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Providing a Model to Establish a Network of Incubators in the Ministry of Energy(Electricity Industry) to Promote Entrepreneurship

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ABSTRACT: The purpose of this study is providing preliminary comments on the establishment and operation of the network of development technology centers in the Ministry of Energy in the power field . Despite of the past efforts and actions in relation to science and technology parks, unfortunately good results have not been achieved, because these actions haven't had necessary coordination and compliance to create a consistent and coherent standard network between technology development centers of Ministry and haven't had a scientific perspective based on a designed pattern. In this study, considering the realities and existing needs, the network model is presented. The development and completion of the product and the business cycle based on strategic innovation had good function. Obviously, considering the various technologies in the field of electric power industry, the Ministry of Energy needs better ways in the field of science and technology management till can answer its today and tomorrow's needs. Network of the growth centers is one of solutions that if it be implemented properly, can have an important role in this regard and the growth of entrepreneurship in the Ministry of Energy and consequently in the country. In this regard, previous research and experts opinions were used to extract and screen effective indicators and sub-indicators in establishment of incubator network. Then, paired comparison questionnaire and DEMATEL questionnaire were used to weight both criteria and indicators and calculate effectiveness and impact of sub-indicators. The results showed that effective measures in order of importance are as follows: communication index, empowerment index, index of services, infrastructure index, resources and facilities index. These are management indicators. According to the results, an appropriate model was designed. Expert population included managers and professionals in incubators of Department of Energy. All the experts were specialized in issues related to incubators of the Department of Energy. They had a direct relationship with changes in the incubators.

KEYWORDS: Network Incubators, Strategic Innovation, Entrepreneurship, Electricity Industry, The Ministry of Energy

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1. INTRODUCTION

New institutions, small and medium-sized enterprises are effective in scientific development and economic prosperity and consequently entrepreneurship. Development of these institutions depends on necessary infrastructure to reduce risk-taking and support the institutions during start up activities (Scaramouzi, 2002). Incubators are one of the most important infrastructures. Model of incubators is used to reduce risk and increase the success of small and medium enterprises. This developing model was experienced in different countries around the world. The incubators are such institutions, which mainly create small and medium businesses by relying on science and technology to help the entrepreneurs and emerging companies in order to accelerate conversion of innovation within the companies and ideas into products and services in society (text of conversations in the seminar on incubators and their role in employment of graduates, 2001).

Technological progress and economic development of any country is closely associated with the research activities in the country. There is a strong relationship between gross domestic production, exports and research and development costs in major exporting countries. This indicates the important role of research activities in promoting technological, economic growth and capabilities of export countries (Jane. R. K, & Triandis, H. C, 1990).

Nowadays, more research is conducted on research and development to increase productivity, improve product quality and manufacturing techniques and ultimately reduce costs, reduce waste, and improve customer satisfaction in developed countries than basic and applied research. In many of these countries, more than 60% of national research expenditure is allocated to research development. Incubators as forefront of technological growth and development can play an important role in this context. In recent decades, incubators were the most significant issues in industry, universities and governments. According to importance of the subject matter, performance and the approach to incubators can play a significant effect in development of science and technology. In this case, selection of an appropriate model is one of the major factors influencing establishment of incubators. The present study aimed to provide an appropriate model for establishment of incubators network at the Department of Energy (electricity industry).

2. Literature review

R.Gholami, H.A Aghajani, M.Hassan Zadeh (2009) conducted a study titled as "Presenting a conceptual model to determine the subject of activities in scientific and technological parks and incubators". They stated that much attention has been focused on scientific and technological parks and incubators in recent years. Establishment and development of incubators are emphasized in the fourth national development plan. The study presented a model to determine the subject of activities in parks and incubators based on domestic and international experiences (extracted indicators: scientific relationship with universities and research centers, relationship with the IT department, relationship with specialized sector).

