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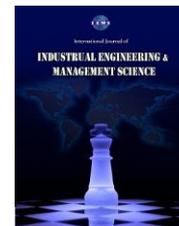
National Innovation Systems in Iran: Challenges and Approaches

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A B S T R A C T

Today, researchers have presented a variety of innovations that are referred to as generations of innovation and are divided into two general linear and systemic categories. One of the approaches to innovation in the systemic perspective is the National Innovation System. The study of national innovation systems suggests foundations and new approaches to government technology policies. The approach of national innovation systems emphasizes that the flow of information and technology between people, investment, and institutions is key to the innovation process. With a glance at the performance of universities, research institutes and private firms in Iran, it can be seen that, despite many abilities in technology development, many of them have failed to make commercialization of technology. In this research, with the aim of identifying the weaknesses of the National Innovation System of Iran, we first discuss the definition of the innovation system and its features and functions. Then, with the functionalist approach to this system, the weaknesses of the National Innovation System of Iran are enumerated. Finally, a framework is developed to identify the failures that these weaknesses arise from them.

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1. Introduction

1.1. Definition of Innovation

Sometimes in the speeches and texts of some researchers, the concept of innovation is used interchangeably with terms such as creativity, discovery, and invention, while each of these has its own definition. For a better understanding of innovation, it is better to consider each of them separately:

1. Creativity: It is the use of mental abilities to create new thought and/or the emergence of a new idea [1].

2. Discovery: it is to reveal and exploit, and to emerge or proclaim something that has existed but has not been noticed or understood [2].

3. Invention: Converting a thought from potential to actual, or applying a new thought on existing means and tools, or making changes to existing tools to achieve new results. The nature of the invention is such that the creation of a new phenomenon takes place after repeated studies and experiments, based on the discovery of previous laws [2].

The concept of innovation was first introduced by Joseph Schumpeter in 1934. He linked innovation with economic development and introduced it as a new combination of wealth-generating resources. His work consisted of five specific cases: introducing new products, new production methods, the identification of new markets, capturing new sources of raw materials and facilities and new ways of organizing the trade [3]. In the sight of this prominent economist and his followers, a new invention or technology change is considered an innovation that has led to a new economic value [4]. Since then, and over the past few decades, the concept of innovation has undergone many changes.

In Webster's Dictionary, innovation is the ability to do something innovative that results in a new product or service, this ability may derive from the intelligence and talent or by training [5]. In the Oslo Manual 2005, innovation is defined as the implementation of a new or significantly improved product (product or service) or process, or a new organizational method in the business management, organization, or external relationships [4]

1.2. Innovation process

Innovation is a process that included all discovery, invention, product development, process creation and development, organizational changes, and dissemination and updating of these process [6]. Generally, in the organization, innovation is carried out in a sequential manner through successive steps. To succeed in the innovation process, managers must make sure that the steps take place in an ordered way, and if one step or element would be absent, then the innovation process would be defeated. Samad Aali has proposed the necessary steps for successful innovation:
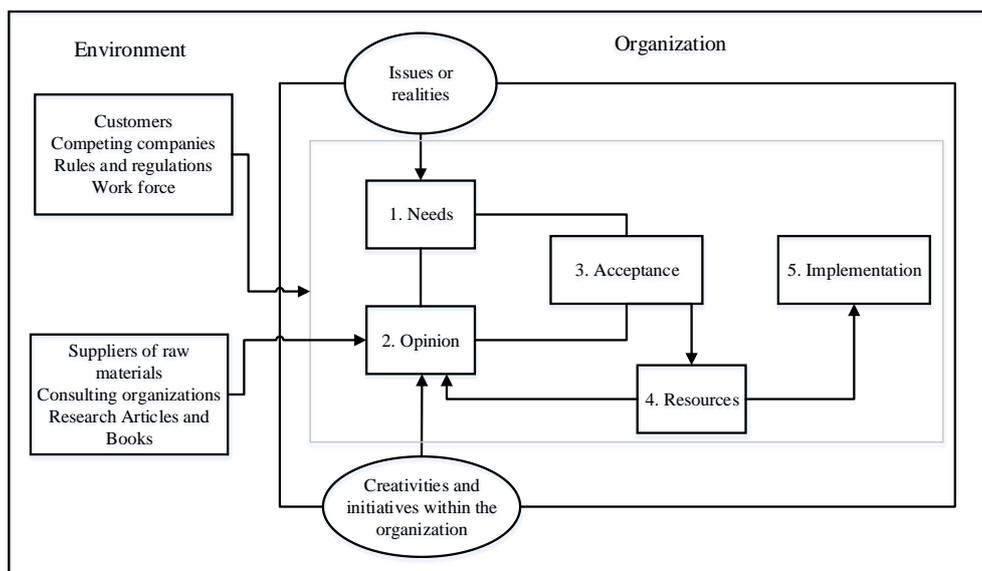

Figure 1- Steps to successful innovation (Aali, 2000)

1.3. Innovation system

Today, management and technology researchers believe that technology development cannot be seen as a separate phenomenon, but should be studied as a part of a broader "innovation" system. The innovation system also focuses on a wide range of institutions including educational and training institutions, research and development institutions, design and production institutions, marketing and distribution institutions, intellectual property and distribution institutions, and sets of infrastructures such as people and goods transportation networks.

