factors influencing success of innovative business initiatives in the small Bangladesh industry, including government costs, business policies, administrative and legal problems, and financial constraints (Hossain, 1998). Henderson and Robertson (2000) described the educational system and counseling system in UK as an effective factor in the success of business practices (Henderson & Robertson, 2000). According to a research study on the

structure, processes, strategies, and resources allocated to the technology transfer, and political and cultural aspects of technology transfer, from major research centers of Europe to the commercial centers of the continent, six factors including focusing on market, organizational culture, internal and organizational management, intellectual property rights management, networking, entrepreneurship, and creation of new business identified as success factors of this process (Zieminski & Warda, 1999). Shurry and others have identified problems of obtaining required financial resources as the most important factor in success of new and entrepreneurial business actions (Shurry, Lomax, & Vyakarnam, 2001). Michaelis and others considered government regulations and tax regulations as a major barrier to entrepreneurship (Michaelis, Smith, & Richard, 2001). In a study at the university of Metropolis in England, the most important factors affecting success of business practices, financial-economic barriers, consulting services and other intellectual, professional and financial assistance, high entrepreneurial risk, confidence in own abilities, entrepreneurial skills, having an appropriate entrepreneurial idea, and sufficient awareness of region's market were introduced. From the view of Marques and others (2005) four factors of education, tendencies and values, innovation, and creativity form personal characteristic of knowledge-based human resources (Marques et al., 2005). Sveiby has identified individual competence as an effective factor in innovation, and it has defined capacity of employees to produce visible and intangible assets that in a knowledge-based organization consists of five dependent variables which are: explicit knowledge, skill, experience, values, and social networks (Sveiby, 2001).

Among domestic studies, Mirghafouri and others (2012) considered demographic variables, individual-personal, technical-technological, market, financial, and administrative-legal factors affect commercialization success (Mirghafouri et al., 2012). Kamali and Mohammadpour (2013) discussed market manner with the defined functions does not have a direct impact on innovation performance and has a major impact on the innovation stimulus and capacities (Kamali & Mohammadpour, 2013). Goodarzi and others (2013) presented a model for technology commercialization in the governmental institutions consists of four components: commercialization steps and activities, stakeholders within and outside the organization, as well as internal and external rolling factors influence on the process of technology commercialization. The commercialization process also consists of five main stages and 14 sub-stages, during each step of commercialization, eight activities are possible to do that development activities and technology documentation, bargaining with stakeholders, and coordination and decision making are much more important than other activities (Goodarzi et al., 2013). Hoveida and others examined relationship between organizational trust and organizational innovation in schools, Rastegar and Hashemi focused on relationship between servant leadership and breeding organizational trust as a context for organizational innovation and Mirshah jaafari and Fattahian focused on impact of technology, strategy and culture on innovation and organizational creativity (Danesh Fard, 2016).

There is a lack of appropriate databases on knowledge-based companies in the country and although useful researches has been done to present the model, identify the components, and investigate the factors influencing innovation, there is a lack of comprehensive research in this area of study in the country, and more studies are needed especially in the context of knowledge-based companies that play an important role in the economy of the country. Also there is a clear research gap specially in presenting a road map that can comprehensively cover the entire process of innovation and the factors affecting it, and can present strategies for key factors of success. From other study constraints, limited data collection methods and narrow analyzes of findings caused non functional results, can be noted. This factors motivated us to implement a comprehensive research to develop an integrated map that can guide the practice of knowledge-based companies in the path of innovation and commercialization and facilitates their effectiveness.

3. Research methodology

This study based on the philosophy of research, is a qualitative research, with an inductive approach and based on the orientation, since it aims to exploit the results of the findings to solve existing problems in a specific field of research, is an applicable research. In this research,

due to the intertwined and disturbed nature of the problem and emphasis on constructing the problem and providing an accepted and committed solution, the Strategic Options Development and Analysis (SODA) Approach, one of the soft operations research approaches is used.