H.Soltan Panah and V.Khaksar (2007) conducted a study entitled as "examining the effects of establishment and development of scientific and technological incubators and parks on industrial success". They attempted to explain the effective role of scientific and technological incubators and parks in entrepreneurship and establishment of small and medium-sized enterprises. These were addressed as infrastructure development centers in different countries. Over 3,000 centers were established in developed and developing countries in the past three decades(extracted indicators: services related to development growth and promotion of technological units, marketing and project tracking services, consulting services, the ability to provide services(managerial, legal, financial, credit, project tracking and marketing), educational services, public service).

M.H Kermani (2012) conducted a study entitled as "conceptual models and frameworks in incubators". They stated that incubators have become a pervasive phenomenon in many parts of the world and as a mean to promote IT-based firms. In this paper, different models and frameworks were introduced for understanding incubators by a review of relevant literature. Two function-oriented and source-oriented models were explained and the components were described (extracted indicators: familiarity with technical and economic structures of society, familiarity with function of the private sector, Introduction to principles of incubators).

I.Mohammadian and M.Rezaei (2005) conducted another study entitled as "presenting a fuzzy model to evaluate performance of IT units in incubators". In the study, a model was presented for evaluation of IT units in incubators during their lives based on expert opinions (extracted indicators: adaptability feature, flexibility).

S.I Shariati (2012) conducted a study entitled as "presenting a model for interaction of leading industry with technological parks and incubators". They stated that the capability of this center, to interact effectively with industrial-manufacturing centers and universities is particularly important since IT management and commercialization of ideas are defined as the mission of technological incubators and parks(extracted indices: technological infrastructure, technical infrastructure, software infrastructure, software, hardware infrastructure).

A.Bøllingtof (2008) provided a framework for assessment of technological incubators in scientific park in an article entitled as "assessing appropriate and inappropriate programs of technological incubators in scientific park"(extracted indices: the capability of commercializing research achievements, the context to create entrepreneurship, the capability to facilitate local economy prosperity based on technology).

N.Aksoy (2009) conducted a study titled as "examining the effects of technology on business growth: a framework for technological development centers in Turkey". They concluded that entrepreneurship and innovation are widely accepted as an important source of business success, value-added jobs and national economic development. These were also addressed as a wide range of mechanisms, which promote support of innovative entrepreneurship(extracted indicators: fiscal space for expansion and growth of small and medium sized scientific-based units, branches or offices relevant to financial support organizations).

C.J Chen (2009) conducted a study entitled as "growth of business from the bottom up: networking leverage and cooperation of styles to create an active entrepreneurial environment for production". This exploratory study aimed to introduce two active entrepreneurial environment and self-manufacturer with respect to bottom to up business growth jointly established by entrepreneurs(extracted indices: coordination, control, monitoring, feedback).

E.J. Karynansy (2011) conducted a study entitled as "UPS technological growth in scientific and technological parks and incubators in the universities: relationship between life cycle development and launching the sources of growth". They stated that University Science Park incubators (USIs) have emerged as a means by which government, academia and business can develop high technological business firms(spin out HTBFs) from initial conception to established small firms, which are ready to move beyond the Scientific Par (extracted indicators, suppliers, transport, finance, data privacy and confidentiality, specialized trainings).

According to the literature on incubators and relevant components in studies conducted in Iran and abroad, the present study attempted to extract the factors affecting establishment of incubator network and its performance.

3. THEORETICAL PRINCIPLES OF THE RESEARCH

3.1. Definition of Incubators

Growth centre or incubator is one of the tools of scientific and technological development and economic growth established to support small and medium enterprises and educated entrepreneurs in order to provide context for establishment of new companies by providing public facilities. Nowadays, incubators are accepted as the tools to convert creativity, scientific and research achievements into marketable products and entrepreneurial development. Nowadays, there are more than 5,000 incubators worldwide among which 1000 centres are in Asia (nearly half of them in China), 900 centers in Europe and nearly 400 centres in Latin America (Abavonel L., 2009)

In the literature on entrepreneurship and scientific development, incubators are established as centres for development or establishment of small businesses (usually with an emphasis on science and technology), which possess a small management staff and adequate physical space and common facilities for companies and entrepreneurs.

