

Comparison of Performance of Business Incubators at Universities and National Research Institutes

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I. Introduction

Business incubators (BIs) are established to incubate (objectively help) newly born firms so that they become competitive enough to survive. The newly born firms with competitive technology usually do not have enough managerial and technical resources to successfully develop, market and sell products. BI usually provides the firms not only with expensive research facilities but with necessary managerial and technical nurturing services such as helping to finance funds, to market products, to get legal assistance, and to let the firms utilize research equipments and facilities. BIs, about 2,500 in South Korea, are mainly located at universities and national research institutes since research equipments and facilities essential to incubate firms are easily accessible in universities and institutes.

Firstly, performance of BIs was measured by whether physical equipments and facilities are available to the newly born firms. Later, not only the existence of physical facilities but of managerial and technical services were measures of BIs' performance evaluation. Prior studies (Yang et al., 2002; Lee and Choi, 2001; and Song, 2000) concerning BIs' performance reported whether physical facilities and services were available or not, and if the facilities and services are available, and how many times BIs can provide such facilities and services.

The purpose of this research was two fold. Firstly, we hypothesized BIs' performance affected the relationship between an incubated firm's market and technology environments and the firm's performance. Secondly, any differences in the firms' environments, the firms' performance, and BIs' performances were investigated between two groups of BIs; BIs at universities (UBI) and BIs at national research institutes (RBI).

Results of this study would add additional evidence of BIs' performance from service consumers' viewpoint. Findings also have some practical value; they can be applied to setting more effective procedures for BIs' performance evaluation.

II. Prior Studies

Prior studies for this research were grouped into two categories. One group of prior studies reported critical success factors for BIs. The other group found environmental variables influencing newly born firms' performance.

Smilor (1987) studied BIs in U.S. and found BIs' critical success factors to be BI management expertise, support for obtaining funds, effective administrative services, successful link for local social network, and entrepreneur education. Lalkaka and Rustam (1997) studied BIs in their planning, operating and monitoring stages and found similar success factors to those in the Smilor study. Park et al. (1999) studied BIs to find BIs' success factors to support for obtaining funds, to provide information network service, to make specific areas and to establish a research link of government, industries, universities and research institutes. Yang et al. (2002) suggested a BI evaluation model in which BI management and BI services are important performance factors. Lee and Choi (2001) suggested variables such as operating strategies, physical

and human resources, incubating services, and service of link to outside resources were BIs' critical success factors.

MacMillian and Day (1987) analyzed success variables of inner-firm ventures and found that the market environment critically impacted upon successful operation of the ventures. Roure and Keeley (1990) reported that technology variables such as product development time and market factors affected newly born venture firms. Zahra (1996) and Zahra and Covin (1995) concluded that uncertainties of environments had significant impacts on small firms' survival. Ahn and Kim (2002) suggested not only technology and business environments but technology and business resources jointly impacted upon IT venture firms' performances.

This study analyzed results of prior studies and found a lack of an comprehensive incubating performance model in which BI performance affected the relationship between market and technology environments of firms in BIs (BI firms) and the BI firms' performance. We also investigated any differences in the BI firms' environments, the firms' performance and BI performance between two different groups of firms: those at universities BIs (UBI firms) and those at Research Institutes BIs (RBI firms).

III. Research Procedures

3-1 Research Model

Prior studies demonstrated that in the industry of information processing ventures a firm's management system should adjust or "fit" to the technology environment in order to obtain acceptable performance measures of the firm. Ahn and Kim (2002) also reported that performance of management strategies were subject to the fitness of the strategies to the market and technology environments.

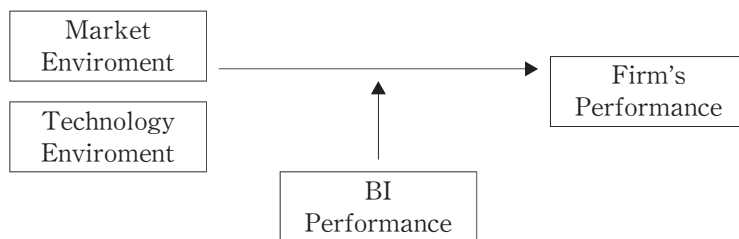


Figure 1 Research Model

Prior environment-performance studies and BI research advised a conceptual model in which a BI's performance would affect the relationship between a BI firm's market and teleology environments and the firm's performance. Figure 1 depicted the relationships that a firm's market and technology environment variables could relate to the firm's performance and a BI's performance could affect the relationship.

