

Innovation Strategy Based on Industry 4.0 and Digital Transformation in SME Companies in Iran

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Abstract

Small and medium enterprises (SMEs) have become a vital factor for national competitiveness and firms and companies, and the world is increasingly moving towards a knowledge-based economy. Innovation and technological changes are strongly influenced by the country/place where they occur. The main purpose of this study is to present the framework of SME innovation strategy with the approach of the fourth generation industry in Iran, which has been done using the GT method i.e a blend of qualitative and quantitative methods. The research population includes small and medium businesses and industrial townships in Tehran. The method of data collection in the qualitative part is the interview and in the quantitative part a questionnaire. The findings show that the innovation strategy framework in SME in the fourth industrial revolution is one of the causal factors with 5 components including small and medium businesses, organization maturity model, digitization, rules and regulations and innovation strategy. The results consist of 8 sub-components, which can be enumerated as market development,

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increasing exports, increasing productivity, creating added value, improving financial credits, training work managers, entrepreneurship and finally creating employment. The results show that the program factors have an effect on the facilitating factors; the causal factors on the innovation framework; the informational factors on the obstacles; supervisory and control factors on facilitating factors; barriers on the innovation framework; ; Financial resources have an effect on obstacles, consequences on innovation framework and structural factors on obstacles in small and medium enterprises. In our country, despite the fact that more than 59% of all production units are included in the EMS small and medium industries group, these companies have not gained a significant share in the national gross product and creating added value and are suffering from severe shortages. While small and medium-sized companies can move away from the traditional focus on the product and take steps in the development of product innovation by using the fourth generation industry and new technology, creating a strategy and coming up with new products and services will create more added value; The formulation of the strategy for any organization calls for an innovative point of view .

Keywords: Fourth Industrial Revolution, Innovation Strategy, SME, Industry 4.0, Digitization of Industry.

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1.Introduction

The emergence of the internet economy of the fourth industrial revolution will be much bigger than the previous three industrial revolutions. In such a way that it will overshadow not only the ways of life and work, but also the culture and social identity of mankind. The first industrial revolution took place in 1784 with the rise of mechanical technology and the steam engine. The second industrial revolution took place in 1870 with the advent of electricity. Computers and computing machines gave rise to the third industrial revolution in 1969. Today, we can witness the most powerful and complex technological revolution due to the growth and maturity of the Internet and online communication. So that scientists interpret the fourth industrial revolution as a change that mankind has not undergone before and consider this stage as the cultural renaissance of the current century and the turning point of human life on the planet.

Providing fourth generation industry solutions requires a wide range of technology fields. To provide these solutions, SMEs may need the support of various supply chain actors through an open input innovation strategy. Researchers examine the contribution of four types of supply chain actors to input innovation, including suppliers, competitors with complementary technologies, research and development centers, and customers. The authors analyze how these four actors moderate the impact of 4G industry integrated solutions on three key competitive strategies: cost, focus, and differentiation. The expansion of fourth generation industry technologies increases customer loyalty and technological innovation. Cooperation with competitors (complementary technologies) affects these results and reduces technology costs. Integration of customers and R&D centers increases costs, but R&D centers can foster long-term innovation (Benitez and et.al ,2021) .

In the last few years, a significant number of maturity models has been introduced to guide companies towards the fourth generation industry. However, there is a gap between them and self-assessment tools, as well as the need for suitable tools for SMEs, which especially address their actual starting point. A tool for assessing the readiness of SMEs is introduced, focusing on the definition of "level". This tool is the first step that can fill the gap between their reality and the early stages of the developed frameworks of the fourth generation industry.

This tool offers a holistic analysis and is accurate and clear (Pan Nogueras and et.al , 2021).

The widespread diffusion of disruptive technologies such as artificial intelligence (AI) is rapidly changing the way SMEs move towards greater transformation and innovation. Individual technology absorption capacity (TAC) enables Chief Information Officers (CIOs) to use such technologies more effectively, efficiently and easily. The CIO is involved at the micro level of the company and the TAC encourages the companies at the medium level. Although CIO encourages the use of disruptive technologies, studies in this field are still scarce (Scuotto and et.al ,2022) .

