

A Study of Factors Influencing the Improvement of Technology Business Incubator's Effectiveness: An Explanatory Model

Alireza Ghasemizad

Abstract—In Both developed and developing countries, governments play a basic role in making policies, programs and instruments which support the development of micro, small and medium enterprises. One of the mechanisms employed to nurture small firms for more than two decades is business incubation. One of the mechanisms employed to nurture small firms for more than two decades is technology business incubation. The main aim of this research was to establish influencing factors in Technology Business Incubator's effectiveness and their explanatory model. Therefore, among 56 Technology Business Incubators in Iran, 32 active incubators were selected and by stratified random sampling, 528 start-ups were chosen. The validity of research questionnaires was determined by expert consensus, item analysis and factor analysis; and their reliability calculated by Cronbach's alpha. Data analysis was then made through SPSS and LISREL soft wares. Both organizational procedures and entrepreneurial behaviors were the meaningful mediators. Organizational procedures with ($P < .01$, $\beta = 0.45$) was stronger mediator for the improvement of Technology Business Incubator's effectiveness comparing to entrepreneurial behavior with ($P < .01$, $\beta = 0.36$).

Keywords—Technology, Incubators, Effectiveness, Explanatory model.

I. INTRODUCTION

TECHNOLOGY transfer has nowadays turned into a major function of the modern universities. Most universities across the world have come to the result that for their survival and remaining competitive, they need to revise their traditional approaches concerning instruction and training, releasing papers and compilations, research activities and transfer of cultural heritage; and look for new areas of activity as well. Governments and communities have also realized that their welfare is conditioned to how they can tailor science and technology to their domestic needs. The new activities by universities and governments are namely establishing science and technology parks, technology incubators, spinouts, as well as R&D centers. To help the small and start-up companies to grow and survive is among the targets of such institutions pursue. Supporting start-ups will greatly add to their chances of success and survival [1].

Business incubation is the basic instrument to support and nurture small firms for more than two decades. They are playing an important role, by providing a set of facilities as

physical space, legal and technical advises, shared services and financial supports to faceplate start-ups graduating for surviving in the outside competitive environments [2].

For the technology incubators to be able to realize their philosophy of existence, which is providing help and support to newly established companies, and meet the targets they are pursuing, the factors improving their effectiveness should be recognized.

As the literature review reads concerning functioning and effectiveness of incubators, it could be claimed that so far, there have been limited research activities in this area and the researches carried out are in metric or descriptive forms. Moreover, the literature misses research studies concerning factors improving the effectiveness of technology incubators. According to [3] the absence of a complete framework for measuring effectiveness and functioning of technology incubators or recognizing the contributing factors has put the managers of such centers in a challenging situation.

By recognizing the factors motivating promotion of effectiveness, one may expect improvement in the following areas:

- Capital attraction; attracting investors to cooperate in realizing the targets of the organization
- Financial management and budget attraction from governmental resources
- Establishing relations with related companies, the government and the suppliers
- Synergy and agreement between the staff and technology-developer companies, and between the government and local or international technology-developers,
- Humanitarian management [4].

The special significance of the present research is that it introduces new arrangement of variables and puts them in a new explanatory model. The relations between such variables have not been already fully examined. The present research expects to be able to provide the policymakers and managers of technology incubators with some breakthroughs to improve the effectiveness of their activities. This study seeks to recognize the working factors for giving rise to the effectiveness of technology incubators and estimating each factor's contribution in the framework of the explanatory model.

The theoretical framework of the factors contributing to the improvement of incubators effectiveness

Based on a review of the research studies carried out around the technology incubators, probably there has not been a research study on a theoretical framework for factors affecting improvement of technology business incubators' effectiveness and the role of effective variables; and this poses a challenge to the present study. As [5] demonstrated, we are facing a theoretical gap as to functioning estimation and defining the best possible instruction for the technology incubators.

The theoretical basis which incubators incubation draws on has its roots in failures and defeats in the market. Defeat in the market happens when the competitive environment for production and sale of goods or services fails to come to the expected results. The factors of defeat in the market include external factors, information gaps, monopolies, and public sector products.

