Why choose technology parks for business location in Pakistan

Sami Ullah
Faculty of Management Studies, University of Central Punjab, Lahore, Pakistan
Abdul Sami
University of Jhang, Jhang, Pakistan
Tooba Ahmad
Department of Humanities, COMSATS University Islamabad – Lahore Campus, Lahore, Pakistan, and
Tariq Mehmood
Preston University – CCMIT-Malir Campus, Karachi, Pakistan

Received 6 July 2021
Revised 2 September 2021
Accepted 19 October 2021

Abstract

Purpose – Technology parks (TPs) are used as a tool to improve economic outlook of the region through innovation generation. This study aims to evaluate the perception of tenants of TPs to determine the gap in the expectation and identify types of firms preferring to locate in a TP.

Design/methodology/approach – This is the first study in Pakistan to collect data about perceived benefits of TPs in Pakistan from the decision-makers of 110 tenant firms. The cluster analysis and lift ratios are used to draw statistical inferences.

Findings – The firms can be classified into three clusters – commercial-orientation firms, science and technology-oriented firms and young tech firms – with distinct needs for survival and growth in a TP. Moreover, TPs should not just be treated as property projects for providing support services, also knowledge sharing, training and development opportunities and proximity to hubs of knowledge and markets is vital to attract a variety of industry.

Originality/value – Academia and policymakers have been equally interested in the potential impacts of these innovation hubs. However, there have been lack of empirical evidence on how and what to offer the incumbents of these TPs. The government of Pakistan is trying to build more TPs for promoting business activities under CPEC. Therefore, it is extremely important to determine the needs of tenants of TPs for successful utilization of huge amount of public money to be invested in TPs.

Keywords Technology parks, Innovation, Knowledge sharing, Technological development, Social and business networking

Paper type Research paper

1. Introduction

The terms "Science parks" or "Technology parks" have been interchangeably used in the literature. Scholars have defined technology parks (TPs) in literature as geographical locations at which several innovative, knowledge-intensive firms are located together with a

This research is part of Higher Education Commission, Pakistan sponsored project no. 315.75/RG/R&D/HEC/2020/2086. The authors are thankful to the Pakistan Software Export Board, Punjab Information Technology Board, and Ministry of Information Technology, Pakistan, for extending support in data collection.

Innovation & Management Review
Vol. 20 No. 4, 2023
pp. 365-379
Emerald Publishing Limited
2515-8961
DOI 10.1108/INMR-07-2021-0114

formal and informal objective of boosting innovative activity (Link & Scott, 2015). The historical development of TPs has resulted in various objectives ranging from academic-industry linkage to regional development. Most recently, these TPs are used as hubs of innovation and capacity building in a region so that such a region can produce creative output (Liberati, Marinucci and Tanzi, 2016). If we look at TPs from a policy perspective, we can argue that business people use these TPs as a supply-driven measure to increase collaboration and enhance connectivity among the tenants of TPs (Edler and Georghiou, 2007). However, the macro-level analysis of TPs reveals their utility as a source of preventing market failure and supporting research and development activity at designated places to avoid stagnation and saturation. On the other hand, from a micro-level perspective, TPs provide high-quality infrastructural support at a low cost to the hosted firms. TPs enable small firms not to invest significant capital amounts in starting a business (Van Winden and Carvalho, 2015). Moreover, the co-location of firms in similar industries, and even better if universities are also present, provides added benefits of proximity (Hobbs, Link and Scott, 2017).

Although the idea of TPs has attracted academicians for a long time, the development of knowledge in this field is still in its embryonic phase, and empirical work has limited geographical coverage as only the UK and China are repeatedly analyzed (Hobbs *et al.*, 2017). Moreover, research on TPs has focused only on achieving their political goals with limited irrefutable evidence. The only conclusive evidence was the positive effect tenants perceived from networking and collaboration. However, evidence of positive economic effects is non-conclusive (Albahari, Klofsten and Rubio-Romero, 2019). Mora-Valentín, Ortiz-de-Urbina-Criado and Nájera-Sánchez (2018) suggested the need for more research on TPs, keeping in view the theoretical and empirical developments in this domain. Specifically, developing countries with advantages of low labor cost and a high potential for IT exports need to understand the effectiveness of TPs and how they can further support tenant firms to strengthen their economic output.

Thus, it is vital for Pakistan, where 22 TPs are fully functional, 40 TPs are under construction and 60 new TPs are expected to be completed by 2023, to thoroughly conduct a needs analysis and determine the perception of existing tenants about the attributes of existing TPs. The unique contribution of this study is that it is a pioneer in providing empirical evidence on the perception of TPs' tenants in Pakistan on the perceived benefits and services and facilities provided at these TPs, while grouping tenants into different classifications. Three major research questions addressed in this research are (1) What are the benefits TPs' tenants perceived as linked with the facilities and services provided at TPs? (2) How do tenants' perceptions differ across distinct types of firms? (3) How do tenants associate facilities and services provided at TPs with perceived benefits?

2. Literature review

Surprisingly, the needs of firms in TPs and their satisfaction with the infrastructural facilities, services and professional support have been ignored as a research topic (Albahari *et al.*, 2019; Ng, Junker, Appel-Meulenbroek, Cloodt & Arentze, 2020). Link and Scott (2003) studied the collaboration of universities and science parks and found the positive effect of this collaboration on the achievement of goals of the stakeholders. According to Etzkowitz and Zhou (2018), venture capital support provided to the tenants of TPs further strengthens their effect on economic output. Thus, better management of a community of businesses and standard resource bundle and professional support for development is highly likely to positively affect the performance of individual firms and TPs.

