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Performance Indicators of Technology Incubators

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The social impact of innovation

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Performance Indicators of Technology Incubators

Executive Summary

Nowadays, evaluation of the incubators is one of important issues in the national innovation system field of research. Since incubators characterized by particular features, new frameworks are required for evaluating them. Proceeding of national/regional/sectoral innovation systems is one of the aims of technology incubators, thus it may be necessary to adopt an approach emphasizing innovation capabilities.

This paper attempts to identify and prioritize the incubators' performance indicators; therefore, by literature review and considering role of innovation capabilities approach, 27 performance indicators are identified and then prioritized by factor analysis. Eventually the 27 indicators are categorized into seven groups of 1) Directing activities; 2) Granted facilities and incubatees' welfare; 3) Executive and facilitation policies of incubator; 4) Incubatees' achievements; 5) Incubator's staff; 6) incubation; and 7) Incubatees' performance monitoring.

Keywords: performance indicator, incubators, innovation capabilities, exploratory factor analysis

1- Introduction

One important issue in the technology policy field of research is how to facilitate technological innovation and accelerate the process of creating value from science and technology. All aspects of this process have been considered within one total system, known as the national innovation system (NIS). It is defined as a network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies[1]. Although the different actors of this system are visible, however what is more important is the extent in which each actor can contribute to technological innovation[2]. Technology incubators are actors which have important contributions by provision of facilities to startups and the acceleration of technology commercialization.

The first incubator was established in 1959 in Batavia, New York in the United States. Charles Mancuso rented space in his Batavia industrial center to small and starting companies and guided them through their growth process[3]. There is evidence to show that new businesses which developed within the incubators were more successful than others in terms of sale and employment growth[4], survivability[5], and technical and commercial cooperative relations[6].

There have numerous attempts to develop and promote incubators in recent decades. But "What the world needs now is not just more incubators, but improved ones"[7]. Accordingly, there have been various researches for improvement of incubators, such as studies on performance assessment, aiming to influence the incubator management. Since incubators are characterized by particular features, new frameworks are required for evaluating them. In this paper, performance indicators of the incubators identified and prioritized by Innovation capabilities approach.

The definition of Incubation process will be influenced by Innovation capabilities approach. Based on this approach, improvement of Innovation capabilities of Incubatees/startups will be the core aspect of performance. Consequently through the approach, performance indicators are developed by means of related literature and are prioritized by factor analysis. The rest of the paper is organized as follows: part two, Literature review; part three, Data analysis; part four, Research findings; and the last part, conclusion.

2- Literature review

Incubators are defined in various ways, but four components emphasized in the existing literature: 1) shared office space, 2) a pool of shared support services to reduce overhead costs, 3) professional business support or advice (''coaching''), and 4) network provision, internal and/or external. In the incubator literature, the relative emphasis on each component has varied over time, from an initial focus on facilities and administrative services to a more recent emphasis on the importance of business support. For experts the importance of such a support is so much that they say without business support activities, the denomination "hotel" would be a better description than incubator[8].

Parallel with the changing attitude toward technology incubation services, the literature of performance assessment of incubators has experienced a gradual evolution as well. Primary studies focused on the outputs of incubators. These studies suggested indicators such as the number of

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[1] Freeman, c.,"*Technology and Economic Performance: Lessons from Japan*". London: Pinter, 1987.

[2] Aaboen, L.," Explaining Incubators using firm analogy". Technovation, 29, 657-670, 2009.

[3] Aerts, K. M. "Critical role and screening practices of European business incubators", Technovation 27 (5), 254-267, 2007.

[4] Mian, S. "Assessing and managing the university technology business incubator: an integrative framework" Journal of Business Venturing 12 (4), 251-285, 1997.

[5] Reitan, B. "Fostering technical entrepreneurship in research communities: granting scholarships to would-be entrepreneurs", Technovation 17 (6), 287-296, 1997.

[6] Colombo, M. D. "How effective are technology incubators?: Evidence from Italy". Research Policy 31 (7), 1103-1122, 2002.

[7] Lalkaka, R. "Technology business incubators to help build an innovation-based economy". Journal of Change Management, 2002.

[8] Bergek, A. N. "Incubator best practice: a framework". Technovation 28, 20-28, 2008.

graduates, number of discontinued businesses, revenues[9], management policies and their effectiveness, services and their value-added[10]. Gradually, process-based indicators are considered in the studies and new factors such as efficiency and facilitation are added to the result based factors like effectiveness and survivability[11]. This approach continued in more complicated way by offering some factors such as pooling resources, sharing resources, consulting/counseling services, public image, networking, clustering, geographic proximity, costing, and funding[12].