Fourth generation industry is about the realization of digital transformation by connecting machines to plants, fleets and humans through sensors and control elements to create smart networks, smart factories, smart manufacturing and smart value chains. By using fourth generation industry technologies, an SME can increase its organizational agility, adaptability and flexibility to deal with today's competitive environment and become a valuable and innovative partner in power dynamics with its large purchasing counterparts. However, SMEs using 4G industry technology face technological, trust and big data challenges (Han & Trimi, 2022). Organizational agility, i.e. the ability to anticipate or react quickly to external changes, is essential to survive and compete in today's turbulent panorama characterized by technological advances and digitization. Environments are still looming. Therefore, it is important to examine the history of the company's agility and identify the factors that enable them to compete better. At the same time, agility is less studied in this field. Focusing on SMEs, this study examines three antecedents of agility, i.e., digital technology capability, communication capability, innovation capability, and the effects of agility on three outcomes, i.e., product financial performance ,and process innovation. Our findings show that these capabilities contribute to organizational agility in SMEs and, in turn, agility has a positive effect on performance, thus confirming that agility contributes to the success of SMEs and that technological digital media play a major role in this process. Therefore, it is strategically important for SMEs to increase their efforts to develop these capabilities by creating sustainable businesses. They must establish a relational and innovative culture and also

change their business culture by adopting digital technologies (Han and et.al ,2022).

The complex and rapid developments of the last few decades have caused various societies to try to prepare themselves more than ever to accept new developments. Until a few decades ago, establishing and keeping large companies active and, as a result, the dependence of most organizations on the government was considered an economic privilege. It was also argued that the bigger these companies were, the more dynamic and powerful the economy became. This way of thinking was welcomed and flourished in a few decades, and giant companies emerged accordingly. But the recent developments, especially the increase in population, moment-to-moment innovations, more complex management and decision-making processes, and the need for instant decisions caused fundamental changes in the structure of these giant organizations. Since the second half of the 20th century, different patterns of industrial development have been experimented in the countries of the world. Among these models, small and medium enterprises (SME) are industrial. These SMEs are recognized as important elements of economic-social developments in most countries. They are very important when it comes to creating job opportunities with low investments, regional development, organizational development of companies based on technology principles, product innovation and creating new methods. Therefore, the current research aims to provide the framework of innovation strategy in SME in the fourth industrial revolution with a case study of industrial townships in Tehran province and tries to answer the following questions:

1- How should the innovation strategy framework in SME in the Fourth Industrial Revolution be presented?

2- What are the criteria for presenting the innovation strategy framework in SME in the fourth industrial revolution?

3- Is the framework of innovation strategy in SME in the 4th industrial revolution which is resulted from the qualitative part, empirically verified?

Research literature

The literature related to the business of small and medium-sized units is very extensive, and this expansion has caused various definitions for this unit to be presented in different countries; These definitions

vary in age, structure, population, culture and degree of development. Small and medium-sized companies in different countries of the world have many similarities, even so, it is not possible to come up with a single unified definition for them; Each country has provided a definition of these businesses according to its special conditions. Most of these definitions are based on quantitative criteria, such as the number of employees and the amount of turnover (Malekinezhad, 2006). To access the research background, databases and external sites such as Google Scholar, Emerald, Science Direct, Springer, ProQuest, etc.; Also, internal databases such as the National Library of Iran, Normagz, Mogiran, comprehensive humanities portal, Irandoc, etc. were searched. The search results showed that the topic of the current research has been investigated quite inadequately and there is an obvious research gap in the field of presenting the framework of SME innovation strategy in the fourth industrial revolution and creating digital transformation in the industry of four countries. Some related researches are mentioned below:

Ivashchenko and others (2021) in their research entitled "Digital Tools in Cross-Cultural Analysis of SME Financial State Support in the Conditions of Pandemic Crisis" examined the main effects of the pandemic on the economy, focusing on business disruption , especially for SME.