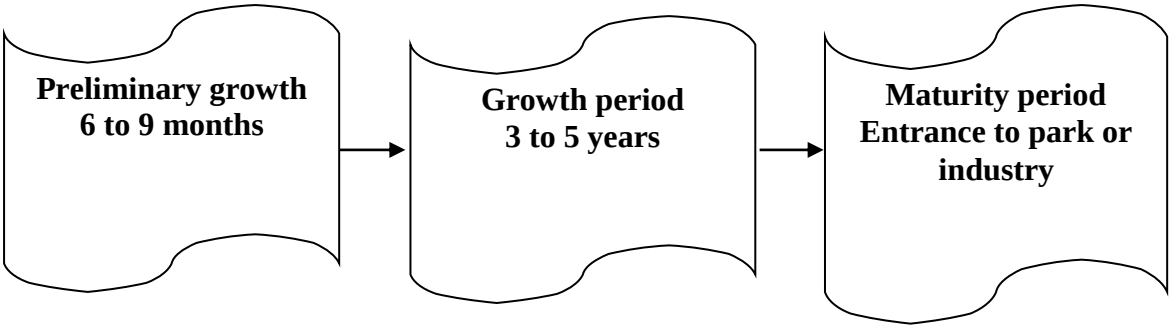


Figure 1: Incubators (Abavonel, L., 2009)

According to statute or other legal documents, the units with legal identity independent from incubators operate in the following fields:

- Applied Research and Development
- Engineering Design
- Reverse Engineering
- Technological transfer
- Providing specialized services
- Commercializing research achievement

These units are as follows:

- Private companies
- Industrial research and development units
- Research centers affiliated with universities or executive

3.2. History of Parks and Incubators

The first industrial park or industrial zone was established in America in 1905, "the central manufacturing district in Chicago". The idea of focusing industry on a given location after World War II was introduced in America. According to new definitions, the first scientific-technological park was founded in Menlo Park in California in 1948. The first wave was initiated by 1950s and early 1960s with establishment of the most important and successful parks. Stanford Industrial Park in Northern California in Silicon Valley, Triangle Research Park in Northern Carolina, and industrial center (Waltham) in 128 Boston Road were established in this period (Drescher, 2003). New models were introduced in late 1970s and 1980s. The second wave of scientific and technological park was initiated in 1980 (Lalkaka, 1998).

The first scientific and technological parks in Europe were established in the late 1960s among which "Cambridge" and "Heriot-Watt" in England and "Neville Node" and "Sophia Antipolis" in France can be cited (Aghayi, 2006). Nowadays, there are more than 1,000 scientific and technological parks in more than 55 countries around the world (Safari Niar, 2003). Incubators in recent definition have quickly developed in the United States in 1950. Nowadays, more than 3,000 incubators are operating worldwide primarily located in the United States, Europe and Japan. Over 500 incubators are in transition to an open economy in developing countries (Madah, 2003).

3.3. History and Statistics Relevant to Incubators in Various Countries

Incubators (business) are the basis of health care system initiated in the United States in early 1950s. They had not developed much by early 1970s. They were used for industrial growth in certain regional and economic circumstances. By late 1970s, business incubators in the United States and in other member states of the OECD had become a tool to improve regional and national competitiveness and encourage the emergence of innovative and technology-based firms. Development of incubators accelerated by narrowing the relationship between the concept of incubator, higher education and research institutions in the 1980s. Development of business incubators around industrial clusters based on specific technologies such as biotechnology, environmental technologies and informational technologies continued in 1990s. The number of incubators reached thirteen items in the world in 1980. The incubators quickly developed in the 1980s, especially in the second half of the 1980s in industrial countries. There were 2000 incubators in the world in 1992.