According to Albahari *et al.* (2019), managers of firms have considered the difference in supply and demand of facilities and services provided at TPs as the most significant obstacle

to their performance. The mismatch in supply and demand prevents existing firms from achieving their goals and causes potential new firms to perceive it negatively and look for other alternatives. Thus, analyzing tenants' perceptions about the attributes and benefits of TPs will allow policymakers and firms to make a more informed decision.

Moreover, the previous research by Díez-Vial and Fernández-Olmos (2015) and Ubeda, Ortiz-de-Urbina-Criado and Mora-Valentín (2019) showed the difference in needs of TPs firms. Therefore, we should consider the TPs firms' diversity to understand the variety in needs of tenants' subgroups. So far, the research on TPs' effectiveness has focused on new start-ups only (Chan, Oerlemans & Pretorius, 2010; Fukugawa, 2013; Guadix, Carrillo-Castrillo, Onieva and Navascues, 2016), ignoring the fact that research centers, support service providers and established firms are also part of TPs (Van der Borgh, Cloodt & Romme, 2012). According to Ferguson and Olofsson (2004), TP firms also vary concerning the maturity phase. Thus, distinctive characteristics of TPs can induce growth at distinct stages of development for start-ups and established firms. For example, the image of TP is relatively more important for new start-ups and young firms than for established firms. In addition, Chan and Lau (2005) found that the importance of TP attributes varies for various development phases of young firms and start-ups. However, we are sure that the facilities and services provided in TPs support the research and innovation policy objectives (Ferrara, Lamperti and Mavilia, 2016; Hobbs *et al.*, 2017).

3. Perceived benefits of technology parks

In this study, we have used the tenants' needs to analyze which features of TPs they perceive as most valuable.

3.1 Collaboration and knowledge sharing

One of the main objectives of developing a TP is to ensure the co-location of similar firms. This proximity offers opportunities for interaction and collaboration among the stakeholders and promotes growth in industrial activity and the likelihood of increased creative output (Berbegal-Mirabent, Torre, & Gil-Doménech, 2020; Edler & Georghiou, 2007). Apart from knowledge sharing, the co-location of similar firms results in reducing costs and developing strong social networks among the tenants. The literature shows that firms in industrial sectors with a need for a highly skilled labor force prefer to concentrate in one geographical area (Albahari, 2021; Henriques, Sobreiro, & Kimura, 2018). This proximity helps in the circulation of critical information. Moreover, tacit knowledge, often considered the most complex form of knowledge and most challenging to transfer, becomes relatively easy to share through face-to-face and strong social interactions (Marchiori & Franco, 2020; Ubeda *et al.*, 2019).

3.2 Proximity to research institutes or universities

In the literature, proximity to research and development (R&D) institutions and universities has been found to positively affect the innovative outcome of firms (Berbegal-Mirabent *et al.*, 2020). According to Dettwiler, Lindelöf and Löfsten (2006), start-ups put more value to proximity to a university when asked about the benefits of being close to a university, customers and similar firms. Similarly, Ferguson and Olofsson (2004) found that newly established firms are relatively more interested in staying close to a university than staying close to new customers. Also, Audretsch and Lehmann (2006) argued that due to the advantages of potential knowledge spillover and access to human capital, small and medium-sized firms prefer to locate close to universities. Thus, owners of TPs near a university or an R&D institute expect tenants to value this feature.

3.3 Co-location of similar firms

According to Chan and Lau (2005), TPs' tenants are mostly part of an industrial value chain, and distinct functions performed by firms are interconnected. Therefore, both upstream and downstream collaboration opportunities with suitable partners are more likely for firms in TPs. Similarly, the findings of Koçak and Can (2014) study show relatively higher chances of joint projects or product development for firms in similar industries and TPs attempting to host similar firms in one location. Therefore, one expects cooperation among the co-located firms to be higher in TPs (Van Winden & Carvalho, 2015). Moreover, proximity to similar firms improves organizational learning (Hussain & Malek, 2013).

3.4 Proximity to target markets

The proximity of the firm to its target market facilitates the achievement of commercial goals, and it helps attain valuable information about the likes and dislikes of customers and optimization of products and services through market information (Henriques *et al.*, 2018). Audretsch, Belitski and Caiazza (2021) found supporting evidence for an increase in incremental innovation output for firms having a close and intense connection with customers. Conversely, Romijn and Albu (2002) found a statistically insignificant relationship between the creative output and its networking with customers. On the other hand, Albahari, Barge-Gil, Pérez-Canto and Modrego (2018) argued that the novelty of young firms in TPs attracts customers for the short-term, but it diminishes as the firm matures and becomes less innovative.

3.5 Living conditions on the site

The livability of TPs is essential for both park managers and tenants. The quality of landscape, environment, facilities and services provided at the TPs has been used as a marketing tool to attract clients. Besides being the hub of innovation and technology, the TPs are also property initiatives with vibrant culture, landscaped community area, green environment, quality of life and a touch of nature (Albahari, 2021; Hobbs *et al.*, 2017). The proximity of nature and a green environment has often been associated with psychological well-being. In the literature, office spaces with a view of greenery have been found to have a significant positive effect on the well-being of employees and reduction of stress on the job (Zhang, Yang, Cheng, & Chen, 2021).

3.6 Prestige associated with location

The quality of the landscape and environment of the park and its surroundings builds a reputation and image of TP in the eyes of tenants and other stakeholders (European Commission, 2014). The TP prestige is significant for new start-ups trying to gain legitimacy and overcome the survival issues (Ferguson & Olofsson, 2004). The study by Chan *et al.* (2010) found that firms use the location of TPs to build their reputation and brand image to gain commercial benefits rather than using this place for networking and other technological benefits. In addition, several other studies found that state-of-the-art facilities and services provided at SPs improve the professional outlook of the companies (Chan & Lau, 2005; McAdam & McAdam, 2008).

