The Critical Success Factors of Technology Incubators: An Empirical Study

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Abstract

Technology incubators (TIs) become popular in late 80's. The study investigates critical factors that affect the success of incubators. An email survey of 193 established TIs was conducted using questionnaires. The results indicate that: (1) The history and size of an incubator affect the level of its success. In general, the larger the incubator, the more likely it will succeed. (2) It helps if technology transfer is available to clients of the incubator. (3) Cooperation and support from academic institutions and availability of entertainment facilities are positively related to the success of the incubator. (4) The diversity and entrepreneurship of the clients are significant. (5) Office support, research facility, and a climate for strategic alliance are also important. The paper concludes with the implication of the findings and issues for future research.

1. Background

Formal business incubators are designed to provide a nurturing environment; furnishing essential space, business assistance and support services that are crucial to the survival of the small business, especially during the initial stages of development until they are able to survive independently. The nurturing environment is usually created by providing on-site support services and favorable rental space costs [1-2]. Technology incubators (TIs), the major types of business incubators, have become popular since 80's. TIs not only assist client firms in research and development (R&D) and technology transfer efforts by whatever means available but also help reduce the risk and enhance the possibility to success[1]. TI have fostered the growth of many companies involved in emerging technologies such as software, medical and bio-technologies, robotics, and instrumentation [6].

The TI industry in Taiwan was introduced by Small and Medium Enterprise Bureau (SMEB) in 1996 to help domestic medium and small businesses undertake the rapid change of the environment of management so that they may breakthrough the bottleneck of management, grow up by degrees, and eventually face the advent of the 21st century with powerful capability of competition [7]. How to develop a successful TI industry has become an extremely important issue since then. We raise the following fundamental questions: What steps may be taken to determine whether or not Taiwanese TI have gained all the benefits that previous successful TI worldwide have offered? The answers to these questions are crucial to the development of an effective TI industry in Taiwan. Therefore, this study is aimed at identifying the critical success factors required for the sustained development of TI.

2. Literature Review

Amalgamating available literature [1-3, 5-27], by examining case studies and through interviews and with clients and managers of various TIs, has identified benefits and important factors for operating TIs. Based on a thorough literature review, we first propose an integrated model successful TI management. The model emphasizes the following three important dimensions (see Figure 1):

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[1] Culp [3] point that contrasting the survival rate for 1991 [4] was 85 percent in incubators industry with the general business survival rate of 50 percent [5] indicated that technology incubator firms tend to have a higher incidence of survival than did non-incubator firms.

(1) Macro environment: Four influencing factors in this dimension are: policy, economic, law, and technology.

(2) Networking with other sponsors: Four determining factors in this dimension are: client, university, sponsor, and community.

(3) Internal management system: An assessment of the facility's management practices and operational policies in light of the program objectives provides a review of the effective utilization of resources resulting in the success of the program [17]. Key elements in this dimension include goals, marketing, R&D, finance, human resources, physical services, and law services of TIs.