Each system consists of components (actors), relations, and characteristics. Components are the operational parts of the system, which include individuals, industries (firms), universities research institutes, banks and government policymakers, and in the innovation system approach, firms are the main component of the system. Institutions such as laws, regulations, and social norms are also components of the innovation system. In fact, these institutions are defined as a cluster of formal and informal rules that shape behaviors. Since institutions determine the rules of the game of social interactions, understanding them is very important to understand the dynamics of the innovation system [7].

Relations are the connection between various components of the system that can be in the following ways [8]:

1. Market exchanges that include vertical links backward and forward, as well as horizontal links (in relation to competitors).

2. Unilateral financial, skills and knowledge flows that may be within an innovation system or between organizations of different systems of innovation (e.g., several countries).

3. Non-market interactions between actors

The dynamic factor of the system is the presence of feedback (interaction) in it. Without feedback, the system has a static state. The more interactions between the components of a system are, the more dynamic the system is [9].

Characteristics are components features and relationships between them, and they determine the specifications of the system. Since the components of the innovation system interact with each other, their characteristics also come from the system. System dynamics (i.e. strength, flexibility, the ability to change and respond to environmental changes) is the first and most important feature. Changes in the system can be created internally, as new components (actors or artifacts) are formed during the withdrawal of other components of the system, the relations between the components are changed, and the characteristics (the ability of actors, the nature and severity of communication between Actors) are different. Similar changes can also occur or be required externally due to changes in the environment, such as changing the nature and extent of interactions between different parts of the system due to the advancements in communication and information.

1.4. National Innovation System

National Innovation System is an interactive system of existing institutions, private and public companies, universities and government offices that target the production of science and technology (S&T) within national borders, and it helps new technologies to develop and release, and provides the format and structure for governments to create and implement policies for influencing the innovation process. National Innovation

System can be considered as a management system including a main body, structural elements, and external environment as follows [10]:

- Main body: economic enterprises (industries), universities, parks, and incubators of science and technology, research centers, government organizations, and financial institutions

- Structural Elements: competitive market, research, innovation infrastructures, partnership and cooperation, and access to information

- External Environment: the country's management system, innovation culture, government policies and plans, operational mechanisms (laws and regulations, technology dissemination, intellectual property, risk capital, education system, etc.).

Such a system should be defined at national level, because first of all, many of the non-development problems are limited to the borders and political sanctions of the countries. Second, knowledge, that is the key to innovation, is much more difficult to cross borders than other goods, and also policies that directly contribute to the production and use of knowledge are those designed and implemented at the national level.

In following the relations between the components of the National Innovation System and the position of each of them are described:
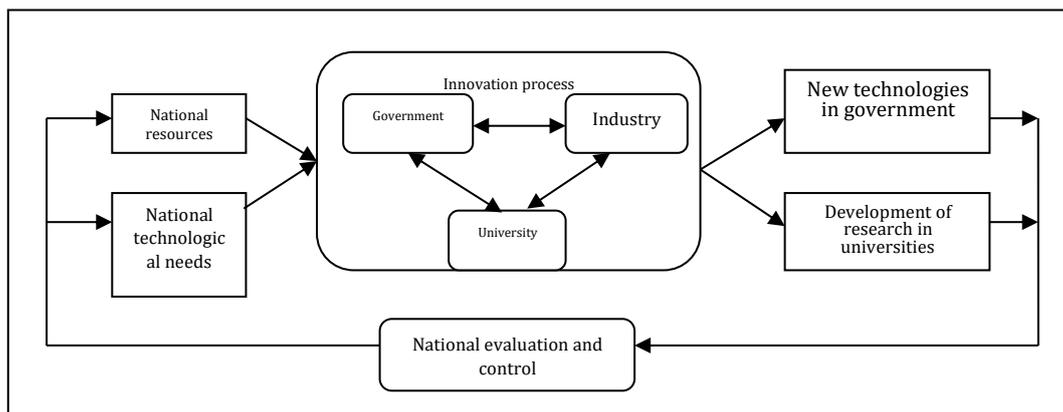

Figure 2- Relations between the Components of the National Innovation System (Abdoli, 2007)

In table 1, the most important actors of the National Innovation System are shown [4].

