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Original Research

Future Research of Science, Technology, and Innovation Policymaking for Laboratories in Iran

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Abstract

Science, technology, and innovation policy-making laboratories, by providing policymakers with educational, research, and consulting services, before the introduction of policy recommendations to the regulatory and legal structures, make it possible to test the policies on a small scale. Thus, the waste of huge resources allocated to the development of political solutions and additional damages may be prevented. On the other hand, future research as a process gives a more complete understanding of the forces of the long-term future, which should be taken into account in developing policy-making, planning, and decision-making. Therefore, future research of science, technology, and innovation policy-making laboratories to synchronize with today's world and for optimal policies is a necessity addressed in the present study. This study was applied in terms of objective and mixed in terms of method (literature review). In this survey, experts' opinions, interaction analysis, and scenarios have been used. The approach of the present study was future research. For data analysis, the SPSS, MicMac, and ScenarioWizard were used. The statistical population included a group of experts in the field of science, technology, and innovation policy-making. The analysis of data related to different states using ScenarioWizard showed that the probability of occurrence of 9 scenarios was more than other scenarios and the probability of occurrence of other 297 scenarios was very small and weak. The initial review of the scenarios showed the relative dominance of static state over desired and critical states. Out of 9 scenarios, 4 scenarios were strong and more probable. Scenario 1 with an impact score of 221 was the strongest, most desired, and most probable scenario facing science, technology, and innovation policy-making laboratories. Scenario 2 with an impact score of 181 was one of the most desired and probable scenarios facing science, technology, and innovation policy-making laboratories. Scenario 3 had an impact score of 102. Under this scenario, 4 key influencing driving forces were desired and 8 key influencing driving forces were static. Scenario 4 had an impact score of 65. Under this scenario, 8 key influencing driving forces were static and 4 key influencing driving forces were undesired.

Keywords: Science, Technology, Innovation, Policy-Making Laboratories, Futures Research, Iran.

Introduction

Since today science and technology are increasingly developing, policymakers may lack the necessary knowledge about networks, tools, software operations, other scientific and technological developments, and related challenges and as a result making decisions to direct them. This leads to a gap between politics, science, and technology. In such a situation, science, technology, and innovation policy-making laboratories with an interdisciplinary approach and focusing on such issues can take a creative and forward step at the service of policymakers. Also, by providing policymakers with educational, research, and consulting services, these laboratories make it possible to test policies on a small scale before the introduction of policy recommendations to the regulatory and legal structures. In this way, they prevent the waste of huge resources allocated to the development of policy solutions and additional damages. It can be said that these laboratories are centers of thought to bring together experts, researchers, technologists, and policymakers to discuss and investigate new issues, topics, challenges, and ideas on science, technology, and innovation. (Namdarian, 2015).

Some laboratories are established under the ownership of the government and the supervision of managers. While some laboratories are supported by the private sector (Pourrezzat, Borhani & Faghihi, 2022). Policy labs are also referred to as “public innovation labs,” “public sector innovation labs,” “government innovation labs,” “organizational innovation labs,” “policy innovation labs,” “innovation labs,” “public policy labs,” “social innovation labs,” “systems change labs,” and “design labs,” and “policy labs” (Whicher, 2021; Hinrichs-Krapels, Bailey, Boulding, Duffy, Hesketh & Pollitt 2020). Policy Labs consist of teams, institutions, and structures specialized in designing public policies and engaging all stakeholders in the design process using innovative methods (Wellstead, Gofen & Carter, 2021). The study of policies in the Labs can be considered as railing, indicating the direction of all movements and behaviors of the studied governance system (Izadparast, Pourezzat & Amirkabiri, 2023).

Policy-making can be done in two ways, micro and macro policy. Micro-policies show procedures in a system. Macro-policies are also comprehensive and include a wide range of very sensitive and temporary decisions to long-term strategies and show the general objective of the idea. Such policies can also be used in laboratories and determine these innovations (laboratories) can take which ways to be more successful (Pourrezzat et al., 2022). On the other hand, future research as a process provides a more complete understanding of the forces of the long-term future, which should be taken into account in developing policies, planning, and decision-making. The best and most useful cases of future research are when it is directly related to the analysis of political consequences. Futures research in the field of government activities cannot define and develop policies but can provide conditions so that policies are implemented in a more desired, flexible, and sustainable manner in parallel with the changes in time and conditions (Safdari Ranjbar & Ghazinoori, 2019). The general goal of studies in the future field is to help policy-making through early diagnosis and analysis of information, creating insights, and supporting the development of plans and decisions (Komatsu, Salgado, Deserti & Rizzo, 2021).

Accordingly, researchers and practitioners of futures research increasingly emphasize the role of futures research as a process-oriented tool of innovation policy (Fartash, Mohseni

Kiasari, & Mesma Khosroshahi, 2021). Future research of the laboratories shows whether investing in this innovation is desired and economical according to the economic conditions of the country (Jenny, 2021). According to the above, there is still no comprehensive study that shows the key components of science, technology, and innovation policy-making laboratories as well as the future of these laboratories in the country.