In addition, the issue of incubators' performance assessment dealt with in another research streams which include; identifying critical success factors of technology incubators[13], evaluation of the success rate of the incubators by comparing on- and off-incubator firms[14], comparing critical success factors of incubators in two different institutional environments[15], surveying the relation between the way incubatees are selected and incubators' performance[16], and analyzing the influence of counseling and networking interactions of the incubator on the type of beneficial technical and business assistances for new technology based firms (NTBFs)[17].

Lack of an approach which is appropriate to the properties of incubators is observed in the above studies. Adopting innovation capability approach can be suitable for incubators, because incubators' value added is depend on the ability of incubatees to survive and grow in business[18], and the cooperative exchanges undertaken by entrepreneurs and incubators are aimed at facilitating the process of technological innovation [19].

Technological innovation has been defined new invention as well as its introduction to the market as a new product, process, or service. In fact, technological innovation contains two complicated concepts of invention and innovation. The former is to create a functional method to do something, a new technological idea. However, the latter is to commercialize the products, processes, and services[20]. Also it is emphasized that innovation is more than a novel idea, but a process that includes developing the idea into a useable product or service to gain a competitive advantage in the marketplace[21]. Indeed, concept of innovation includes various elements, from invention to commercializing and introducing the technological idea to the market as a new product, process, or service.

In line with above discussions, innovation capability explained as indicator of a firm's capacity in the development of new products, processes, and systems[22]. Such a capacity assists the firms to compete in dynamic markets. Innovation capabilities refer to firm's capabilities, grounded in the processes, systems, and organizational structure, which can be applicable to the product/process

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[9] Association, N. B. "The state of the incubation industry", Athens: National Business Incubation Association, 1991

[10] Mian, S. "Assessing and managing the university technology business incubator: an integrative framework" Journal of Business Venturing 12 (4), 251-285, 1997.

[11] Services, C. f. "Benchmarking of Business Incubators", Final report to European Commission Enterprise Directorate-General. Kent: Centre for Strategy and Evaluation Services, 2002.

[12] Chan, K. L. "Assessing technology incubator programs in the science park: the good, the bad and the ugly", Technovation 25, 1215-1228, 2005.

[13] Lee, F. C."The Critical Success Factors of Technology Incubators. An Empirical Study", Asia-Pacific Region of Decision Sciences Institute (APDSI), Fifth International Conference. Tokyo, Japan, 2000.

[14] Colombo, M. D. "How effective are technology incubators?: Evidence from Italy". Research Policy 31 (7), 1103-1122, 2002.

[15] Lee, S. O. "A Comparison of Critical Success Factors for Effective Operations of University Business Incubators in the United States and Korea". Journal of Small Business Management, 2004.

[16] Aerts, K. M. "Critical role and screening practices of European business incubators", Technovation 27 (5), 254-267, 2007.

[17] Scillitoe, J. C. "The role of incubator interactions in assisting new ventures". Technovation30, 155-167, 2010.

[18] Mian, S. "Assessing value-added contributions of university technology business incubators to tenant firms", Research policy 25, 325-335, 1996.

[19]Mian, S. "Assessing and managing the university technology business incubator: an integrative framework" Journal of Business Venturing 12 (4), 251-285, 1997.

[20] Betz, F. Managing Technological Innovation. NY: John Wiley &. Sons, Inc, 2003.

[21] Chandler, A. H. "The Dynamic Firm: The Role of Technology, Strategy, Organization, and Regions", NY: Oxford University Press, 1998.

[22] Prahalad, C. H. "The Core Competence of the Corporation". Harvard Business Review, 68(3), 79-91, 1990.

innovation. Innovation capabilities tend to be imperfectly imitable because they are born of organizational skill and accumulative corporate learning[23]. Innovation capability is therefore defined as the ability to continuously transform knowledge and ideas into new products, processes and systems for the benefit of the firm and its stakeholders[24].

According to this perspective, incubators' performance could be assessed based on improvement of innovation capabilities of incubatees. Based on this idea, indicators of incubator's performance could be identified as well. These indicators can measure incubators assistance to improvement of the innovation capabilities of incubatees. In other words, the indicators must determine to what extent necessary resources for innovation (commercialization of incubatees' technological ideas), provided by incubator?

So we explored indicators that can indicate the incubator's assistance to the process of improving innovation capability of incubatees. These indicators presented at the following table.