Table 1- The most important actors of the National Innovation System

Organization type	Example
Political	ministries, national councils of science and technology
Administrative	organizations and public offices implementing innovation policies
Regulation	standard organization, industrial property office, quality certificate providers
Social	professional associations
Educational	universities, institutes, schools and vocational school
Scientific Non-Commercial	government laboratories in the field of defense or health, laboratory centers of industrial assemblies
Commercial	innovative firms, joint ventures, consortiums
Mediator	organizations that link the fields of science and technology to the industry, such as innovation centers, commercial chambers, specialized communities, universities' contact to industrial units, technology transfer centers, science parks

The national perspective and the aspect that lie within the framework of national innovation systems, are based on principles that are associated with the national institutions, culture, language, current norms, technology policies, and education of each country. These innovation systems are open and homogeneous and can even be addressed at local and cluster levels. Therefore, cluster, regional and technological innovation systems are sometimes used as complementary, and sometimes as rivals, along with national innovation systems.

1.5. Regional system of innovation

A region is a space where shared values, trust, and other intangible assets make interactive learning processes success and reduce the costs of interactions between firms [11]. Cook and colleagues have identified "The culture of cooperation, the culture of participation, the ability to institutional change, the coordination and consensus of the public and private sectors, the culture of productivity, corporate responsibility towards society and the presence of exchange mechanism in specialized and technological fields" as essential factors in the success of regional innovation [12]

1.6. The sectorial system of innovation

According to Malerba, sectorial innovation systems are a set of new products for specific applications and a set of factors that market and non-market interactions for the creation, production, and sale of those products, included. The sectorial systems have the knowledge, technology, special inputs and available and potential demand bases. The mechanisms of interaction (inside or outside the firm), the competition and selection processes, and institutions, in each sectorial system, are special to that system. Sectorial system boundaries are not always national and, in fact, are often considered locally and in association with the regional system of innovation. Although the pattern of each section is different from the other, it seems that there are close patterns between different countries, in similar sectors. A sectorial system with the presence of efficient enterprises and interactions between enterprises, institutions and non-economic organizations affects the internationalization of countries (Malerba, 2002).

1.7. The technological system of innovation

One of the innovation systems that have a close interaction with economic development and the National Innovation System is the technological system of innovation. The functions and tasks of the technological system of innovation are:

1) Entrepreneurial activities: The presence of entrepreneurs in innovation systems is of prime importance. Without entrepreneurs, innovation will not happen, and there will be no innovation system. The role of the entrepreneur is to capture the potential of developing new knowledge, networks and markets, and the sole function of creating and exploiting the benefits of business opportunities.

2) Knowledge development learning: Learning mechanisms are the key to every innovation process. Lundwall, for example, believes that the most fundamental source in modern economics is knowledge and, consequently, the most important thing to learn. Therefore, the expansion of research and development and knowledge is one of the most fundamental prerequisites for the innovation system.

3) Dissemination of knowledge through networks: According to Carlson the critical function and task of networks are to exchange information.

4) Market task and function: New technology often has problems to compete with existing technologies. Therefore, it is important to create secure spaces for new technologies. One possibility is to create temporary markets for special technology applications that can be done by governments. Another possibility is the creation of a temporary competitive advantage by right taxation and other ways.

5) Resource mobilization: The necessary resources (both financial and human) are the primary input for all activities of the innovation system. Particularly for bio-fields technology, bio-resources are a specific factor for the success or failure of the project.

6) Creating legal / contractual frameworks for change: A part of incubators should be created to improve the new technology. In this case, extensions and the creation of coalitions can act as a catalyst for new technologies [13].

1.8. Technological learning system

Technology learning is defined as a process for enhancing technological capability through the process of acquiring external knowledge. This process occurs at all levels of the national economy from the individual level to the level of companies, industries, sectors, or governments [14]. which leads to adaptation of imported technology, modification and technological changes in industrial sectors of developing countries [15]. Kim has defined technological learning as the acquisition of knowledge, and more importantly the creation of new knowledge, and a dynamic process of acquiring technological capabilities [16]. Huang also defines it as a process by which technology-intensive companies create or upgrade their abilities [17].

The technological learning process can be divided into two types of internal technological learning and external technological learning [17]. Internal technological learning begins with the creation and exploitation of technology by organization people and is defined as the process of acquiring new information and knowledge by members of the organization by exchanging and transferring it to other members or units of the organization [16]. While external technological learning begins with the identification of knowledge created outside the organization, and it is defined as the process of acquiring new information and knowledge by members of the organization through interactions with other organizations [14]. Companies with external learning resources are included in strategic alliances, competitors, customers, academic researches, and so on. Companies should understand the importance of both internal and external technological learnings, and simultaneously noticed the exchanges related to allocation of resources to each one [18].

According to the technological learning literature on effective extra- and intra-organizational factors, generally factors and sub factors can be presented in the form of table 2 and table 3.