In the last half century, new methods and techniques have been developed to deal with turbulent issues or problems that are very complex and unstructured, their solution is difficult or impossible, There is a poor definition of the problem components and the relationships between them, disagreement is formed about the goals or operations, while there are common values and interests for cooperation. These methods and methodologies are structured and accurate but not mathematical. The collection of these methods and methodologies known as soft operations research, soft systems, or problem building methods, which one of these approaches is SODA (Mingers, 2011).

Among the various methods of soft operation research such as SODA, Soft Systems Methodology (SSM), Strategic Choice Approach (SCA), Robustness Analysis (RA), Drama Theory, Viable system model (VSM), etc.; SODA approach was chosen because it's emphasis on pragmatism, individualism, and perception of individuals; and it's purpose to construct the problem and provide a compatible and committed solution. Also this approach is useful when multiple and different perspectives require to agreement to reach a common objective and specially situation of this study is the same.

SODA is a suitable and qualitative method to solve complex problems that uses a cognitive mapping to understand the problem and what it may take about it. The cognitive mapping root in psychology is a cognition that seeks to understand how people think and interpret their experiences. This methodology is based on personal construct theory, sociology of social interactions, and operation research. Personal structuring is an attempt to understand the ways in which each of us experiences the world and also to understand the behavior of individuals. Due to this theory and methods that help to understand and interpret others' view of reality, Eden presented the SODA approach, which it's output presented by cognitive mapping. The SODA approach was first developed in 1980, widely used by small and large public and private organizations at the level of top and middle managers. The SODA approach by providing a comprehensive picture about under reviewed subject and identify all it's dimensions, as well as the strategic and critical dimensions, provides this possibility so that the experts can make an ongoing effort to achieve the desired goal, and can be reassured about reaching that goal. As a result, they will provide analyzes that are based on the circumstances of problem (Eden & Ackermann, 2001).

The sources of this study are experts in the field of knowledge-based companies. In this research, sampling of the population is done theoretically. Theoretical sampling is the process of data collection to generate theory by which the analyst collects, codifies and analyzes his data simultaneously, and decides which data is needed and where to find them to improve his theory until it emerges. The judging criterion for time to stop the theoretical sampling is "theoretical adequacy" of the categories and refers to a situation in which no further data are found through which the researcher can grow features of the category (Lee, 2001). In the same way that the researcher sees similar data over and over again, he empirically assures that a certain category has reach to adequacy. When a category reaches to it's necessary adequacy, nothing remains except that the researcher goes to new groups of data about other categories and strives to those categories also reach to their necessary adequacy (Lee, 2001). In this research, the data were collected by interviewing with general guidance and semi-structured. Some of the questions raised in the interviews with regard to the research objectives described in the Table 3.

According to the definition, theoretical sampling would continue as long as the categories reach the theoretical adequacy. In this regard, the interview process continued until the categories were

Table 3. Interview questions

Questions	Research goals
How is the innovation and commercialization process in your company?	Designing an integrated map
What activities are required to complete each stage of the innovation process?	
What are the influencing factors on innovation process?	
How did you build your knowledge-based?	
What is the relationship between innovation and commercialization?	
What are the components of innovation and commercialization?	
Do you use a particular scientific model to develop your innovation?	
What factors influenced the success of your knowledge-based business?	Presenting strategies
What is the difference between innovation in knowledge-based companies and other companies?	
What strategies have you used to develop the potential of innovation and commercialization in your company?	
What practical solutions have you taken to develop your company's innovation potential?	
What are your suggestions for developing the knowledge-base industry of the country?	
How do you connect with universities and science centers to use scientific ideas?	
Have the results of using scientific ideas been effective in developing innovation?	

repeated, and no new concept was extracted from the interviews; therefore, the theoretical adequacy criterion was met. A total of 13 sources (interviewees) from the managers of knowledge-based companies in Tehran province analyzed. The characteristics of these managers are described in the Table 4.