Mohammadi, Ilyasi and Roshni (2020) in their research entitled "Industrial Economy Fourth Generation: A New Industrial Paradigm Based on Intelligence and Digitalization" concluded that one of the most important economic trends in recent years is moving towards the fourth industrial generation. And its influence has been on various industries and sectors, especially the production sector. The fourth generation or the fourth industrial revolution is the name given to automation and data exchange in production technologies .

Karari, Zahabi and Haddadi (2018) in their research entitled "The Fourth Industrial Revolution and the Model of Industrial Development of the Country" showed that the perspective of the fourth industrial revolution and the expansion of signs of movement towards the digitization of manufacturing and service industries in the world class, causes many patterns - opportunities and threats for our country's industries to deal with. Safar et al (2018) in their research entitled "Concept of SME business model for industry 4.0 environment" concluded that technological advances lead the industry to the fourth

industrial revolution. With the Internet of Things in the fourth industrial revolution, both small companies and medium and large companies underwent radical changes. Bär et al (2018) in their research entitled "Considering Industry 4.0 aspects in the supply chain for an SME" concluded that the fourth generation industry has made a huge change in manufacturing companies. The fourth generation industry has many advantages and effects on the supply chain of companies.

Ibarra; Ganzarain & Igartua (2018) in their research entitled "Business model innovation through Industry 4.0: A review" came to the conclusion that the fourth industrial revolution is the most powerful driver of innovation that transforms factories into smart environments. The fourth industrial revolution provides horizontal and vertical interoperability and integration of production systems with the intensification of competition and globalization.

Müller; Buliga & Voigt (2018) in their research entitled "Fortune favors the prepared: How SMEs approach business model innovations in Industry 4.0" came to the conclusion that the fourth generation industry somehow causes a change in the production business frameworks of economic and small enterprises (small and medium enterprises).

Guo & Sung (2015) in their research entitled "A new approach factor-entropy with application to business costs of SMEs in Shanghai", stated that in order to effectively solve the problem of simplification and index system, the assessment of task on SME business costs in Shanghai has been carried out, and factor analysis has been used to interpret the data indicators, through a cross-sectional survey, and considering the empowerment of the target it has been done using the entropy method.

Zare (2015) in her research entitled "The benefits of e-business adoption: an empirical study of Iranian SMEs", examines the impact of web-based e-commerce on small and medium enterprises (SMEs) in Iran. The findings show that the small and medium-sized companies in the sample have benefited from the implementation of e-business in two operational and functional areas of their organization.

Fadai (2014) in his research entitled "Presenting a model for developing innovation strategy for small and medium organizations", came to the conclusion that in order for companies to continue their business life in the fast-paced field of technology and information

systems, they must turn to innovation and creativity. Rahmanian and Nasr (2010) in their research entitled " *Creating Absorption Capacity for Organizing Open Innovation in SMEs*", came to the conclusion that innovation is one of the important strategies of competition for both small and large factories. Unfortunately, SMEs are in conflict with innovative activities.

Research method

This research was done using the GT method, which is a combination of qualitative and quantitative methods. Then the model was validated using a quantitative method. This requires the use of a mixed research method, implemented in an exploratory way. In most of the past researches, a phenomenon called the presentation of innovation strategy framework in SME with the approach of the fourth generation industry has not been recognized and addressed. In some cases, only certain aspects of it have received attention separately, and not the whole thing by and large. Therefore, it can be said that comprehensive research in the form of a conceptual model has not been done yet. In this research, both field and library methods were used to collect the information needed.

The research community includes small and medium businesses and industrial townships in Tehran. In the present study, the method of collecting information in the qualitative part is to use interviews and in the quantitative part to use questionnaires. In this article, the analysis of the data obtained from the interviews, observations, and the analysis of documents is presented in two parts: qualitative and quantitative(data analysis). The data analysis procedure in this study includes open, central and selective coding in the first part and field study in SME companies in the second part. At first, with the help of foundational data theory methodology and analysis of texts from in-depth interviews, the results of open, central and selective coding are explained and a conceptual model for the design of the model is developed.