Table 2- Extra-organizational factors influencing technological learning (Ansari and Habibzadeh, 2016),(Attarpoor, 2014), (Ghazinoori et al., 2013)

number	Factor	Sub-factor
1	Technological Features	- The complexity of technology - The novelty technology
2	Industry feature	Industry's dominant and standard technology

3	Market feature	- Access and entry into international markets - Competition in the market -Market type
4	Political conditions	Government policy and support
5	Economic conditions	- The degree of economic dependence on the industry - Global technology prices

Table 3- Intra-organizational factors influencing technological learning (Ansari and Habibzadeh, 2016),(Attarpoor, 2014), (Ghazinoori et al., 2013)

number	indices	sub-indices
1	ability to carry out R&D activities	- investing on R&D - the number of R&D unit personnel - accumulation and use of R&D documents - R&D equipment - sharing of knowledge and information in the R&D unit - gradual and fundamental innovation
2	production capability	- quality control capability - maintenance capability - design capability - technical capacity - human capability
3	communication capability	-the ability to use external links (universities, suppliers)
4	organizational capability	- proper organizational structure - promoting organizational culture - creating management practices
5	capital investment capability	- the skills and resources required for projects and contracts - capital costs of projects and contracts
6	motivational system	-top management support - valuation and promotion
7	education system	- formation of formal and informal training programs
8	knowledge management system	- ability to collect data - ability to search and refine knowledge - ability to connect and share knowledge - ability to encode knowledge
9	absorption capacity	- ability to acquisition - ability to adapt - ability to convert - ability to use

2. The functions of the innovation system

The contribution of an element or a set of components to achieve a goal is what is called here function [19]. Each innovation system must perform functions and activities for the development of innovation, which these functions and activities are carried out at different levels and by different actors in the innovation system [20]. Because at the macro level, the most important function of the National Innovation System is "creation", "dissemination" and "exploitation" of knowledge and innovation, in order to formulate this function, a set of sub-functions or activities in the innovation system must be

performed to provide conditions for the creation, dissemination and exploitation of knowledge and innovation [21]. Therefore, the function of various actors in the system can be considered as those activities and factors that affect the development and propagation of innovations. However, there is no agreement among the experts on the precise and coherent nature of all the functions of the innovation system.

Many researchers have attempted to define the functions of the innovation system. Depending on their research goals, they have had different approaches to the functions of the National Innovation System. In various scientific sources, by Edquist, Lundwall, Johnson, Carlson, OECD and others, various functions and activities for the innovation system have been expressed that address various issues such as policy-making, support for research activities, conducting research activities, empowerment, networking, knowledge dissemination, and entrepreneurship.

On the other hand, some of the most important functions of the National Innovation System can be classified as follows [22]:

1- Policymaking:

• Determine general frameworks and approve laws;

•Inter-sectoral policy-making, coordination, monitoring, and evaluation;

•Policy management and coordination, monitoring and evaluation of sectors, and the formulation of guidelines;

• Implementing sectoral policies.

2. Creating and Developing Knowledge Capacity:

• Basic research;

• Applied research;

• Developmental research;

• Market research;

• Reverse engineering and engineering design;

• Maintaining and improvement of written knowledge inventory;

• Social integration and improving the overall capacity of technology acceptance;

3. Facilitate research and innovation:

• Designing a financing mechanism for innovation and entrepreneurship in accordance with the requirements of various types of research from public and private sources in the form of venture capital funds;

• Supporting non-commercial institutions and organizations active in fundamental and applied research;

• Supporting development projects in the commercial sector;

• Supporting priority research fields and independent of institutions;

• Supporting knowledge-based and technology-based companies;

• Supporting entrepreneurship and providing legal, administrative and managerial services to entrepreneurs and startups;

• Protection of intellectual property rights;

• Supporting standardization;

• Regulation and guiding the market and facilitating the expansion of markets and access to them.

4. Human Resources Development:

• Training, development, and promotion of human resources.
• Facilitate human resource mobility.

5. Improving the transfer and dissemination capability of knowledge and technology:

• raising awareness and displaying technology;

• Improving access to information and technology;

• Improve the innovation capacity of enterprises;

• Transfering knowledge and technology from outside to inside and between domestic organizations;

• Improving knowledge distribution and updating;

• Improving knowledge transfer mechanisms;

• Improving the adaptation of existing power to the interesting knowledge and technology;

• Improving knowledge and technology dissemination platforms (local or industrial networks).

6- Production of goods and services:

• Production of goods and services.
In some categories, due to the importance of entrepreneurship in innovation systems, "supporting entrepreneurship" is distinguished from the "funding and support for innovation and entrepreneurship" activity [20]. In short, entrepreneurship is a situation in which a person can provide a new and complete framework for reorganizing resources in such a way he/she believes in its profitability. Some of the drivers and motivators of business start-ups are business start-ups due to the need (the unemployed), the desire to maintain and increase revenues (in terms of profitability), and the desire to be independent.
In another study, Johnson identified a total of 10 activities, including two main activities and eight support activities for the functions of the innovation system [19]:
• Main activities

- Focus on identifying existing problems and issues, and appeals to the National Innovation System

- Creating new knowledge, technology, and innovations to solving these problems and issues

• Supportive activities

- Providing incentives and motivations for companies innovative activities

- Provision of resources, investment, and funding for innovative activities

- Guiding and directing the innovative activities and impact on resource orientation of organizations

- Identifying the potential for growth and innovation;

- facilitating the exchange of knowledge and information;

- Stimulating or creating markets when they are not spontaneously developed;

- Reducing social uncertainty;

- neutralizing resistance to change at the time of innovation.