These factors could be classified in 3 categories as follows:

- intra-organizational factors
- extra-organizational factors
- personal factors

The studies by [6, 7, and 8] insist on the significance of external factors and their effects on incubators.

The explanatory studies by [8] favor intra- and extra-organizational factors for incubators effectiveness. In addition, behavioral theories were devised around the incubators in order to support the researches, which analyze the environmental effects. Such theories are used to study the effects of the external and internal environments on incubators and incubatees [9].

According to the 'dynamic capabilities theory', if the incubators integrate their internal and external advantages to cope themselves with the rapidly changing environments, they will be more possible to succeed. According to [10] and [11], effectiveness of the incubators depends on the environment they are working in.

As far as personal factors are concerned, entrepreneurship behavior could be underlined as the most important one. According to the structural theory and economic ones, a properly established incubator that is located in an environment prevailed by innovations and interaction, interacting with industries, or having access to rich resources of experienced entrepreneurs, comparatively is more akin to success successful [9].

In addition, studies by [12] show that there is a relation between entrepreneurship specification and success. Moreover, incubator is the producer of supporting programs for businesses. The entrepreneurs get into the incubator as customers and get in joint work and joint production with the incubator [13].

The relationship between incubator and entrepreneurs could be observed in the Fig. 1.

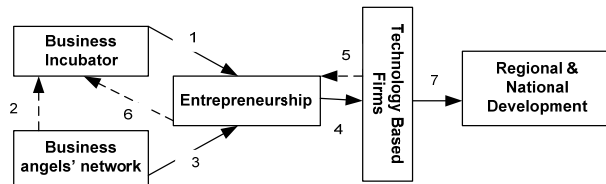


Fig. 1 Relationship between incubator and entrepreneurs

As shown, the real incubators stimulate job creation (arrow 1). In addition, the real entrepreneur manages the risk and do not restrain risk making. A better entrepreneurship is directly encouraged by more development of business-angels networks (arrow 3) and indirectly encourages and motivates the networks to invest in the projects available to the incubator (arrow 2). Rise in entrepreneurship provokes growth of new technology-based industries (arrow 4) and this growth will leave a considerable direct effect on regional and social development and other issues (arrow 7). Based on the available evidences the new technology-based industries provoke boost of entrepreneurship activities (arrow 5) and give rise to the number of projects for the incubators and entrepreneurs. This shows that such companies are able to survive in the external non-controlled environments after leaving the incubator.

As to the organizational structure, the role of the 'agency theory' could be referred to; the theory insists on the relation between the supervisors who distribute the jobs between different sections. Most organizational problems have their roots in the nature of relations, since it is difficult for them to continuously monitor all sections because of the differences in objectives and visions of the managers and the workers. This theory provides a strong basis for researches on the relations between the managers and the incubatees [9].

Some challenges are also emerged when the principal and the agent hold different notions on risk-taking. In other words, incubator manager and incubatees might go for different measures since they hold different positions on risk-taking [14].

Attention to the relation between the incubator manager and the incubatee ignores the truth that establishing a relation in incubator by networking is a prerequisite. In addition, traditionally the incubatee is not able to work for the manager of the incubator as an agent – somebody who has to follow his orders one by one. An incubatee strives for his own success rather than working for the manager's success [9]. That is because the main objective of the start-ups is to realize their own targets, which are survival and trading their products and services, and seeking to meet the expectations of the incubator's manager comes next.

And the 'institutional theory' discusses the processes which by developing structures, schemes, laws, norms and daily activities provide a pattern of instructions for social behavior. Students present in institutions need to cope themselves with the existing regulations and policies and follow them besides holding an inclination for stimulating controversy and change in social structures [15].