Table 1 – Performance indicators for technology incubators

Indicators
• Training courses for incubatees
• Training courses for the incubator's staff
• Consulting services for the business plan of incubatees
• Consulting services for legal issues of incubatees(in terms of intellectual property rights, license, and registering)
• Consulting services for technical issues of incubatees
• Consulting services for incubatees by graduates
• Purposed technologies of incubator
• Financial support for the incubatees acquired from governmental and non-governmental sponsors
• Rent and service tariffs subsidies for incubatees
• Administrative services for incubatees (secretarial, accounting, and personnel issues)
• Allocated space for incubatees in the incubator location
• Communicational facilities
• Scientific and educational facilities (library, laboratory, conference room, etc.)
• Cooperation and networking with other institutes (universities, financial institutes, industries, suppliers, contractors, research centers/official or non-official)
• Joint projects between incubatees in the incubator
• Incubatees' presence in professional fairs
• Incubator's staff sufficiency
• Incubator's staff with high education levels
• Review of incubatees performance by incubator(official/non-official)
• Tenancy duration of graduate firms
• Employment rate of incubatees and graduates
• Graduation of firms
• Patented inventions of incubatees (during their residence in the incubator)
• Commercialized technological ideas since the foundation of the incubator
• Annual growth in incubatees' revenue
• Annual growth of incubatees' revenue by selling the invention or licensing
• Satisfaction rate of incubatees from received services

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[23] Chen, C. "Technology commercialization, incubator and venture capital, and new venture performance" Journal of Business Research, 2009.
[24] Lawson, B. S. "Developing innovation capability in organizations: A dynamic capabilities approach", International Journal of Innovation Management, 2001.

It's obvious that above indicators must be defined in ratio-based form for comparison purposes. For example, "training courses for incubatees" could be stated as "average hours of training courses for incubatees".

3-Data analysis

In order to analyze the detected indicators, incubators' experts and managers in Tehran as well as knowledge workers and managers of incubatees were considered for research. Based on factor analysis method literature, sample size must be more than the number of variables. In the present research, 98 people were questioned. However, this sample size is suitable for factor analysis of 27 variables.

In order to collect the data in this research, a questionnaire was designed in form of 5-choice LIKERT Scale based on the 27 indicators. The main question inquired experts, was "what extent each identified indicator, indicate the incubator's assistance to improve the innovation capability of the incubatees". Furthermore it was explained that innovation capability means commercializing incubatees' technological ideas. This questionnaire was distributed in 9 incubators in Tehran and 98 questionnaires were given back. In order to measure reliability, Cornbrach's Alpha Test was used, where the calculated alpha for the questionnaire was equal to 0.854 and, as a result, the questionnaire's reliability was confirmed.

Before carrying out Exploratory Factor Analysis it is required to assess the appropriateness of the data for the factor analysis. So sampling adequacy test as well as Bartlett test calculated. Table 2 shows results of these tests and data appropriateness for the factor analysis.(KMO>0.7,sig<0.05)

Table 2 – results of KMO Test and Bartlett Test

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.717
Bartlett's Test of Sphericity	Df	351
	Sig.	.000

One of the important issues in factor analysis is to determine the number of factors, for which one of the useful principles is eigenvalue that indicates the explained variance amount by each factor. Eigenvalue of 1 is considered as the basis for the number of factors; so factors by eigenvalue of which is more than one are selected.

For interpreting the factors it should be determined what measures of the factor loadings should be considered as significant. According to literature, factor loadings greater than 0.3 are significant. Factor loadings, greater than 0.4 have a high level of significance. Factor loadings, greater than 0.5 are considered as very significant. In this research, the basis of factor loading's significance is 0.5; therefore, a variable (indicator) with factor loading lesser than 0.5 was eliminated.

4- Research findings

After all variables are identified, it's determined a suitable title for factors by considering the variables related to each of them. In other words, after doing a factor analysis, seven factors were identified for the 27 indicators. Table 3 presents factor loadings of indicators across 7 factors. Consequently, table 4 shows categorization of indicators, naming the factors and their priorities. The criterion for prioritizing the indicators is their factor loading and the criterion for prioritizing the factors is the percentage for each of their variance explanation.