Patterson et al. have identified two broad categories of innovation activities and presented them as follows:

1) Government-related activities include:

- Formulating policies and allocating budgets at the national level

- Specialist consulting activities

- The legislation required for policy making

- Establishing international activities in the field of science, technology, and innovation

2) Joint activities between the government and the private sector including:

- Investing in innovation-related activities

- conducting R&D and innovation

- Creating communication and knowledge flows

- Human resource development and capacity building

- Provision of infrastructure and technical services

Various other studies have also addressed the functions of the innovation system. Table 4 lists some of these functions.

Table 4- A summary of some of the functions of the National Innovation System (Noroozi and Tabatabaeian, 2016)

Reference	Functions							
Suurs and Hekkert, 2009	Entrepreneurial activities	science development	Knowledge dissemination	Directing researches	Market shaping	Supply and allocation of resources	Support by backup groups	
Van Alphen et al., 2009	Entrepreneurial activities	science development	Knowledge dissemination	Directing researches	Market shaping	Supply and allocation of resources	Creating legitimacy	
Bergek et al., 2008	Entrepreneurial experiments	Development and dissemination of knowledge		Influence on directing decisions	Market shaping	Supply and allocation of resources	Creating legitimacy	Extending positive side effects
Negro et al., & Hekkert et al., 2007	Entrepreneurial activities	science development	Knowledge dissemination through networks	Directing researches	Market shaping	Supply and allocation of resources	Creating legitimacy / overcoming resistance to change	
Edquist, 2005		R & D / Creating advantage / Providing consulting services	Networking	Provide minimum quality / Create and modify the industrial structure / Create and modify the rules	New product market formation	Financing Innovation / Supportive Activities		
Jacobson and Bergek, 2004	Create new knowledge			Leading the research process	Smooth market formation	Supply resources		Smoothing development of side effects
Liu and White, 2001	implementation	Research	communication		Final consumption	Education		
Rickne, 2000	Create and publish new products / Create and publish innovative opportunities	Conducting market research	Increase Networking	Guiding technology	Creating markets and disseminating market knowledge	Human resources improvement / support / smoothing finance / creating labor market	Legitimize the technology and firm	
Johnson, 1998			Smoothing the exchange of knowledge and information	Guiding the research process / identifying potential developments	Create and simulate the market	Supplying sources / providing	Overcoming Resistance to Change	

3. Weaknesses and shortcomings in the National Innovation System

Perhaps the most important aspect of the strength of the innovation systems identified by Edquist is that the innovation is based on interactive learning between organizations in the approach of innovation systems and in general, the innovation of companies is not isolated [23]. Another important aspect is that institutions are considered vital elements in all versions of innovation systems. Institutions also form the function of organizations and the relationships between them or formed based on them. In addition, all versions of the innovation system approach consider the process of innovation as an evolutionary one.

The above features have led to major advances in studies of innovation processes. At the same time, innovation systems have weaknesses; for example, this feature of the gradual evolution of the innovation process has made it even impossible for the components involved in it to determine what the final result will be or what route will be chosen. Therefore, since the level of performance of the innovation system varies and depends on the internal structure and learned knowledge, innovation systems never operate in an optimal manner. Consequently, the concept of optimality does not apply to them. The definition of the entity in the innovation system is also ambiguous. Some scholars take organizational actors as institutions, and others take institutional rules (rules of the game). In addition, the functional boundaries of the systems are very vague. Relations between variables are not described in a precise manner too.

One of the other weaknesses of the innovation system is very little knowledge about the determinants of innovation. The other weaknesses of the innovation system are ignoring other types of learning processes that lead directly to innovation. In addition, the innovation system approach largely ignores individual learning in the form of education. The lack of a theoretical component about the role of the government in this approach is also seen as a significant neglect because the government and government

agencies are clearly the major determinants of innovation in any innovation system, and if the interaction between these actors in the combination of the innovation process mechanisms do not take place effectively and properly, there would be systemic imperfections. In this case, the innovation learning by actors is blocked by the slowdown of the innovation system. So far, many studies have been conducted to investigate systemic imperfections and the causes and factors that affect the inefficient functioning of innovation systems globally.

Voltois et al. by studying all researches carried out in this field, provided a categorization as follows that allows analyzing the location of occurrence of bottlenecks that are related to systemic defects and adopting preventive policies [24]:

Infrastructure failures: Infrastructure failures, in addition to physical infrastructure, imply the infrastructure elements of communications and the infrastructure of science and technology.

Institutional failures: Institutional failures are in relation to formal institutional mechanisms (hard institutional failure, such as written rules and regulations) and informal institutional mechanisms (soft institutional failures such as political culture and social values) that impede innovation.