The number of incubators was more than 47273 in the world in 2011. In addition, 70 countries around the world are equipped with incubators. Table (1) shows statistics on incubators in different countries (Arnodet, R., 2011).

Table 1: The number of incubators in different countries (Arnodet, R., 2011)

Row	Country	The number of incubators	Row	Country	The number of incubators
1	America	3915	21	Romania	67
2	Germany	2811	22	India	604
3	Korea	1023	23	Sweden	507
4	Netherlands	981	24	Slovenia	619
5	France	2017	25	Hungary	341
6	Japan	2571	26	Mexico	204
7	Brazil	874	27	Italy	367
8	China	1908	28	Bulgaria	198

9	England	817	29	Slovakian	86
10	New Zealand	795	30	Ukraine	119
11	Australia	917	31	Portugal	316
12	Finland	687	32	Czech Republic	378
13	Canada	871	33	Austria	479
14	Poland	345	34	Indonesia	315
15	Israel	298	35	Turkey	196
16	Denmark	487	36	Latvia	129
17	Uzbekistan	59	37	Estonia	102
18	Egypt	86	38	White Russia	98
19	Macedonia	101	39	Lithuania	63
20	Russia	497	40	Iran	99

It is noteworthy that North American incubators have created nearly 57,000 companies and more than 735,000 new jobs. According to the latest statistics, incubators and parks were introduced by late 2011. So far, many efforts around the country were dedicated to construction of such complexes (Behzad Soltani, 2003).

4. MATERIALS AND METHODS

This is an applied research conducted as a survey using descriptive approach. Survey aims to recognize the society. Thus, systematic data was collected from the subjects. In this study, the researcher attempted to deduce what exists without any intervention subjectively in order to obtain objective results. The purpose of using this methodology lies in recording, analyzing and interpreting the current situation. In this study, a questionnaire and opinions of experts and specialists were used in the field of multi-criteria decision-making in order to collect and decide on the options.

4.1. Determining Indicators of Establishment of Incubators Network in Department of Energy

Indicators of establishment of incubators network in department of energy were prioritized by a review of literature. The screening questionnaire was distributed among five members of the expert. The scores of all screened indicators and sub-indicators were calculated as follows:

1- Communicational Indicators:

- Scientific relationship with universities and research centers
- Relationship with Technological Unit
- Relationships with specialized unit

2- Infrastructure index:

- Technological infrastructure
- Technical infrastructure
- Software Infrastructure
- Hardware Infrastructure

3- Management Index:

- Coordination
- Control

- Monitoring
- Feedback
- Suppliers

4- Service Index

- Department of Public Services
- Department of Education Services
- Department of Consulting Services
- Department of project-tracking and marketing services
- Services related to development, growth and promotion of technological units

5- Empowerment Index:

- Empowerment of commercializing research achievements
- Empowerment of facilitating local economy prosperity based on technology
- Empowerment in flexibility
- Empowerment in providing services (managerial, legal, financial, credit, project-tracking and marketing)

6- Facilities and resources index

- Branches or offices of financial support organizations
- Financial environment for growth of knowledge-based small and medium enterprises
- Adequate financial resources
- Transport
- Data privacy and confidentiality

4.2. Statistical Population

The statistical population consisted of managers and specialists of the incubators in department of energy and all the experts specialized in issues related to incubators in department of energy who have a direct relationship with changes in these centers. To summarize final indices and filling out the questionnaire (questionnaire for extracting the indices), opinions of five experts (their characteristics are presented in the following) were used. No sampling procedure was carried out due to small sample size. The opinions of 16 experts in the organization were used to weight the factors. Their opinions were used to weight and rate the factors using DEMATEL and hierarchical methods.

Characteristics of the experts are as follows:

1- Bachelor or higher than that
2- Executive and managerial history over 5 years
3- Familiarity with administrative affairs and continuous relationships with incubators in department of energy

5. DATA ANALYSIS

Hierarchical method was used to calculate weights of both indices and sub-indices in order to help the decision-maker. DEMATEL method was used to measure the effectiveness and impact of the indicators.