3-2 Research Variables

The research variables in Figure 1 were constructed and modified mainly from prior studies. The market environment variable were constructed from nine items of five-Likert scale (5: Strongly Agree, 1: Strongly Disagree) questionnaire including number of competitors, difficulty of market entries, existence of main competitor, market competition of main product, forecast of customers' preferences, forecast of product technology, forecast of competitors' behavior, market growth, and unfilled market demand (see Table 1). The technology environment variable had eight questions being level of product technology, integration of new technology, investment of technology development, technology development cycle, technology gap to tech leader, number of patents developed, concerted technology from industry-university-research con-

cord, and concerted technology from other firms (see Table 2).

Firms' performance were measured from 14 question items constituting financial as well as non-financial measures. Performance items were selected based on the newly developed Balanced Scorecard (Kaplan and Norton, 1993) concept (Table 3). BIs' performance were measured using 17 question items modified from results of prior studies (Yang et al., 2002; Lee and Choi, 2001; and Park et al., 1999). As in Table 4, BI Performance measures included measures for incubating service foundation, and for sufficiency or adequateness of incubating services.

3-3 Samples

Sample BIs were selected based on convenience since we wanted as many BIs in Korea as possible. University BIs came mainly from universities in metro Seoul, Busan and Daejeon areas and research BIs came from the Daejeon Research Institute Complex. Ninety three samples (sixty three UBI firms and thirty RBI firms) were finally used as valid data for this study. Data were collected using questionnaires via site visits, phone calls, e-mails, and post mails and were analyzed using non-parametric (Kruskal-Wallis), factor and correlation statistical methods.

IV. Results

UBI firms and RBI firms showed similar in their size of the number of employees; UBI firms averaged 5.83 persons and RBI firms had 6.30. All BI firms reported that they were small but were incorporated. Main industries of BI firms included computer and OA manufacturing, machinery manufacturing, and manufacturing of electronic parts, video-audio parts, and communication parts.

4-1 Differences in Variables

One of research objectives was to identify any differences in variables of research model (see Figure 1). Following are results of difference analysis of main research variables.

4-1-1 Market Environment

Market environment variable was measured using nine 5-Likert scale (5: Strongly Agree, 1: Strongly Disagree) question items (ME1 – ME9, see table 1). Both UBI and RBI firms responded to all market environment items very similarly except ME6 and ME9. RBI firms evaluated more optimistically forecast of product technology (ME6) and unfilled market

Table 1 Market Environment

Items	Group	Average	Std Dev	KW test	Sig.
number of competitors (ME1)	RBI Firms	3.47	0.97	0.768	0.381
	UBI Firms	3.27	1.00		
difficulty of market entries (ME2)	RBI Firms	2.57	1.17	1.389	0.239
	UBI Firms	2.75	0.80		
existence of main competitor (ME3)	RBI Firms	3.13	1.01	0.076	0.783
	UBI Firms	3.17	0.83		
market competition of main product (ME4)	RBI Firms	3.33	1.03	0.131	0.717
	UBI Firms	3.35	0.86		
forecast of customers' preferences (ME5)	RBI Firms	2.73	0.74	1.722	0.189
	UBI Firms	2.94	0.84		
forecast of product technology (ME6)	RBI Firms	2.33	0.76	12.512	0.000**
	UBI Firms	2.92	0.68		
forecast of competitors' behavior (ME7)	RBI Firms	2.67	0.76	2.677	0.102
	UBI Firms	2.86	0.62		
market growth (ME8)	RBI Firms	3.77	0.73	1.734	0.188
	UBI Firms	3.57	0.69		
unfilled market demand (ME9)	RBI Firms	3.87	0.73	5.014	0.025**
	UBI Firms	3.56	0.69		

**p<0.05

demand (ME9) than UBI firms did. That meant RBI firms were more technically adapted to the environment and they, therefore, likely to see more possible niche market for products from technologies. Interesting was that all firms responded greater than 3 in 5 scale to number of competitors (ME1), existence of main competitor (ME3), and market competition of main product (ME4) items, which meant that all firms estimated the market was significantly competitive.

