LOCATING IN UNIVERSITY-RELATED TECHNOLOGY PARKS: AN EXPLORATORY STUDY

Ben Paul B. Gutierrez[*]

This research explores the factors important in the choice of a technology park location. After drawing out potential factors from the literature and from local experts, a questionnaire was designed and fielded among local prospective investors to the park. Results reveal that local information technology organizations place more value to economic considerations rather than university-related locator-factors. The paper ends with the implications of the study for the conceptualization of the University of the Philippines Diliman Science and Technology Park.

I. INTRODUCTION

This research paper evaluates the factors influencing the choice of technology park location. In June 2000 the Office of the Vice President for Development (OVPD) of the University of the Philippines commissioned a market study to provide information for the conceptualization of the University of the Philippines Diliman Science and Technology Park. It is important to identify the needs of the future locators, who are the customers of the Park, during the planning and development of the Park.

More specifically, the objectives of the study are to identify the dominant attributes in the choice of technology park location and to determine the order of importance of the identified attributes among the prospective locators. Finally, another objective is to evaluate the acceptability of a concept on the proposed UP Diliman Science and Technology Park.

II. LITERATURE REVIEW

Universities, through the university-related research parks, have played an important role in regional economic development (Bass, 1998; Westhead and Batsone, 1998; Wheeler, 1990). These technology parks, or science and industrial parks, started in universities that had links with the industry (Bass, 1998; Lee, 1982).

Frederick Terman, an engineering professor at Stanford University, helped develop these links with the industry that led to the development of one of the

[*] Associate Professor of Marketing, College of Business Administration, University of the Philippines. This research was supported by the Office of the Vice President for Development (OVPD) of the University of the Philippines and was based on an earlier version prepared for the OVPD in February 2001. The author acknowledges the helpful comments of his reviewers. The usual disclaimer applies.

world's first industrial parks on university land in 1951 (Aley, 1997).

America's classic innovative hot spots – regions with a critical mass of high technology firms – have been Silicon Valley near San Jose, California and Route 128 near Boston, Massachusetts. In the 1990s, the most promising hot spots were Silicon Gulch in Austin, Texas and the Research Triangle Park in North Carolina (Herbig, 1993).

Wheeler (1990) found that universities appear to play an important role in the locator decision process of both high technology and non-high technology firms. A mail survey of 538 park tenants across 64 university parks in America revealed that the top 15 location factors were all university-related. Her results also indicated that economic development activities measured by the level of economic incentives were not major factors in location decisions.

Westhead and Batstone (1998) compared the perceived benefits of 47 technology-based firms locating in a science park that has formal links with a University versus 48 firms locating outside the science park (off-park). They found that science park tenants valued their location, established informal and formal links with universities and valued the "prestige" of being associated with a university-related science park. This finding supports Castells' (1996) view that "in a world of imperfect information flows, many new and small technology-based firms would be willing to pay a rental premium to increase their technological and commercial reputation."

In contrast, Massingil (1988) asserted that economic factors tend to dominate the 37 identified variables important in site selection decisions in Alabama. He claimed that in the selection of industrial sites, factors such as quality of post-secondary institutions and the proximity to colleges and universities were not major concerns.

Nevertheless, there is a great deal of evidence demonstrating the involvement of universities in technology parks. One example of a university research park is the 16-acre development called MetroTech Center near Brooklyn's Polytechnic University in New York (Post, 1992). According to George Bugliarello, president of the university, the slum districts and the feared exodus of big business prompted the designation of the site as a redevelopment area in 1982. Polytechnic became the master developer in spite of its limited real estate experience and capital. By the early 1990s, the New York City wasteland had been transformed into an over $1 billion high technology academic corporate park.

The Britanny region of France is a good example of the involvement of universities in technology parks. The Centre National d'Etudes Telecommunications located in Lannion provides a good base for the European research and development (R&D) facility devoted to telecommunications and related fields. Aside from proximity to Rennes Atalante science and technology park, Gwynne (1996) claimed that the availability of 55,000 students and 3,500 researchers - including the good English skills of engineers and technicians - were major factors that attracted investors.

