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THE ROLE OF SCIENCE AND TECHNOLOGY PARKS IN ENHANCING UNIVERSITY–INDUSTRY COLLABORATION IN PAKISTAN

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Abstract
In recent years, science and technology parks (STPs) have been increasingly leveraged as policy instruments to stimulate innovation and develop knowledge-based clusters in both developed and developing countries. These parks are intended to provide firms with resources to enhance technological and innovative capabilities. This study examines the role of STPs in facilitating university-industry interactions within the context of a developing country. A case study of Software Technology Parks (STPs) in Islamabad, Pakistan, served as the primary data source. Findings indicate that STPs in Islamabad have a limited impact on strengthening academic-industry linkages, with only 19% of firms reporting connections to higher education institutions. Among these, linkages were predominantly focused on human resources (19%) or informal collaborations (12.5%). The study highlights the need for policy interventions and strategic initiatives to enhance the effectiveness of STPs in promoting meaningful university-industry partnerships in Pakistan.

INTRODUCTION

In last four decades, several countries (either from developed or developing countries) have adopted different policy instruments for knowledge base economic development mainly through science and technology parks (S&T Parks), creation of venture capital and technology incubators. The development of science and technology parks was more popular strategy as compared to other policy mechanisms. Various terminologies have been used to describe science and technology parks in different regions, and countries i.e. science or research parks in USA, UK, and Spain, technopoles in France, innovation centre in Korea, science and technology parks in many developing countries (Sandoval Hamón et al., 2024; Díez-Vial and Montoro-Sánchez, 2016; Brinkhoff et al., 2012; Sanz 2002, 2003 cited from Malaraja and Zawdie 2008).

The concept of science and technology parks was originated in United States about 57 years ago with the establishment of the Stanford Research Park in 1951. The Cambridge Park, launched in 1970, was the earliest such establishment in the United Kingdom (Vaidyanathan, 2008). After 1980s, some Asian countries like Singapore, China, Taiwan, Malaysia, India and Hong Kong have also established S&T Parks to enhance their scientific and technological capacity in order to underpin their economic growth. In general, the focus of these countries was on the areas of information and communication technology, biotechnology, nanotechnology and bioinformatics. In recent times, many OIC (Organization of Islamic Countries) member countries particularly Iran, Saudi Arabia and Jordan have also introduced similar type of developments for their regional economic development.

For different countries, regions and sectors different reason for the development of science & technology parks have been observed. In USA, UK and many other developed countries, parks were developed to

create linkages between universities and industry, commercialize university research and regional development. While most Asian and other developing countries have set different objectives, these include development of new technology-based firms, cluster development and provide high standard infrastructure to attract foreign investment.

In literature, studies have been carried out to assess the objectives of science and technology parks in terms of creation of interaction between universities and industries (Quintas et al, 1992, Bower, 1993; Vedovello, 1997; Phillomore, 1999; Löfsten and Lindelöf, 2002a, 2005; Malairaja and Zawdie, 2008; Díez-Vial and Montoro-Sánchez, 2016), development of new business (Ferguson and Olofsson, 2004) and enhancing the performance of tenants (Bakouros et al, 2002; Siegel et al (2003); Bigliardi et al, 2006; Tsamis, 2006). These studies covered the developed nation, newly industrialized countries and economy in transitions. However, no such studies have been found in the context of developing countries, particularly for the university-industry linkages.

This paper analyses contribution of science and technology parks towards fostering university–industry linkages in developing countries such as Pakistan. Pakistan is a lower middle-income developing country, has taken many policies initiative (privatization, development of new sectors, liberalization and structuring of higher education) after 1990s. Information technology sector is also one of the major sectors, which has been given important emphasis by the government. On the one hand, government has given incentives (tax holidays for 15 years and 100% foreign equity ownership) and on the other hand, it developed infrastructure to attract multinational companies and new businesses in IT sector.

This paper is structured as follows. Section 2 reviews the literature on university-industry linkages and software technology parks, with a specific focus on Pakistan; Section 3 outlines the research methodology; Section 4 presents the empirical findings, organized around the characteristics of firms in Islamabad's software technology parks, the nature of their university interactions, and international comparisons; and Section 5 concludes the paper.