Research findings

Figure 1 shows the proposed model of the current research. This model consists of various components with causal factors on the right side of the model. Causal factors are predictive or independent factors affecting the outcome or dependent variable. In the current research,

the causal factors consist of 5 components, including small and medium businesses, organization maturity model, digitization, rules and regulations, and innovation strategy. In the left part of the model, the results are reported, which actually play the role of the dependent variable. The results consist of 8 sub-components, which can be enumerated as market development, increasing exports, increasing productivity, creating added value, improving financial credits, training work managers, entrepreneurship and finally creating employment.

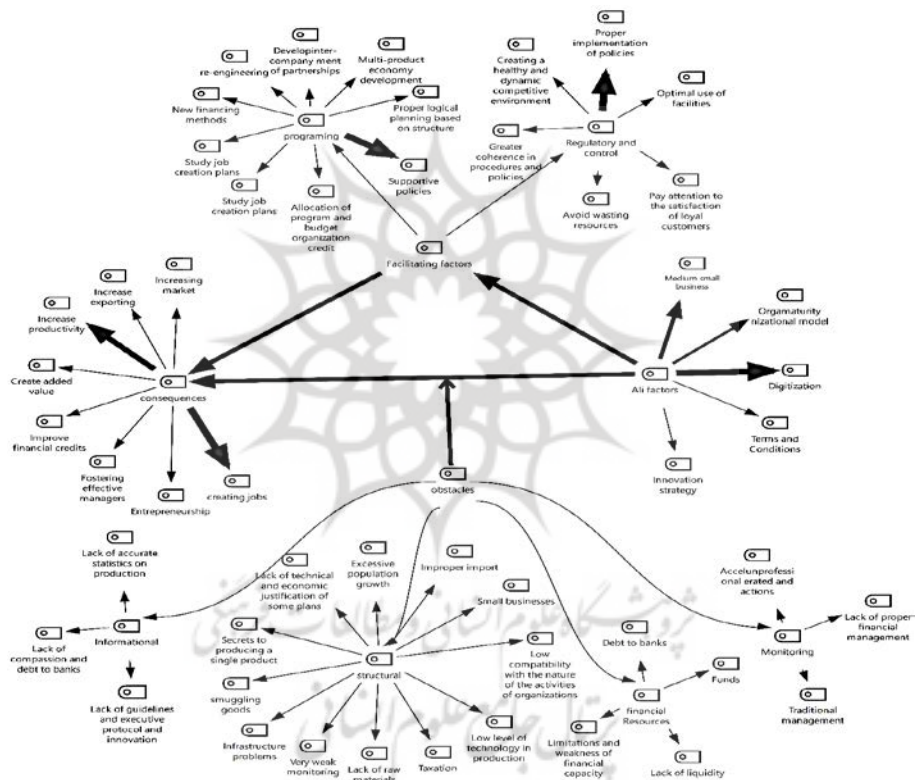


Figure 1. Paradigmatic framework resulting from the implementation of the foundational data method

There are obstacles in every organization. In our model, a variable called obstacles is considered. The obstacle variable actually plays the role of Moderator Variable, which is an independent variable and has a secondary role. Moderating variables are actually intervening

variables that increase or decrease the intensity of the independent variable in a relationship. In the above model, the identified moderating factors include regulatory factors, financial resources, structural and infrastructure-related factors, and information factors including executive guidelines and portfolios.

Another variable that has been considered in the proposed model of the current research is the investigation of the role of the mediator variable that mediates the relationship between two independent and dependent variables. In other words, unlike the modulating variable, this variable does not increase or decrease the intensity of the effect, but absorbs it. The mediating variable in the model is facilitating factors, divided into two sub-components of supervision and control and program. Regulatory factors include the correct implementation of policies and greater coherence in procedures and policies. Program factors also include the development of multi-level economy, re-engineering and future research. Therefore, in order to achieve the mentioned goals, it is very important to pay attention to mediating and moderating factors.