Taiwan's Hsinchu Science Park, established in 1980 in northern Taiwan, flourished with the annual supply of 2,800 computer scientists and engineers trained by nearby Ching Hua and Chiao Tung Universities, and another 5,000 technical-school graduates (May-Yee, 2000). However, the park's success can also be explained by the support of the Taiwan government's strategy of building facilities first and offering juicy incentives in the form of five-year income tax exemption to technology companies and unlimited tax-free import of capital goods.

The second Taiwan science park, established in 1995 in Tainan attempted to duplicate Hsinchu. The government provided NT$2.4 billion (US$75 million) to develop the park. Incentives to attract locators were very generous. For instance, in late 2000 the lease period was for 20 years renewable at the rate of NT$10.3 (only 32 US cents) per square meter per month. Moreover, investors were attracted by a five-year corporate income tax exemption, four-year exemption on capital invested in facilities, and no import duties. Taiwan also maintained a development fund, which can be invested in locating companies for up to 25-30 percent with technology as equity (Ho, 2000).

A study conducted by Deloitte & Touche Fantus shows that incentives matter but their influence seems to be less than other factors (May-Yee, 2000). Among the 10 identified criteria, incentives were considered important but only secondary to the four essential criteria: access to skilled and educated workforce, proximity to world-class research institutions, an attractive quality of life, and access to venture capital. The first two appear to be university-related. Cambridge was able to attract a US$80 million Microsoft research lab without tax breaks or additional incentives because of Cambridge University's talent pool of computer scientists. If a location does not have such a talent pool, it must offer some incentives as experienced by Costa Rica and Ireland. A few other countries had the talent but had to include sweeteners for locators; for example, Dresden in Germany, the Jerusalem-Tel Aviv-Haifa triangle in Israel, the Software Technology Parks in Bangalore, India (May-Yee, 2001), Campinas in Brazil (Druckerman, 2000), Iceland (Baglole, 2001), and Malaysia (Prystay, 2001).

Franco (1985) identified 16 important factors contributing to the success of university-affiliated parks. He concluded that procedural factors (related to the development and operation of parks) are more likely to be anticipated and controlled than are the institutional factors (involving relationships between academia and private enterprise). The third set of factors, however, includes external indicators which are beyond the immediate control of park management or participants. Although least controllable, external factors offer many opportunities that a particular research park can offer by virtue of its location.

Such synergies of external factors beyond the control of university park management are also highlighted in the Deloitte & Touche Fantus study as reported by May-Yee (2000). These external factors include reasonable costs of doing business, an established technology presence, available bandwidth and adequate infrastructure, and a favorable business climate and regulatory environment.

Infrastructure should not be taken for granted as investors might give a lukewarm response to the technology park site. What happened to the $533 million International Technology Park in Bangalore, India in

1997 is a good example (McDermott, 1997). Costa Rica attracted Intel in 1998 by granting more licenses to foreign airlines to increase the number of daily international flights, building a power substation and reducing the energy rate for Intel by 28 percent (May-Yee, 2000). A McKinsey report on Multimedia Corridor of Malaysia recommended awarding high-value contracts to global technology companies, building more infrastructures and a stronger talent pool, plus more incentives (May-Yee, 2001).

Phillimore (1999) claimed that the development of technology parks followed the outdated linear model of innovation, which assumes that scientific knowledge can be easily transferred from a research university to an adjacent park for development. However, the newer and more recognized model looks at innovation as a complex, non-linear process that involves feedback loops and creation of synergies through a diverse range of networks. Thus, a more suitable framework of analysis on the importance of research and development in regional development would require a study of three focal groups: the industry, universities, and communities (Lee, 1982). Still another of level of study involves the analysis of technology policy and the administrative framework as they relate to the growth of research parks (Bass, 1998).

Franco (1985) suggested six major issues that should be considered in the development and operation of university-affiliated research parks. These are: 1) a development and management scheme that recognizes the long-term evolutionary nature of such ventures (see also Phillimore, 1999; Lee, 1982), and that is flexible enough to respond to unanticipated or unique opportunities; 2) an emphasis on research linkages (rather than manufacturing efforts) as the primary elements of park activities; 3) a clear understanding of the different roles of park participants; 4) the importance of academic (including faculty) participation in the long-range development of these parks; 5) efforts to tie academic-business research linkages within park settings to the educational institution's overall mission; and 6) the necessity for substantive and ongoing coordination between park management and government/community representatives.