TABLE I
INGREDIENTS OF RECOMMENDED MODEL

factors	components	reference
Extra-organizational factors	Governments financial and supports for the incubator Contact between the start ups and business environment out of incubator Contact between the incubators and regional agency and boards Encouraging investor to invest in incubator Access to the information resources Access to the experts out of the incubator Access of start ups to capital, bank facilities and other financial resources Contacts between the incubator and sponsoring university Contacts between the incubator and industries as well as factories	[6,7,8,9,10,11] (Dynamic capability theory & behavioral theory)
Intra-organizational factors	Incubator's safety services Incubator's manager experience Screening start ups upon entering the incubator Reduce the rental Considering feedbacks from start ups by the incubator manager Informal contacts between start ups Contacts between the incubator manager and start ups	[6,7,8] (Dynamic capability theory & behavioral theory)
Organizational procedures	Consonant incubator's goals with start ups in parallel Declaring laws and regulations to the start ups along with explanations Declaring the incubators activities-incubation stages, how to use the services, evaluations, etc to start ups along with explanations Start ups' commitment to realization of the incubator's goals as well as their goals Existence written official regulations in support start ups who have left the incubator in due time Existence written official regulations in support start ups who are stationed in incubator	(Agency theory & Institutional theory)
Entrepreneurs hip behavior	Employee change orientation Employee strategic vision Creation of an energetic working environment	[16]
Effectiveness	services and value-added motivation control and evaluation management and policy effectiveness networking performance outcomes geographical proximity	[17,18,19,20,3,9]

From this viewpoint, the incubators could play the role of a mediator, which affects the institutions concerning the incubatees; so that they would be able to add to their merits and make up for demerits. According to this theory, by combining the cognitive, cultural, traditional and disciplinary factors with joint activities and sustainable resources, a kind of order and integration for stability and survival of companies present in incubator is introduced [9].

A. Ingredients of Recommended Model

Generally, the theoretical framework shaped based on review of the former studies and the available variables could be rendered as the following table. (Table I)

B. Research Questions

1. Are organizational procedures meaningful mediators for the relations between intra-organizational, extra-organizational and incubators effectiveness?
2. Is entrepreneurship behavior of the start-ups a meaningful mediator for the relations between intra-organizational, extra-organizational and incubators effectiveness?
3. What is the suitable model for boosting the incubators effectiveness?
4. How much does the recommended model fit?

II. METHODOLOGY

A descriptive- correlation method applied in the research. After gathering data from incubators, recommended model and causal effects among variables investigated.

A. Population and Sample

The survey population includes all Iranian start ups in technology incubators in 2008. In order to select the sample, first a complete list of technology incubators was provided from the Ministry of research, science and technology then all the incubators were recognized. From the 56 established incubators a 32 (active ones) were selected. Based on the size of start-ups in incubators, the categorical random sampling was selected and the proper sample was chosen; and questionnaires were distributed among them. So the size of the sample was 600, among which some 528 questionnaires were suitable to be analyzed. It is noteworthy that 850 companies were active in the 32 selected incubators. Accordingly, the sample constitutes 62 percent of the survey population. According to [21], a number of 265 for 850 populations are suitable.

B. Research Instruments

The tools used for data collection were the following questionnaires:

1. Questionnaire of technology incubator's effectiveness

The questionnaire included 7 components: services and value-added (10 items); motivation (4 items); control and evaluation (6 items); management and policy effectiveness (10 items); networking (7 items); performance outcomes (7 items); and geographical proximity (4 items). The range of responses were from 1 to 5 (very little to very much). The questionnaire

included 48 items. After the preliminary compilation and editing them, the questionnaire underwent item-analysis for validity. The help of the scale total score calculated each item's correlation coefficient. Given the [22] studies, which result in the coefficient for each item should never be less than 25 % of the total score, the coefficient of 35 % was picked up. For more validity, the coefficients lower than 35 % were deleted.

All the remaining coefficients were meaningful at the level of lower than 0.05. Later, based on the factor analysis by principal component and with regard to the assurance indicators Eigenvalue and Scree plot deletion of factors, which were in linier curve model, 7 factors were selected as the main ones. For calculation of the scales' reliability, the Cronbach's Alpha method was applied. Cronbach's Alpha coefficients for questionnaires are reflected in Table II.

2. Questionnaires of Intra-and Extra-Organizational Factors

The validity of this questionnaire was first gained from the consensus of experts; then the item analysis was carried out based on the correlation coefficient between each item and the total score; and the coefficients less than 35 % were deleted. The questionnaire was also analyzed by the factor analysis method and 16 items included in 2 factors were considered as the main ones.

