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Construct of Iran's National Innovation System Based on Innovation and Foresight (Usage of Benchmarking and Delphi Method)

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Abstract: Conditions and the atmosphere for business have been changed such that under these circumstances, the topic of innovation can be an effective responder to the needs of present and future stakeholders of organizations. With this regard, innovating organizations-including private and public- research centers and universities are like actors that in the event of establishment of effective relations with each other can benefit better and more economically from their technological abilities and the latter realizes when a national innovation system based on Foresight and in Accordance with requirements is designed and implemented at the national level.

This manuscript was prepared based on a qualitative research and by the description method. The purpose is by developing the three key concepts of organizational innovation, Foresight and national innovation system to describe the effect of innovative and foresight genes on the construct of Iran's national innovation system. At the end, using the methods of benchmarking and Delphi, it is attempted to present a six level national innovation system such that the themes of foresight and organizational innovation for effective role-playing is reflected at all the relevant levels.

Keywords: Innovation, Foresight, National Innovation System, Benchmarking

I. Introduction

In the opinion of Lundvall, innovation is a consistent process of seeking, screening and achieving the result of which is new products, technology and new forms of organizations and creation of future organizations and markets (Lundvall, 2005). Basically, innovation occurs when ideas in the form of technological change are developed in the framework of products/services (innovation of product) or are developed in a non technological change in the framework of organizational structure (organizational innovation) (Armbruster, 2008). Innovation is characteristically creative and is performed by one individual. Yet, in today's changing world which is managed by organizations, innovation also most commonly occurs in organizations. On the one hand, the speed of development of market needs is consistently more than the speed of technological innovation; as a result, the gap between the present technology and the market needs itself demonstrates that need for organizational innovation exists in a systematic way.

Due to specialization, innovation is rooted in science and technology and is among the major abilities of organizations and countries in creation of wealth and the result of preemptive preparation for facing the continuous changes of present and the future. As a result, innovative organizations are generally futuristic organizations that search for building their desired future from the heart of today's changes so that they can coordinate themselves with the longer term needs of stakeholders; and this dual strategy means that foresighted attention to the essence of innovation and taking advantage of it for shaping future is preferred.

Since the gist of foresight and innovation is the topic of changes in various domains such as science and technology, economics and social, the main question is: what is the role and position of innovation and foresight in formation of Iran's national innovation system? In general, the national system of innovation seeks to identify the actors in the realm of science and technology and create a meaningful relationship between them for achieving additional benefit from each other's technological abilities for better response to the national market needs (Martin, Johnston, 1999). Therefore, to create and strengthen a national system of innovation there is need for more universities, private and public innovating organizations that can reach the necessary maturity and co-evolution by futuristic interactions and strategic agreements.

As a result, in this study initially the theoretical concepts of innovation, foresight and the national innovation system have been presented. Next, Japan's national innovation system has been considered as a benchmarking system. Additionally and subsequently, by describing the Delphi method, a suggested model for Iran's national innovation system –as a new processing model- is presented and the relevant analysis has been performed.

II. Innovation

The first definition of innovation was presented by Joseph Schumpeter. According to this definition, innovation is reflected in outputs including the following items that lead to the occurrence of a different activity (Schumpeter, 1934).

1-A new product or new quality of a commodity, 2-Presentation of a new production method, 3-Creation of a new market, 4-A new method of provision, 5-A new organizational structure.

Trott has classified innovation into seven groups of innovation in product, innovation in process, organizational innovation, management innovation, production innovation, business innovation, services' innovation (Trott, 2005). Armbruster and colleagues (2008) also, by considering the classification of innovation presented by Teed and colleagues (2005), identified four kinds of innovation which are: 1-Technological innovation in product 2-Non technological services' innovation 3-Innovation in the technological process 4-Innovation in non technological process (organizational innovation) (Armbruster, 2008).

On this basis, now a day, innovating organizations try to take advantage of all dimensions of innovation in an integrated fashion such that their abilities in using and developing needed technologies for the desired response to the stakeholders' present and future needs consistent with national goals are strengthened.

III. Foresight

In the year 2000, Ben Martin defined Foresight by implementing revisions as follows:

"Foresight, is the process of systematic endeavor for longer-term outlook towards the future of science, technology, environment, economy and society whose goal is identification of general novel technologies and strengthening of strategic research domains and probably brings with it the most economic and social benefits." (Center for Future Study in Science and Technology of Defense, 2010) and (Martin, 2001).