5.1. Hierarchical Analysis Process Model

At this stage, the subject and objective of decision-making were associated with each other as hierarchical elements of decision. Design elements include "decision-making criteria" and "decision options". Analytic hierarchy process requires breaking a problem with several indicators to a hierarchy of levels. High level indicates are the main objective of decision-making process. The second level represents major and fundamental indicators, which may break into "sub-indices and detailed indices in the next level". The last level presents decision options. Figure 2 shows the hierarchy of a decision problem (Mehregan, 2004).

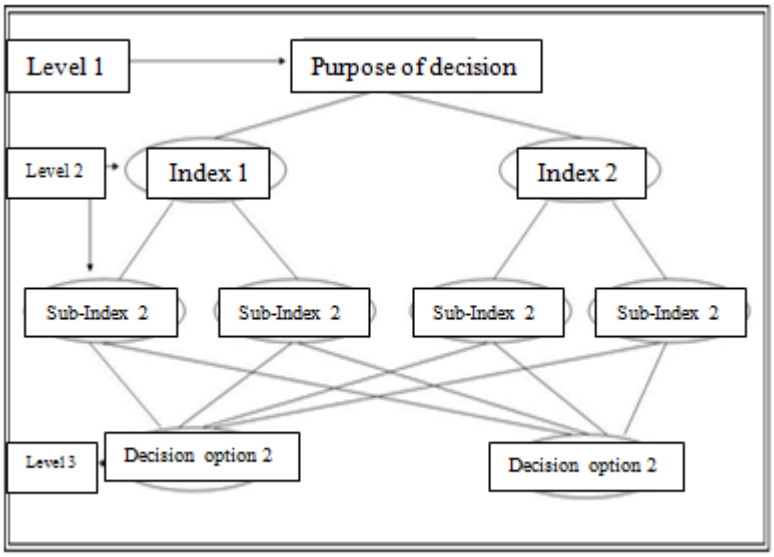


Figure 2: Hierarchy of a decision problem

5.2. Final Model of Hierarchical Analysis

In Figure 3, the model extracted by AHP approach is presented following screening the indices and sub-indices.