Based on the literature review, the study tested eight hypotheses, namely:

1. Proximity to a university influences the choice of a science and technology park location.
2. Access to skilled and educated workforce influences the choice of a science and technology park location.
3. The quality of life offered by a park is positively associated with the choice of a science and technology park location.
4. Adequate infrastructure is positively associated with the choice of a science and technology park location.
5. A reasonable cost of doing business has a direct influence on the choice of science and technology park location.
6. A favorable business climate and regulatory environment has a direct influence on the choice of a science and technology park location.
7. Government incentives have a positive relationship with the choice of a science and technology park location.

8. Track record of technology park management has a positive relationship with the choice of a science and technology park location.

The hypotheses consider university-related factors (items 1 and 2), economic criteria (items 4, 5 and 6) and perceptual evaluations (items 3 and 8).

III. METHOD

The questionnaire was utilized to gather primary data. To prepare the items of the questionnaire, various locator-factors were generated through a literature search of journals/magazines and electronic databases. An in-depth interview with Angel S. Averia of Systems Standards, Inc. and the Philippine Computer Society was also conducted to review the locator-factors. Furthermore, the preliminary version of the questionnaire was reviewed by Dr. Jose Magpantay of the National Institute of Physics and Rafael N.V. Mantaring of the Technology Business Development of Ayala Corporation.

The population from which the sample was drawn included all potential technology park investors in the Philippines and abroad. To reduce the scope of the study and to work within the budget, only local companies were sampled. The sampling frame was the membership lists of the Semiconductor and Electronics Industries in the Philippines, Inc. and the Philippine Computer Society in the 1997 IT Resource Handbook published by WS Computer Publishing Corp. Other visible names in the industry were also included. The questionnaire was sent to 211 respondents in October 2000: 51 by electronic mail, 142 via facsimile machine and another 18 sent by post. Follow-ups through the telephone were conducted until November. A second round of mailings through fax and telephone follow-ups was conducted starting mid-January until February 2001.

Before a respondent was asked to accomplish the full questionnaire, two questions pre-qualified the respondents. These questions relate to the involvement of the organization in research and development (R&D) and/or information technology ventures and whether the organization had a plan to establish an R&D facility within 2-10 years. A negative answer to any of the two questions rendered the questionnaire unusable. A qualified respondent then evaluated 47 locator-factors on a 5-point Likert-type scale (1 = of no importance; 5=extremely important).

No questionnaires were received from electronic mail and by post thus reducing the respondent base to 142. Out of this base, 28 responded, but six of the questionnaires were unusable, leaving an effective response rate of only 15.5 percent.

IV. RESULTS

Fifty percent of the respondents were CEOs while 40 percent were middle managers from operations, marketing and human resources management. Ninety five percent of the respondents obtained undergraduate degrees, and 45 percent have graduate degrees. About 73 percent of respondent organizations were local companies and 23 percent were subsidiaries of multinational corporations. There were four small companies (below P10 million sales), four medium-scale companies (P11-100 million in sales), and 13 large corporations (above P100 million in sales). Table 1 indicates that a majority of the respondents came from companies engaged in electronics, semiconductor devices, and software development. The areas of R&D interests closely mirrored that of the companies' main line of business.

Table 1
Sample Profile: Main Line of Business/R&D Areas of Interest

Code		Main Line of Business		R&D Interest Areas	
		Frequency	Percent	Frequency	Percent
3	Electronics	6	19.4	11	22.9
4	Materials science			6	12.5
5	Manufacturing technology	6	19.4	8	16.7
7	Software development	8	25.8	11	22.9
8	Semiconductor devices	4	12.9	5	10.4
9	Telecommunications	2	6.5	5	10.4
10	Others	5	16.1	2	4.2
	Tota	31	100.0	48	100.0

Note: Multiple responses were allowed. Respondents were required to choose three main contributors and three R&D interest areas.

There were 47 locator-factors evaluated by the respondents. The 10 locator-factors (Table 2, see Appendix 1 for the full list) with the highest importance ratings have mean ratings ranging from 4.18 to 4.71. It appeared that the respondents valued more highly the economic factors such as incentives and infrastructure. On the other hand, the 10 locator-factors rated at the bottom have mean ratings ranging from 2.57 to 3.09. Respondents seemed to value less the factor "proximity to a research university" (3.41), and other associated advantages: access to laboratories and equipment (3.23), research linkage (3.23), access to consultants (3.18), access to research students (3.05) and access to libraries (2.86).