The implementation process of this research has been done in two parts. The first part is the study of the existing literature and the documents and opinions of researchers on the subject of the knowledge society, the trends of the existing knowledge society, as well as the study of the literature and concepts. The other part, based on the opinion of experts, identifies and determines the drivers, key uncertainties, weighting, and scoring. Then, rank them and draw a general vision for developing the scenario framework and finally write different scenarios and provide strategic recommendations from the scenarios.

Research questions

The present study attempted to answer the following questions:

1. What are the factors affecting the future of science, technology, and innovation policy-making laboratories?
2. What are the driving forces affecting the future of science, technology, and innovation policy-making laboratories in Iran?
3. What is the importance of each of the identified driving forces on the future of research on Scientology in Iran?
4. What are the future scenarios of science, technology, and innovation policy-making laboratories in Iran?

Literature Review

To interpret the findings in the field of Futures research of science, technology, and innovation policy-making laboratories in Iran, the literature background is explained as follows:

Namdarian (2015) conducted a comparative study of some of the most prestigious science, technology, and innovation policy-making laboratories in the world. The study results showed that activities of science, technology, and innovation policy-making laboratories can be classified into 8 categories. These classes include: studying the legal bases of science, technology, and innovation; holding specialized science, technology, and innovation conferences; education and promotion; studying and reviewing the consequences and effects of the policy; identifying and investigating new technologies; studying and reviewing the ethical considerations of science, technology, and innovation; study and review of entrepreneurship and innovation; and improving interactions between technology researchers and policymakers.

Fuller and Lochard (2016) in a study investigated political laboratories in the European Union member states entitled "Public Policy-making laboratories". In this study, more than twenty people in charge of policy-making laboratories and "influencers" participated in a series of telephone, Skype, and face-to-face interviews to confirm their answers to the questionnaire and describe the projects carried out in the relevant structure. The study results showed that public policy-making laboratories were in 10 clusters as follows: 1. Culture and education, 2. Economy and digital society, 3. Finance and tax affairs, 4. Healthy and inclusive societies, 5. Innovation in the public sector, 6. Jobs and growth, 7. Local and regional economic development, 8. Migration, integration, and humanitarian aid, 9. Resource efficiency, circular economy and waste, and 10. Transport and displacement.

Babyar (2019) discussed the role of laboratories in clinical sciences in a study entitled "Laboratory Science and a Glimpse of the Future". The study results showed that clinical laboratories should improve the quality while simultaneously increasing the structure at the international level. Clinical laboratory science practices, expectations, processes, and participation in care coordination should be standardized around the world. Biomedical research should strive for consistency in quality, and safety, and strive for international alignment. Public health research can be improved using dedicated resources and global communication. Reimbursement policies and structures should be consistent with changing laboratory innovations. Finally, general research and data on laboratory operations, successes, errors, and general laboratory epidemiology could be improved. With these recommendations, laboratory science can grow as a leader and partner in medicine.

Lee and Ma (2020) investigated the role and functions of the UK BIT policy labs, Denmark MindLab, and Singapore THE lab. The results showed that the BIT policy laboratory as a unit tries to provide accurate scientific evidence to support effective policies. MindLab policy laboratory takes the initiative to create and implement projects with agencies and organizations. Singapore THE policy laboratory is dedicated to gathering ethnographic insights from diverse stakeholders to support design thinking in policy implementation. The significant differences can be attributed to different political regimes and political environments, suggesting fruitful ways for policy-making laboratories in other countries. Olejniczak, Borkowska-Waszak, Domaradzka-Widła and Park (2020) state that lab activities are embedded within the main policy cycle as they often build in a smaller loop of design-test-ing adaptation. Hinrichs-Krapels et al. (2020) suggest that labs could provide evidence to policymakers that a particular issue is not ready to be on the policy agenda. The role of policy labs in policy formulation received slightly more attention. Fleischer and Carstens (2021) acknowledged that policy labs were unconventional actors compared to the formulation process dominated by traditional and hierarchical bureaucracies.

Ghazinoori, Nasiri and Aghaei (2022) studied and classified political laboratories based on the type of affiliation to a state or non-state institution, as well as the focus on a research course. The results of studies showed that the laboratories of Bretagne Creative, Sitra, Le LAB pole employ, Vinnova, DILA Open Law Lab and Irandak policy design laboratory have an affiliation to a state institution and focus on a specific research approach and HPL laboratories, TACSI, Brown Policy Lab, Policy Lab Design, Danish Design Center and Sharif Data and Governance Lab have an affiliation to a non-governmental organization and focus on a specific research approach.

Literature review showed that most of the studies conducted in the previous years had a historical and overview view of science, technology, and innovation policy-making laboratories, and future research methods including scenario planning had not been used to identify the main components and draw the future of this innovation (science, technology and innovation policy-making laboratories).

Materials and Methods

This study was applied in terms of objective and mixed in terms of method (literature review). In this survey, experts' opinions, interaction analysis, and scenario planning have been used. The approach of the present study was future research. For data analysis, SPSS, MikMac, and ScenarioWizard have been used. The statistical population included a group of experts in the field of science, technology, and innovation policy. The validity of the present study was confirmed according to the opinion of professors in the field of the subject, whose opinion confirmed the face validity of this questionnaire. Cronbach's alpha coefficient was used to confirm reliability. Given that Cronbach's alpha for all factors was higher than 0.7, the reliability of the constructs of these factors was high, indicating that the questions related to the factors had a good fit.