3.7 Cost of accommodation and services

TPs provide several facilities, including meeting and conference rooms, reception areas, laboratories, R&D facilities, training and development activities and leisure facilities on sharing basis for all the tenants (McAdam & McAdam, 2008; Ng *et al.*, 2020). The facilities offered at TPs aim to provide an enabling environment for the new start-up to focus on their core activities and

avoid troubles related to supporting services (Audretsch *et al.*, 2021; Fukugawa, 2013). Moreover, sharing these facilities reduces the rental cost for tenants (Guadix *et al.*, 2016).

Based on the literature review, it can be concluded that tenants assume the benefits of TPs when choosing to rent a place. In this way, follow the list of attributes used in this study about benefits provided in TPs in Pakistan: (1) Knowledge – Opportunity for sharing knowledge and other business collaborations; (2) University – How close the TP is to any university or research institution; (3) Firms – How close are other firms in similar sectors; (4) Customers – How close are the markets and customers related to firm; (5) Liveability – Quality of maintenance services provided at TP; (6) Image – How prestigious is the building of TP and (7) Cost – Rental cost for office space and other shared services.

4. Data and methods

4.1 Sampling procedure

At the start of this research in August 2020, there were 22 TPs in Pakistan. Following are the pre-requisites for a TP to be eligible to participate in this survey: physical location, presence or affiliation or proximity to a university or research institute, a team of professionals for providing support services and sharing of facilities among the tenants. After implementing this criterion, we shortlisted and contacted six TPs for data collection and research support. We did not include the other TPs because they did not meet one or more of the shortlisting criteria. The sample of TPs consisted of Arfa Software Technology Park Lahore, Aiwan-e-Iqbal Software Technology Park Lahore, National Science and Technology Park Islamabad, Pakistan Software Export Board Technology Park Karachi, Meridian Software Technology Park Rawalpindi and Information Technology Park Peshawar. We have contacted the TPs management to collect data from the decision-making individuals of tenant firms. The management officials of all six TPs agreed to participate in this research voluntarily. Since the management of these TPs had close contact with tenants, we have followed a top-down approach to collect data from 360 firms in 6 TPs in Pakistan. We have also prepared a survey instrument and shared it online with senior managers or chief executive officers (CEOs). Considering that all firms were in TPs, they faced the same legal, institutional and cultural environment (Acs, Audretsch, & Lehmann, 2013). We have distributed the survey instrument between October and December of 2020.

4.2 Measurement of variables

The first section of the questionnaire had demographic questions to get information about respondents and organizations. In addition, we have asked the respondents to choose the level of product development most relevant to their firm. We have also provided a list of seven sectors, and we required the respondents to choose one or more sectors related to their firm's activities. In the second section of the survey instrument, we shared a list of 15 pre-determined attributes of TPs with the respondent, and we asked them to choose which of these attributes their TP offered (Table 1 provides the list). In the third section of the questionnaire, we obtained the respondents' opinions on the seven benefits of TPs. We have also required the respondents to choose any two benefits of TPs that played a significant role in choosing TP for their firm location. The quantitative approach of data collection adopted in this research aims to present pre-determined benefits of a product or service to consumers and gain insight into it to determine their needs (Ng *et al.*, 2020).

4.3 Data analysis

We have conducted the data analysis in two stages. In stage I, we adopted a two-step clustering algorithm to identify different meaningful subgroups of firms based on selected

Labels	Attributes	Examples
R&D	R&D facilities	Laboratory, clean room, piloting room
Equipment	Equipment	3D printer, autoclave, centrifuge
Specialties	Specialties	Particle accelerator, wind tunnel, joint permits
Workspace	Workspace	Conference centers, co-working space, meeting rooms
Business support	Business support	ICT support, administrative, consultancy
Training	Training programs	Incubator programs, workshops, lectures
Park management	Park management	Maintenance, cleaning, safety, security
Information	Information access	Library, network platform, databases
Venture capital	Venture capital access	Legal and finance agencies, investment funds
Networking	Networking events	Conferences, symposiums, business courses
Social	Social event	Concerts, marathons, food festivals
Dining	Dining facilities	Restaurant, cafeteria
Residential	Residential facilities	Hotel, residential housing
Leisure	Leisure facilities	Cinema, sports facilities, wellness, shops
Additional	Additional facilities	Expat center, daycare, car share service

Source(s): Adopted from Ng *et al.* (2020)

Table 1. Attributes of technology parks in Pakistan

characteristics of the tenant firms. Since the information on the number of clusters in data were not available *a-priori*, and the data have both categorical and continuous variables, the two-step clustering algorithm technique was better than the alternatives like *k*-means or hierarchical clustering (Kaufman & Rousseeuw, 2009). For the model's fitness, the values of Akaike's information criterion (AIC) or Bayesian information criterion (BIC) estimated should be as low as possible, whereas the value of distance measure should be as high as possible. This method also produced estimates for cohesiveness ratio, for which the higher magnitude indicates that clusters are different between and similar within. According to Sarstedt and Mooi (2014), the value of cluster ratio equal to or more than 0.2 is considered fair.

In stage II, we have used the participants' responses to develop and analyze associations between benefits and attributes of TPs. We required the respondents to select if, out of 15 TPs (A) attributes, any attribute was associated with the list of 7 benefits of TPs (B). We have also provided the option of not applicable (N/A) if any attribute was not mapping to any benefit. Therefore, data generated through this step allowed conducting three analysis procedures.

(1) We have assessed the quality of fit for an association between attributes and benefits through a chi-square test. We also assessed the option of N/A as to whether it is significantly different from other associations, whether it is not and whether it proved to be significant.