4-1-2 Technology Environment

Technology environment variable was measured using eight 5-Likert scale (5: Strongly Agree, 1: Strongly Disagree) question items (TE1 – TE8, see table 2).

Table 2 Technology Environment

Items	Group	Average	Std Dev	KW test	Sig.
level of product technology (TE1)	RBI Firms	4.07	0.69	2.214	0.137
	UBI Firms	3.86	0.56		
integration of new technology (TE2)	RBI Firms	3.93	0.69	9.442	0.002**
	UBI Firms	3.46	0.69		
investment of technology development (TE3)	RBI Firms	3.43	0.86	0.206	0.650
	UBI Firms	3.30	0.85		
technology development cycle (TE4)	RBI Firms	3.30	0.92	0.693	0.405
	UBI Firms	3.11	0.76		
technology gap to tech leader (TE5)	RBI Firms	3.40	0.97	1.250	0.263
	UBI Firms	3.62	0.79		
number of patents developed (TE6)	RBI Firms	2.97	0.76	0.193	0.660
	UBI Firms	3.05	0.92		
concerted technology from induni-res concord (TE7)	RBI Firms	3.53	0.86	4.811	0.028**
	UBI Firms	3.02	0.99		
concerted technology from other firms (TE8)	RBI Firms	3.07	0.83	0.143	0.706
	UBI Firms	3.08	1.05		

**p<0.05

RBI firms marked higher on some technology environment items like integration of new technology (TE2) and concerted technology from

Table 3 Firm Performance

Items	Group	Average	Std Dev	KW test	Sig.
sales growth (FP1)	RBI Firms	3.14	1.01	0.305	0.581
	UBI Firms	3.24	0.98		
total asset growth (FP2)	RBI Firms	2.89	1.07	0.149	0.699
	UBI Firms	2.87	0.89		
product development (FP3)	RBI Firms	3.82	0.72	4.976	0.026**
	UBI Firms	3.45	0.69		
technologies certified (FP4)	RBI Firms	3.82	0.55	7.367	0.007**
	UBI Firms	3.42	0.62		
product quality (FP5)	RBI Firms	4.00	0.61	2.609	0.106
	UBI Firms	3.78	0.58		
customer satisfaction (FP6)	RBI Firms	3.75	0.75	0.383	0.536
	UBI Firms	3.67	0.80		
expertise in dealing customers (FP7)	RBI Firms	3.75	0.80	1.477	0.224
	UBI Firms	3.46	0.80		
expertise in developing products (FP8)	RBI Firms	4.14	0.76	11.554	0.001**
	UBI Firms	3.56	0.76		
benchmarking (FP9)	RBI Firms	3.36	0.78	3.759	0.053*
	UBI Firms	3.08	0.52		
acceptance of knowledge (FP10)	RBI Firms	3.68	0.77	1.139	0.286
	UBI Firms	3.52	0.67		
innovation of new product (FP11)	RBI Firms	3.82	0.67	3.026	0.082*
	UBI Firms	3.56	0.67		
self innovation (FP12)	RBI Firms	3.79	0.92	3.998	0.046**
	UBI Firms	3.54	0.64		
timely innovation (FP13)	RBI Firms	3.79	0.63	12.979	0.000**
	UBI Firms	3.25	0.62		
innovation into marketability (FP14)	RBI Firms	3.50	0.69	0.643	0.423
	UBI Firms	3.35	0.63		

**p<0.05, *p<0.10

industry-university-research institutes concord (TE7). This meant RBIs would choose firm with special technologies that would best utilize RIs' incubating facilities.

4-1-3 Firm Performance

Firm performance variable was measured using fourteen 5-Likert scale (5: Strongly Agree, 1: Strongly Disagree) question items (FP1 – FP14, see table 3).

Table 3 showed five firm performance items (FP3, FP4, FP8, FP12, FP13) which were significantly different between UBI firms and RBI firms. Also data showed RBI firms evaluated their performances higher than UBI firms. RBI firms would satisfied their performance especially in managing innovation (FP12, FP14), developing expertise (FP 8), and manufacturing technology-driven products.