3. Questionnaire of Organizational Procedures

The validity of the questionnaire was determined based on the consensus of experts, item analysis and factor analysis. As a result, 6 items were selected in the form of one factor.

4. Questionnaire of Entrepreneurship Behavior

However, [16] had calculated the validity of this questionnaire, more assurance validity and reliability were decided to be estimated. The questionnaire's validity was gained from the consensus of experts and item analysis. The

analysis of correlation coefficient between the items while the total score caused elimination of 3 items for being under 35 % and handing in 7 items.

Questionnaires' Reliability

For estimation of the questionnaires reliability, the Cronbach's Alpha approach was applied. Cronbach's Alpha coefficients for questionnaires are reflected in Table II.

III. RESULTS

A. Answers to the 1st and 2nd Research's Main Question

1. Are the organizational procedures meaningful mediators for the relations between the intra- and extra-organizational factors and the incubators effectiveness?
2. Is the entrepreneurship behavior a meaningful mediator for the relations between the intra and extra-organizational factors and the incubators effectiveness?

B. Data Analysis for the Recommended Model

First the partial models and then the comprehensive model were followed. Fig. 2 the paths of study during the research (recommended model)

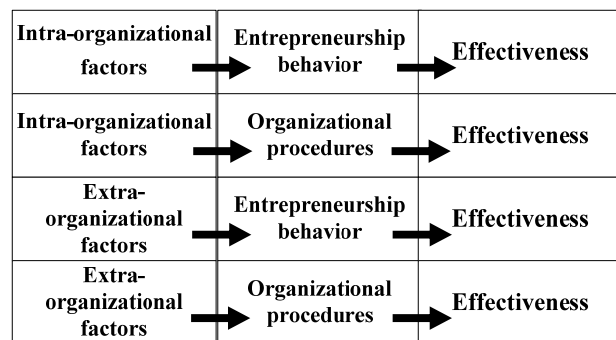


Fig. 2 Investigated path in the research

TABLE II
CRONBACH'S ALPHA FOREACH SCALES

scales	Coronbach's Alpha
services and value-added management and policy effectiveness	0.83
control and evaluation	0.75
control and evaluation	0.73
Networking	0.73
performance outcomes	0.84
geographical proximity	0.72
Extra-organizational factors	0.68
Intra-organizational factor	0.74
Organizational procedures	0.80
Entrepreneurship behavior	0.86
	0.76

C. Analysis of the Path of the Recommended Model

In this model, the variables of the intra- and extra-organizational factors have been considered as exogenous variables, the variables of entrepreneurship and organizational procedures as mediator variables, and variables of technology incubators' effectiveness as endogenous variables.

Regarding the present research and the role of the mediator variables (organizational procedures and entrepreneur behavior) and relying on the recommended stages by [23], the following stages were carried out for the model test:

1. Examining the direct impact of primary exogenous variables on endogenous variables (Figs. 3, 4),
2. Examining the impact of exogenous variables on mediator variables (Fig. 4)
3. Examining the impact of mediators, on endogenous by control of exogenous variables (Figs. 4, 5)

Study of the regression coefficients' decrease from stage 1 to stage 3: In this part, the provisioned values of exogenous variables from stage 1 to stage 3 were studied.

D. Model Presentation and its Fitness

In the charts of the standard coefficients' path, the regression (β) indicates the coefficient of the path, which is shown on the path arrows. Moreover, each of the equations R & R^2 below of each endogenous variables and amount of $(1-R^2)$ or each error equation variance is also inversely at the end of endogenous variables shown. Each of these figures shows a regression equation; eventually, all equations are combined and after deletion of non-meaningful equations the final shape of the model are drawn and finally the fitness index of the model is computed.

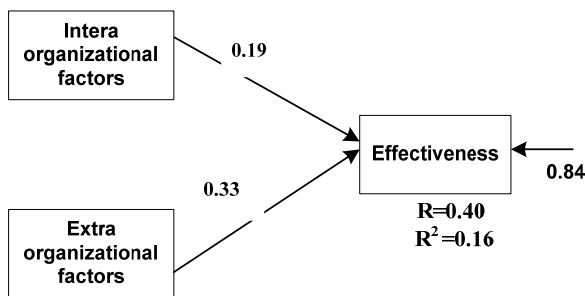


Fig. 3 The impact of the primary exogenous variables on effectiveness

The Fig. 3 shows the impact of the primary exogenous variables on effectiveness variable.