4. Analysis of the findings

The steps of SODA approach in order to monitor the map to developing Innovation and Commercialization are as follows:

Table 4. People interviewed

Name of knowledge-based company	Field of activity	Job position of the person interviewed	Career experience
Vira Business	Laboratory equipment	Top management	3 Years
Sherif Tech	Information technology	Top management	4 Years
Nikan Saleh	Telecommunications	Top management	5 Years
Yas Drug	Advanced drugs	Top management	4 Years
Yekta Power	Telecommunications	Top management	4 Years
Atlas	Information technology	Top management	4 Years
Health Idea	Advanced drugs	Top management	4 Years
New Elixir of Asia	Petrochemicals	Top management	4 Years
Sahar Active Oxygen	Laboratory equipment	Top management	3 Years
AfraNet	Information technology	Top management	4 Years
Abfa	Telecommunications	Top management	4 Years
Pars Regulator	Petrochemicals	Top management	3 Years
Novin Plastic	Laboratory equipment	Top management	3 Years

4.1. Individual interview

The basis of SODA approach is rooted in individual mentality. Each person has a mental and personal attitude towards reality of the problem, and wisdom and experience of experts is a key element to make a sure decision. At this stage, after entering the problem situation, with the help of different interviews and meetings with experts on this subject we gathered information about innovation and commercialization in knowledge-based companies.

4.2. Making the map of each expert

At this stage, according to the data collected through interviews with each of experts, the map of each expert is made. In order to extract the map, main concepts have been identified and during meetings with the experts, the type of relationship between these concepts has been identified.

4.3. Integrating the maps and making the integrated map

At this stage, facilitator aggregates the maps and obtains the final map. At this stage, the concepts and relationships between them, which extracted from separate interviews with experts, came together, relations combined and merged, and eventually turned into a single map. The final map of this study is shown in Figure 2.

4.4. Forming the workshop

Since the SODA process is formed by teamwork and integrating information of experts, and in building the problem, it emphasizes the individual's identity of each member; at this stage, a workshop has been set up to reinforce the negotiations and to develop the scope of problem definition. This increases the complexity of the problem. Of course, this workshop is designed to reduce the group's thinking error and to increase the possibility of determining desired strategies (this stage is one of the most important stages of SODA). In this workshop, using the experts' opinions and aggregating individual maps obtained from the previous steps, a general map of the problem is made.

4.5. Modeling

In this step, facilitator creates the problem model using Decision Explorer (DE) software. The final map of this research, which is depicted in DE software environment, is shown in Figure 3.

Figure 2. Map integration.