Interactive failures: interactive failure as a network of interactions between different institutions, pointed to a strong network failure (strong cooperative relationships between the actors of the innovation system that could risk the misguided orientation due to the lack of information exchange by the intermediate actors) and a poor networking (poor interaction between actors and complementary technologies such as knowledge, expertise and capacity, leading to a lack of a shared vision of future development of technologies and preventing the coordination of research and investment activities).

Capabilities failures: Capability failures also indicate lack of capacity (such as learning and flexibility potential), competence or resources of companies in the leap of old technology or paradigm into new ones.

4. Weaknesses and failures in the National Innovation System of Iran

As noted earlier, developed and developing countries differ in terms of the political, economic and technical factors of the innovation system. Therefore, the problems of these systems are different in developed countries. Among the common problems in the National Innovation System of developing countries are as follows:

-The lack of S&T institutional networks such as universities, research institutions, and standardization institutions

-Separation of S&T institutions from the productive sectors of the economy

-Inappropriate level of cooperation between the main areas of public-monetary and financial policy, foreign investment, intellectual property, competition, trade, industrial development, health, etc., Which have a common relationship with investing in S&T development

-The inadequacy of coordination between S&T policies at the national, regional and sectoral level

- Lack of cooperation and consultation with all major actors such as government agencies, businesses, universities, S&T institutions, consumers, workforce and civil society in the formulation and implementation of science, technology and innovation policies.

Unfortunately, in our country, because of the historical record that existing institutions are often rooted in the attitude of imitation of similar foreign institutions (and not the national needs), National Innovation System has many weaknesses and lack of required coherence.

Ghazi Nouri and Ghazi Nouri, in a study with the identification of the following weaknesses, propose solutions to correct them [25]:

At the general policy level:

- Lack of a unified and multi-sectoral council that has the role of coordination and policy-making

- Lack of think tanks and counseling centers in policy-making and planning

At the level of developing and coordinating technology and innovation policies:

- Ignoring the futuristic technology activities carried out by various centers and deliver the results to policymakers.

- Lack of undertaker for the evaluation of research and development activities to guide and prioritize research activities

At the level of facilitating research and innovation:

- Lack of immaterial support such as intellectual property and patent registration

- Shortage of nongovernmental financial support

- The weakness of international collaborations in research and development

At R&D level:

- Lack of systematization and division of research works among existing institutions

At the level of technology dissemination:

- Lack of required institutions in the field of technology diffusions, such as research and technology centers, marketing and technology registration companies, technology information network and standard technology centers

At the level of technology users:

- Lack of knowledge about the demand of enterprises and manufacturing companies and services, which is considered to be the driving force of innovative activities. Because these institutions are separated from the innovation system and placed in the industrial and guild sector.

The above weaknesses are related to institutionalization. These two researchers have derived the great weaknesses of Iran's national innovation system as follows:

1. The absence of a technology-centered inter-institutional coordination center
2. The lack or absence of decision-making bodies for technology policy
3. General weakness of the administrative structure of the country
4. Lack of attention to and comply with the intellectual property
5. Considering technology as hardware

In another study on proposing reforms to Iran's national innovation system, the weaknesses of this system are as follows [26]:

1. Lack of integrity and common contradictions among the national components of system innovation
2. The absence of a clear and transparent technology policy in the country that covers goals, tools and institutions
3. Inefficiency in determining the technology priorities for the country
4. Disregard the intellectual property
5. Hard governmental bureaucracy that complicates the implementation of government decisions and policies
6. The phenomenon of brain drain
7. Lack of research and development activities in the private sector

8 ·Lack of technological cooperation with foreign research centers

9 ·Low rates of entrepreneurship in the private sector

10 ·Lack of risky investments

11. Low rate of foreign investment, especially in the field of superior technology

In another study on institutional mapping and national work partitioning, the current challenges of the Iranian national innovation system are listed as below [13]:

1 The lack of integration of the innovation system from the perspective of the theoretical foundations that govern it

2. Top-down, magisterial and non-delegated strategic style in policy making

3 Overlapping, lack of separation of responsibilities and unclear responsibilities of policymaker institutes

4 Irregular and interrupted organizational communications

5 The marginalization of nonprofit, non-governmental organizations and advisers such as NGOs or associations

6· Non-involvement of civil society in a participatory policy-making processes

7. The insignificant involvement of the technological and industrial sectors in policy making

8. Not having a proper methodology and a competent authority in evaluating policies for evaluating performance and improvement

9. Inadequate transfer of academic talents to the industry and brain drain

10 ·Closed system in international communication

11 ·Unbalanced allocation of funds to organizations, especially in the budget

12 ·Inappropriate funds distribution channels

13 ·Uncertain and insignificant private financing

14 ·Lack of scientific infrastructures, informing and disseminating scientific achievements

15 ·The lack of scientific and academic mastery in technology commercialization techniques

16 ·Low stability of science and technology policies and programs

17 ·Insufficient attention to demand-side policies

18 ·Imports and economic disadvantage in the commercialization of technological products

19 ·Uncertainty over intellectual property rights

In his study, Abdi examined the documents and enquired the experts, list the following problems for the National Innovation System of Iran [27]