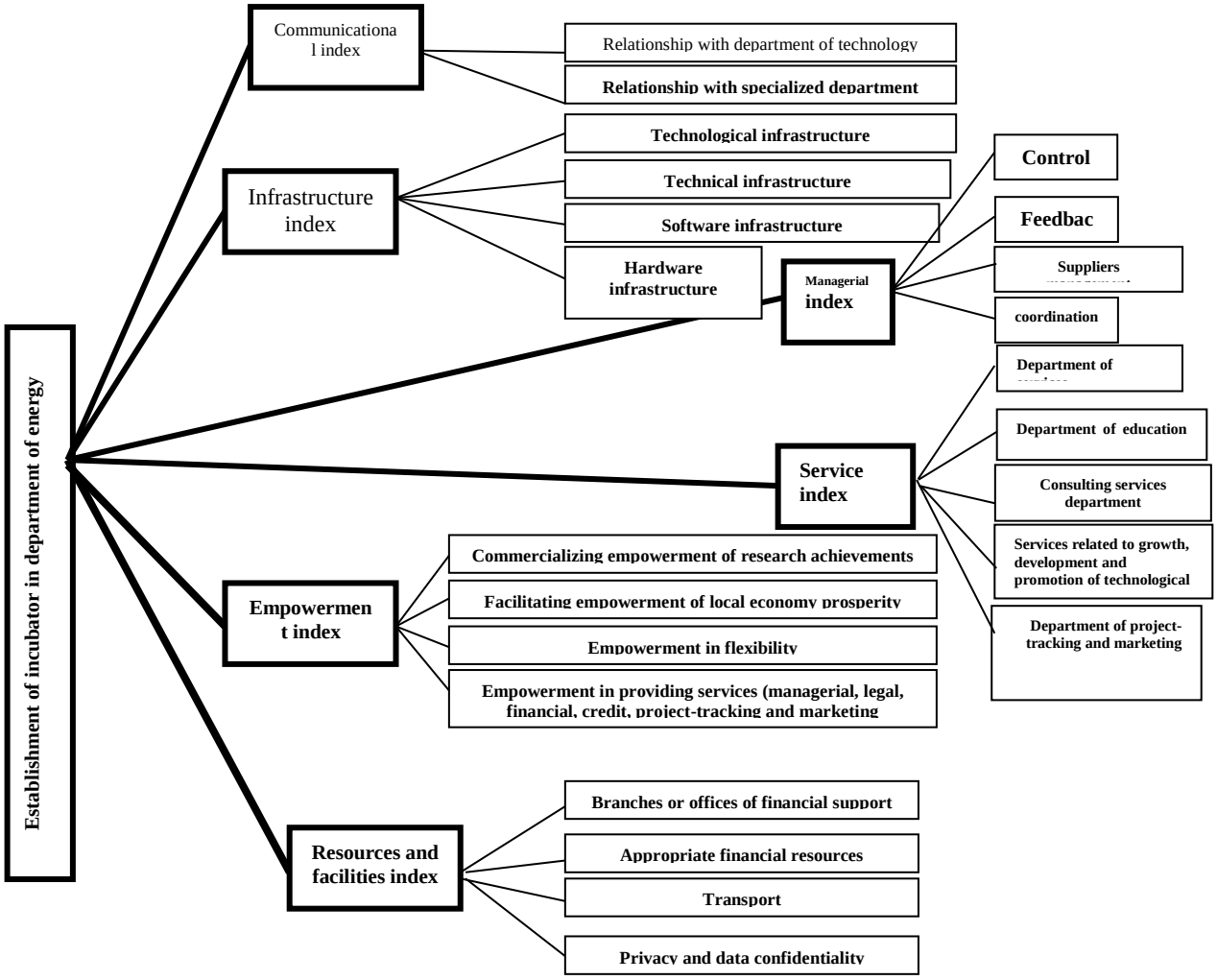


Table 2: Weights obtained by Expert Choice Software

Weight prioritization	Index from perspective of experts	Weights
1	Relationship with specialized department of each other	0.231
2	Empowerment in providing services (managerial, legal, financial, credit, project-tracking and marketing)	0.153
3	Scientific relationship with universities and research centers	0.092
4	Services related to development, growth and promotion of technological units	0.084
5	Empowerment in commercializing research achievements	0.082
6	Technological infrastructure	0.055
7	Consulting services department	0.051
8	Empowerment in flexibility	0.032
9	Technical empowerment	0.031
10	Data privacy and confidentiality mechanism	0.029

11	Educational services	0.027
12	Relationship with technological department	0.025
13	Suppliers management	0.017
14	Appropriate financial resources	0.016
15	Empowerment in providing services (managerial, legal, financial, credit, project-tracking and marketing)	0.014
16	Hardware infrastructure	0.013
17	Department of project-tracking and marketing services	0.011
18	Coordination	0.009
19	Public services department	0.007
20	Transport	0.007
21	Software infrastructure	0.005
22	Feedback	0.004
23	Branches or offices of financial support organization	0.003
24	Control	0.002

The impact and effectiveness of sub-indices were calculated using DEMATEL method. The results are presented in Table 3.