A majority of the respondents seemed to favorably regard the concept description of the proposed UP Diliman Science and Technology Park (see Appendix 2). It was too early to measure actual investment in the Park given the limited three-paragraph concept description. However, indications of actual investment in the Park were obtained by using two surrogate variables: Q51, considering investment (or intention to invest) and Q52, recommending the Park to other companies or investors. Sixty three

Table 2
Ten Most Important Locator-Factors

Top Ten Locator-Factors	Bottom Ten Locator-Factors
1. Tax and duty free importation of equipment	1. Permanent residency status for foreign nationals
2. Government incentives	2. Technology business incubator
3. Continuous power supply	3. Build-operate-transfer option
4. Reasonable cost of doing business	4. Library access
5. Skilled and educated workforce	5. Mixed cluster of locators
6. Telecommunications backbone	6. Recreation facilities
7. Transparent rules/policies	7. Endorsement of world-class IT companies
8. Security policies and procedures	8. Access to graduate research students
9. Favorable business climate and regulations	9. Presence of world-class IT locators
10. Vision and mission of park	10. Access to venture capital

percent of the respondents would consider investing in the Park; half of them qualified their answer with some conditions. To the question of recommending the Park to other companies, 85 percent answered yes, 25 percent with qualifications. These two surrogate variables to actual investment in the Park were significantly correlated (Pearson $r = 0.594$, $p = .004$, 2-tailed).

The limited number of cases precluded a factor analysis of the entire 47 locators together. Instead, the locator-factors were categorized into the eight classes which were predetermined during the questionnaire design (see Appendix 3). The eight categories had moderate to high scale reliabilities with Cronbach alphas ranging from 0.74 to 0.91. These categories were then correlated with the dependent variable, intention to invest in the UP Diliman Science and Technology Park. Only one category, cost of doing business, was significantly correlated (Pearson $r = 0.433$, $p = .044$, 2-tailed).

Individual locator-items were also correlated with the dependent variable. Most of the significant items were external factors and related to the cost of doing business. These items were continuous power supply ($r = 0.489$, $p = .021$, 2-tailed), reasonable cost of doing business ($r = 0.399$, $p = .066$, 2-tailed), competitive salary scales ($r = 0.439$, $p = .041$, 2-tailed), coordination with the government ($r = 0.404$, $p = .062$, 2-tailed), one-stop processing center ($r = 0.577$, $p = .005$, 2-tailed), and government incentives ($r = 0.374$, $p = .086$, 2-tailed).

Finally, a logistic regression model was fitted with "intention to invest in the Park" as the dependent variable and the eight locator-classes as predictor variables. Total item scores in each locator-class were utilized. The small sample size precluded entering the eight predictor-variables together in the model. Instead, three predictor-variables were entered initially; only the significant variables were retained and new variables were then entered. The last iteration is shown in Table 3.

Table 3
Model Coefficients and Diagnostics

Model Summary

Variable	B	S.E.	Wald	df	Sig	R	Exp(B)
Cost business	6.2314	2.8861	4.6619	1	.0308	.3046	508.4833
Bus. climate	–3.7405	1.9294	3.7586	1	.0525	–.2476	.0237
Incentives	–.7706	.8456	.8305	1	.3621	.0000	.4627
Constant	–10.8256	5.6495	3.6719	1	.0553		

–2 Log Likelihood	15.261
Goodness of Fit	14.948
Cox & Snell - R^2	.472
Nagelkerke - R^2	.634

	Chi-Square	df	Significance
Model	13.422	3	.0038
Block	13.422	3	.0038
Step	13.422	3	.0038

Hosmer and Lemeshow Goodness-of-Fit Test

	Chi-Square	df	Significance
Goodness-of-fit test	5.2008	8	.7359

The estimated model was significant at the 95 percent confidence level (-2Log Likelihood = 15.261; χ = 13.422, p = .0038). Two locator-classes have significant coefficients, cost of doing business and business climate. The latter, however, had the wrong sign. The logistic regression results show that the cost of doing business is the primary consideration of the Philippine managers when choosing a technology park location, lending support only to hypothesis 5.