The research data included all the outputs produced by researchers in the form of books, articles, academic theses, and research projects in the field of science, technology, and innovation policy-making laboratories inside and outside of Iran, including printed and electronic versions in Farsi and English during 2000-2019. For data collection, national and international databases have been used with specialized searches. In this study, two approaches have been used to achieve the driving forces. Based on these two approaches, the first step included the study of texts to determine trends and driving forces. In the second step, the knowledge extracted from the first step was examined with the participation and involvement of stakeholders.

The method of data collection in the first step was library studies and interviews with subject experts through questionnaires. This step was done to identify key factors and driving forces in the field of science, technology, and innovation policy-making laboratories. In this step, the questionnaire was redesigned. The tool for data collection in the second step was a researcher-made questionnaire based on the results obtained from the first step. This step was done to confirm and value the key factors and driving forces obtained from the previous step using the opinions of subject experts in this field.

According to future research literature, the period of such research is between ten and thirty years. However, the present study is inspired by most of the future research during the fifteen years concerning policy-making laboratories. The beneficiaries of the research include experts in the field of science, technology, and innovation policy-making. Accordingly, the beneficiaries were classified into two groups. The first group included university faculty members. The second group included experts in the field of science, technology, and innovation policy-making in research centers and research institutes of communication and technology.

Results

Step 1

To analyze future research of science, technology, and innovation policy-making laboratories in Iran, first, according to literature review and interviews, 8 items and 37 sub-items were extracted. Then, these factors were used in the form of a questionnaire to determine the importance of each of these factors among experts. The identified factors in this step include socio-cultural, economic, political, technological, policy-making, and management systems related to laboratories, professionals, and facilities (Table 1).

Table 1
List Of Factors Affecting the Future of Science, Technology, and Innovation Policy-Making Laboratories

Index	Item
sociocultural	Valuing the role of science, technology, and innovation in social relations
	Democratization of the flow of science, technology, and innovation
	Free access
	Improving the position of science, technology, and innovation policy-making laboratories in public opinion and attitude toward it
	Social functions of science, technology, and innovation policy-making laboratories
economical	Science, technology, and innovation as components affecting the economy
	Increasing the supply and demand of knowledge goods
	Creating information structures to access information and establish a knowledge-based economy
political	Competition between policy laboratories at the national and international level
	Supply and demand balance concerning science, technology, and innovation
	Globalization
	Scientific sanctions
technological	Internet speed in the country
	Infrastructure of new information technologies in science, technology, and innovation policy-making laboratories
	New forms of content
	Intelligentization of science, technology, and innovation policy-making laboratories
Policy-making and systematic management related to laboratories	Tendency to revise curriculums and references
	Officials' understanding of the position and importance of science, technology, and innovation policy-making laboratories
	Knowledge and awareness of the basic problems of science, technology, and innovation policy-making laboratories
	Provision of strategic, executive documents and related incentives in the field of science, technology, and innovation policy-making laboratories
laboratories	Study of the legal grounds of science, technology, and innovation
	Reduction in the gap between policy design and implementation
	Specialized science, technology, and innovation conferences
	Interactions between researchers, technologists, innovators, and policymakers
	Identification and review of new and emerging technologies
	Establishment of relationships between "science, university and industry" and "technology and innovation"
	Expansion of foreign relations and facilitating international cooperation
Professionals and experts	The emergence of new roles and functions for experts in science, technology, and innovation policy-making laboratories to provide new services
	Coordination between the expertise and development of science, technology, and innovation policy-making laboratories
	Interaction and consensus among experts
	Attention to the position and marketing of professionals in the new environment
facilities	Consulting services for researchers and entrepreneurs
	Technology development, innovation, and commercialization facilities
	Provision of physical assets such as location

Index	Item
	Special support and financial facilities
	Management empowerment support
	Organizational empowerment support

Step 2

After introducing the extracted 37 key factors, by reviewing the literature and interviewing the experts, the key factors entered the expert questionnaire were measured and the experts were asked to select the importance of each factor from one to five. The results of 10 expert questionnaires were analyzed by SPSS 20. Table 2 shows key factors affecting the future of science, technology, and innovation policy-making laboratories based on the importance coefficient of each.

Table 2
List of Key Factors Affecting Science, Technology, and Innovation Policy-Making Laboratories by SPSS

index	item	Descriptive Statistics		
		M	SD	importance coefficient
sociocultural	Valuing the role of science, technology, and innovation in social relations	2.98	1.07	58.18
	Democratization of the flow of science, technology, and innovation	3.80	0.86	75.45
	Free access	3.47	0.97	67.73
	Improving the position of science, technology, and innovation policy-making laboratories in public opinion and attitude toward it	3.18	1.10	62.27
	Social functions of science, technology, and innovation policy-making laboratories	2.97	1.12	58.60
economical	Science, technology, and innovation as components affecting the economy	4.35	0.81	86.82
	Increasing the supply and demand of knowledge goods	3.93	1.03	77.27
	Creating information structures to access information and establish a knowledge-based economy	3.64	0.83	71.16
political	Competition between policy laboratories at the national and international level	3.27	0.91	63.72
	Supply and demand balance concerning science, technology, and innovation	3.81	0.98	74.88
	Globalization	3.90	0.98	76.28
	Scientific sanctions	3.58	0.91	70.23
technological	Internet speed in the country	4.14	0.79	80