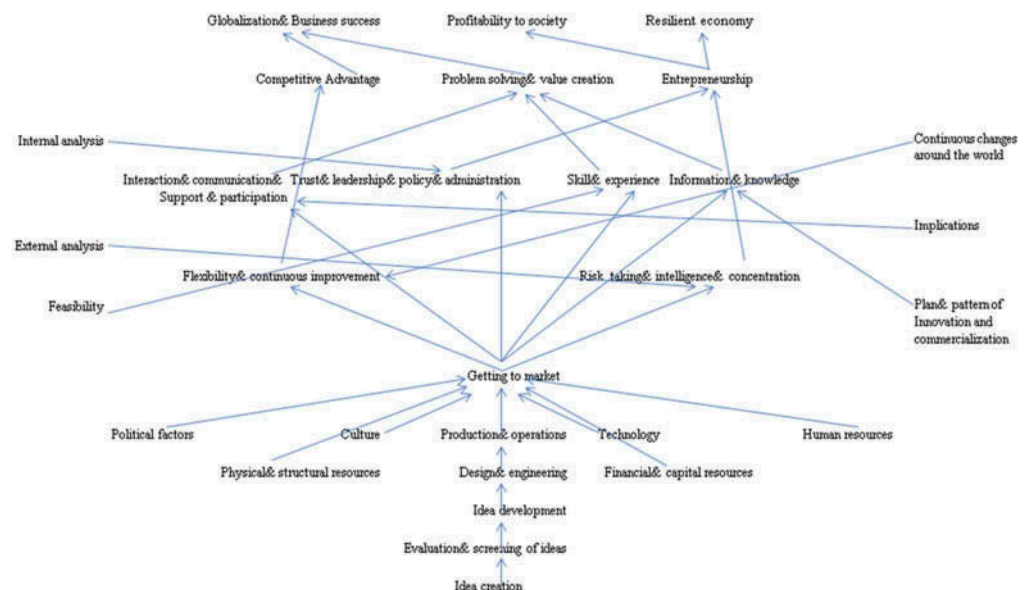
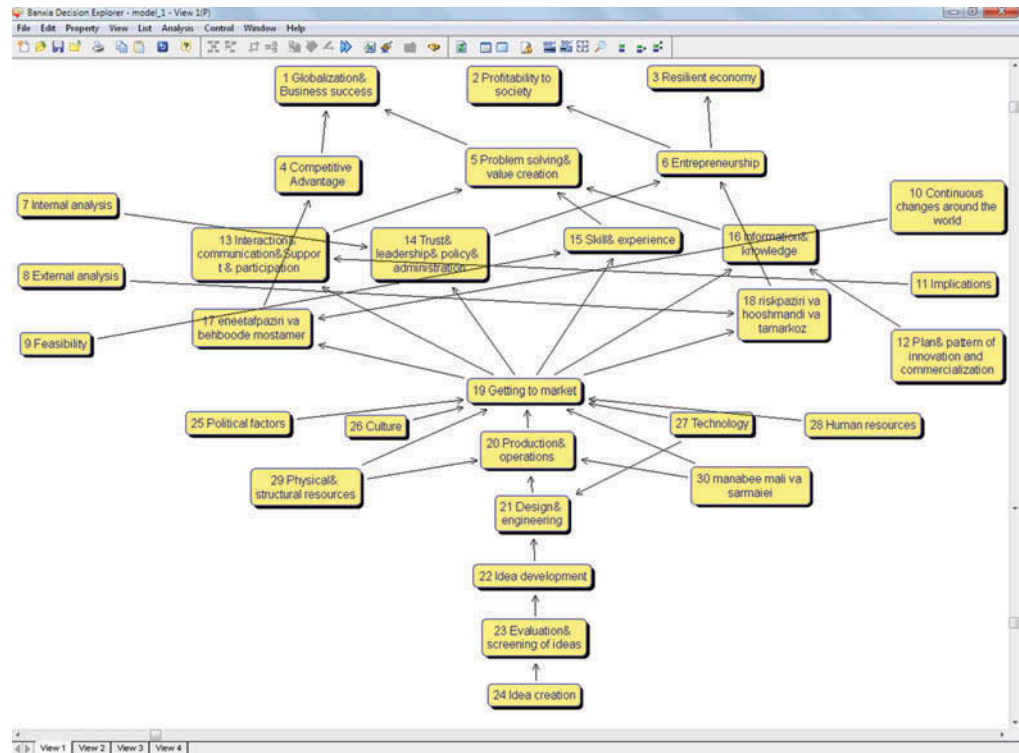


Figure 3. Final map in the software.



4.6. Analyze

At this stage, using the DE software, the map obtained from previous steps is analyzed. In this analysis, mapping components prepared in the SODA Approach include Goals/values, Key Issues/Potent Issues, and Options are identified.

4–6–1 Goals/values: There is always no one goal in map, but there are several goals that can be supported by each other. A specific starting point for identifying goals is to examine the top points of the model, nodes that are not linked to other nodes are goals. According to the map drawn at the previous stage, Resilient economy, Profitability to society, Globalization, Business success, are considered as the goals.

4–6–2 Key Issues/Potent Issues: The next step is identifying key issues. Issues can be seen as topics that need spend resources (time and money), and among these key issues, the most important ones are important to us. There are two analyzes to identify key issues that are:

4–6–2–1 Domain Analysis: In this analysis, the number of inputs and outputs of each node is determined. It basically calculates the crowding of each node. Based on the number obtained for each node, a node is considered as a significant node.