(2) After excluding N/A cases, the probability for each benefit $P(B_j)$, j represents TPs benefits. We have separately estimated the same attribute mentioned by respondents. We have also calculated the conditional probability $P(B_j|A_i)$ as the probability that B_j (j represents 7 benefits of TPs) is selected against a particular attribute A_i (i represents 15 attributes of TPs). If $P(B_j)$ is not associated with any attributed A_i of the TP, the estimated value of the expected ratio (I) would be less than or equal to 1. Thus, greater than 1 value of the expected ratio (I) shows an association of benefit with an attribute of TP. This expected ratio (I) is called as lift ratio in the marketing literature. The lift ratio provides more information as compared to the simple conditional probability of $P(B_j|A_i)$ as the latter ignores cases with no meaningful relationship (i.e. $I \leq 1$). We have used in this research the following formula for lift ratio estimation:

$$\text{Lift ratio } (I)(A_i \rightarrow B_j) = \frac{P(B_j|A_i)}{P(B_j)} = \frac{P(A_i, B_j)}{P(A_i)P(B_j)}$$

Greater than 1 value of lift ratio shows A_i and B_j are associated, and less than 1 value of lift ratio shows A_i and B_j are not associated.

(3) We have further investigated the association between benefits and attributes of TPs with reference to clusters identified in the data.

5. Results

5.1 Descriptive statistics

We have focused our study on what services and facilities these TPs provide and how firms perceive these benefits as supporting their development and growth. The researcher has contacted managers or CEOs of tenants of 360 firms from 6 shortlisted TPs to participate in the survey. We have received the completed responses from 110 firms; thus, the response rate was 31%. There is significant diversification in the age of firms participating in this survey. We have used the procedure developed by Armstrong and Overton (1977) to manage non-response bias in the data. The comparison of two groups in this study based on the size of TP, age of firm, length of stay in TP and sector of activity showed no significant difference among the groups. Only firm age was found significantly different for both groups ($t = 2.638$, $p = 0.008$). Therefore, we can infer that there is no non-response bias in the data for this research.

5.2 Distinguishing organization types

To differentiate the types of firms participating in this research and adequately determine their needs, we have divided 110 firms into 6 clusters. We have chosen number 6 conservatively to initiate the clustering process. According to Kaufman and Rousseeuw (2009), the minimum sample for a valid cluster should be $2m$, where m represents the number of variables considered. Six variables selected for clustering were (1) technology industries, (2) value-added services, (3) new product development, (4) size of the park, (5) scientific research and (6) length of stay.

We have assessed multiple solutions to generate meaningful clusters during the clustering process. For the final solution, we followed the criteria of the high value of cohesiveness coefficient and a higher value for the weakest predictor. The two-step clustering algorithm followed in auto-clustering resulted in eight clusters when using the AIC as a criterion and six clusters when using the BIC. The division into 6 and 8 clusters resulted in many small clusters affecting the validity of inferences drawn this way. Therefore, we have selected three clusters solution with the highest ratio as a measure of distance (1.506) and the highest silhouette coefficient (0.4) value. As shown in Table 2, we have labeled three clusters identified in this analysis as (1) commercial-orientation firms, (2) science and technology-oriented firms and (3) young tech firms. We can infer the following about these three clusters.

5.2.1 Commercial-orientation firms (C1). This cluster of firms in TPs is not actively participating in technology industries and scientific research activity. Moreover, these firms are less active in concept development with no participation in scientific research. In this cluster, 68% of firms are small-sized and stay in TPs for more than seven years without further expansion (Table 2). However, further analysis of these clusters revealed that these firms are from the IT/telecommunication sector (34% of cluster members), and they are more active in value-added services.

Table 2.
Comparative statistics of three selected clusters

Cluster variables	Total sample (110)				C1 (31)		C2 (41)		C3 (38)		Predictor
	n	%	Mean	SD	*n*	%	*n*	%	*n*	%	
Technology industries	58	53			0	0%	21	51%	37	97%	0.98
Value-added services	19	17			0	0%	19	46%	0	0%	0.63
New product development			1.86	1.39	0.92	1.19	3.21	1.64	2.19	1.48	0.42
Size of firm											
Less than 10	52	47			21	68%	11	27%	20	53%	0.35
Between 10 and 50	33	30			6	19%	8	20%	19	50%	
Between 50 and 150	16	15			6	19%	10	24%	0	0%	
More than 150	9	8			0	0%	9	22%	0	0%	
Scientific research	21	19			0	0%	14	34%	7	18%	0.21
Length of stay			7.92	10.49	7.58	5.84	10.95	15.34	4.91	3.94	0.1

5.2.2 R&D-oriented firms (C2). This cluster is not actively participating in technology industries, but it is relatively more active in scientific research than C1. This group is particularly active in new product development; thus, several firms in this cluster are engaged in scientific research and value-added activity. Firms of all sizes are part of this cluster, and these firms stay in TPs for the longest time compared to the firms in other clusters. The firms in this cluster mainly focus on providing value-added services through scientific research.

5.2.3 Young tech firms (C3). The firms in this cluster are actively engaged in technological activities but not in scientific research. The firms in this group are moderately active in the new product development process with no involvement in scientific research activities. These firms are small and medium in size and are new in TPs. Thus, one can infer that these young, small-sized firms are fighting for survival and are relatively less active in new product development activities (Brunswicker & Vanhaverbeke, 2015). Due to limited resources, these young firms may be using existing research for commercialization rather than engaging in new scientific research.