V. CONCLUSION

Economic considerations tend to dominate the locator-factors sought by local companies in a technology park, a result similar to that obtained by Massingill (1988). Inspection of the respondents' ratings demonstrated this, but more importantly, the correlation and logistic regression analyses confirmed such a conclusion.

The role of a research university appeared to be valued less than government incentives, infrastructure, and a reasonable cost of doing business. This result implies that the respondents did not consider externalities associated with locating in a technology park of a research university such as access to frontier research, supply of highly skilled new entrants to the workforce, laboratories and equipment, etc. Respondent ratings for these university-related items were at the bottom half in the ranking of the locator-items.

While the results are just perceptions, they indicate that the companies view the University as just a source of graduates. There seems to be a lack of understanding on what the academe can do for the industry. This low perception of the university's role is manifested in the minimal research linkage between academe and the industry.

One limitation of the study is the low response rate of 15.5 percent; hence, the results are only indicative rather than conclusive. Although the two qualifying items of the questionnaire were quite stringent, most prospective respondents may have self-screened themselves, unless they were too lazy to respond to the questionnaire for some reason. The sample was carefully chosen to reflect the organizations who would probably invest in an R&D facility or who may be predisposed towards R&D because they belong to the rapidly innovating information technology sector. However, the results of this study may provide an indication of the state of R&D in the country including the values of its managers.

Another limitation of the study is the base of respondent organizations. The sampling frame was limited to local and multinational organizations operating in the Philippines. Small entrepreneurs and incubators or startups are also potential customers of the Park who may have different needs and expectations. By their very nature, the incubators might value R&D and university research collaboration more, including the need for venture capital. Incubators are, however, mainly unorganized and difficult to identify. These incubator issues can be addressed in a separate study.

Big multinationals based abroad searching for an R & D investment location may place more importance to other factors such as those identified by the Deloitte & Touche Fantus study (May-Yee, 2000). It is recommended that the Park developers think big and look towards attracting foreign investors, who would have more access to capital. The Park management must find out the needs of these foreign investors to actively woo them. A starting point would be to invite the multinational corporations already operating locally to establish their R&D facilities in the Park.

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Appendix 1
Mean Ratings of Locator-Factors

	N	Mean	Std. Dev
Q39 Tax & duty-free import of equipment	21	4.71	0.64
Q37 Government incentives	22	4.64	0.66
Q19 Power supply	22	4.59	0.59
Q23 Cost of doing business	22	4.55	0.60
Q03 Skilled & educated workforce	22	4.45	0.96
Q18 Telecommunications backbone	22	4.32	0.89
Q31 Transparent rules/policies	22	4.27	0.88
Q22 Security policies	22	4.27	0.70
Q29 Business climate/regulations	22	4.23	0.75
Q46 Vision and mission of park	22	4.18	0.73
Q28 Flexible lease terms	22	4.14	0.94
Q24 Competitive salary scales	22	4.14	0.77
Q17 Bandwidth	22	4.09	0.92
Q33 One-stop processing	22	4.05	0.90
Q42 Deduction of 50% cost of mgt training	21	4.00	1.10
Q20 IT support	22	4.00	0.87
Q44 Business experience of park manager	21	3.95	0.86
Q43 Track record of park management	21	3.95	0.74
Q04 English language skills	22	3.86	1.04
Q49 Reputation of site developer	21	3.86	0.96
Q48 Reputation of park owners	22	3.82	0.85
Q08 Engineering and science graduates	22	3.77	0.87
Q05 Range of IT workers	22	3.77	1.23
Q21 Transport links	22	3.73	1.03
Q38 Option to pay 5% gross income tax	22	3.73	1.45
Q25 Technology presence	22	3.64	0.90
Q45 Technical competence & education of park manager	21	3.62	1.02
Q47 Private ownership and management of park	22	3.59	0.85
Q13 Quality of life	22	3.50	0.91
Q32 Government coordination	22	3.45	1.26
Q15 Residential facilities	22	3.45	1.06
Q07 Proximity to university	22	3.41	1.01
Q11 Laboratories & equipment	22	3.23	1.15
Q12 Research linkage	22	3.23	1.19
Q06 Consultants	22	3.18	1.18
Q14 Open spaces	22	3.14	1.08
Q40 Hiring of foreign nationals	21	3.10	1.45
Q30 Venture capital	22	3.09	1.23
Q27 Presence of world-class locators	22	3.05	1.33
Q09 Research students	22	3.05	1.33
Q26 Endorsement of world-class IT company	22	3.00	1.31
Q16 Recreation facilities	22	2.95	1.13
Q36 Mixed cluster of locators	21	2.90	1.00
Q10 Library access	22	2.86	1.28
Q34 Build-operate-transfer option	22	2.77	1.41
Q35 Technology business incubator	21	2.76	1.18
Q41 Permanent residency status	21	2.57	1.54

Ratings on a 5-point Likert-type scale (1 = of no importance; 5=extremely important).