4–6–2–2 Central Analysis: The second method of analyzing the main nodes is central analysis that examines the structure of the model in order to determine which views are more centralized (Eden & Ackermann, 2001).

It should be noted that the results of second method analysis provide a more accurate view of the key issues than the first method. The reason is that the results of domain analysis can be influenced by this fact that one participant has given more time to one comment. In this study, by identifying those comments that indicate which nodes in both domain and central analysis have

Table 5. Domain and central analysis

Score	Central analysis	Score	Domain analysis	Rank
19	Getting to market	13	Getting to market	1
13	Risk taking and intelligence and concentration	4	Problem solving and value creation	2
13	Trust and leadership and policy and administration	4	Entrepreneurship	3
12	Production and operations	4	Production and operations	4
12	Flexibility and continuous improvement	3	Interaction and communication and support and participation	5
12	Information and knowledge	3	Trust and leadership and policy and administration	6
12	Skill and experience	3	Skill and experience	7
12	Interaction and communication and support and participation	3	Information and knowledge	8
11	Financial and capital resources	3	Flexibility and continuous improvement	9
11	Physical and structural resources	3	Risk taking and intelligence and concentration	10
11	Human resources	3	Design and engineering	11
11	Technology	2	Globalization and business success	12
10	Culture	2	Competitive Advantage	13
10	Political factors	2	Idea development	14
9	Problem solving and value creation	2	Evaluation and screening of ideas	15
8	Design and engineering	2	Idea creation	16
8	Entrepreneurship	2	Technology	17
7	Idea creation	2	Human resources	18
7	Competitive Advantage	2	Physical and structural resources	19
6	Plan and pattern of Innovation and commercialization	2	Financial and capital resources	20
6	Implications	1	Profitability to society	21
6	Continuous changes around the world	1	Resilient economy	22
6	Feasibility	1	Internal analysis	23
6	Internal analysis	1	External analysis	24
6	External analysis	1	Feasibility	25
5	Globalization and business success	1	Continuous changes around the world	26
4	Evaluation and screening of ideas	1	Implications	27
4	Idea development	1	Plan and pattern of Innovation and commercialization	28
3	Resilient economy	1	Political factors	29
3	Profitability to society	1	Culture	30

the highest score, more confidence can be found in identifying key issues (important nodes). The results of domain and central analysis are shown in Table 5:

According to the above analysis, Getting to Market–Risk taking and Intelligence–Trust and Leadership and Policy–Production and Preparation–Flexibility and Continuous improvement–Information and Knowledge–Skill and Experience–Interaction and Communication and Support and Participation; are considered as important issues, respectively.

As it is known, “Getting to Market” as the most important factor in the outcome of the process of innovation and commercialization, can alone lead to the success and failure of the whole chain.

Therefore, the study of various ways to conquer and enter the market, as well as identifying the key factors affecting it is vital, which will be addressed in the next step.

4–6–3 Options: The bottom points of the model are normally our options, among these, key options are important to us. The key options are those options that have more impact on key issues and goals. Accordingly, Human resources–Technology–Culture–Political factors–Financial and Capital resources–Physical and Structural resources are considered as important options.

Considering the agreed map, Human resources–Technology–Culture–Political factors–Financial and Capital resources –Physical and Structural resources have the greatest impact on the key issues identified in the previous step, i.e., “Getting to Market,” and considered as important options. In SODA approach, as it’s name suggests, we have to focus on strengthening key options that have a significant impact on key issues, and key issues at the higher levels, in turn, lead to the goal.