5.3 Importance of TP attributes and perceived benefits

Table 3 shows the conditional probabilities of benefits offered by TPs and each attribute. There was an option of choosing N/A if the respondent considered some benefits of TP not relevant to their company. We have excluded the N/A option in this section since it aims to identify those TP attributes considered necessary by tenants. Generally, all the attributes were considered relevant to one or the other benefit of TP, so the N/A response was only 8%. After excluding the N/A option, out of the remaining six identified benefits of TPs, the image was found statistically different from a random chance of selection, and it is not associated with any of the TP attributes.

We have required the respondents to select a maximum of two most important benefits of TPs which are most relevant for their firm, ignoring the principal TP attributes. Therefore, respondents chose to select less than two or even zero TP attributes, but the majority selected two benefits. Table 3 shows the number of times the respondents selected a TP attribute as most important. We have also provided the ranking of attributes in the last row of Table 3. We have based the rank order on the times the respondents selected the TP attribute and its association with the number of times they selected this benefit as the most crucial attribute for the firm. We will discuss how the perceived benefits of TPs are related to TP in the next section.

Table 3.
Percentage of association of attributes of TPs and benefits perceived by respondents, lift rations and tenants ranking of TP benefits

Attributes	Knowledge		University		Firms		Customers		Livability		Image		Cost		N/A	*N* (total)	%
	%	LR	%	LR	%	LR	%	LR	%	LR	%	LR	%	LR			
R&D	19%	1.04	14%	**1.81**	7%	1.28	6%	0.71	2%	*0.12*	8%	0.61	36%	**1.79**	5%	97	6
Equipment	21%	0.75	8%	**1.55**	8%	**1.62**	3%	*0.34*	1%	*0.06*	4%	*0.23*	44%	**2.45**	3%	81	5
Specialties	25%	1.18	8%	1.01	12%	**2.35**	4%	*0.39*	5%	*0.29*	5%	*0.39*	41%	**1.9**	13%	65	4
Workspace	24%	1.03	5%	*0.48*	8%	1.04	11%	1.08	9%	*0.48*	18%	**1.51**	28%	1.29	8%	166	11
Business support	23%	0.95	6%	*0.39*	4%	*0.23*	3%	*0.29*	16%	0.88	8%	0.64	35%	**2.18**	10%	124	8
Training	48%	**1.98**	18%	**2.21**	6%	0.78	21%	**1.59**	3%	*0.25*	6%	*0.41*	9%	0.34	7%	138	9
Park management	6%	*0.11*	1%	*0.09*	1%	*0.16*	3%	*0.17*	34%	**1.98**	21%	**1.9**	29%	**1.54**	9%	153	10
Information	45%	**2.05**	18%	**2.71**	5%	0.92	10%	0.99	2%	*0.12*	2%	*0.29*	9%	0.48	9%	92	6
Venture capital	28%		2%		11%		21%		3%		13%		7%		23%	38	2
Networking	42%	**1.51**	12%	**1.69**	15%	**1.95**	19%	**2.51**	3%	*0.16*	9%	0.71	6%	0.25	3%	182	12
Social	25%	0.95	8%	0.85	6%	**1.83**	15%	**1.53**	25%	1.36	19%	1.3	5%	0.13	5%	135	9
Dining	8%	*0.39*	3%	*0.34*	1%	*0.31*	5%	0.7	36%	**2.31**	13%	1.05	22%	0.99	2%	85	6
Residential	9%		3%						35%		16%		31%		11%	23	1
Leisure	5%	*0.21*	4%	*0.18*			2%	*0.17*	58%	**3.14**	20%	**1.78**	9%	0.38	4%	89	6
Additional	6%	*0.22*	1%	*0.17*			5%	*0.19*	51%	**2.95**	19%	**1.72**	12%	0.55	3%	74	5
B_j mean	21%		9%		5%		7%		20%		12%		18%		8%	100%	100
Frequency of TPs benefits	22%		20%		15%		15%		10%		10%		4%				
Ranking of TPs benefits	1		6		7		4		5		2		3				
	332		109		82		125		281		179		321		113		

Note(s): Lift ratio (LR) in bold indicates strong association ($I > 1.5$), italics indicates not associated ($I < 0.5$)

5.4 Associations between attributes and benefits

We have not considered the respondents selecting N/A as an option in the TP attributes for analysis in this section. Thus, we reduced the sample of responses (pairs of responses on attributes and benefits) suitable for assessing the association between attributes and benefits to 1,429 from 1,542 total responses. The expected probability association of an Attribute (A_i) with a Benefit (B_j) is the product of $P(B_j)$ and the number of times it is associated with A_i.

We have analyzed the strength of the relationship between TP attributes and their benefits perceived by tenants through the lift ratio (I). We have calculated the lift ratio by dividing the conditional probability of a given benefit of a TP attribute by the total probability of that benefit. If the value of lift ratio is higher than 1, it shows a relationship between attribute and perceived benefit, and the value less than or equal to 1 shows no relationship. Similarly, the value of lift ratio above 1.5 shows a significant relationship. In contrast, a value below 0.5 shows an absence of any relationship and an insignificant result. Table 3 depicts these thresholds by showing the strong relationships in a bold case and no relationship in an italic case.