2. STUDIES ON UNIVERSITY-INDUSTRY LINKAGES AND S&T PARKS

2.1. University – Industry Linkages

University – Industry Linkages paid a good deal of attention by government policy institutes from different countries after 1970s (Vedovello, 1998). The strong linkages between academia and industry not only generate shared benefits but also, in the long run, contribute to improving a country's economic situation as well as its industrial competitiveness (Quintas et al., 1992; Vedovello, 1997). There are many reasons which motivate industry – university cooperation. Some of the important reasons for universities are: (1) universities can obtain additional funds, when its traditional sponsor (i.e. government) is operating under financial constraints, (2) industry-sponsored research provides students an exposure to real world research problems and, (3) university research staff has opportunity to work with industry on intellectually challenging research programmes. On the other hand, reasons for industry include: (1) contact with university researcher, including competent fresh graduates and experienced teaching staff, (2) support in continuing learning and training and, (3) right to use facilities, which are not available in the company (Atlan, 1990; Peters and Fusfeld, 1982; cited from Wu, 2000).

The most important role of university, in relation with industry, creates technical manpower for industrial employment. Secondly, produce industry applicable research which can be stock of new knowledge or solve the problems that industry faced (Etzkowitz et al., 1997). Monck et al. (1998) states that linkages between individual firms and higher education institutes might include:

- Transfer of people including founder-members of firms, key personnel and staff into employment in firms;
- Transfer of knowledge;

- Contract or sponsoring research (conducted by researchers or students) in the university;
- Contract development, design, analysis, testing, evaluation, etc. and
- Access to university facilities.

In Pakistan, universities have more high-level S&T manpower than any other sector (65% of total PhDs in the country are employed in universities), but only 25% of university faculty is involved in research activities even on a part time basis (Qureshi and Qazi, 1997). Very little research has been conducted on university-industry linkages in Pakistan; only three such studies can be found (Bashir, 2003; Naqvi, 2006 and Qureshi, 2006). These studies have been carried out in different contexts and have adopted different methodologies.

Bashir (2003) uses the information provided on the websites of universities, higher education commission and other government bodies in Pakistan in attempt to investigate the university-linkages. He reported that half of the universities did not have websites while out of the rest half most of the universities did not give any information regarding the university-linkages. The study stated that although most of the Pakistani firms operate at low level of technology but apparently they don't feel the need to cooperate with universities for improving their technologies. At the same time the universities have not been able to commercialize their research and gain confidence of the industry. Hence, the lack of properly established relationships between industries and universities is hindering the process of technological innovation in Pakistan. However, the results were not conclusive due to lack of information available on the websites and very poor response, from universities, to his questionnaire on university – industry interaction.

Naqvi (2006), focusing on the government's IT Policy of 2000, observed that universities have failed to produce the industry relevant research to boost the IT industry in Pakistan. According to her, in general government has provided incentives to universities and research organizations as well as individual scientists to enhance their productivity; however, not many initiatives have been taken by the government to promote the university-industry linkages in Information Technology sector in the country. It was further stated that a few initiatives which have been taken, have failed to start "R&D culture" either in the academia or in the industry and have not been successful in starting collaborative research between the two actors.

Qureshi (2006), who conducted his research in the context of triple helix model, did not find high level of linkages between university and industry in the last five decades in Pakistan. According to the study, the protectionist policies, import substitution strategies and little domestic science and technology effort were the main reasons for not creating more effective linkages among these major stakeholders. However, a few academic institutions such as National University of Science and Technology, University of Karachi, HEJ Institute of Chemistry and National Institute of Biotechnology and Genetic Engineering (NIBGE) were mentioned as the institutions which have been relatively successful in creating linkages with the industry.

2.2 Software Technology Parks of Pakistan

Software Industry is one of the fastest growing industries in the world. It has achieved tremendous growth, especially in the last three decades. It has played a vital role in the economic development of many developed and developing countries. It has provided an option for developing counties to leapfrog with developed or advanced nations. There are several countries that have seen significant growth in their software industry e.g. India, Singapore, Philippines, Malaysia etc. Pakistan's software industry has also shown significant growth in recent years, particularly after the year 2000 (Hassan, 2000).