index	item	Descriptive Statistics		
		M	SD	importance coefficient
	Infrastructure of new information technologies in science, technology, and innovation policy laboratories	4.19	0.72	81.86
	New forms of content	3.76	0.92	73.02
	Intelligentization of science, technology, and innovation policy-making laboratories	3.98	0.97	78.14
Policy-making and systematic management related to laboratories	Tendency to revise curriculums and references	3.75	0.86	73.95
	Officials' understanding of the position and importance of science, technology, and innovation policy-making laboratories	4.34	0.77	86.05
	Knowledge and awareness of the basic problems of science, technology, and innovation policy-making laboratories	4.42	0.82	87.44
	Provision of strategic, executive documents and related incentives in the field of science, technology, and innovation policy-making laboratories	4.47	0.79	88.64
laboratories	Study of the legal grounds of science, technology, and innovation	2.90	1.28	56.36
	Reduction in the gap between policy design and implementation	4.37	0.81	86.82
	Specialized science, technology, and innovation conferences	3.93	0.80	78.18
	Interactions between researchers, technologists, innovators, and policymakers	3.95	0.81	77.73
	Identification and review of new and emerging technologies	4.52	0.90	88.64
	Establishment of relationships between "science, university and industry" and "technology and innovation"	3.52	1.09	68.18
	Expansion of foreign relations and facilitating international cooperation	3.53	1.02	69.09
Professionals and experts	The emergence of new roles and functions for experts in science, technology, and innovation policy-making laboratories to provide new services	3.45	0.94	67.27
	Coordination between the expertise and development of science, technology, and innovation policy-making laboratories	3.55	0.98	70
	Interaction and consensus among experts	3.77	0.91	73.64
	Attention to the position and marketing of professionals in the new environment	3.15	1.18	62.33

index	item	Descriptive Statistics		
		M	SD	importance coefficient
facilities	Consulting services for researchers and entrepreneurs	3.77	0.71	73.64
	Technology development, innovation, and commercialization facilities	3.02	1.21	58.64
	Provision of physical assets such as location	2.64	1.34	53.64
	Special financial support and facilities	3.81	0.88	74.42
	Management empowerment support	3.86	0.81	75.35
	Organizational empowerment support	1.04	0.90	79.55

As shown in Table 2, in the socio-cultural index, the item of democratization of the flow of science, technology and innovation with an importance coefficient of 75.45; in the economic index, the item of science, technology and innovation as a component affecting the economy with an importance coefficient of 86.82; in the political index, the item of globalization with an importance coefficient of 76.28; in the technological index, the item of the infrastructure of new information technologies with an importance coefficient of 81.86; in the index of policy-making and management of systems related to laboratories, the item of provision of strategic, executive documents and related incentives in the field of science, technology and innovation policy-making laboratories with an importance coefficient of 88.64; in the laboratories index, the item of identification and review of new and emerging technologies with an importance coefficient of 88.64; in the index of professional context and experts, the item of interaction and consensus among experts with an importance coefficient of 73.64; and in the index of facilities, the item of organizational empowerment support with an importance coefficient of 79.55 were the most important factors affecting the future of science, technology and innovation policy-making laboratories.

Step 3

After determining the list of key factors, to identify and rank factors, the variables were entered into the interaction analysis matrix and this matrix was provided to the experts. Then, the average of the collected responses was entered into the MicMac in step 4.

Step 4

After the questionnaire data was entered into the software, the effects of key factors on science, technology, and innovation policy-making laboratories were calculated directly and indirectly. Table 3 shows the key factors affecting the laboratories directly and indirectly.

Table 3
Key Factors Affecting Laboratories Directly And Indirectly

Rank	Factor	Directly	Factor	Directly	Factor	Indirectly	Factor
1	Globalization	339	identification and review of new and emerging technologies	359	Globalization	338	identification and review of new and emerging technologies
2	Officials' understanding of the position and importance of laboratories	339	provision of strategic documents	355	Officials' understanding of the position and importance of laboratories	337	provision of strategic documents
3	Democratization of science, technology, and innovation	320	Competition between laboratories	339	Democratization of science, technology, and innovation	319	Competition between laboratories
4	provision of strategic documents	320	Knowledge and awareness of problems	336	provision of strategic documents	317	Supply and demand balance
5	Intelligentization of laboratories	309	Supply and demand balance	332	Intelligentization of laboratories	309	Globalization
6	Organizational support	309	Globalization	332	Financial support	307	Knowledge and awareness
7	Financial support	309	Organizational support	332	Creating information structures	306	Expanding relationships
8	Science, technology, and innovation	305	Officials' understanding	324	Scientific sanctions	306	Interactions
9	Creating information structures	305	Research interactions	324	Organizational support	305	Empowerment support
10	Scientific sanctions	305	Expanding relationships	324	Science and technology	304	Officials' understanding
11	Free access	301	Increasing supply and demand	317	Free access	298	Increasing supply and demand
12	Competition between laboratories	297	Emergence of new roles	317	Competition between laboratories	292	Emergence of new roles
13	Specialized conferences	286	Expanding relationships	309	Specialized conferences	285	Interaction and consensus
14	Consulting services	286	Specialized conferences	309	Consulting services	284	Intelligentization
15	Knowledge and awareness of problems	282	Interaction and consensus	309	Knowledge and awareness	282	Organizational support
16	Reducing the gap between policy design and implementation	278	Financial support	301	Reduction in gap	278	Specialized conferences