From the analysis of relationships, we can infer that those benefits of knowledge-sharing collaboration opportunities in TPs are strongly associated with access to information and the opportunity to attend training programs and networking opportunities. They are less associated with TP management in terms of cleanliness and maintenance. On the other hand, no relationship of knowledge with R&D facilities shows that tenants perceive these activities will not contribute to mutual learning of firms or this culture of mutual learning is not prevalent at TPs. A university or research institute's proximity is related to R&D facilities, equipment, training opportunities, information and business networking opportunities. Considering this scenario, we can state that firms are most interested in staying close to academic staff for their insights and attracting valuable human resources development opportunities in training and development and access to updated information. The strong relationship of proximity to firms in related sectors with equipment and specialties indicated the existence of some form of collaboration among the firms at TPs. Moreover, proximity to customers and markets is strongly associated with training opportunities, business networking and social events. We have used the site livability to determine the quality of space and services provided at TPs. As expected, livability is strongly related to park management, dining, leisure and the TP's additional facilities. Cost of accommodation and services in rentals is one of the most significant benefits of TPs, showing strong association with R&D, equipment, specialties, business support and park management. Low rentals and economies of scale achieved due to shared use of facilities could be reasons for a strong relationship between this benefit and TP attributes.

We have used further analysis and the association between benefits of TPs and their attributes for individual respondents to compare three selected clusters of firms with the entire group. In Table 4, the results of the chi-square test ($\chi^2\,(12, n = 1356) = 44.30, p < 0.000$) show that firms in different clusters are significantly different from each other in terms of TPs benefits. For firms clustered as commercial-orientation firms, the livability benefit of TPs is the most crucial one and plays a vital role in the location decision. The other two essential benefits for this cluster are cost and knowledge sharing and collaboration opportunities.

Table 4.
Cluster-based statistics of association of benefits with attribute of TPs in Pakistan

Cluster	Knowledge	University	Firms	Customers	Livability	Image	Cost	Total
Commercial	19%	7%	7%	14%	23%	14%	18%	410
Science	29%	8%	2%	6%	19%	13%	23%	489
Young tech	26%	9%	7%	7%	21%	12%	21%	530
Total group	24%	7%	5%	9%	21%	13%	21%	100%
	332	109	82	125	281	179	321	1,429

The cluster of R&D-oriented firms values knowledge more than any other benefits of TPs. Similarly, young tech firms value knowledge-sharing opportunities the most, although other attributes like livability and cost are also important for firms in this cluster.

6. Discussion

This research aimed to find how tenant firms of TPs in Pakistan perceive different benefits offered in TPs. We can infer that tenant firms have associated training and business networking opportunities with proximity to specific stakeholders. In contrast, they have associated TPs' livability, image and prestige with the park management, leisure and additional facilities provided in TPs. It is pertinent to mention that tenant firms hold particular perceptions about each of the TP attributes, and R&D, equipment, and specialties are the exceptions associated with proximity and cost benefits offered by TPs.

Our significant contribution to the literature is analyzing the association between perceived benefits and TP attributes through conditional probabilities of TPs' benefits given their attributes and the tenants' diversity. In line with studies mentioned in the literature, knowledge sharing and collaboration opportunities and proximity to universities are essential benefits of TPs (Dettwiler *et al.*, 2006; Ferguson & Olofsson, 2004), even though these factors were not assumed *a-priori* as the most significant benefits of TPs.

Our research presents two significant contributions. This research contributes to the literature on TPs by linking TPs' specific attributes (facilities provided) to the benefits perceived by the tenants. The literature on examining the needs of tenants of TPs is scarce and scattered (Albahari *et al.*, 2019; Ng *et al.*, 2020). Several patterns have emerged through the cluster analysis and the lift ratio analysis for further inferences. For example, proximity to a university or a research institute is associated with R&D, training and development, access to the latest information and networking opportunities for TPs tenants. The TPs tenants have possibly used this proximity to connect with academia to gain valuable insight on different business challenges. On the contrary, users associate the TPs knowledge benefit only with information and training opportunities, suggesting that TPs should look beyond primary infrastructural support. The R&D facilities should also be their priority for mutual learning of tenant firms considering that it is vital for Pakistan because the digital entrepreneurial ecosystem is at a nascent stage, and collaboration for technological development and innovation is of utmost importance to compete at a global level (Roldan, Hansen, & Garcia-Perez-de-Lema, 2018).

The second significant contribution of this study is to acknowledge that TPs should accommodate heterogeneous firms and do the cluster analysis to find patterns among the firms' responses. Several research studies in the literature have already acknowledged that TPs host a variety of firms (Díez-Vial & Fernández-Olmos, 2015 ; Ng *et al.*, 2020). For example, commercial-orientation firms value proximity to customers and markets more than the other two clusters, thus focusing less on R&D activities. Proximity to customers allows these tenant firms to gain maturity in business and develop a new product for later venturing into new markets (Liberati *et al.*, 2016; Van der Borgh *et al.*, 2012). On the other hand, R&D-oriented firms consider business networking and proximity to the firms in related sectors as an essential benefit of TPs. Furthermore, the firms in this cluster have stayed for the longest time in TPs due to the relevance of unique benefits offered at TPs. The young tech firms are smaller and younger concerning the length of stay at TP. These firms value TPs' cost, image and prestige benefits more than any other benefit. This group of firms is relatively more cost-driven because small and medium-sized firms assume that open innovation strategies are less beneficial (Gassmann, Enkel, & Chesbrough, 2010). It will not be wrong to assume that these small and young firms might be facing financial constraints and forced to be cost-driven (Chan & Lau, 2005; Ng *et al.*, 2020).

7. Conclusion

This research contributes to both theoretical and practical aspects of TPs. From academic contributions perspective, Mora-Valentín *et al.* (2018) and Ng *et al.* (2020) identified a gap in the literature in terms of understanding on conceptualization and development of TPs considering the tenants' needs. This research aimed to fill this gap by highlighting how TPs can cater to the variety of needs of different tenants by offering unique benefits. On the other hand, from practitioners' point of view, this research has examined the diverse needs of distinct types of tenant firms in TPs, concerning their perception about the TPs benefits and attributes in Pakistan. Moreover, TPs are a vital part of the economic development planned under CPEC, and therefore, policymakers should consider these findings for deciding the attributes and facilities to be provided at TPs according to the needs of the target group of tenants.