Intra and extra organizational factors with ($P < .01$, $\beta = 0.19$) and ($P < .01$, $\beta = 0.33$) regularly, had a meaningful effect on technology incubators' effectiveness.

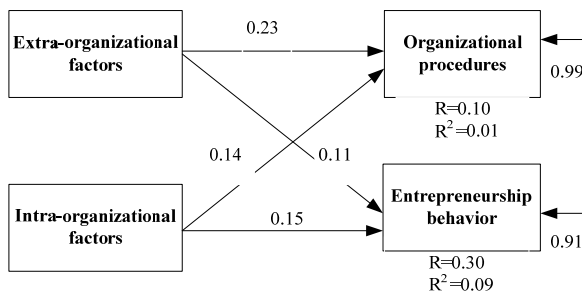


Fig. 4 Effects of exogenous variables on mediators

Extra-organizational factors with ($P < .01$, $\beta = 23$) and ($P < .01$, $\beta = 11$) regularly, had a meaningful impacts on mediators and intra-organizational factors with ($P < .01$, $\beta = 0.11$) regularly had a meaningful effects on organizational procedures and entrepreneurship behavior and with ($P < .01$, $\beta = 15$) had a meaningful effect on entrepreneurship behavior.

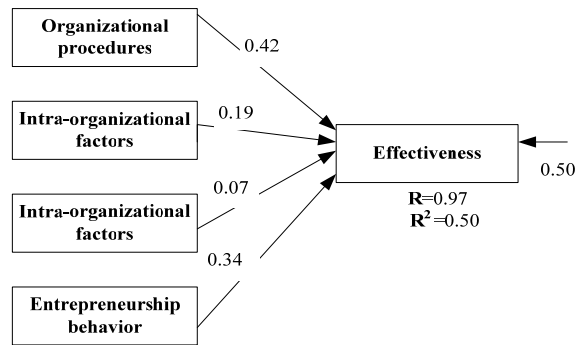


Fig. 5 Influences of mediators on endogenous with control of exogenous

Fig. 5 shows the impact of mediator variables on endogenous variables with control of exogenous ones. It is clear that except for the intra-organizational factors, the other 3 factors are meaningful predictors of incubator's effectiveness. That is organizational procedures with ($P < .01$, $\beta = 0.42$), intra organizational factors with ($P < .01$, $\beta = 0.19$), and entrepreneur behavior with ($P < .01$, $\beta = 0.34$) had meaningful effect on the technology incubator's effectiveness.

After review and comparison of the regression, coefficients from stage 1 to stage 3 the following outcomes were resulted:

1. The regression coefficient of the extra-organizational factors on mediation of effectiveness variables was equal to 0.33, which dropped to 0.19 in direct effect case.
2. The regression coefficient of the intra-organizational factors on mediation of effectiveness variables was equal to 0.18, which dropped to 0.07 in direct effect case.

Decrease of the regression coefficients in direct effect cases indicates the meaningful mediation for extra-organizational factors and especially intra-organizational factors. Based on the information driven from figures and stages of path analysis and elimination of non-meaningful paths, the final model was resulted. Fig. 6.

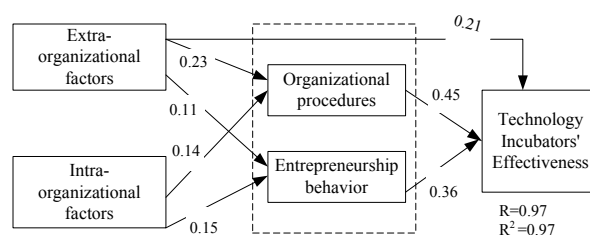


Fig. 6 Final model

E. Model Fitness

To examine the recommended model's fitting, the chi-square was calculated. It resulted $X^2 = 43.92$ which was meaningful at $P < 0.0001$. The other figures were as follows: AGFI = 0.77, GFI = 0.97, IFI = 0.93, CFI = 0.93, NFI = 0.93; but the value for RMSEA was equal to 0.08, which was not

meaningful at 0.05, and this indicated harmony of the model with the real case.