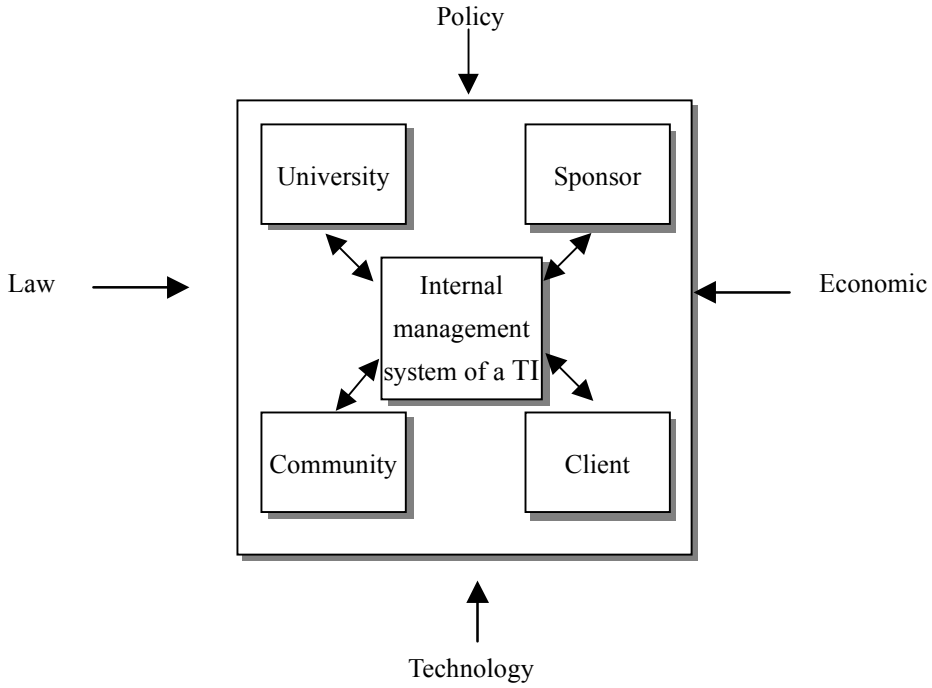

Fig. 1 An integrated model for Technology incubator management

In this paper, we focus our discussion on clarifying critical factors in (2) and (3). Tables 1 to 4 summarize literature and identified variables/indicators under the four networking factors of the TI management, i.e., client, university, sponsor of TIs, and community. Tables 5 to 8 summarize literature and identified variables/indicators under the internal management system factors of the TI management, i.e., goals, marketing, R&D, finance, human resources, physical services, and law services of TIs.

Table 1 Summary of the literature related to the client factor

	Variables/indicators	Literature
Criteria for admitting clients	Perceived characteristics of entrepreneurs Well defined market and customers Projected growth potential The incubator's objectives Proprietary advanced technology concept or prototype Qualified management team, e.g., experience, talent Ability to pay for rent and services Potential attractiveness to investors Existing commercial product, process or service Promising strategic business plans	3, 6, 19, 23, 24,27-29
Interaction among clients and TIs	Degree of consultation and management Rating the services	Same as above

Table 2 Summary of the literature related to the university factor

Variables/indicators	Literature
Typical incubator services and their impacts	
Shared office services	12, 25, 30
Business assistance	25, 31
Access to capital	25, 32
Business network	13, 25
Rent breaks	12, 31
University-related services and their impact	
Faculty consultants	10, 33, 34
Student employees	10, 33, 34
University image	25, 35
Library services	10, 25
Labs and networks	25, 36, 37
Mainframe computers	12, 38
Related R&D activity	10, 33, 37
Technology transfer programs	10, 12, 25, 39
Employee education and training	10, 12, 34
Sports and social activity	10, 27

Sources: [16]

Table 3 Summary of the literature related to the sponsor factor

	Variables/indicators	Literature
Financial help	Seed fund Obtain bridge financing Apply financial tools	6, 9, 19, 23-24, 27-29,40
Non-financial help	Obtaining information Networking with other incubator managers Training incubator manager or other management assistance Providing business, financial or technical assistance to clients Coordinating with, or obtaining cooperation from other organizations	6, 9, 19, 27, 40

Table 4 Summary of the literature related to the community factor

Variables/indicators	Literature
Supports of finance and human resources from the community Creation of job opportunity Resources of potential clients Sales market Innovation environment and synergy	6, 9, 23-24, 40

Table 5 Summary of literatures related to the factor of major goals and objectives

Variables/Indicators	Literature
Low rental fee	12, 24, 27, 31
Definite develop goals	10, 19, 23-25, 27, 29, 41
Business network	13, 22, 24
Business assistant	9, 11
Exit policy	25, 42
Structure and governance	9, 22, 29, 43

Table 6 Summary of literature related to the factor of marketing services

Variables/Indicators	Literature
Develop / use market databases Provide formal market research Assist with product design Develop product prototypes Test and certify products Develop international trade Develop marketing partnerships	9, 22-23, 27, 29, 43-44

Table 7 Summary of literature related to the factor of financial services

Variables/Indicators	Literature
Provide seed funds Assist in financial analysis. Help obtain venture capital financing Prepare financing proposals Obtain Small Business Innovation Research (SBIR) support Assist with large federal grants Obtain bridge financing Assist in evaluation of tenant enterprise	9, 22-25, 27, 43-44

Table 8 Summary of literature related to the factor of law services

Variables/Indicators	Literature
Assist in enterprise incorporation Develop license agreement Facilitate intellectual property protection Provide tax assistance Assist with government procurement issues Comply with federal, other standards Arrange for contract services	10, 12, 25, 27, 30, 44

Table 9 Summary of literature related to the factor of human resource services

Variables/Indicators	Literature
Provide technology education Provide temporary staff Brokering access to research expertise Provide management training Select and assess employees	10, 12, 17, 23, 27, 33-34