We can conclude that TPs do not just provide a location-based advantage and support facilities; instead, they add unique value to the success of a tenant firm through several benefits in the form of training programs, business and social networking, access to information, and proximity to knowledge centers and clientele. It allows firms to improve their products and services to stay competitive in the market using a conducive environment and facilities of TPs. These techno-entrepreneurial activities will increase the innovation capacity of firms and make the entrepreneurial ecosystem conducive to the survival and growth of new firms (Ullah, Sami, & Ahmad, 2021). Therefore, policymakers should plan TPs looking beyond mere infrastructural support to convert them into hubs of innovation and market leadership.

Just like other research initiatives, this research is not without its limitations. We have distributed the questionnaire to 360 firms from 6 TPs selected through explicit criteria. Therefore, this study is representative of only these 6 TPs. Moreover, because of the 30% response rate, we have obtained data from 110 firms for statistical analysis. Second, the use of cross-sectional data is another limitation of this study.

References

Acs, Z. J., Audretsch, D. B., & Lehmann, E. E. (2013). The knowledge spillover theory of entrepreneurship. *Small Business Economics*, *41*(4), 757–774.

Albahari, A. (2021). The logic behind science and technology parks. *Handbook of research on business and technology incubation and acceleration*. Cheltenham: Edward Elgar Publishing.

Albahari, A., Barge-Gil, A., Pérez-Canto, S., & Modrego, A. (2018). The influence of science and technology park characteristics on firms' innovation results. *Papers in Regional Science*, *97*(2), 253–279.

Albahari, A., Klofsten, M., & Rubio-Romero, J. C. (2019). Science and technology parks: A study of value creation for park tenants. *The Journal of Technology Transfer*, *44*(4), 1256–1272.

Armstrong, J. S., & Overton, T. S. (1977). Estimating nonresponse bias in mail surveys. *Journal of Marketing Research*, *14*(3), 396–402.

Audretsch, D. B., Belitski, M., & Caiazza, R. (2021). Start-ups, innovation and knowledge spillovers. *The Journal of Technology Transfer*, *46*(1), 1–22.

Audretsch, D. B., & Lehmann, E. (2006). Location and new venture creation. In S. Parker (Ed.), *The Life Cycle of Entrepreneurial Ventures* (pp. 137–160). New York: Springer.

Berbegal-Mirabent, J., Torre, R. D. L., & Gil-Doménech, D. (2020). Capitalising new knowledge through R&D alliances: Evidence from Catalan technology centres. *International Journal of Technology Management*, *83*(4), 246–268.

Brunswicker, S., & Vanhaverbeke, W. (2015). Open innovation in small and medium-sized enterprises (SMEs): External knowledge sourcing strategies and internal organizational facilitators. *Journal of Small Business Management*, *53*(4), 1241–1263.

Chan, K., & Lau, T. (2005). Assessing technology incubator programs in the science park: The good, the bad and the ugly. *Technovation*, *25*(10), 1215–1228.

Chan, K.-Y. A., Oerlemans, L. A., & Pretorius, M. W. (2010). Knowledge exchange behaviours of science park firms: The innovation hub case. *Technology Analysis and Strategic Management*, *22*(2), 207–228.

Dettwiler, P., Lindelöf, P., & Löfsten, H. (2006). Utility of location: A comparative survey between small new technology-based firms located on and off science parks – Implications for facilities management. *Technovation*, *26*(4), 506–517.

Díez-Vial, I., & Fernández-Olmos, M. (2015). Knowledge spillovers in science and technology parks: How can firms benefit most? *The Journal of Technology Transfer*, *40*(1), 70–84.

Edler, J., & Georghiou, L. (2007). Public procurement and innovation – Resurrecting the demand side. *Research Policy*, *36*(7), 949–963.

Etzkowitz, H., & Zhou, C. (2018). Innovation incommensurability and the science park. *R&D Management*, *48*(1), 73–87.

European Commission (2014). *Setting Up, Managing and Evaluating EU Science and Technology Parks: An Advice and Guidance Report on Good Practice*. Brussels: Regional and Urban Policy.

Ferguson, R., & Olofsson, C. (2004). Science parks and the development of NTBFs – Location, survival and growth. *The Journal of Technology Transfer*, *29*(1), 5–17.

Ferrara, M., Lamperti, F., & Mavilia, R. (2016). Looking for best performers: A pilot study towards the evaluation of science parks. *Scientometrics*, *106*(2), 717–750.

Fukugawa, N. (2013). Heterogeneity among science parks with incubators as intermediaries of research collaborations between startups and universities in Japan. *International Journal of Technology Transfer and Commercialisation*, *12*(4), 231–262.

Gassmann, O., Enkel, E., & Chesbrough, H. (2010). The future of open innovation. *R&D Management*, *40*(3), 213–221.

Guadix, J., Carrillo-Castrillo, J., Onieva, L., & Navascues, J. (2016). Success variables in science and technology parks. *Journal of Business Research*, *69*(11), 4870–4875.

Henriques, I. C., Sobreiro, V. A., & Kimura, H. (2018). Science and technology park: Future challenges. *Technology in Society*, *53*, 144–160.

Hobbs, K. G., Link, A. N., & Scott, J. T. (2017). Science and technology parks: An annotated and analytical literature review. *The Journal of Technology Transfer*, *42*(4), 957–976.

Hussain, M. Y., & Malek, J. A. (2013). Knowledge transfer and the role of local absorptive capability at science and technology parks. *The Learning Organization*, *20*(4/5), 291–307.