The Government of Pakistan has been proactively developing the IT sector in Pakistan during the last few years. In order to encourage investment and entrepreneurship in the software industry, Pakistan government has also established Software

Technology Parks (STPs) in three major cities i.e. Karachi, Lahore and Islamabad. Pakistan has tried to emulate technology parks model of Asian countries such as China, India, Taiwan and Korea, but few government funded parks in Pakistan were setup in existing public buildings and declared as STPs with some additional facilities like extending high-speed fiber connectivity, backup international connectivity via VSAT and providing modern facilities while maintaining the rent at an affordable level to enable the IT companies to remain competitive. The STPs were launched by Pakistan Software Export Board (PSEB) in a bid to enhance exports of Pakistan's IT and IT-enabled Services (PSEB, 2024).

The main objective of these STPs is to create a cluster of software companies, similar to the Silicon Valley and IT Parks of Bangalore. There are total ten buildings in three large cities of Pakistan which have been declared as STPs. Over 750,000 sq. ft. of office space is provided to IT firms in these parks. Lahore has five STPs with a total space of 276,986 sq. ft. whereas Karachi and Islamabad have two parks each with the office space of 190,000 and 253,000 sq. ft., respectively. The federal and provincial governments are planning for the establishment of more STPs in the country. The federal government has allocated the land for STPs in Chak Shahzad (Islamabad) and near the international airports of Karachi and Lahore. Punjab government has already started construction of its first STP in Lahore. Its total cost is nearly US$ 55 million and total covered area is about 475,000 sq. ft., which have been completed in late 2010.

Higher education institutions are also planning to establish science and technology parks within their campuses or in close proximity to universities. In this regard, National University of Science & Technology (NUST), has allocated land for first university-based science and technology park in Pakistan. It has also created a technology incubator centre (TIC) in Islamabad, where they are providing the business and management services and other incubation facilities to its tenants.

3. RESEARCH METHODOLOGY

For studying the role of Software Technology Parks in establishing the linkages between university and industry, a questionnaire was prepared to collect data from ICT firms located at Software Technology Parks in Islamabad. The questionnaire was designed to obtain the information relating to university – industry linkages and role of STPs in establishing these linkages. In particular, information about firm's links with higher education institutions, type of linkages, links with other firms operating in and outside the STP and collaboration with companies abroad. Questions for assessing the other advantages and benefits of locating at STP were also part of the questionnaire.

Table 1: Taxonomy of University-Industry Linkages

TYPES OF LINKS	LINK DESCRIPTION
A. Formal Links	Joint research project
	Establishment of research contract
	Engagement of university academic staff for consultancy
	Funding of student research
B. Informal Links	Personal contact with university academic staff
	Access to specialized literature
	Access to University department research
	Attendance at seminars and conferences
	Access to university equipment
	Attendance at general education/training programs /exhibitions
C. Human Resources Links	Students' involvement in projects
	Recruitment of fresh graduates
	Recruitment of experienced professionals
	Formally organized training of firms' personnel in university

Source: Adopted from Vedovello (1997)

In the present study, university – industry linkages have been divided into three main categories. (See Table 1 for Taxonomy of Links between University-Industry). This approach was adopted by Vedovello (1997), who explored the links between companies and universities in United Kingdom. She studied Surrey Research Park to examine three broad categories of links between tenants located at Surrey Parks and researchers in academia.

According to Vedovello (1997) formal links are those concerned with the utilization of the scientific and technical information, knowledge, expertise and equipment available at universities and firms, these types of links not only require the commitment of two different partners but also involve financial liability from firm prior to the establishment of these links.

Table 2. Software technology parks in Pakistan

Name/Location of STP	Size (Sq. ft.)	Year of Establishment	No. of Firms
Aiwan-e-Iqbal Complex, Egerton Road, Lahore	108,000	-	16
NetSol IT Village, Main Ghazi Road, Lahore	50,000	2004	03
Imran House, 39 Empress Road, Lahore	30,000	-	02
Bahria Complex, 103-A, Mall Road, Lahore	50,986	-	02
JGC-Descon Engineering, Lahore	38,000	-	01
Ceasar Towers, Main Sharah-e-Faisal Road, Karachi	100,000	-	22
C-1, Tariq Center, Main Tariq Road, Karachi.	90,000	-	04
Awami Markaz, G-5, Islamabad (STP-I)	80,000	1997	36
Evacuee Trust Complex, F-5, Islamabad (STP-II)	173,000	-	29
Rose IT Park, Rawalpindi	30,000	-	01