In other words, a kind of conceptual framework will emerge, which will be the origin of the ultimate goal and research questions. In Figure 2, the output of the path coefficients of the structural equation model, which was also verified in the previous stages of fitting, is presented.

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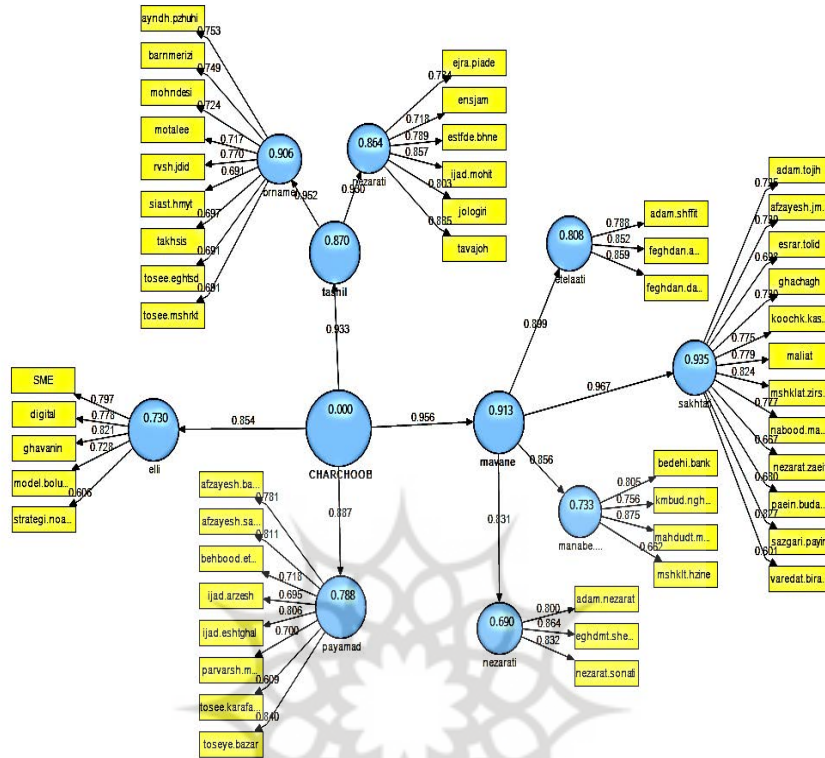


Figure 2. Output of the path coefficients of the structural equation model

Figure 3 shows the model of significant numbers related to each route. Since it is not possible to comment on the significance of those coefficients through the size or smallness of the coefficients of the standard estimation model, the T-value model is used to measure the significance of the path coefficients. And if the significant values are greater than the absolute value of 1.96, these relationships are significant at the 95% confidence level.