IV. CONCLUSION

According to the economic theories and the resource-based viewpoint, if an incubator is established properly and in an environment prevailed by innovation and interaction with industries, with access to rich resources of experienced and innovative entrepreneurs and management teams, compared with those which act more successfully than the incubators which have no access to such resources.

As a result, the more the incubators insist on the job making and entrepreneurship behavior of the start ups and supports them, the more they could be hopeful for improvement of their effectiveness.

In addition, based on the structural theory, which is used to study entrepreneurship and establishment of new companies [9], an organization and its staff affects each other part. Therefore, the incubator is considered an important and effective mechanism for developing a good relationship between the technology-centered entrepreneurs in the university.

Through a series of cultural activities, the incubators pave the ground for the emergence and formation of new ideas in the community. For establishing the entrepreneurship gets prevailing in the society, the citizens should be encouraged to create jobs. To make people inclined to job making, many measures should be taken including getting people together and informing them on job-making facilities. This might be carried out in different forms as providing training courses, which could bring about improvement of personal skills and turning individuals into entrepreneurs. Education and Training is a good starting point to get people informed about the innovation and entrepreneurship facilities. In addition, education and training is provided by the technology incubators, which are mostly affiliated to universities in order to provoke entrepreneurship spirit in the community. The presence of this spirit leads to formation of new ideas.

The present research complies with the statements by [9, 24,25], concerning the role of entrepreneurship behavior in incubators' effectiveness and confirms their findings. In the recommended model, the organizational procedures showed more mediation for the incubators' effectiveness. This finding could be justified by the agency theory. Some challenges appear when the employer and employee hold conflicting ideas concerning risk-taking. The point is that the employer and employee might prefer different measures because their viewpoints concerning risk-taking are different.

The institutional theory also discusses the processes, which by developing structures, schemes, laws, norms and daily activities provide a pattern of instructions for social behavior. For the organizations to appear successful in realizing their targets, the compilation laws and procedures are important. Procedures determine the range decisions of which are authorized or forbidden. Moreover, such laws and procedures could lead the mentality of the organizations' members (start ups) to compliance with the incubators' targets. Therefore, it

could be claimed that establishing flexible organizational procedures usually makes the responsibilities of the incubators and the start-ups clear.

Accordingly, the authorities of the start-ups will clearly understand what the incubator expects them. This will cause the authorities of the start-ups in the incubators feel closer to the incubators' management and their objectives and try to prevent the overlapping of responsibilities and duties. Therefore, the results of the present study are in line with the statements by [14,15].

The extra-organizational factors likelihood could also directly leave a positive impact on incubators' effectiveness. Such factors are on the one hand due to the relation between the incubators and the start-ups and the industries out of the incubators and on the other hand, due to the devised laws and regulations and the supports by the government, university and local authorities. All this probably will improve the incubators' effectiveness. In this case, the results of the research are in line with those by [6, 8,7].

Considering the field-related literature, it is likely that the first model which has pinpointed the factors effective on the improvement of incubators' effectiveness based on path analysis, is the explanatory model achieved by the researcher in the present study though it is still in preliminary stages. That is why the present study could be a starting point for developing various explanatory models for promoting the technology incubators' effectiveness in Iran and across the world.

RESEARCH LIMITATIONS

The research tools were limited to questionnaire, which imposed certain limitations.

Given that not all incubators were active, the survey population did not include all the incubators and was restricted only to the active ones. So generalizing the results should be made with due care.

The effectiveness studied is the perceived effectiveness by the managers of the start-ups in incubators and so it is not the same as the effectiveness measured by the metric indexes.

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A. Ghasemizad was born in 1973 in Kazeroun -Iran. His degree is PhD in Higher Education Administration at Islamic Azad University at Science and Research of Tehran in Iran. He works at Islamic Azad University of Kazeroun Branch in Department of Public Management as Faculty Member.