Source: PSEB (2024)

In Informal links the professionals made contracts with each other by attending events organized by either university or industry, events include conferences, workshops, exhibitions, trainings. These links are also concerned with access of literature and equipment by the industrial people. Human resources (HR) links comprised of hiring of fresh graduate & experienced faculty staff, engaging the students in industrial projects and organized the training programs for industrial employee. Informal and human resource links do not necessary require any official agreement between university and industry, sometimes these links need small amount of contribution from firms.

The primary data was collected through a survey of firms operating in two Software Technology Parks (STPs) in Islamabad: Awami Markaz (STP-1) and the Evacuee Trust Complex Building (STP-2). These STPs were selected because they are among the oldest in the country, with the Awami Markaz STP, established in 1997, being the first of its kind in Pakistan. Together, the two Islamabad STPs house 65 ICT companies, significantly more than the STPs in Lahore and Karachi, which accommodate only 24 and 26 firms, respectively (see Table 2). The survey questionnaire was administered to firms located in both software technology parks. At the time of survey, there were only 24 and 4 companies present at STP-I and STP-II respectively. Out of these, only 21 firms have agreed to participate in this study and only sixteen firms (76%) had sent their response.

The data obtained through the survey was analyzed by using the statistical software package, Statistical Package for Social Science (SPSS). The analysis of the data was mainly based on descriptive analysis as most of the data did not allow any statistical test because the main research question of the study was based qualitative data. However, statistical tests were also used where they were

applicable. For university and industry linkages, cross tabulation was used to analyze the linkages between firms and higher education institutions. This test was also used to evaluate the advantages of technology parks to firms. Friedman test was used for statistical analysis of the data regarding the advantages of STPs.

4. RESULTS AND DISCUSSION

4.1 Characteristics and Advantages for firms located at Software Technology Parks of Islamabad

In total sixteen firms have responded to questionnaire (14 from STP-1 and 2 from STP-II) out of 21, which were agreed to participate in this study. Table 3 shows the various characteristics of firms which are located at these STPs. The size of firms is measured in terms of total turnover and total employment. This study used employment as an indicator to measure the size of firms. Results showed that, majority of firms were small in size representing nearly 50%, while only four (26%) firms have more than one hundred employees in their setup and three of these four were either foreign based or joint venture. Bulks of firms doing business at parks were older (80% firms); only few enterprises have either started new business or launched their branch office at these parks.

Table 3. Characteristics of Firms Located at Software Technology Parks of Islamabad

Employment	Years of Location	Firms Age	Ownership of Firms	Status of firms	Market Orientation
7% (1-10 employees)	13% (< 1 year)	36% (<5 years)	50% (Local Private)	50% (Start-up firms)	20% (Domestic Market)
40% (11-25 employees)	6% (1-3 years)	36% (6-10 years)	6% (Local Private State – Owned)	38% (Existing Firms)	47% (Export oriented)
20% (26-50 employees)	25% (4-6 years)	7% (11-15 years)	25% (Joint Ventures)	12% (Company's Branch)	33% (Both - Export & Domestic)
7% (51-100 employees)	56% (> 6 years)	14% (16-25 years)	19% (Foreign based)	~	~
26% (more than 100 employees)	~	7% (> 25 years)	~	~	~

Source: Mangrio (2009)

Designing and development of the software products was the main business for the firms who were working for the international market. It is worth noting that at the time of survey; nearly 80% firms were focused on international as well as domestic market, and only four companies were involved in export market when they started their business at software parks of Islamabad. The main objective for the establishment of these STPs seems to be the creation of the clusters of software firms for encouraging new businesses in Information Technology sector in the country. A cluster is defined as a group of associated ventures located in one geographical region or centered at a science park (Baptista and Swann, 1998). It has been discussed that clusters of firms can attract new firms to the region or at the park (Koh et al., 2005). In this study, it was also observed that the software parks of Islamabad have been successful in attracting new firms as half (50%) out of total 16 firms who responded to our questionnaire were startup firms. Most of these firms were local private representing 50%, while only three firms were foreign based.