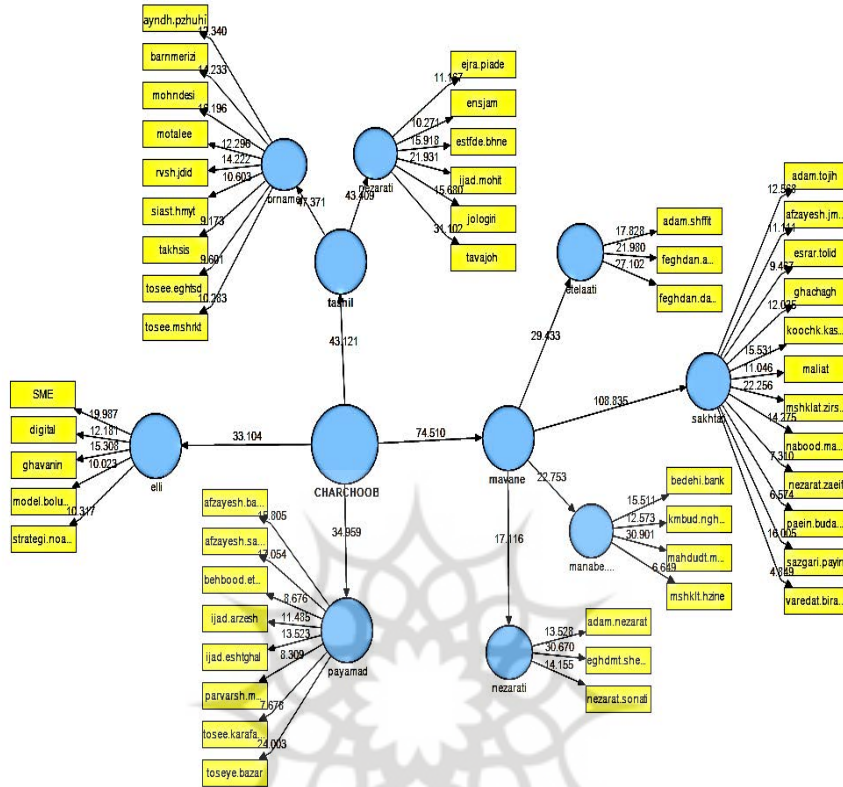


Figure 3. Significant coefficients of the research model

Table 1 shows the results of the model, according to the table:

1. Program factors have an effect on the facilitating factors, 2. Causal factors on the innovation framework, 3. Informational factors on the barriers, 4. Monitoring and control factors on the facilitating factors, 5. Barriers on the innovation framework, 6. Supervisory barriers on the barriers, 7. Financial resources on the obstacles, the impact on the innovation framework and 8. Finally it is the structural factors that have an effect on the obstacles in small and medium enterprises.

Table 1. Model estimation results

Row	Title	Result
1	Program factors affect facilitators in small and medium enterprises	confirmed
2	Causal factors affect the innovation framework in small and medium enterprises	confirmed

Row	Title	Result
3	Information factors affect barriers in small and medium enterprises	confirmed
4	Regulatory and control factors affect the facilitators in small and medium enterprises	confirmed
5	Barriers affect the innovation framework in small and medium-sized enterprises	confirmed
6	Regulatory barriers affect barriers in small and medium enterprises	confirmed
7	Financial resources affect barriers in small and medium enterprises	confirmed
8	Implications affect the innovation framework in small and medium-sized enterprises	confirmed
9	Structural factors affect barriers in small and medium enterprises	confirmed

Small and medium businesses form a changing sector in most economies of the world. In Iran, they account for 4% of all companies. Often they can not go through their life cycle and enter the stage of growth and success. The findings related to the category of strategies, in this case study, are consistent with some previous works and have differences too, there is an opinion that business strategy, of the type of focus and cost leadership, is involved in small and medium businesses . But in the present study, the researchers came to the conclusion that differentiation and innovation strategies in products can be effective in small and medium businesses in Iran's industry; In the perspective of population ecology, the environmental forces are the determinants of business, and in the current research, environmental factors are not the only determinants of growth, and internal factors also play a role in this direction and actually they play a far more crucial role. The findings of the research emphasize the combination of resource-based perspective, motivational perspective and strategic adaptation in terms of environmental perspectives and business ethics.

The component of corporate social responsibility is consistent with Ormanedhi and Stringa's (2008) research, which stated the "distinctive advantage of delivering virtue" to describe a company's competitive behavior. Iranian SME companies were selected as the research population and, using a questionnaire, several managers or supervisors with the highest average were selected for interview. After conducting the interview and using the foundation's data theorizing

method, a questionnaire was designed and tested in the studied community.