4-1-4 Business Incubator Performance

BI performance variable was measured using seventeen 5-Likert scale (5: Strongly Agree, 1: Strongly Disagree) question items (IP1 – IP17, see table 4).

Item 17 represented overall satisfaction of BI firms to all support services of the BI. On average, BI firms rated very similar in items including satisfaction of BI incubating services except transparency of operating procedures (IP3) and pertinency of rental fee (IP4), which RBI firms evaluated higher than UBI firms.

4-2 Factor Analysis

Common factors from research variables question items were extracted to explain variables more concisely. To extract factors, varimax rotation method was used. Crombach alpha was used to examine validity of extracted factors. Both market environment and technology environment variables had three factors. Firm performance had four factors,

Table 4 Business Incubator Performance

Items	Group	Average	Std Dev	KW test	Sig.
special concern of BI (IP1)	RBI Firms	3.83	1.09	1.620	0.203
	UBI Firms	3.65	0.83		
specialty of BI Personnel (IP2)	RBI Firms	3.77	0.90	0.866	0.352
	UBI Firms	3.65	0.72		
transparency of BI operating procedures (IP3)	RBI Firms	3.77	0.97	9.086	0.003**
	UBI Firms	3.29	0.76		
pertinency of rental fee (IP4)	RBI Firms	3.40	0.81	7.082	0.008**
	UBI Firms	2.86	0.86		
valid entry and completion procedures (IP5)	RBI Firms	3.27	0.78	0.206	0.650
	UBI Firms	3.25	0.59		
satisfaction of facility usage (IP6)	RBI Firms	3.37	1.10	0.001	0.972
	UBI Firms	3.43	0.82		
satisfaction of administrative service (IP7)	RBI Firms	3.47	0.97	0.732	0.393
	UBI Firms	3.68	0.71		
satisfaction of marketing support service (IP8)	RBI Firms	3.13	0.97	0.173	0.677
	UBI Firms	3.22	0.81		
satisfaction of funding and tax support service (IP9)	RBI Firms	3.37	0.96	0.056	0.812
	UBI Firms	3.30	0.82		
satisfaction of legal support service (IP10)	RBI Firms	2.97	0.85	0.235	0.628
	UBI Firms	3.06	0.72		
satisfaction of technology support service (IP11)	RBI Firms	3.03	1.00	2.631	0.105
	UBI Firms	3.35	0.79		
satisfaction of product R&D support service (IP12)	RBI Firms	3.07	1.08	0.094	0.759
	UBI Firms	3.06	0.67		
satisfaction of special equipment usage (IP13)	RBI Firms	3.23	0.97	0.004	0.950
	UBI Firms	3.25	0.82		
link to universities, research institutes (IP14)	RBI Firms	3.17	1.02	0.206	0.650
	UBI Firms	3.13	0.79		
link to incubating completed firms (IP15)	RBI Firms	3.03	0.89	0.800	0.371
	UBI Firms	3.16	0.83		
link to government agencies (IP16)	RBI Firms	3.20	0.92	3.035	0.081*
	UBI Firms	2.90	0.69		
overall satisfaction (IP17)	RBI Firms	3.47	0.90	0.810	0.368
	UBI Firms	3.41	0.66		

**p<0.05, *p<0.10

and BI performance items were extracted into three factors (see table 5).

Following is summary of factors for each research variable:

Market Environment – Market Competition (ME-F1), Market Uncertainty (ME-F2), Market expectation (ME-F3)

Technology Environment – Technology Development (TE-F1), Technology Level (TE-F2), Technology Change (TE-F3)

Firm Performance – Customer Performance (FP-F1), Innovation Performance (FP-F2), Financial Performance (FP-F3), Operating Performance (FP-F4)

Business Incubator Performance – Facility/General Support (IP-F1), Technology Support/ Link (IP-F2), Rental Fee (IP-F3)

All factors was extracted based on the condition of their eigen value being greater than one. Factors except TE-F3 were found reliable based on the condition of Cronbach alpha being greater than 0.6. UBI Firms and RBI firms responded differently in factors of Market Uncertainty (ME-F2), Market expectation (ME-F3), Technology Level (TE-F2), Customer Performance (FP-F1), Innovation Performance (FP-F2), Operating Performance (FP-F4), and Rental Fee (IP-F3). That meant differences in factors represented differences in individual question items, and, therefore, explanation in individual variables (tables 1-4) would apply to the factors as well.