In the Foresight program of the European Union (STRATA), Foresight is: an important tool in development and management of future based innovation systems that are built on the basis of a wide array of future based coordinated activities in a society (Miles & Keenan, 2002).

Considering the mentioned definitions, it becomes clear that technology and innovation are in very close relation with foresight. Such that, realization of any of these elements without the other lacks full meaning. As a result, when foresight is implemented in a real way, advantages such as: increase and advancement of communications, more concentration on a longer term future, creation of coordination, consensus on an ideal future in the next 10 to 20 years and creation of commitment for putting the futuristic ideas into action are presented as the 5 C's.

IV. National Innovation System

Scientists have presented various definitions of the national innovation system and some of the important definitions are brought below:

- National innovation system is a system in which private and public organizations, universities and governmental agencies interact to help create science and technology within national boundaries. Interaction between these units may be technological, trading, legal, social or financial and the purpose of these interactions is development, support, investment and law making for new science and technology (Niosi, 2002).
- National innovation system is a network of organizations and collection of policies and institutions that influence the creation of new technology in an economy (Martin, 1999).

As a result, the national innovation system, by attention to a desired future, attempts to realize the grounds for advancement of capacity for innovation and development of technology in organizations and by strengthening the communication of innovating organizations, it provides for realization of priorities and national goals

V. Japan's National Innovation System: A Worldwide Benchmark

In the year 1949, Japan's scientific council was established for presenting opinions and suggestions to the government in areas such as advancement of the level of science and technology, training of researchers and making research applicable. This council showed that there it lack of movement in the direction of business and political interests after the second world war; As a result, part of its counseling role was delegated to the science and technology council. This council is under the auspices of the prime minister and scientists form its members. Japan's science and technology policy are implemented by the ministers of the cabinet (particularly minister of education, minister of industry and international business), and the science and technology agency.

Agency of science and technology also has various duties the most important of which is coordination of technological scientific activities of various ministries and specification of the source performing research which is not located in domain of individual ministry activities (such as nuclear energy, science of aviation and aerospace, marine and natural resources' science). The national innovation system of Japan is among the most progressive and effective systems of national innovation at an international level and the council of science and technology as its major trustee, divides this country's technological capital to counseling groups, council for

science and technology policy making, Japan's science council and ministries (particularly ministry of economy, business and industry and ministry of education, physical education and science and technology). Ministries have formulated the strategies for achievement and use of technologies and announced them to offices, agencies and science and technology parks. These offices have the role of supporting and facilitating performance of research projects and send them to major centers of knowledge creation (universities, centers for development research and ...). Agencies also exist at the lower levels of the national innovation system that have the responsibility to expand new technologies. Agencies on the one hand have the responsibility of acquiring the needs of industry and announcing it to scientific policy makers and on another hand have the duty of presenting new technologies to industry and supporting researchers (Boushehri, 2009), (Sadeghi, 2011) and (Ghazinouri, 2008). In this paper-based on descriptions provided for the method of benchmarking¹ in the methods section-using benchmarking Japan's national innovation system's structure, it is attempted to design an appropriate structure for Iran's national innovation system while keeping in mind the two concepts of innovation and foresight.

VI. Study Method

This study was qualitative and its purpose was descriptive. As a result, a general and schematic description of structure/diagram of Iran's national innovation system has been provided. This research tries to demonstrate the construct of Iran's national innovation system based on constituents of innovation (displayed as innovating organizations) and foresight and by using methods of procedural benchmarking and the classic Delphi.

VII. Method of Benchmarking

Benchmarking includes systematic search for obtaining the best methods and organizational experiences for achievement of the highest level of functioning including the three kinds of strategic, process and product oriented approaches (Stapenhurst, 2009).

In this study, considering that the title is related to the structure and process of the national innovation system, the method of process benchmarking has been used, the stages of which have been designed and implemented as follows:

1. Determination of the purpose of benchmarking.
2. Formation of a steering committee including 5 experts.
3. Identification and extrusion of information about various countries' national innovation system: Japan, Germany, England, South Korea and
4. Determination of indices of screening and prioritizing including: antiquity, success and system's maturity.
5. Evaluation and prioritization of the relevant national innovation systems by the steering committee.
6. Performing the study and taking ideas from the structure of Japan's national innovation system (first priority).