In the field of policy making:

-The lack of a centralized institution responsible for policy making in science, technology, and innovation in the country

- Lack of proper system for monitoring and evaluation in the activities of science, technology, and innovation in the country

In the field of R & D financing:

-The complexity of the regulations governing research and technology

-Lack of legal, cultural and structural infrastructure needed to protect intellectual property

-Uncertainty about the main priorities in directing the research and technological activities

-The excessive reliance of the research and technology resources on government

- Low share of Iran's research in GDP

In the field of R & D implementation:
-Lack of specialized research and development units in the country
-Lack of sufficient incentives to increase the share of the private sector in research
- The lack of a commercialization and business perspective of the research centers managers (especially governmental)

In the field of human resource development:
- The lack of a sectoral proportion between the goals and content of the educational system to national needs, especially the lack of a vision for the training of new technology specialists
- Integrating the roles of investor, manager, standardizer and evaluator of the higher education sector, all of which are performed by the government.

In the field of entrepreneurship promotion:
-The excessive emphasis of the educational system on transferring knowledge rather than invention
-The bureaucratic attitude governing the research centers and universities of the country in relation to innovative activities incompatible with the spirit of entrepreneurship
- Lack of technological financing institutions and venture capital investment for entrepreneurs

In the field of technology dissemination:
- Very limited knowledge of policymakers and specialists with the concept and importance of technology dissemination in the innovation system.
- Poor international scientific communication on scientific, research and educational outputs
- The lack of scientific, industrial and technological clusters and networks
- The lack of mechanisms facilitating the diffusion of technology (including the strong intellectual property system and the rules for facilitating the diffusion of technology)

Bagheri also pointed out some weaknesses in Iran's innovation system in his studies:

1.In the functions of the National Innovation System, mostly we can see the activities of the institutions belongs to industry, government, and universities together, without necessarily having the required and appropriate connection between them. In other words, the presence of the three domains of government, university, and industry in performing a particular function in the National Innovation System does not mean that they can be properly linked; for example, in National Innovation System of Iran and in the function of conducting research and innovation, one can see the simultaneous presence of these three domains, but everyone acknowledges that this simultaneous presence in the field of research has led to the establishment of an appropriate relationship among them (especially in the form of joint research projects or transfer of research achievements) and this continues to be one of the serious problems of National Innovation System of the country [28].

2 Repeated, uncoordinated and confusing measures of domestic research centers and the lack of applied research results due to weakness in technology policy making [29].

3. The absence of a general approach to policymaking in science, technology, and innovation that causes the various institutions in the innovation system to be not interconnected [29]

Overall, regarding the functions that are considered for the National Innovation System (as mentioned earlier), we can cite the problems and weaknesses of Iran's national innovation system in terms of its six functions:

In the field of policy making:

-The lack of a general approach in policy making for science, technology, and innovation to align the activities of various actors in the innovation system·

- The absence of a multi-sectoral united council responsible for policy-making and coordination acceptable by all institutions and has the power to enforce policy and coordinate.

In the field of facilitating and directing research and innovation activities:

- The complexity of the laws and regulations governing research and technology

- Lack of legal, cultural and structural infrastructure needed to support intellectual property

- The lack of clear priorities in directing research and technology activities

- Intensive reliance of the research and technology sector on governmental resources

In the field of research and development:

-Lack of specialized research and development units

-Lack of international collaborations in research and development

-Lack of private sector share in research and development

- Lack of systematization and work division between research centers, and scattered and repeated works

- Lack of a responsible institution to evaluate and monitor research and development activities and innovation activities

In the field of entrepreneurship:

-The excessive emphasis of the educational system on transferring knowledge rather than invention

- Imports and economic disadvantage in the commercialization of technological products

- The lack of scientific and academic mastery in technology commercialization techniques

- Lack of risk capital

In the field of human resource development:

- The lack of a sectoral proportion between the goals and content of the educational system to national needs, especially the lack of a vision for the training of new technology specialists

- brain drains

In the field of technology dissemination:

-The inability to appropriately communicate the research institutions in the country

-Lack of knowledge about the importance and concept of technology diffusion among officials and experts

-Lack of mechanisms for facilitating the diffusion of technology (protection of intellectual property rights and laws and technology diffusion institutions)

-The absence of scientific, industrial and technological networks

The table 5Table 5 presents the researchers who referred to each of these weaknesses.