Table 3 –Rotated Component Matrix[a]

	Component						
	1	2	3	4	5	6	7
1. training courses for incubatees	.901	.058	.068	.030	.048	-.049	-.205

Table 3 –Rotated Component Matrix[a]

	Component						
	1	2	3	4	5	6	7
2. training courses for incubator's staff	.246	.052	.122	.115	.813	.093	.211
3. consulting services for business plan	.819	.204	.091	.048	-.020	.157	.244
4. consulting services for legal issues	.859	.004	.079	.001	.085	-.151	-.283
5. consulting services for technical issues	.866	.110	.042	.016	.020	.178	.213
6. consulting services for incubatees by graduates	.878	.170	.129	.052	.041	-.005	.188
7. Purposed technologies	.918	.070	.078	.053	.090	-.079	-.269
8. Financial support	.170	.887	.114	.081	-.009	.033	.138
9. Rent and service tariffs subsidies	.068	.798	.089	-.019	-.003	-.062	-.291
10. Administrative services for incubatees	.156	.130	.906	-.007	.071	-.093	-.144
11. Allocated space for incubatees	.172	.783	.091	.043	.042	-.060	-.351
12. Communicational facilities	.068	.821	.129	.013	-.026	.136	.457
13. Scientific and educational facilities	.121	.886	.123	.093	.096	.006	.036
14. Cooperation and networking with other institutes	.064	.183	.833	.044	-.112	.042	.217
15. Joint projects between incubatees	.078	.118	.918	.009	.045	.013	.113
16. Incubatees' presence in professional fairs	.096	.104	.930	.032	.059	-.035	-.081
17. Incubator's staff sufficiency	-.041	.023	-.070	.049	.868	-.024	-.177
18. Incubator's staff with high education levels	.036	-.028	.035	.128	.915	.023	-.103
19. Review of incubatees performance by incubator	-.029	.110	.053	-.035	-.106	-.324	.685
20. tenancy duration of graduate firms	.138	.097	-.065	-.001	.015	.657	-.440
21. Employment rate of incubatees and graduate	-.001	-.037	-.038	.074	.127	.831	-.202
22. Graduation of firms	-.068	.066	.022	-.011	-.070	.910	.172
23. Patented inventions of incubatees	-.005	.048	-.070	.892	.091	-.052	-.074
24. Commercialized technological ideas	-.032	.089	.041	.843	-.027	.082	.433
25. incubatees' revenue	.059	.021	.060	.919	.098	.024	-.047
26. incubatees' revenue by selling the invention	.126	.046	.060	.925	.123	.047	-.136
27. Satisfaction rate of incubatees	.011	.855	.120	.015	-.059	.095	.277

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

Table 3 –Rotated Component Matrix[a]

	Component						
	1	2	3	4	5	6	7

Table 4 – Indicators' classification and prioritizing

Priority	Factor	Indicators based on their priorities	Factor loading
1	Directing activities (21.44)	1. Purposed technologies of incubator (presentation and introduction of the technology among the incubatees)	0.918
		2. Training courses for incubatees	0.901
		3. Consulting services for incubatees by graduates	0.878
		4. Consulting services for technical issues of incubatees	0.866
		5. Consulting services for legal issues of incubatees (in terms of intellectual property, license, and registering)	0.859
		6. Consulting services for the business plan of incubatees	0.819
2	Granted facilities and incubatees' welfare (19.74)	1. Financial support for the incubatees acquired from governmental and non-governmental sponsors	0.887
		2. Scientific and educational facilities (library, laboratory, conference room, etc.)	0.886
		3. Satisfaction rate of incubatees from received services	0.855
		4. Communicational facilities	0.821
		5. Rent and service tariffs subsidies for incubatees	0.798
		6. Allocated space for incubatees in the incubator location	0.783
3	Executive and facilitation policies of incubator (15.06)	1. Incubatees' presence in professional fairs	0.930
		2. Joint projects between incubatees in the incubator	0.918
		3. Administrative services for incubatees (secretarial, accounting, and personnel issues)	0.906
		4. Cooperation and networking with other institutes (universities, financial institutes, industries, suppliers, contractors, research centers/official or non-official)	0.833
4	Incubatees' achievements (14.57)	1. Annual growth of incubatees' revenue by selling the invention or licensing	0.925
		2. Annual growth in incubatees' revenue	0.919
		3. Patented inventions of incubatees (during their residence in the incubator)	0.892
		4. Commercialized technological ideas since the foundation of the incubator	0.843
5	Incubator's staff (10.57)	1. Incubator's staff with high education levels	0.915
		2. Incubator's staff sufficiency	0.868
		3. Training courses for the incubator's staff	0.813
6	Incubation (8.76)	1. Graduation of firms	0.910
		2. Employment rate of incubatees and graduates	0.831
		3. Tenancy duration of graduate firms	0.657
7	Incubatees' performance monitoring	1. Review of incubatees performance by incubator (official/non-official)	0.685

Results from factor analysis are appropriate when the extracted factors explain an acceptable amount of variance. In social researches a 60% explanation of variance considered enough. The table below shows the explained variance of the factors. As it is obvious, 7 extracted factors explain more than 83% variance.