VIII. The Classic Delphi Method

This is a method for collection of the view points of professionals with respect for anonymity and summarizing their votes with the approach of prediction and foresight regarding a particular issue (Keeney, Hasson, McKenna, 2001).

For performing this method, the relevant steering committee, with attention to the data on process benchmarking from Japan's national innovation system-which has had good success in creating a national innovation system-and the initial question of this paper, prepared a questionnaire. Subsequently by attention to the approach of foresight in construct of a national innovation system, the following four panels including 18 experts and professionals in innovation, technology and futures study participated:

1. Foresight panel
2. Science and technology policy panel
3. Organizational innovation panel
4. Technology and industry panel

In the first stage of performing the Delphi method, a questionnaire based on open questions and with consideration for anonymity was provided to the panels and after response of the members, the questionnaires were collected by the steering committee and grouped. This work resulted in creation of a questionnaire with 20 key questions in the second stage. This questionnaire along with responses in the first step was distributed among the members of the panels. At this stage and after collection and analysis of the responses it was observed that based on a Likert scale, even though the viewpoint of the professionals had converged, yet, numerous differences based on the quaternary axis existed. Therefore, the steering committee after grouping the responses in the second stage redistributed the questionnaire and integrated responses for a third time. In this stage, members of the panels with attention to two prior responding experiences and familiarity with the professional view points of other experts presented their supplementary opinions. Such that after collection and analysis of the view points, it became evident that convergence of opinions and similarity of ideas have a good quality. Therefore, the results of the second and third viewpoints in addition to the findings from the benchmarking study were used for designing Iran's national innovation system.

¹ The diagrams of national innovation system for countries such as: Japan, Germany, England, South Korea, have been presented in fifth reference which was used for benchmarking in this study.

IX. Results and Analysis

Suggested National Innovation System for Iran

Even initial attempts for creating a national innovation system has been made, yet, this issue still needs more precise designs and increasing support. Currently, some relevant organizations in science, technology and innovation policy making such as the ministry of science, research and technology, the higher council for cultural revolution, expediency council, and the presidential scientific deputy are considered among its most important care takers in the country (Hosnavi et al, 2013). In the suggested flow diagram, the parts that exist in a general fashion have been demonstrated and for the first time, this system is presented in a classified way. The structure of this flow diagram has been improved based on benchmarking Japan's national innovation system which has been performed by implementing changes based on the results of the Delphi method. In this flow diagram, the place of foresight in Iran's suggested national innovation system is clearly evident. The innovating organizations which are one of the major elements of the national innovation system also lead to the national innovation system's gaining increased flexibility, speed and coordination with regards to transfer of technology in the industrial sector, services and agriculture. As shown in the figure 1 below, organizational innovation is placed in the location for facilitation of research and innovation and technology transfer. Off course, organizational innovation has indirect influence on performing R&D and applying technology. One of the important parts of the suggested diagram for Iran's national innovation system is the foresight section which is present in all six levels and its position in the national innovation system is discussed below:

Position of Foresight in the Suggested Model:

First Level: Foresight and Preparation Public Policies

By forming a compound specialty team from members of the major governmental organizations, foresight has been discussed and considering the results obtained from it, national priorities, national macro purposes and the general governmental policies are described. In other words, the pre requirement for describing general policies, is performing persistent foresighting in domains such as science and technology, sociology, economics, environment and

Second Level: Preparation and Coordination of Technology and Innovation Policies

At this level also using technological foresight, the council for policy making and coordination of science and technology can specify the technological priorities in industry, services and agriculture. This council can also lead to positive role creation in the subdivisions by interaction and contact with institutes of scientific information and technology of Iran.

Third Level: Organizational Innovation (Facilitation of Research and Innovation)

For organizations to free themselves from path dependency and prior processes and become close to newer processes, they need organizational innovation. Yet, organizational innovation finds meaning when the relevant organizations possess an appropriate level of future technology, organization and needed information. As a result, by using the capacity for anticipative foresight, one can reach effective organizational innovation for facilitation of research and innovation.

Fourth Level: Performing Research and Development

Universities, industrial laboratories, innovating and progressive organizations, using the prepared document of foresight as well as strategic cooperation based on open innovation, can become familiar with future needed technologies and by performing research and development based on national necessities, can advance the ability for production or domestication of technologies and play an important role in decreasing the technological deficiencies and strengthening technological and non technological innovation.