Rank	Factor	Directly	Factor	Directly	Factor	Indirectly	Factor
17	Tendency to revise curriculums and references	271	Reduction in gap	297	Tendency to review	272	Science, technology and innovation
18	Attention to the position and marketing of professionals in the new environment	267	Science, technology, and innovation	294	Interaction and consensus	267	Reduction in gap
19	Increasing supply and demand	263	Internet speed	293	Attention to position	266	Internet speed
20	Interaction and consensus among experts	263	Tendency to review	286	Increasing supply and demand	263	Financial support
21	Valuing the role of science, technology, and innovation	259	Coordination	286	Valuing science	259	Tendency to review
22	Infrastructural of new technologies	255	Empowerment	282	Infrastructure	254	Coordination
23	Identification and review of new and emerging technologies	248	Establishment of relationships	275	Identification	249	Establishment of relationships
24	Internet speed in the country	244	Infrastructure	263	The emergence of new roles	247	Infrastructure
25	Interactions between researchers, technologists, innovators, and policymakers	244	New forms of content	252	Coordination	246	New forms of content
26	Emergence of new roles and functions	244	Scientific sanctions	248	Internet speed	245	Scientific sanctions
27	Coordination between the expertise and development of the laboratories	244	Facilities	233	Interactions	245	Free access
28	Empowerment support	240	Free access	229	Empowerment support	244	Facilities
29	Study of legal grounds	236	Position promotion	225	Facilities	239	Position promotion
30	Technology development, innovation, and commercialization facilities	236	Consulting services	225	Study of ground	238	Consulting services

Rank	Factor	Directly	Factor	Directly	Factor	Indirectly	Factor
31	Promotion of the position of laboratories	233	Attention to the situation	213	Establishment of relationships	237	Attention to the situation
32	Social functions of laboratories	233	Creating information structures	206	Expanding relationships	233	Creating information structures
33	Establishment of relationships between "science, university and industry" and "technology and innovation".	233	Democratization of science	190	Improving the position of laboratories	231	Democratization of science
34	Expansion of foreign relations	225	Social functions	129	Social functions	231	Social functions
35	Supply and demand balance	221	Provision of physical assets	122	Supply and demand balance	221	Provision of physical assets
36	New forms of content	221	Study of grounds	118	New forms of content	220	Study of grounds
37	Provision of physical assets	210	Valuable role of science	103	Provision of physical assets	207	Valuable role of science

Step 5

Future Scenarios of Science, Technology, and Innovation Policy-Making Laboratories Using Scenario Wizard. After selecting the twelve key driving forces affecting the future of science, technology, and innovation policy-making laboratories, it is time to draw different future states. For this purpose, after a literature review and current state analysis, thirty-five possible states were defined for twelve key influencing driving forces in three critical, static, and desired states, and according to each of the key factors, a range of these states was assigned to each of their forces as shown in Table 4. The key driving forces affecting the future of science, technology, and innovation policy-making laboratories were drawn in different states and a name was selected for each. In the section of each, some of their imaginable characteristics have been discussed. The critical state is at the end of the range and refers to the undesired state of the forces and the impact on the future of science, technology, and innovation policy-making laboratories.

In other words, the static state represents the current state and its continuation at an average speed in the future. The desired state also refers to the ideal state ahead for each of the forces. In the morphological analysis section, in the panels of experts participating in this study, different imaginable states for each of these variables were discussed and the participants presented their positive and negative opinions about each of the proposed states. Finally, in the next section, which is to identify the interaction between these key variables (descriptors), the assumed possible states for each of the key variables were studied and discussed in expert panels. Table 4 shows different states for each of the key variables (descriptors). Next, their desirability for science, technology, and innovation policy-making laboratories was determined by the consensus of experts. Green shows the desired state, red shows the undesired state, and yellow shows the static state.