5. Conclusions

By studying the final map of this study and the key options of the map, we find that the results of this study about Technology and Getting to market are consistent with Rothwell&Zegfeld model which is a successive model and technical flow is located in the process center. This model is a path toward market which impacted by existing and newfound needs of market on one hand, and technology evolution on the other (Ferguson, 2008). The results of this study about Human resources and Culture are consistent with Sang&Gibson model. The four levels of knowledge and technology transfer in this model include creation of knowledge and technology, sharing, implementation and commercialization (Gibson & Naquin, 2011). Also these results are consistent with Kokobu model which in this model the commercialization process has the following steps: Conceptual and feasibility studies; Basic research; Applied research; Utilization researches; Business researches; Design of commercialization model; Real Production (Farrokhran, 2013). The results of this study about Technology, Getting to market, Financial and Capital resources, Physical and Structural resources are consistent with Jolley Model which postulates nine steps to commercialize technology including: Assuming a dual vision (technique–market); Providing resources and approving them; Developing a business for defining commercialization abilities; Equipping resources for demonstration; Displaying content in products and processes (demonstration and technology proofing); Equipping market components; Improving level of acceptance; Equip supplementary assets to deliver goods; Continuing to commercialize and realizing long-term value (Olsen & Poly, 2008).

By studying the final map of the problem, all the research objectives can be found. In this map, the leveling of developing innovation and commercialization of knowledge-based companies process, the link between all it’s constituent parts and strategic components were identified which after identifying important issues and options, experts can determine their strategies to achieve the goal.

In the following, after discussing about key options extracted from the map, the most important strategies agreed by the experts on these options are presented.

5–1 Human Resources: The starting point for innovation in knowledge-based is strongly dependent on the knowledge, expertise and commitment of human resources as main inputs in the process of value creation and innovation. Strategic human resource operations are the main tools of these companies to shape and influence the skills, attitudes and behaviors of individuals in fulfilling their job tasks, finally to achieve organizational goals and innovation. In order to innovate, organizations can use human capital to develop organizational expertise to create new goods and services. By identifying and implementing a set of strategic human resource operations, organizations can increase the individuals’ willingness and motivation to carry out their tasks in order to enhance and develop organizational expertise to achieve organizational innovation. In this way, strategic human resource operations can guide innovative activities because they create the ability

to discover and use knowledge and expertise in the organization. After improving management processes, organizations need to motivation and ability of human capital to make creative ideas, develop innovative methods, and create new situations for their own progress. Strategic human resource operations can influence and change the choices, capacities, and behaviors of staff to achieve organizational goals and play a crucial role in crystallizing the necessary conditions for speeding up and grouping and guiding individuals to the development of innovative activities. By employing some strategic human resource operations, such as recruitment, training, participation, performance appraisal and reward as motivational tools for employees, organizations can force employees to creativity and innovation (Sadeghi & Mohtashemi, 2011). The agreed strategies of experts in this area are as follows:

- Employing people with knowledge, skills, competencies, incentives and values in a combination
- Teaching diversity in thinking styles, experiences, perspectives and specialties
- Applying the counseling system
- Providing legal and financial incentives for inventors, founders and employees
- Making a driver, talented and creative atmosphere to express explicit knowledge and skills, and to create the field of cultivating taste, morale and motivation of the staff.

5-2 Technology: Many knowledge-based companies use the technology of the day but do not have long-term profitability, because such companies do not understand that technology is not wealthy itself, but the management of technology creates wealth and capital and if innovation and technology are not combined with proper principles and management knowledge, the stagnation of the innovation culture and the copying of the technology will bring successful behavior to a halt soon. The prerequisite for survival of post-modern world companies is the profitability and creation of wealth, and the most important component of wealth creation in such an environment is the creation of technology along the long-term goals of strategic management of technology. Technology management means the ability to create a mutual understanding between business and technology, understand the limitations of the strategic planning process and the use of technology as a part of the strategic planning process of the company. Therefore technology management can be considered as a part of strategic management. In fact, technology management is the management of a system that enables the creation, acquisition, and use of technology, and includes the responsibility that these activities place in order to serve the human being and meet the needs of the customer. Research, invention and development are the most fundamental components of technological creation and technological advancement, but there is a more important component in the path of wealth generation, which is the commercialization or use of technology. In other words, the benefits of technology are realized when the result reaches the customer. It is very important that the organization's technology be properly managed so that the organization achieves a competitive and efficient state (Ghanbari Nejad & Mohammadi Almani, 2012). Accordingly, the most important agreed strategies are as follows:

- Expanding the use of superior and high value-added technologies and maintaining it's results
- Mastering the critical aspects of technology over time
- Intellectual property management and technology monopolization
- Having a dual vision of the technology-market and market awareness and technology market assessment
- Implementation of technology commercialization strategies (Leading-Imitative -Defensive-Importer of technology-Open innovation) tailored to their own plans and considerations.