Fifth Level: Expansion of Technology

At the level of expansion of technology, agencies that commercialize research findings (universities and research centers) can by being informed of the future national needs, identify the group of technologies that are considered the national priorities and by applying them to business, they can reach a competitive advantage. In other words, by considering the organizational innovation approach, these agencies will increase the effectiveness and efficiency of their actions with regards to commercializing technologies and technological innovation to business.

Sixth Level: Application of Technology

At the level of application of technology, organizations, companies and large and small industries with high, medium and/or low technologies can under the title of innovating organizations and by paying attention to the document of Iran's national innovation system and open innovative approach, provide for increased industrial co-evolution, exchange and combine technologies at hand for presentation of future innovations, presentation of

innovating products, obtain desired market equity, create and increase public welfare and finally produce national strength. Additionally, these organizations themselves can by systematic performance of foresight technological projects, while building their future, provide for their future technological needs and opportunities and think about their provision from before.

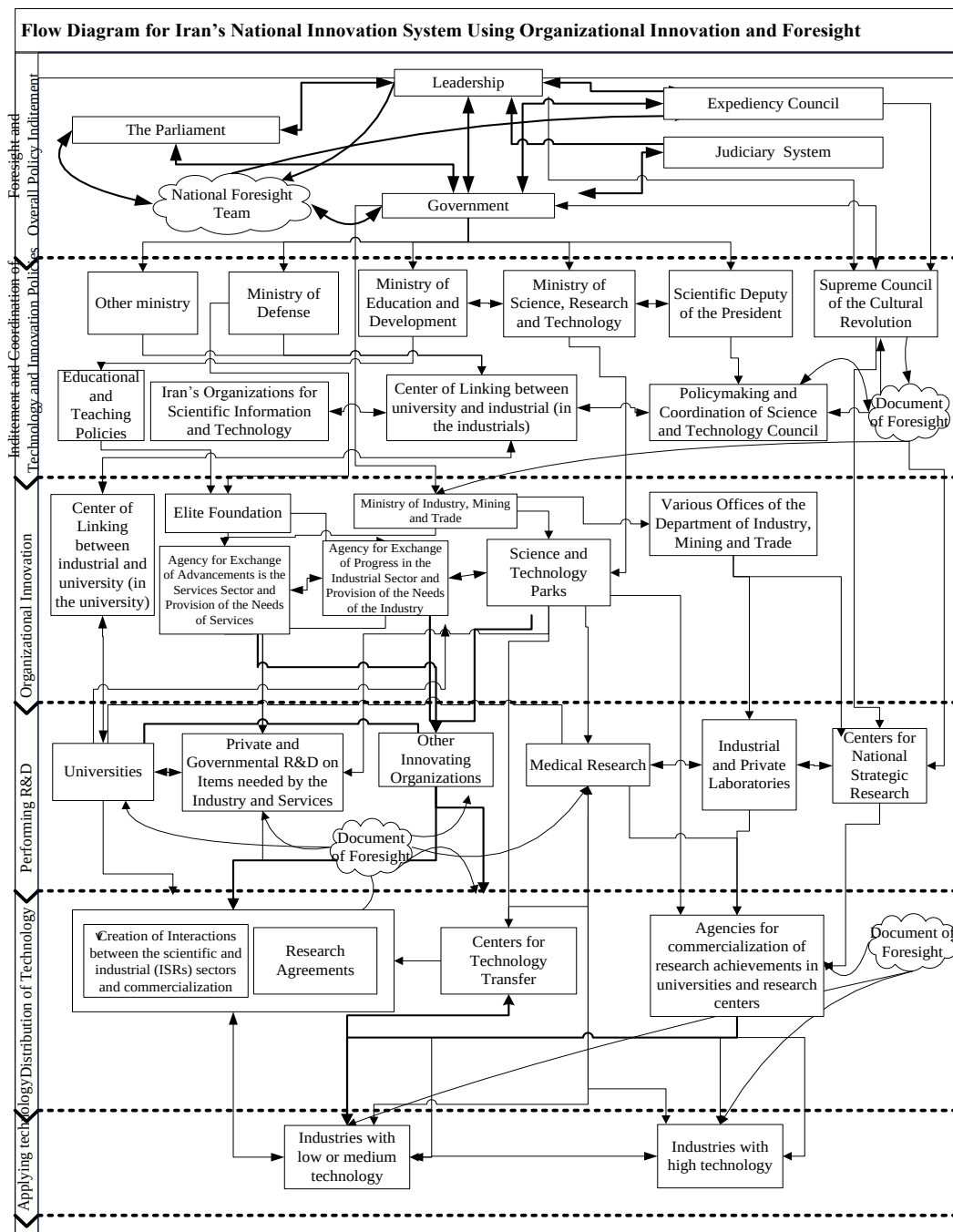


Figure 1. Flow diagram for Iran's National Innovation System

X. Analysis and Suggestions

Analyses are based on the suggested national innovation system for Iran and the results of the viewpoints expressed in the Delphi method which are presented as follows:

• Presentation of the Innovating Comprehensive Evaluation Model

For evaluating innovation, there is need for a comprehensive evaluation model at the three levels, macro (top level of national innovation system: policy makers of innovation), meso (middle of national innovation system: intermediate institutes of innovation) and micro (bottom of national innovation system: Innovating Organizations and companies) and the bases for precise evaluation is existence of appropriate

measures/indicators so by this means while evaluating functioning, rate of convergence and maturity of the national innovation system and organizational innovation becomes clear.

- **Determination of the Effect of the National Innovation System on the comprehensive Scientific Plan of the Country and the Reverse**

One of the challenges of the Islamic Republic of Iran is realization of a comprehensive Scientific Plan for the country-that contains a futuristic approach- and the other challenge is stabilization of a national innovation system for realization of a desired future. As evidence shows, these two have close relationship with each other and each can be the other's complement. Therefore, it is necessary that the synergy and co-evolution of the relation between these two architectures and their implementation be continuously evaluated.

- **Deepening of the Relationship between Organizational Innovation, Suggestion and encouragement Systems**

In most organizations, particularly public organizations, high value is placed on inventions and inventors. Special incitements are considered for inventors (financial and spiritual). Yet, most of these organizations use less strategic actions for improvement in organizational processes or innovation. The problem is that for individuals who try to improve processes, less encouragement is used. As a result, organization personnel have low motivation for making suggestions. Therefore, since the system of suggestions is a bed for advancement of organizational innovation, it needs to include true and strategic support.