Table 10 Summary of literature related to the factor of R&D services

Variables/Indicators	LIterature
Access to external technical facilities Locate key technology staff Assist technology ferret and outreach Use researchers and technologies databases Evaluate competing technologies	10, 12, 25, 27, 33, 37, 39

Table 11 Summary of literature related to the factor of shared services

	Variables/Indicators	Literature
Physical infrastructure	Internet / network / telecom service Cafeteria / lunch room Software libraries Conference room Computer equipment leasing	10, 16-17, 25, 27
Office services	Word processing / clerical Photocopier Telephone Shipping / receiving Mail sorting Security Custodian / Maintenance Receptionist Facsimile (Fax) Computer technical support services	12, 23-25, 30

Similarly, amalgamating available literature [3, 9-12, 17, 19, 30, 36, 45-48], by examining case studies and through interviews and with clients and managers of various TIs, has identified criteria for evaluating the performance of TIs. They are criteria to (a) foster new start-up enterprises, (b) create new jobs, (c) promote technology transfer, (d) commercialize new technology, and (e) get revenue, (f) revitalize local economy, and (g) accelerate economy. Figure 2 illustrates our revised theoretical model of TI management, in which these critical factors identified in the (2) and (3) and their relationship with TTs' performance need to be further examined.

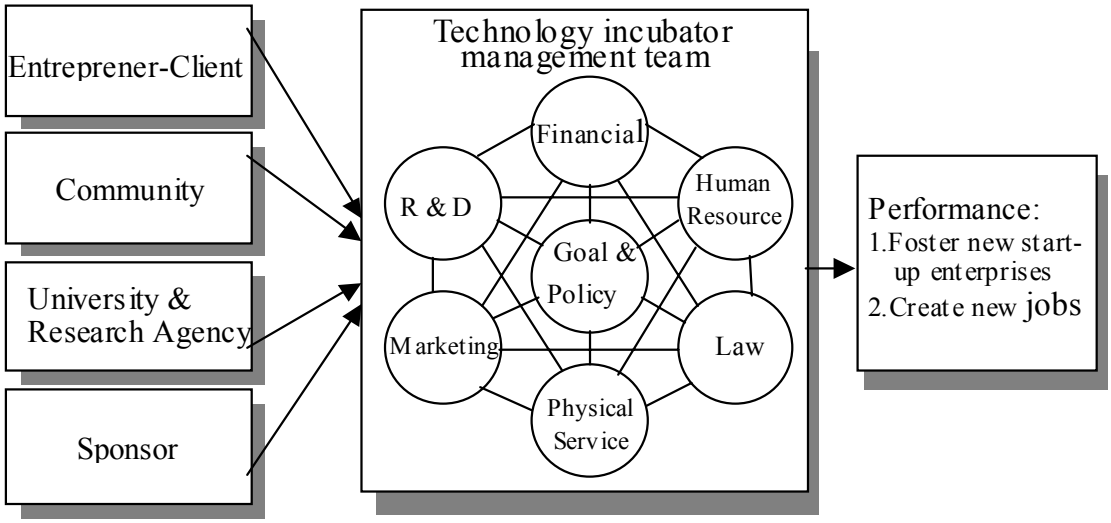

Fig. 2 The revised internal incubation model

3. Methodology

The research methodology for the study made use of questionnaire via electronic email and fax to survey well-established technology incubators in the world to examine factors that have been identified as important determinants of TI. The design of questionnaire instrument was referred to [3-4, 6, 19, 27]. The content of questionnaire instrument contains six sections: (a) profile of incubator; (b) profile of sponsors; (c) profile of clients; (d) incubator supporting service; (e) performance of the incubator; (f) major difficulties.

The questionnaire was reviewed by a top manager of a local TI manager, and a colleague who is an expert in technology management, and pre-test on several local TI managers to ensure its content validity and to verify the clarity of the questions. 193 questionnaires were delivered to TIs in selected areas, 33 for TIS in the USA and Canada, 25 for TIs in Israel, and 5 for TIs in Singapore, Hong Kong, and Japan. We received 39 survey results. Total response rate of the mail survey was 20.21% based on valid responses. Table 12 presents the total rate and response rates in different areas. Data were analyzed using we employed descriptive and non-parametric statistics (Mann-Whitney U test) to analyze our survey data.