Table 3: Calculation of weights of effectiveness and impact of sub-indicators

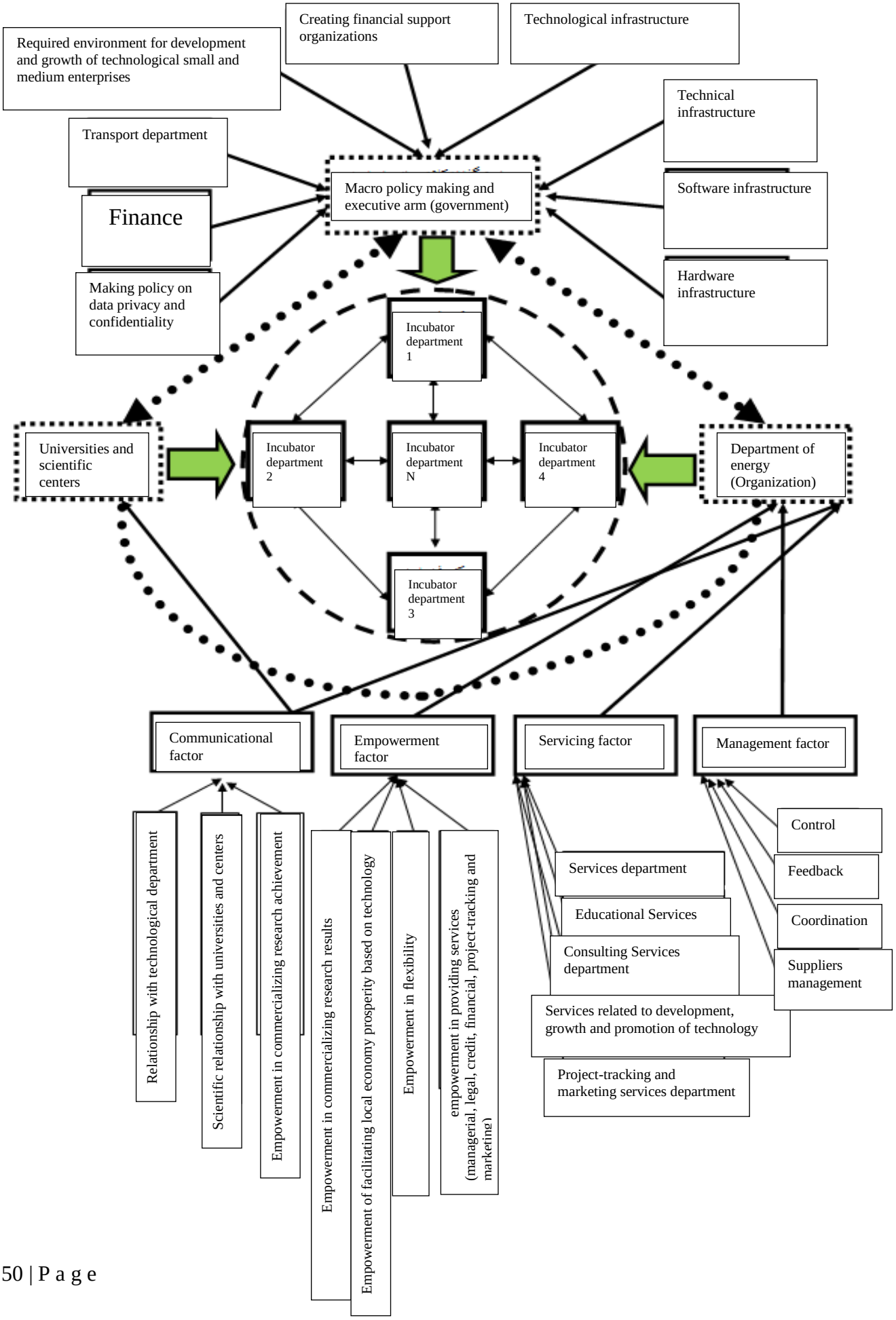
Factor number (categorized)	**R + J**	**Type**	**Factor number**	**Factor number (categorized)**	**R-J**	**Type**	**Factor number**
Descending order of sum of effectiveness and impact R + J	7.198	12	1	**Effective indices R-J<0**	4.18	19	1
	6.9	13	2		2.904	20	2
	6.892	1	3		2.718	21	3
	6.888	8	4		2.664	8	4
	6.888	9	5		2.636	13	5
	6.838	21	6		2.628	1	6
	6.669	11	7		2.489	10	7
	6.652	20	8		2.449	11	8
	6.629	10	9		2.354	9	9
	6.483	16	10		2.338	12	10
	6.378	17	11		2.275	22	11
	6.359	15	12		2.246	23	12
	6.32	24	13		2.18	18	13
	6.25	19	14		2.126	17	14
	6.18	18	15		2.052	24	15
	6.146	14	16		2.021	16	16
	6.126	23	17		1.9	14	17
	6.097	22	18		1.687	15	18
	5.964	3	19		1.601	2	19
	5.895	2	20		1.532	3	20
	5.815	6	21		1.503	7	21
	5.773	7	22		1.461	6	22
	5.769	4	23		1.442	5	23
	5.652	5	24		1.325	4	24