The analysis of the results using the structural equation method showed that the relationships between the constructs or hidden variables can be cited and the variables have been correctly identified. According to the paradigmatic framework of the foundation's data theory, 6 main categories are causal, central, strategic, consequential, contextual and intervening, for the purpose of small and medium businesses in Iran, it was recognized that these categories are complementary to each other. The causal category refers to events that lead to the occurrence or expansion of a phenomenon; The central category always appears in the data and all other main categories are related to it; The strategic category means ways to control, manage and deal with the central phenomenon; Contextual categories indicate a chain of environmental conditions that affect the strategy, and intermediate or intervening categories are a chain of variable specific conditions that affect other categories. According to this logic, based on the open codes (indices) obtained from the interviews, sub-categories (components) were extracted and the relationship between them was determined. The components of causal conditions include three categories; Innovative human capital, progressive organizational culture and independence of financial capital. The central category, in this research, is; Continuation of the entrepreneurial eagerness of the leader. The components of the strategy category include development strategies, business acumen and dynamic innovation capability. The components of environmental dynamics and environmental adaptability are in the contextual category, and the mediating category includes the components of social responsibility of business and social capital of business and finally the result of business with indicators of increase in sales, increase in customer satisfaction of the company, increase in the volume of new products (product innovation) and the number of employees (The amount of employment generation) in the company is determined. It is noteworthy that the meaning of each component (subcategory) is given according to the indicators (open codes) obtained from the interview process.

Discussion and Conclusion

Identified contextual factors that have a direct effect on the content, the attention of policy makers and decision-making managers to these

factors leads to effective and efficient decisions in determining the policy. For example, in the field of fundamental and applied research, it is different according to the nature and type of its outputs. Or that the position and power of participants is effective in pushing policies towards their own motives and interests. Therefore, before making any decision and adopting any strategy, all the conditions governing the project, including the type of research, technology features, its life stage and complexity, the motivations and power and position of each partner, should be defined and optimally adopted accordingly. Upstream policies and laws play an important role in this field. In the form of these general and standard rules and principles, appropriate policies for each situation according to the background factors and expected goals on a case-by-case and decentralized basis, through negotiation and agreement between participants should be adopted, and in order to deepen theoretical knowledge in this field, more theoretical and practical research and fieldwork will be required. The important achievement of this research is to provide a framework and strategy for the policy makers of this field, to properly consider research and development management systems, which is an issue intertwined with the entire process, and to adopt appropriate policies.

Since the current research is fundamental and has presented a theoretical framework, it is suggested that through field studies and especially conducting case studies and action research, the effects of each of the dimensions of the proposed framework in providing the innovation strategy framework in SME with the approach of the fourth generation industry in Iran should be further investigated in order to get more practical results, recommendations and solutions. The innovation and new feature of this project is that the present project confirms its novelty with a glimpse of global innovations. According to the researches and surveys and studies done so far, no project has been done with 3 options of innovation strategy , small and medium enterprises and the fourth industrial revolution. In order to achieve the applications resulted from this research, the following suggestions are made:

1. SME managers can use the present research for the possibility of better and simultaneous evaluation of vital and influencing factors on the level of readiness, competence and innovation based on the fourth generation industry.

2. Industrialists of the country and managers of various SME industries can properly identify the risk and sensitivity analysis of influencing variables for evaluating the levels of preparation, competence and innovation based on the fourth generation industry through the dynamic feature of the systems.

3. In identifying effective variables and components, researchers can use the present research in their future research through qualitative and quantitative reviews of experts and experienced managers in the field of industry, and it is a basis for not needing to re-examine many areas related to the level of preparation, competence and innovation.

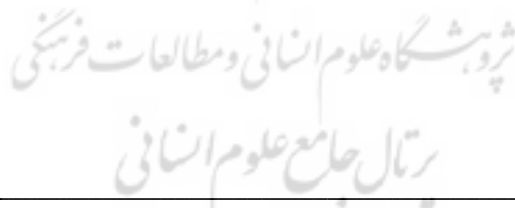
4. Researchers can use or develop the presented framework to evaluate the levels of readiness, competence and innovation based on the fourth generation industry to do future framework research for measuring indicators.

5. Through the presented scenarios extracted from the dynamic framework to analyze the results of actions in the future, the industry policy makers will be able to identify the most suitable scenarios to achieve and fulfill the requirements of the fourth generation industry concepts. This research tries to analyze the complex system focused on reducing the existing obstacles in SME and migrating to the fourth generation industry in an organization, the conditions of knowing and analyzing as much as possible the important and effective variables in the fourth generation industry by considering feedbacks, delays and non-linear relationships between variables to measure scenarios and analyze the sensitivity of effective variables of SME.

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