Table 4
Different States of Key Factors

Descriptors	variant [1]	variant [2]	variant [3]
Globalization	desired (a1)	static (a2)	critical (a3)
Officials' understanding of the position and importance of science, technology, and innovation policy-making laboratories	strong understanding (b1)	-	weak understanding (b2)
Democratization of the flow of science, technology, and innovation	public (c1)	static (c2)	exclusive (c3)
Provision of strategic, executive documents and related incentives in the field of science, technology, and innovation policy-making laboratories	regular development (d1)	unknown (d2)	undeveloped (d3)
Intelligentization of science, technology, and innovation policy-making laboratories	desired (e1)	static (e2)	critical (e3)
Special financial support and facilities	strong (f1)	-	weak (f2)
Organizational empowerment support	strong (g1)	-	weak (g2)
Science, technology, and innovation as components affecting the economy	desired (h1)	static (h2)	critical (h3)
Creating information infrastructures to access information and establish a knowledge-based economy	strong (i1)	static (i2)	weak (i3)
Scientific sanctions	non-sanction (g1)	static (j2)	severe sanction (j3)
Free access	desired (k1)	static (k2)	limited (k3)
Competition between policy laboratories at the national and international level	targeted (l1)	-	non-targeted (l2)

ScenarioWizard was used to analyze the relationships between different states and achieve future scenarios. Since the objective was to prepare possible scenarios from the combination of thirty-two states for twelve key driving forces, it is expected to extract a scenario that includes 12 key driving forces $3^8 \times 2^4 = 10497$ and all possibilities in the future of science, technology, and innovation policy-making laboratories. By performing heavy calculations and considering direct and indirect relationships between key driving forces, ScenarioWizard makes it possible to extract scenarios with strong probability, scenarios with high probability of consistency, and scenarios with weak probability. The significant number of scenarios, including all possible combinations, may have no equal value. Hence, it is necessary to select and introduce more suitable scenarios that are more consistent based on the existing indicators. By forming expert panels and a matrix of interactions and performing software analysis, the scenarios for the future of science, technology, and innovation policy-making laboratories were ranked.

As shown in Table 4, for the twelve key driving forces influencing science, technology, and innovation policy-making laboratories, 32 possible states have been drawn in a range of different states. Here, based on the possible states, to measure the impact of each state on other states, a 32 × 32 matrix was formed and provided to the experts. For each of the possible states, the question was raised, If each of the thirty-two states occurs in the laboratories, what effect will it have on the occurrence or non-occurrence of other states? The result of the evaluation was determined by entering figures between -3 and 3.

Forming the interaction matrix during the meetings that were held with the presence of the management team and the expert team, the relationships between the relevant descriptors were converted into quantitative parameters in the form of interaction analysis and placed in the cells of the interaction matrix. To determine consistent scenarios, it was necessary to determine which variables strengthen other variables and which variables resist other variables (Zali, 2012). The impact with consistency was scored 0-3 (ineffective, weak, and strong) and in case of inconsistency, it was scored -3 to 0 (ineffective to strong). The relationships between the descriptors are analyzed in the form of a network and used to predict the final scenarios. The impact relationships may be one-way or two-way. In this study, the interaction was analyzed using ScenarioWizard. This software helps to avoid long manual calculations.

Extraction of compatible scenarios

Here, it is necessary to identify the consistency between the scenarios. In this study, scenarios with inconsistency zero were reported as the strongest scenarios, and scenarios with inconsistency one and some scenarios with inconsistency two were also reported. Under these scenarios, one or two descriptors lack internal consistency, but the scenario still seems believable. These scenarios were reported to show the openness of believable future scenarios, but they should be interpreted and used with caution. Finally, in order of priority, 4 scenarios with inconsistency zero, and 5 scenarios with inconsistency one and two were selected and introduced. These scenarios draw believable futures ahead.

After analyzing the relationships between different states, ScenarioWizard reported the following scenarios selected and possible scenarios in the future of science, technology, and innovation policy-making laboratories:

- 4 scenarios with strong possibility;
- 9 scenarios with high consistency or believable scenarios and
- 297 scenarios with weak possibility or possible scenarios.
- ScenarioWizard has reported 297 weak or possible scenarios, and policy-making and planning for them is almost impractical and illogical. As mentioned in the methodology section, the logical solution is to select some believable scenarios that are in the range of strong limited scenarios and weak broad scenarios. For this purpose, the consistency score is changed by one standard deviation from zero, and 13 believable scenarios for policy planning are obtained.
- Analysis of data related to different states using ScenarioWizard showed that the probability of occurrence of 9 scenarios was more than other scenarios and the probability of occurrence of other 297 scenarios was very small and weak. The initial review of the scenarios showed the relative dominance of static state over desired and critical states. In the following, we will examine the scenario with the consistency probability (9 scenarios).

The desired, static, and critical key driving forces affecting the future of science, technology, and innovation policy-making laboratories under each scenario are as follows (Table 5):

Table 5

State Of Each of The Key Influencing Driving Forces

driving force / scenario	Globalization	Officials' understanding of the location and importance of the laboratory	Democratization of the flow of science, technology, and innovation	Compilation of strategic and executive documents	Intelligentization policy-making laboratories	Financial support and facilities	Organizational empowerment support	Science, technology, and innovation as components affecting the economy	Creating information infrastructure	Scientific sanctions	Free access	Competition between laboratories
S1	critical	weak	exclusive	undeveloped	critical	weak	weak	critical	weak	Severe sanctions	limited	non-targeted
S2	desired	strong understanding	public	regular development	desired	strong	strong	desired	strong	non-sanction	desired	targeted
S3	static	strong understanding	static	unknown	static	strong	strong	static	static	static	static	targeted
S4	static	weak understanding	static	unknown	static	weak	weak	static	static	static	static	non-targeted
S5	static	strong understanding	public	unknown	static	strong	strong	static	static	static	desired	targeted
S6	static	strong understanding	public	unknown	static	strong	strong	static	strong	static	static	targeted
S7	static	strong understanding	static	unknown	static	strong	strong	static	strong	static	static	targeted
S8	static	strong understanding	static	regular development	static	strong	strong	static	static	static	static	targeted
S9	critical	strong understanding	static	regular development	critical	weak	strong	critical	strong	severe sanction	static	targeted

Table 6 shows the consistency score and total impact score for each of the believable scenarios. Given that in the settings of ScenarioWizard, the output of the scenarios was set in the order of consistency score from highest to lowest, so in the table above, the believable scenarios S1-S9 are in the order of consistency score from highest to lowest. In this table, the number of critical, static, and desired states for each of the believable scenarios is mentioned.