Table 4 – eigenvalues of the factors

Factors	Eigenvalue	%of Variance explained	%of factors
1	4.818	17.843	21.44
2	4.436	16.428	19.74
3	3.385	12.537	15.06
4	3.275	12.130	14.57
5	2.375	8.798	10.57
6	2.215	8.203	9.86
7	1.969	7.292	8.76
total	---	83.232	100

5-Conclusion

Incubators are critical actors of national innovation system. Almost all expected contributions of incubators can be realized through capability building in incubatees/startups. This paper focused on incubators with innovation capability approach and developed performance indicators. Adopting this approach led to identify indicators which indicate the process of innovation capability improvement of incubatees. The resultant factors and indicators as well as each of their priority comprise specific learning; therefore, each of the factors has been analyzed below separately.

The first factor, i.e. directing activities, which shows guidance of incubatees, is most important factor that indicates the development of the incubatees' innovation capability improvement. Each indicator presented under this factor, show one of its aspects. The first indicator (Purposed technologies of incubator) is often a consequence of the cooperation with other institutes and recognizing their requirements, it paves the way for the incubatees to growth and assures about market for their products/services. Each of the other indicators of this category, showing the incubator's responsibility in training and educating the incubatees. Importance of Training courses for incubatees presented by second indicator. Transferring the experiences of graduates to incubatees indicated by third indicator. Furthermore, the importance of technical, legal, and business consultation are shown in the later indicators.

The second factor, called the granted facilities and incubatees' welfare, is in the second place of importance. The first indicator of this category concerns the provided financial resources for the incubatees. Some other indicators of this category, concerning the space and equipment, depend on the incubator's affordability and initial investment for the incubator. Nonetheless, one should not ignore the fact that some shortcomings can be compensated by cooperation and relation with other institutes, particularly universities and research centers, supporting the incubator. Moreover, subsidies associated with incubator's services are effective for incubatees' cost reduction; they could be allocated based on various criterions such as maturity of incubatees. Finally, third indicator, concerned to the incubatees' satisfaction, indicates the importance of taking feedback from incubatees.

The third factor, or executive and facilitation policies of incubator, essentially involves routine tasks of incubator. Facilitating for presence in various fairs indicate the incubator's endeavor to improve the incubatees' marketing ability. The possibility to set joint projects between incubatees leads to enhance learning and networking ability among the incubatees. Office services that are shared to all incubatees can to a large extent result in time and cost savings for them. However, the incubator should not neglect transfer of these skills to incubatees. Finally the indicator of cooperation with other institutes not only improving research, development, manufacturing, and production capabilities of incubatees, but also it can help them to enhance their cooperation capability with other institutes.

Indicators of the fourth factor, which concern incubatees' achievements, are all focused on the outcome for the process of innovation capability improvement. The important point in relation to these indicators is the necessity of long-term view. These indicators should be considered with more caution, particularly in case of the newly-founded incubators.

The fifth category of indicators that placed under the incubator's staff factor, consider the quality and quantity of the incubator's staff. Essentially the access to enough staff with expertise in technology incubation is a pivotal factor to promote the innovation capability, since many of the required services are either delivered or at least coordinated by incubators' staff. Due to the novelty of business/technology incubation expertise, staff training is important matter. It can lead to utilization a kind of staff possessing combined technical and business competencies.

The indicators placed in the sixth factor focus on the outcome of the incubator's performance, being related to the incubation and job creation which need to be considered in long term, like the

indicators of the fourth factor. Moreover the newly-founded incubators are an exception for these indicators.

The indicator related to the last factor, i.e. Incubatees' performance monitoring by incubator, is an important factor in the process of incubatees' capability building. This process ends with the identification of specific needs of each incubatee throughout the stages of their growth.

Finally, above indicators could be considered as guidance for policy makers to evaluate incubators nationally/regionally. However, based on considering this fact that NIS is essentially a network, it seems deployment a mechanism for expanding and improving the incubators' communication (as a part of this network) with different institutes and with each other have most important role in upgrading incubators at national/regional level. So it's proper that policy makers be care about strategic relations between incubators and other NIS actors.