- **Vision of 2025 Iran and the Triple Helix**

In this study, referral has been made to the presence of industries, universities and government in the framework of the national innovation system. Yet, the important factor is the relations between these actors. For effective realization of the 2025 vision-that has a normative approach towards foresight -the relationship between actors needs to be stronger and more synergistic than before. In this regard, four strategic connections exist which need to be redesigned with an innovative insight. These relationships include:

1. Relationship of industry with university
2. Relationship of government with university
3. Relationship of government with industry
4. Relationship of industry, government and university

- **Foresight, Policymaking and Advancement of Innovation**

In general, realization of innovation at all levels (national level to the organizational level) requires technological and innovation policymaking and effective policymaking also needs performing extensive studies and having the advantage of the 5 C's in foresight at related levels. Therefore, for achieving a national innovation system to stimulate technology and advancement of innovation, it is necessary that foresight studies be performed with an intelligent strategy and as the tool for policy making.

XI. Conclusion

Foresight is a process for building the desired future based on increasing changes. As a result, precise analysis of changes and weak signals in domains such as science and technology, social, economics and environment will tremendously help shaping the future. On another hand, innovation also has roots in technological and non technological changes and organizations for effective response to the various present and future needs of their stakeholders to understand changes well and by innovation and re-architecting their methods and structures, attempt to create and present new value packages. These organizations who get to be known as innovating organizations are the main actors in strengthening economy and creating national power and who constantly seek development or attract their needed technologies. Yet, since no company alone has the ability to create all the innovative technologies, it is necessary that a bed be created for open communication between innovating organizations to facilitate their interaction and co-evolution. In general, this strategic desire shows itself in the framework of the national innovation system; because, the existence philosophy of this system is creation of an active network of innovative organizations, universities and governmental policymaking organizations for synergy of technologies and presentation of the needed innovation. As a result, in this study it was tried by consideration of the two genes of innovation and foresight on the one hand and benchmarking Japan's national innovation system on the other hand, to suggest a model for Iran's national system so that Iranian innovating organizations also by taking advantage from the capabilities of this system and in accord with national priorities and goals, can achieve more economic production and creation of increased national welfare.

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