5-3 Culture: Organizational culture can plays the role of driving force in create innovative ideas in knowledge-based, since it can make a commitment for members of the organization to accept innovative norms. Notes that should be considered in order to transform organizational culture into a stimulating culture of innovation in order to institutionalize innovation include: First, to achieve long-term success, companies need to develop leadership skills based on innovation across the organization members. Employee-oriented leadership

behavior and the relationship between staff due to its emphasis on the human dimension more than task-oriented behavior, give the organization more opportunities for creativity and innovation. Second, to flourishing organizational culture we should not kill ideas, but we must encourage them. An organizational culture that opposes any change in the organization is a destructive factor for ideas and will not be able to cope with the changes in the changing society. Today organizations have to be eager to welcome new ideas, if an idea is properly addressed, can be a solution to a fundamental problem, an introduction to a series of other successful operations, or a stimulus and a flawless growth engine to make innovative products or services. Third, empowering ideally leads to increased initiative, passion for work, innovation, and the speed of action in line with organizational goals. Empowerment means delegation of authority, qualification and permission. Delegation of authority cause increase self confidence, keenness of work, and initiative of staff. Fourthly, in the organization we must choose the best and most effective communication model for creating an innovation culture. In this regard, decentralized communication networks are considered for the exchange of information, because in them decentralization allows all members to exchange their expertise with each other, which promotes creativity and innovation. Fifthly, the ability to creativity in solving organizational problems is potentially distributed among all employees. If they are motivated to do so, they can be creative and a leader in their work. Sixth, mistakes are integral parts of organizational life. Many innovative activities created after some kind of mistakes and tend to solve the problem or correct mistakes. An organizational culture that avoids innovation, suppresses even the slightest mistakes made by employees. Trusting employees in addition to make a professional commitment in them, creates an integrated culture for creativity and the spread of innovation (Saeidi Kia, 2009). The agreed strategies of experts in this area are as follows:

- Granting sufficient freedom of action to employees and eliminating fear in the organization
- Attention to the formation of social networks, values, and insights of individuals
- Creating a culture that is effective in learning and competitive culture within the organization
- Considering innovation as a part of the performance evaluation system
- Reducing the role of individual actors in innovation and independent decision making.

5-4 Political factors: The innovation system at the national level plays a role in commercializing ideas and transferring knowledge from the level of knowledge production to exploitation. The national innovation system is a complex of a set of organizations, institutions, strategies, policies, programs, laws, regulations, and facilitating platforms which this elements by focusing on a single objective for the creation, dissemination, use and exploitation of technological science for economic, social, cultural, and political development in the direction of social welfare, are interacting with each other. The most important reasons for the ineffectiveness of the national innovation system, which affects the whole system and its components including knowledge-based companies, are: inappropriate laws that relate primarily to technology protection laws such as intellectual property rights; key constraints such as weaknesses In universities, R&D institutions, government laboratories, growth centers and advanced technology companies and technological weaknesses; weak coordination among components of the national innovation system, including the relationship between industry, university and government; The weakness of the information flow that the existence of this information flow among the components is crucial. The information flow includes such topics as technical knowledge, technology expectations, human resources information, financial information, etc. (Rad Far & Khamseh, 2008). Accordingly, the most important agreed strategies, which should necessarily implement both by the knowledge-based companies and by the government, are as follows:

- Applying network maker policies
- Ensuring economic and investment security

- Direct and indirect government support to facilitate social security laws, monetary and banking laws, export and import laws, tax laws and duties
- Ordering the business system and preventing illegal acts
- Specifying the scope of activities and business constraints.