Kaufman, L., & Rousseeuw, P. J. (2009). *Finding groups in data: An introduction to cluster analysis*. New Jersey: John Wiley and Sons.

Koçak, Ö., & Can, Ö. (2014). Determinants of inter-firm networks among tenants of science technology parks. *Industrial and Corporate Change*, *23*(2), 467–492.

Liberati, D., Marinucci, M., & Tanzi, G. M. (2016). Science and technology parks in Italy: Main features and analysis of their effects on the firms hosted. *The Journal of Technology Transfer*, *41*(4), 694–729.

Link, A., & Scott, J. (2003). US science parks: The diffusion of an innovation and its effects on the academic missions of universities. *International Journal of Industrial Organization*, *21*(9), 1323–1356.

Link, A. N., & Scott, J. T. (2015). Research, science, and technology parks: Vehicles for technology transfer. In A. N. Link, D. Siegel, & M. Wright (Eds.), *The Chicago handbook of university technology transfer and academic entrepreneurship* (pp. 168–187). Chicago: University of Chicago Press.

Marchiori, D., & Franco, M. (2020). Knowledge transfer in the context of inter-organizational networks: Foundations and intellectual structures. *Journal of Innovation and Knowledge*, *5*(2), 130–139.

McAdam, M., & McAdam, R. (2008). High tech start-ups in University Science Park incubators: The relationship between the start-up's lifecycle progression and use of the incubator's resources. *Technovation*, *28*(5), 277–290.

Mora-Valentín, E.-M., Ortiz-de-Urbina-Criado, M., & Nájera-Sánchez, J.-J. (2018). Mapping the conceptual structure of science and technology parks. *The Journal of Technology Transfer*, *43*(5), 1410–1435.

Ng, W. K. B., Junker, R., Appel-Meulenbroek, R., Cloodt, M., & Arentze, T. (2020). Perceived benefits of science park attributes among park tenants in the Netherlands. *The Journal of Technology Transfer*, *45*(4), 1196–1227.

Roldan, L. B., Hansen, P. B., & Garcia-Perez-de-Lema, D. (2018). The relationship between favorable conditions for innovation in technology parks, the innovation produced, and companies' performance: A framework for an analysis model. *Innovation and Management Review*, *15*(3), 286–302.

Romijn, H., & Albu, M. (2002). Innovation, networking and proximity: Lessons from small high technology firms in the UK. *Regional Studies*, *36*(1), 81–86.

Sarstedt, M., & Mooi, E. (2014). *A concise guide to market research: The process, data, and methods using IBM SPSS statistics*. Berlin: Springer.

Ubeda, F., Ortiz-de-Urbina-Criado, M., & Mora-Valentín, E.-M. (2019). Do firms located in science and technology parks enhance innovation performance? The effect of absorptive capacity. *The Journal of Technology Transfer*, *44*(1), 21–48.

Ullah, S., Sami, A., & Ahmad, T. (2021). Entrepreneurial ecosystem and performance of SMEs in Pakistan. *International Journal of Economics and Business Administration*, *9*(2), 192–204.

Van der Borgh, M., Cloodt, M., & Romme, A. G. L. (2012). Value creation by knowledge-based ecosystems: Evidence from a field study. *R&D Management*, *42*(2), 150–169.

Van Winden, W., & Carvalho, L. (2015). Synergy management at knowledge locations. In J. T. Miao, P. Benneworth, & N. A. Phelps (Eds.), *Making 21st century knowledge complexes: Technopoles of the world revisited* (pp. 62–81). London: Routledge.

Zhang, B., Yang, L., Cheng, X., & Chen, F. (2021). How does employee green behavior impact employee well-being? An empirical analysis. *International Journal of Environmental Research and Public Health*, *18*(4), 1669–1688.

Further reading

Balle, A. R., Steffen, M. O., Curado, C., & Oliveira, M. (2019). Interorganizational knowledge sharing in a science and technology park: The use of knowledge sharing mechanisms. *Journal of Knowledge Management*, *23*(10), 2016–2038.

Chen, Y., Vanhaverbeke, W., & Du, J. (2016). The interaction between internal capabilities and external knowledge sourcing: An empirical study of Chinese firms. *R&D Management*, *46*(S3), 1006–1023.

Clarysse, B., & Bruneel, J. (2007). Nurturing and growing innovative start-ups: The role of policy as integrator. *R&D Management*, *37*(2), 139–149.

Diez-Vial, I., & Fernández-Olmos, M. (2017). The effect of science and technology parks on a firm's performance: A dynamic approach over time. *Journal of Evolutionary Economics*, *27*(3), 413–434.

Van de Vrande, V., De Jong, J. P., Vanhaverbeke, W., & De Rochemont, M. (2009). Open innovation in SMEs: Trends, motives and management challenges. *Technovation*, *29*(6–7), 423–437.

About the authors

Dr. Sami Ullah is Assistant Professor of Management at University of Central Punjab. He did his PhD in Management from Lancaster University, UK. His research interests include sustainability, innovation,

technology management, entrepreneurship and regional development. Sami Ullah is the corresponding author and can be contacted at: dr.samiullah@ucp.edu.pk

Dr. Abdul Sami is assistant professor/ HOD management sciences at the University of Jhang, Pakistan. He did his PhD from University Technology Malaysia. His research interests include human resource development, entrepreneurship, technology management, public value and ethical leadership.

Dr. Tooba Ahmad is PhD in international relations and working as lecturer at COMSATS University Islamabad, Lahore Campus. Her research interests include environmental governance, sustainability, regional politics in Asia, Belt and Road Initiative, CPEC and role of economy in international relations.

Dr. Tariq Mehmood is PhD in HRM from Preston University, Karachi. His research interests include human resource development, high performance systems, sustainable development and green HRM.