4-3 Correlation Analysis

Correlation analysis analyzed the impact of BI performance upon the relationship between BI firms' performance and the firms' environments, which was a main research objective of this study. Tables 6-7 presented results of correlation analysis among research factors identified in the factor analysis.

Table 5 Factor Analysis

Var.	Items	Factor Loading	Eigen Value	Factors	Cronbach —	KW test	Sig.
Market Env.	ME1	0.782	3.062	Market Competition (ME-F1)	0.719	0.133	0.716
	ME2	0.471					
	ME3	0.797					
	ME4	0.722					
	ME5	0.744	1.677	Market Uncertainty (ME-F2)	0.712	6.832	0.009**
	ME6	0.770					
	ME7	0.761	1.069	Market expectation (ME-F3)	0.638	5.154	0.023**
	ME8	0.915					
	ME9	0.740					
Tech. Env.	TE3	0.647	2.130	Technology Development (TE-F1)	0.676	0.026	0.872
	TE6	0.605					
	TE7	0.688					
	TE8	0.826					
	TE1	0.811	1.628	Technology Level (TE-F2)	0.591	7.140	0.008**
	TE2	0.774					
	TE4	0.889	1.167	Technology Change (TE-F3)	0.480	0.750	0.387
	TE5	0.658					
Firm Perform	FP5	0.613	4.584	Customer Performance (FP-F1)	0.733	5.847	0.016**
	FP6	0.585					
	FP7	0.770					
	FP8	0.817					
	FP9	0.322					
	FP10	0.532	2.104	Innovation Performance (FP-F2)	0.757	5.769	0.016**
	FP11	0.777					
	FP12	0.695					
	FP13	0.776					
	FP1	0.878	1.300	Financial Performance (FP-F3)	0.886	0.003	0.958
	FP2	0.900					
	FP3	0.694					
	FP4	0.607	1.015	Operating Performance (FP-F4)	0.630	4.881	0.027**
	FP14	0.662					
BI Perform	IP1	0.573	8.582	Facility/General Support (IP-F1)	0.914	1.017	0.313
	IP2	0.780					
	IP3	0.791					
	IP6	0.707					
	IP7	0.679					
	IP8	0.764					
	IP9	0.730					
	IP10	0.695					
	IP5	0.582	1.411	Technology Support/Link (IP-F2)	0.908	0.061	0.804
	IP11	0.786					
	IP12	0.589					
	IP13	0.786					
	IP14	0.679					
	IP15	0.891					
	IP16	0.688					
	IP4	0.911	1.064	Rental Fee (IP-F3)	—	7.082	0.008**

* * p<0.05, * p<0.10

Table 6 Factor Correlation in UBI Firms

	ME-F1	ME-F2	ME-F3	TE-F1	TE-F2	TE-F3	FP-F1	FP-F2	FP-F3	FP-F4
FP-F1	0.279 (0.151)	-0.311 (0.108)	0.472** (0.011)	0.295 (0.128)	0.426** (0.024)	0.349* (0.068)				
FP-F2	-0.196 (0.317)	-0.281 (0.147)	0.503** (0.006)	0.338* (0.079)	0.526** (0.004)	0.131 (0.508)				
FP-F3	0.061 (0.758)	-0.088 (0.654)	-0.072 (0.715)	0.119 (0.545)	-0.115 (0.560)	-0.044 (0.823)				
FP-F4	-0.064 (0.746)	-0.192 (0.329)	0.424** (0.024)	0.452** (0.016)	0.508** (0.006)	0.180 (0.359)				
IP-F1	-0.195 (0.319)	0.092 (0.643)	-0.158 (0.421)	0.122 (0.535)	-0.173 (0.379)	-0.034 (0.866)	-0.354* (0.064)	-0.107 (0.587)	0.100 (0.613)	-0.093 (0.638)
IP-F2	-0.119 (0.545)	0.057 (0.774)	-0.188 (0.337)	0.060 (0.761)	-0.077 (0.695)	0.060 (0.761)	-0.063 (0.749)	0.016 (0.934)	0.156 (0.427)	-0.034 (0.864)
IP-F3	-0.020 (0.921)	-0.101 (0.609)	-0.359* (0.061)	-0.179 (0.362)	-0.490** (0.008)	0.053 (0.790)	-0.282 (0.145)	-0.268 (0.168)	0.035 (0.858)	-0.290 (0.134)