5-5 Financial and capital resources: Investing in the field of knowledge-based companies (due to the inherent risk in innovative projects), have the nature of long-term investment and common financial and credit mechanisms are not suitable to finance them. In spite of the lack of a clear trustee that SMEs can apply to overcome barriers to financing, there are currently significant activities to help SMEs. Among the active groups in providing advisory and financing for SMEs are growth centers and science&technology parks, risky investors, supportive organizations, etc. each one in a way and in the various stages of the life cycle of SMEs is useful. In fact, financing of the knowledge-based companies who are at the start of the business is the most difficult part. It should be noted that a small percentage of companies that are launched every year around the world are funded by traditional venture capitalists. Meanwhile about 90 percent of companies are starting up with private funds. Financing is usually not a simple process, and in many cases it is very complicated and time-consuming (Stiri & Moshiri, 2009). The agreed strategies of experts in this area are as follows:

- Competitive and economic production
- Increasing investment in Research & Development
- Joint ventures and foreign investment capability
- Acquiring the ability of regular long-term forecasts as the basis for sound investment decisions
- Attracting industrial investment enterprises, commercial loans and stocks.

5-6 Physical and structural resources: the implementation of creative ideas and innovations takes place in the knowledge-based companies that are adapted in the form of work environments. In fact, physical spaces are a form in which human behaviors occur and have opposing effects on him. Creativity in humans is a “public” talent like intelligence and memory, and everyone is more or less creative. This natural talent appears to be low or high, depending on the environment and other conditions. There are favorable environments for creativity that will boost, expand and grow it. There are other environments that do not have the greatest potential for creativity. Various factors affect the creativity and innovation of individuals in the workplace, which are: motivation, skills, resources, creative thinking, personality, relaxation and comfort, atmosphere, culture, learning and experience. Among the factors that affect the physical environment more than others, are: relaxation and comfort, creative thinking, motivation, and interactions. Motivation plays an important role in creativity and innovation. A great deal of research has shown that the relationship between work environment and creativity is moderated by motivation. In an appropriate work environment, employees are motivated for creative behaviors. The need to maintain motivation in a research center is essential, because research is a time consuming process, and in addition researchers have encountered many problems to achieve the outcome, and maybe even in some cases do not achieve the desired result. If the researcher loses his motivation during the research, he is disappointed and the research work does not come to an end (Bisadi, Mozafar, & Hoseini, 2013). Accordingly, the most important agreed strategies are as follows:

- Efficiency in physical equipment and space
- Providing the necessary infrastructure for market or the transformation in technology and commercialization processes in the industrial-economic system
- Standardization of processes
- Providing information infrastructure
- emphasizing on downstream processes.

6. Research constraints and suggestions for future research

- The method of collecting data and multiple rounds for obtaining expert comments and creating workshops was very demanding and time consuming, and the lack of appropriate databases on knowledge-based companies made access to custodians more difficult.
- In addition, hiding some of the directors of knowledge-based companies, who came from observance of the principles of information security in order to maintain their competitive advantage, made it difficult to achieve theoretical adequacy of data.
- Access to the managers of knowledge-based companies, due to their many responsibilities and concerns, which caused inconsistency in visits, time lapse, and time-consuming interviews, slows the process of interviews.
- The lack of a comprehensive research in this area of study in the country, in turn, has had an impact on research.
- It is suggested that a case study of knowledge-based companies be considered.
- It is suggested that a comparative study of knowledge-based companies and comparison of these companies with the outside world be considered.
- Alternatively, other research methods in soft OR can be used instead of SODA approach.

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Author details

Amir Ehsan Zahedi¹
 E-mail: amirehsanzm@yahoo.com
 Seyyed Habibollah Mirghafoori¹
 E-mail: mirghafoori@yazd.ac.ir
 ORCID ID: <http://orcid.org/0000-0001-5362-6590>
 Ali Morovati Sharif Abadi¹
 E-mail: alimorovati@yazd.ac.ir

¹ Industrial Management, Economy Management and Accounting Faculty, Yazd University, Yazd, Iran.

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