6. DISCUSSION AND CONCLUSION

According to results and effective indicators and sub-indicators in establishment of incubators network in department of energy and trinary model of the relationship between scientific centers (universities), industry and government (here, department of energy is an industrial and manufacturing organization), we attempted to present a conceptual model for establishment of incubators. The model is shown in figure 4.

It is worth mentioning that support and constituent parts, including scientific centers and universities on one hand and government and other organizations on the other hand, are given in our model according to their functions and role. The relationship and interaction between centers provide the context for establishment of incubators network in department of energy.

Figure4. Providing an appropriate model for establishment of incubators network at department of energy (Electricity Industry) to promote entrepreneurship


Required environment for development and growth of technological small and medium enterprises
Creating financial support organizations
Technological infrastructure
Technical infrastructure
Transport department
Finance
Macro policy making and executive arm (government)
Software infrastructure
Hardware infrastructure
Making policy on data privacy and confidentiality
Incubator department 1
Universities and scientific centers
Incubator department 2
Incubator department N
Incubator department 4
Department of energy (Organization)
Incubator department 3
Communicational factor
Empowerment factor
Servicing factor
Management factor
Relationship with technological department
Scientific relationship with universities and centers
Empowerment in commercializing research achievement
Empowerment in commercializing research results
Empowerment of facilitating local economy prosperity based on technology
Empowerment in flexibility
empowerment in providing services (managerial, legal, credit, financial, project-tracking and marketing)
Services department
Educational Services
Consulting Services department
Services related to development, growth and promotion of technology
Project-tracking and marketing services department
Control
Feedback
Coordination
Suppliers management

The research model was designed with three arms of government, universities and scientific centers and the Department of Energy. The sub-indices extracted from data analysis results and the relationships of these indices with the three arms provide the context for establishment of incubators network in department of energy. In simple terms, we drew the obtained indices based on results with respect to the effective process on network incubators in department of energy.

7. APPLIED RESEARCH RECOMMENDATIONS

1- The government should function properly in order to facilitate the establishment of incubators network of incubators in department of energy because the Department of Energy is one of the agencies under government control and influence, which should be aligned with the principles and requirements of the organization and attempt to facilitate establishment of incubators network with appropriate policies.

2- The scientific centers and universities as scientific resources that direct the incubators scientifically and facilitate the obstacles for implementation of technological projects. These centers should also introduce qualified and efficient human resources and meet the priorities and needs of the organization in format of research projects.

3- Open mechanisms for controlling and monitoring incubators network in order to resolve the problems within the network consisting of incubators because incubators as frontiers, which produce new technology are more aware of problems, obstacles and governing situation in practice. These centers can provide better solutions.

4- Department of Energy as an organizer and coordinator of the incubators network structure of DOE should adopt appropriate policies to raise more positive and effective activities and enhance synergies between incubators.

5- Barriers to development and inefficiency of incubators output in the country should be seriously investigated, especially in Department of Energy.

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ETHICAL CONSIDERATION

Authenticity of the texts, honesty and fidelity has been observed.

AUTHOR CONTRIBUTIONS

Planning and writing of the manuscript was done by the authors.

CONFLICT OF INTEREST

Author/s confirmed no conflict of interest.

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