Table 6

Consistency Score and Total Impact Score for Each of the Believable Scenarios

driving force / scenario	consistency score	total impact score	number of states		
			critical	static	desired
S1	19	221	12	-	-
S2	9	181	-	-	12
S3	2	102	-	8	4
S4	0	65	4	8	-
S5	-2	88	-	6	6
S6	-2	93	-	6	6

S7	-2	96	-	7	5
S8	-2	94	-	7	5
S9	-2	-8	5	2	5

4 scenarios S1, S2, S3, and S4 were strong or probable compatible scenarios with zero inconsistency, whose consistency score is non-negative. Given that these 4 scenarios are the most likely scenarios among other scenarios, we will continue to analyze these scenarios.

Analysis of strong or probable compatible scenarios

Scenario 1

This scenario with an impact score of 221 was the strongest, most desired, and most probable scenario facing science, technology, and innovation policy-making laboratories. All the 12 key driving forces affecting science, technology, and innovation policy-making laboratories were undesired and this scenario is the best and most likely scenario among the strong scenarios.

The weaknesses of this scenario are:

- Struggle for survival (restricting the activities of laboratories at the national level)
- Lack of scientific and social acceptance
- Exclusivity of the flow of science, technology, and innovation
- Neglecting the development of strategic and executive documents
- Lack of attention to the intelligentization of laboratories
- Reducing the efficiency of laboratories
- Minimal support for employees
- Potential flow of science, technology, and innovation
- Lack of coordination with new and updated developments
- Limited free access
- Lack of sense of competition between laboratories

Scenario 2

This scenario, with an impact score of 181, is one of the most desired and challenging scenarios facing science, technology, and innovation policy-making laboratories. All 12 key driving forces affecting science, technology, and innovation policy-making laboratories were desired.

The strengths of this scenario are:

- Expanding the territory of laboratories
- Positive attitude towards laboratories and scientific and social acceptance of laboratories
- Publicizing the flow of science, technology, and innovation
- Development of strategic and executive documents
- Targeted intelligentization of laboratories
- Increasing the efficiency of laboratories
- Maximum support for employees
- Positive effect of science on the economy and creating wealth in society
- Synchronization with new developments and the ability to use new tools
- Expanding the flow of science, technology and innovation

- Desired open access
- Targeted competition of laboratories

Scenario 3

This scenario had an impact score of 102.

4 key driving forces affecting science, technology, and innovation policy-making laboratories were desired and 8 key driving forces were static.

The strengths of this scenario are:

- Positive attitude towards laboratories and scientific and social acceptance of laboratories
- Increasing efficiency of laboratories
- Maximum support for employees
- Targeted competition of laboratories

Scenario 4

This scenario had an impact score of 65.

8 key driving forces affecting science, technology, and innovation policy-making laboratories were static and 4 key driving forces were undesired.

The weaknesses of this scenario are:

- Lack of scientific and social acceptance
- Reducing the efficiency of laboratories
- Minimal support for employees
- Lack of sense of competition between laboratories

Discussion

In the present study, after reviewing the literature on Iran's science, technology, and innovation policy-making laboratories, the country's upstream documents and macro perspectives in the field of science and technology and other fields affecting it, as well as other literature related to policy-making laboratories and future at the national and international level, a list of key factors affecting the future of science, technology, and innovation policy-making laboratories was prepared. This list consisted of two levels of key factors with 8 macro indicators and 37 items. Also, the survey of the opinions of the stakeholders showed their agreement on the high importance of this index.

Ultimately, precision analysis of macro indicators demonstrated 12 driving forces influencing the future of Science, Technology, and Innovation policy laboratories employing MicMac software. Influential driving forces include globalization, perceptions of the position and importance of Science, Technology, and Innovation policy laboratories, the democratization of the flow of Science, Technology, and Innovation, drafting of strategic documents, implementation and relevant incentives, intelligent science, technology, and innovation policy laboratories, financial support and special financial facilities, organizational empowerment support, science, technology and innovation as influential components of country’s economy. Moreover, the creation of information infrastructure to access information and the deployment of a knowledge-based economy, science-related sanctions, Open Access policies, and competition among both national and international policy-making laboratories are noteworthy. The research findings of Namdarian (2015) align with the present study's findings. The study results showed that activities of science, technology, and innovation policy-making laboratories can be classified into 8 categories. These classes include: studying the legal bases of science, technology, and innovation; holding specialized science, technology, and innovation conferences; education and promotion; studying and reviewing the consequences and effects of the policy; identifying and investigating new technologies; studying and reviewing the ethical considerations of science, technology, and innovation; study and review of entrepreneurship and innovation; and improving interactions between technology researchers and policymakers.