Appendix 2
Concept Description of the Proposed University of the Philippines Diliman Science and Technology Park

The University of the Philippines is developing a Science and Technology Park patterned after university-related research parks like Silicon Valley in California, Route 128 near Boston, Massachusetts, Silicon Gulch in Texas and Research Triangle Park in North Carolina. These facilities have proven the symbiotic relationship among the industry, universities and communities.

The intended locators are expected to be at the forefront of research and development and realize the value of collaborating with a research university. The Park's competitive advantage is its proximity to UP including access to its engineering and science students, graduates, faculty, modern libraries, laboratories and equipment. Locators would have an opportunity to engage in research projects in collaboration with the University.

Ayala Foundation signed an agreement with UP in June 2000 to develop a 5-hectare area located at the corner of Katipunan and C.P. Garcia avenues to be called Joint Experimental Facility in Technology Development and Technology-based Entrepreneurship. Another nine hectares are available near the Ayala project that includes the existing Technology Business Incubator established in 1986 under a project with the Department of Science and Technology, and at least 70 hectares would be available in the proposed S & T facility along Commonwealth Avenue.

Q51. Would your company consider investing in the proposed UP Diliman Technology Park in Quezon City, Philippines?

- ☐ Yes
- ☐ Yes, under some conditions. Please specify.____________________________
- ☐ No

Q52. Would you recommend the proposed UP Diliman Technology Park to other companies planning to establish an R&D facility?

- ☐ Yes
- ☐ Yes, under some conditions. Please specify. ____________________________
- ☐ No

Appendix 3
Locator-Factor Categories

Code	*Locator-Factor Item*	*Cronbach Alpha*
	Workforce	
Q03	Access to skilled and educated workforce	
Q04	Good English language skills	0.8562
Q05	Availability of a range of IT workers	
Q06	Access to business and marketing consultants	
	University	
Q07	Proximity to world-class research institution	
Q09	Access to graduate students and faculty consultants	
Q10	Access to modern libraries	0.8987
Q11	Access to advanced laboratories and equipment	
Q12	Research linkage between your company and the academe	
	Quality of life	
Q13	An attractive quality of life	
Q14	Campus-like atmosphere – wide, open spaces	0.9094
Q15	Adequate residential facilities	
Q16	Recreation, sports, and entertainment facilities	
	Infrastructure	
Q17	Available bandwidth and adequate infrastructure	
Q18	Telecommunications backbone and partnership with telecom providers	
Q19	Continuous power supply	0.7921
Q20	Information technology and computer system support	
Q22	Security policies and procedures	
	Economic	
Q23	Reasonable cost of doing business	
Q24	Competitive salary scales for professionals and workers	
Q28	Flexible lease terms at market rates	0.7405
Q33	Assistance in obtaining government permits – one-stop processing center	
Q34	Build-operate-transfer option	
	Business climate	
Q26	Endorsement of world-class IT companies (Microsoft, Cisco, etc.)	
Q27	Presence of world-class IT locators	
Q29	Favorable business climate and regulatory environment	0.8671
Q30	Access to venture capital	
Q35	Presence of technology business incubator	
Q36	Mixed cluster of park locators - IT, electronics, biotechnology, etc.	
	Incentives	
Q37	Availability of government incentives	
Q38	Option to pay 5% gross income tax in lieu of all taxes	
Q40	Hiring of foreign nationals	0.7860
Q41	Permanent residency status for foreign investors and family members	
Q42	Deduction from taxable income of 50% of the cost of labor and management training	
	Park management	
Q43	Track record of technology park management	
Q44	Business experience of park manager in related ventures	
Q45	Technical and educational qualifications of park manager	0.8476
Q46	Clear vision and mission for the park	
Q48	Reputation of park owners or shareholders	
Q49	Reputation of urban planner/site developer	