**p<0.05, *p<0.10

Table 7 Factor Correlation in RBI Firms

	ME-F1	ME-F2	ME-F3	TE-F1	TE-F2	TE-F3	FP-F1	FP-F2	FP-F3	FP-F4
FP-F1	-0.161 (0.231)	0.032 (0.818)	0.258* (0.053)	0.290** (0.029)	0.222* (0.096)	0.316** (0.017)				
FP-F2	0.056 (0.680)	0.076 (0.576)	0.154 (0.252)	0.195 (0.145)	-0.054 (0.692)	-0.034 (0.801)				
FP-F3	0.055 (0.684)	0.260* (0.051)	-0.243* (0.069)	0.652** (0.000)	-0.086 (0.525)	0.233* (0.081)				
FP-F4	-0.180 (0.180)	0.057 (0.673)	0.384** (0.003)	0.370** (0.005)	0.196 (0.143)	0.428** (0.001)				
IP-F1	-0.103 (0.444)	-0.229* (0.086)	0.252* (0.058)	-0.096 (0.476)	0.331** (0.012)	-0.084 (0.533)	0.213 (0.112)	0.257* (0.054)	0.080 (0.556)	0.186 (0.167)
IP-F2	-0.144 (0.287)	-0.004 (0.974)	0.219 (0.101)	0.067 (0.618)	0.314** (0.017)	-0.275** (0.039)	0.387** (0.003)	0.163 (0.227)	0.195 (0.145)	0.069 (0.609)
IP-F3	0.120 (0.375)	0.288** (0.030)	0.005 (0.973)	0.367** (0.005)	-0.227* (0.090)	0.003 (0.980)	0.032 (0.812)	0.328** (0.013)	0.365** (0.005)	0.209 (0.119)

**p<0.05, *p<0.10

Market Competition (ME-F1), Market Uncertainty (ME-F2), Market expectation (ME-F3)
Technology Development (TE-F1), Technology Level (TE-F2), Technology Change (TE-F3)
Customer Performance (FP-F1), Innovation Performance (FP-F2), Financial Performance (FP-F3),
Operating Performance (FP-F4)
Facility/General Support (IP-F1), Technology Support/ Link (IP-F2), Rental Fee (IP-F3)

The upper left pane of tables 6-7 shows the relationship between BI firm environments and BI firm performance. BI firms' performances were generally positively associated with BI firm environments. In RBI firms, innovation performance was significantly related with market and technology environments, but financial performance was the significant factor associated with market and technology environments in UBI firms.

Association of the BI performance with the firms' performance and the firms' environments was shown in the lower pane of tables 6-7. UBI firms were likely to present more significant number of associations than RBI firms between BI performance and environment and performance of the BI firms. This meant that UBI firms were likely to more sensitively react to the incubating services than RBI firms.

V. Summary

This study hypothesized an incubating performance model in which BI performance impacted upon the association between BI firms' market and technology environments of firms and the BI firms' performance. Any differences in the BI firms' environments, the firms' performance and BI performance were also investigated between two different groups of firms: those at universities BIs (UBI firms) and those at Research Institutes BIs (RBI firms).

Variables of the environments, BI firms' performance and BIs' incubating performance were operationalized and statistically analyzed. The results of factor and correlation analyses showed that UBI firms' financial performance measures were associated with environments; RBI firms' innovation performance measures were associated with environments. Overall, UBI firms observed the technology environment less stable and, therefore, UBIs' incubating services were evaluated more

sensitively than those of RBI.

The results of this study would apply to the development of BI evaluation and support policies of the government. BI performance has been evaluated based on the service providers' viewpoint; the existence of physical facilities and services. This study, however, pointed out the importance of BI services consumers' (BI firms) viewpoint.

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