Table 5- Classification of Weaknesses and Problems of the Iranian National Innovation System

Failure field	Problems of the Iranian National Innovation System
Policymaking	The lack of a general approach for policymaking in science, technology, and innovation to direct the various actors of the innovation system aligned
	The absence of a multi-sectoral united council responsible for policy-making and coordination acceptable by all institutions and has the power to enforce policy and coordinate.
Facilitating and directing research and innovation activities	The complexity of the rules and regulations governing research and technology
	The lack of legal and cultural infrastructures required to support intellectual property
	The lack of clear main priorities in directing the research and technological activities
	Intensive reliance of the research and technology sector on governmental resources
Conducting research and development	The lack of specialized research and development units
	The lack of international cooperation in research and development
	The lack of private sector share in research and development
	The lack of systematization and work division between research centers, and scattered and repeated works
	The absence of the institution responsible for the evaluation and monitor the research and development activities and innovation activities
Entrepreneurship	The excessive emphasis of the educational system on transferring knowledge rather than invention
	Imports and economic disadvantage in the commercialization of technological products
	The lack of scientific and academic mastery in technology commercialization techniques
	Lack of risky investments
Human resource development	The lack of a sectoral proportion between the goals and content of the educational system to national needs, especially the lack of a vision for the training of new technology specialists
	Migration of the Brains
Technology dissemination	Not establishing an appropriate relationship between the research institutions in the country
	Lack of knowledge about the importance and concept of technology diffusion among officials and experts
	Lack of mechanisms for facilitating the diffusion of technology (protection of intellectual property rights and laws and technology diffusion institutions)
	The absence of scientific, industrial and technological networks

As stated above, all weaknesses in the innovation systems come from four categories of Interactive, infrastructure, institutional, and capability failures. Matching these with the above table, it can be stated that each of the weaknesses mentioned above can be an example of such failures in Iran's National Innovation System. The table 6 shows that any of these weakness caused by each of the failures.

Table 6- The origin of failure of functional weaknesses of Iran's National Innovation System

Weaknesses field	Weaknesses and problems of Iran's National Innovation System	Infrastructure failure	Institutional failure	Interactive failure	Capability failure
Policymaking	The absence of a general solution in policy making for science, technology, and innovation to align the activities of the innovation system actors	*		*	
	Lack of a unified and multi-sectoral council that has the role of coordination and policy-making		*	*	
Facilitating and directing research and innovation activities	The complexity of the rules and regulations governing research and technology		*		
	Lack of legal, cultural and structural infrastructure necessary to protect intellectual property	*			
	The lack of clear priorities in directing research and technological activities		*		
	Intensive reliance of the research and technology sector on governmental resources				*
Conducting research and development	Lack of specialized research and development units	*			
	Lack of international collaborations in research and development			*	
	Lack of private sector share in R&D				*
	Lack of systematization and work division between research centers, and scattered and repeated works			*	
	The absence of the institution responsible for the evaluation and monitor the research and development activities and innovation activities		*		
Entrepreneurship	The excessive emphasis of the educational system on transferring knowledge rather than invention		*		
	Imports and economic disadvantage in the commercialization of technological products	*			*
	The lack of scientific and academic mastery in technology			*	*

Table 6- The origin of failure of functional weaknesses of Iran's National Innovation System

Weaknesses field	Weaknesses and problems of Iran's National Innovation System	Infrastructure failure	Institutional failure	Interactive failure	Capability failure
	commercialization techniques				
	Lack of risky investments				*
Human resource development	The lack of a sectoral proportion between the goals and content of the educational system to national needs (especially the lack of a vision for the training of new technology specialists)		*		
	Brain drain	*			
Technology dissemination	Lack of proper communication among the institutions responsible for research in the country			*	
	Lack of knowledge about the importance and concept of technology diffusion among officials and experts			*	*
	The absence of mechanisms facilitating the diffusion of technology (protection of intellectual property rights and technology diffusion institutions)	*	*		
	Lack of scientific, industrial and technological networks			*	

5. Conclusion

Despite all the weaknesses and shortcomings, the concept of National Innovation System is increasingly being used by international organizations as an analytical framework, and its acceptance among policymakers all around the world is increasing. Along with the expansion of the systemic innovation concept, the shift in research trends is also evident. The initial studies of the National Innovation System focused on the role of actors in a country that stimulates political, cultural and economic development. In contrast, recent trends in the literature show that international comparisons are now at the focus of the studies. The purpose of these studies, known as benchmarking studies, is to identify "best policies" or "best practices", and then extract the exact measures of the innovation and its implementation. One of the main reasons for this move is that public policy strongly emphasizes the promotion and spread of innovation as a driver of economic growth.

According to the results of this study, Iran seems to have been rather successful in two functions of the National Innovation System, namely the creation of knowledge and guiding the research. Of course, the country has taken major steps to create and develop

the market. Nevertheless, the weakest part of this system is the transfer of knowledge and technology acquired to the industries in which entrepreneurial activities are formed. In other words, it can be argued that since many academic research groups and research laboratories are in the organizational and geographic isolation of state-owned enterprises, there is no effective organizational link between these groups and manufacturing companies [30]. Several factors are posed in the creation of this problem, which perhaps the most important of them is the current management style of science and technology in the country. The results of a field research conducted by the Institute for Research and Planning of Higher Education show that in Iran's National Innovation System, a combination of the magisterial and the market (based on business principles) management styles prevail, and most of the innovation policies of the country are taken from top to down without the broad participation of stakeholders. Another of these factors is the West's economic and technological sanctions against Iran which have reduced the transfer of technology from abroad to the country.

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