Babyar (2019) discussed the role of laboratories in clinical sciences in a study. The study results showed that clinical laboratories should improve the quality while simultaneously increasing the structure at the international level. Clinical laboratory science practices, expectations, processes, and participation in care coordination should be standardized around the world. Biomedical research should strive for consistency in quality, and safety, and strive for international alignment. Public health research can be improved using dedicated resources and global communication. Reimbursement policies and structures should be consistent with changing laboratory innovations. Finally, general research and data on laboratory operations, successes, errors, and general laboratory epidemiology could be improved. With these recommendations, laboratory science can grow as a leader and partner in medicine. Lee and Ma (2020) in a study showed that the BIT policy laboratory as a unit tries to provide accurate scientific evidence to support effective policies. MindLab policy laboratory takes the initiative to create and implement projects with agencies and organizations. Singapore THE policy laboratory is dedicated to gathering ethnographic insights from diverse stakeholders to support design thinking in policy implementation. The significant differences can be attributed to different political regimes and political environments, suggesting fruitful ways for policy-making laboratories in other countries. Olejniczak et al. (2020) state that lab activities are embedded within the main policy cycle as they often build in a smaller loop of design-test-ing adaptation. Hinrichs-Krapels et al. (2020) suggest that labs could provide evidence to policymakers that a particular issue is not ready to be on the policy agenda. The role of policy labs in policy formulation received slightly more attention. Fleischer and Carstens (2022) acknowledged that policy labs were unconventional actors compared to the formulation process dominated by traditional and hierarchical bureaucracies.

Therefore, Science, technology, and innovation policy-making laboratories, by providing policymakers with educational, research, and consulting services, before the introduction of policy recommendations to the regulatory and legal structures, make it possible to test the policies on a small scale. Thus, the waste of huge resources allocated to the development of political solutions and additional damages may be prevented. Now, for laboratories to compete with other global innovations in today's world and to play their main role, they need to be recognized by government officials worldwide. If national officials and politicians realize that science, technology, and innovation are important as a means for solving problems, then they will strive to make better use of such ideas. These discussions also apply to science, technology, and innovation policy laboratories to solve problems and bridge the gap between researchers and policymakers to facilitate the process of open policymaking.

Conclusion

Nowadays, the concept of development is associated with the concept of innovation and technology accompanied by profound semantic changes in recent years. Among current changes is the concept of globalization at the center of technology and innovation and global competition to transform innovation from limited development to regionally specific to borderless development. Science, technology, and innovation policy laboratories as research and development units can eliminate multiple existing problems and improve their current status. Now, for laboratories to compete with other global innovations in today's world and to play their main role, they need to be recognized by government officials worldwide. Governments utilize varied types of policies to develop research and technology in line with their objectives. In short, these policies can be divided into two general categories. First, dissemination-oriented functional policies, which aim to increase innovation capacity and improve overall scientific and technological capabilities, and second, mission-oriented targeted policies, which support the development of specific research and technology with specific sectors in the industry. Altogether, due to the diversity of possible functional policies, researchers and policymakers should choose from target-based functional policies concerning their priorities.

Accordingly, prioritizing is a strategic process for selecting a set of research and technological activities and effectively allocating resources to the activity, helping to increase the flow of research and technological activities considering both the economic and long-term objectives of a society. Recently, Science and technology priorities have been considered more functionally. Any successful activity that is given special attention has received incentives in advance. So, now the concept of priority is being disseminated and therefore attention is paid to functional priorities (such as laboratory infrastructure). By taking advantage of opportunities, prioritizing research and technology is undoubtedly a significant step towards targeting the allocation of financial and human capital to address the present challenges. The need to prioritize science and technology issues, especially in developing countries is widely accepted (with scarcely limited resources) requiring the focus of policymakers in this field. In this regard, the country's research and technology policies and priorities document are periodically drafted to maximize the use of available resources and to intelligently address the activities of the beneficiaries. Due to the introduction of novel approaches in the field of science and technology policy, the increase in the number of activities and the attention to variable challenges of the country at a macro level and alignment with the documents are witnessed as influenced by the general policies of science and technology, communication policies of the sixth development plan and the expiration of the time of previous priorities. It seems that now is the best time for another specialized review of the existing priorities to be presented.

In addition to the role of government officials in the advancement of science and technology, the democratization of the flow of Science, Technology, and innovation can also be mentioned. Public participation in science as one of the dimensions of democracy in society can provide constructive conditions for public views, and this will be realized when science and technology are considered a public demand and enter the context of the daily life of citizens. Although in the last two decades, the emphasis on policy development and planning for the development of science and technology in Iran can be witnessed well in the country's top documents, it seems that there are still gaps in the implementation phase. The perceptual gap between science, technology, and innovation and the public has made people passive acceptors of Science, Technology, and innovation. Thus, lack of acceptance of Science, Technology, and innovation, lack of support for science, technology, and innovation, and most importantly, lack of participation in science, technology, and innovation are considered very serious challenges to the growth of science.

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