Table 12 Questionnaires received and response rate

	USA and Canada	Israel	Others	Total
No. of received／No. of mailed	33／163	5／25	1／5	39／193
Response rate (%)	20.25	20	20	20.21

4. Results and Discussion

4.1 Descriptive Statistics Analysis

The results indicate that: (1) Most of our surveyed TIs are located in urban and suburban arenas, and 90% of them are near academic institutions. It reflects Tis' needs of information and important technologies. (2) The major goal of a TI is to foster new start-up enterprises and create new jobs. (3) The average age of TIs is 8.18 years old. (4) About 55.6% of surveyed TIs can cover their basic operation cost. (5) About 66.7% of surveyed TIs have so-called subsidize policies, but only 18.9% of them have profit sharing policies. (6) In average, the maximum years the client can stay in TIs are 3.53 years. Although most of the TIs have no written exit policy defined in years, but most of them will raise rental fees to encourage graduation.

33.3% of surveyed TIs are sponsored by hybrid sponsors[2], and 25.6% are by universities. In particular, the most frequently offered resources to TIs by state/local governments are: business supports, financial or technical assistant, and cooperation with other organizations; the most frequently offered resource to TIs by academic institutions is the manpower.

Listed in a descending order, the most frequently offered services to clients are services related to office, physical infrastructures, finance, legal consulting, R&D, marketing, and human resources. About 55.3% TI would actively solicit clients' need for help. Moreover, the top three major criteria for admitting clients are projected growth potential, perceived characteristics of entrepreneurs, and meet with the incubator's objectives.

The average number of job created by a TI is 9.15. There are 68.13% clients could successfully survive. The major difficulties are lack of funding (35.8%) and hard to find appropriate clients (20.8%).

4.2 Statistics Test (non-parametric statistics)

We compared the characteristics of the TI in the same industry, but with different rates of survival rate and the number of creating jobs. Several hypotheses are tested to determine whether differences exist between high and low successful among four dimensions. These dimensions include the profile of incubator, sponsor, client and service, which support to clients. Because the respondents of the survey are very outstanding, it is hard to result in a significance level in the tests of statistical hypotheses. The results indicate as follows.

(1) The size of the incubator and history affect the level of success.

In general, the larger the incubator, the more likely it will succeed (showed in Table 13). It also helps if technology transfer is available to support the client;

Table 13 Profile of Incubator to the success factors

	Year of establishment	Major goals and objectives	Scale	
		Promote technology transfer	Rental space	Annual budget
M-W Test	0.021**	0.075*	0.055*	0.099*
Pearson	0.521***	0.298*	0.257	0.339*

* respondents $p < 0.1$, ** respondents $p < 0.05$, *** respondents $p < 0.01$

[2] Hybrid means an incubator is accountable to a consortium with no single controlling entity.

(2) Cooperation and support from academic institutions and availability of entertainment facilities are positively related to the success of an incubator (showed in Table 14).

Table 14 Profile of Sponsors to the success factors

	Be the sub-unit of an university	Receive resources from university / college (Sports and social activity)
M-W Test	0.040**	0.030**
Pearson	0.361**	0.438**

** $p < 0.05$

(3) The diversity and entrepreneurship of the clients are also significant (showed in Table 15).

Table 15 Profile of clients to the success factors

	Major criteria for admitting clients		The kinds of clients accept 進駐廠商種類		
	Perceived characters of entrepreneurs	Projected growth potential	The number of client kinds	Bio-technology and medical	Environment equipment
M-W Test	0.030**	0.072*	0.049**	0.023**	0.023**
Pearson	-0.327*	-0.343*	0.371**	0.424**	0.424**

* p<0.1, ** p<0.05

(4) Office support, research facility, and a climate for strategic alliance are important (showed in Table 16).

Table 16 Incubator support services to the success of a TI

	R&D Service		Office services
	The amount of R&D services	Assist technology ferret and outreach	Telephone
M-W Test	0.043**	0.006***	0.049**
Pearson	0.307*	0.492***	0.366**

* p<0.1, ** p<0.05, *** p<0.01

5. Conclusions

Despite the limitations, the study combines several related literatures to develop an integrative framework to understand the operation model of TI and find the critical successful factors. The results indicate that: (1) The history and size of an incubator affect the level of its success. In general, the larger the incubator, the more likely it will succeed. (2) It helps if technology transfer is available to clients of the incubator. (3) Cooperation and support from academic institutions and availability of entertainment facilities are positively related to the success of the incubator. (4) The diversity and entrepreneurship of the clients are significant. (5) Office support, research facility, and a climate for strategic alliance are also important.

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