Research and Development (R&D) helps the firms to increase their profits through development of new products or production processes. The companies were asked about the presence of R&D cells within their

setups. Eight out of sixteen companies reported that they have R&D cell, but they did not disclose any other detail on research and development. The other important factor which not only help firms to gain more projects and edge with other firm, is quality certification such as ISO 9000, CMM, etc. Pakistan Software Export Board is also assisting firms in achieving quality certification; it launched a program through which they provide technical and financial support to registered firms to get international quality certifications. The study found great number (12 out of 16) firms have no certification, while only one company had CMM level 3 certification, and three others have ISO certification.

Table 4 shows the various advantages of software parks rated by firms. Firms can acquire knowledge from various sources such as universities, government laboratories, research institutes and other firms in the same or other businesses. It is obvious from the results that in view of the firms, interaction with other firms (Firms awarded the highest weightage to the option "interaction with other firms located at park") is the most important source of knowledge for them as compared to others. They view this crucial for their survival in the market, as it can lead to collaboration with other firms for the resource retention, forming partnerships, acquiring services or trainings and data services. According to Koh et al. (2005), locating in close proximity facilitates the firms to have access to a greater number of potential business partners, suppliers, customers and technical expertise. On the other hand, items related to links with universities ('proximity to university' and' Presence of research center for potential cooperation') were given lowest rating among other items.

Table 4. Advantages of Software Technology Parks as rated by firms
(1= Very Low, 2= Low, 3= Medium, 4= High, 5= Very High)

Advantage	No. of Firms	Mean Weightage Awarded
Interaction with other firms located at park	15	3.53
Software Technology Park's location	16	3.50
Access to recruitment of appropriate staff	16	3.19
Quality of infrastructure	16	3.13
Access to basic support services	16	3.00
Incentives offered by government	16	2.56
Advanced business services	15	2.53
Financial incentives	15	2.47
Proximity to university	14	2.21
Presence of research center for potential cooperation	14	2.00

Source: Mangrio (2009)

4.2 University-Industry Interaction in Software Companies located at Software Technology Parks

In this study, firm were asked about their interaction with universities, in three main categories (formal, informal and human resource) of links. Table 5 summarize the overall links of software companies located STPs of Islamabad. The results revealed that majority of the firms at the STPs did not have any linkages with the universities. Only three (about 19%) firms had linkages with the higher education institutions at the time of the study. The same number of firms had linkages with the universities in the past. These results are consistent with those reported by Qureshi (2006) who also found that the relationship between university and industry in Pakistan is very limited. Tsamis (2006), in his study on two parks of Spain, also found low level of interaction between parks-based firms and universities. These results contrast with many other studies which have reported that most of the firms located at S&T Parks are likely to have some kind of linkages with universities (Vedovello,

1997; Löfsten and Lindelöf, 2002a, 2005; Malairaja and Zawdie, 2008; Brinkhoff et al., 2012; Díez-Vial and Montoro-Sánchez, 2016; Sandoval Hamón et al., 2024).

4.2.1 Formal Linkages

Formal linkages are those concerned with the utilization (by the firms) of the scientific and technical information, knowledge, expertise and equipment available at the universities. According to Vedovello (1997), these types of linkages require formal contract / agreement between the two stakeholders. As Table 5 shows, only one firm (6.3%), out of total 16 firms, had formal linkages with the university at the time of study while 2 (12.5%) firms had these linkages in the past. At the time of study, the only formal linkage existed was the "engagement of university academic staff for consultancy". While in the past, two other formal linkages i.e. "joint research project" and "funding of students research" also existed in addition to the "engagement of university academic staff for consultancy".

There may be two possible reasons for the lower level of formal interaction of firms with the universities; (i) formal linkages normally have some financial liability for the firms, and the firms operating at the STPs are too small to fulfill this liability or (ii) firms did not consider expertise, services or facilities available at the universities relevant to their business.

Table 5. Linkages of firms located at the STPs with universities.

Types of links	Linkages in Past		Linkages at Present	
	# of Firms	*% of Firms*	*# of Firms*	*% of Firms*
Any Link	**3**	**18.8**	**3**	**18.8**
Formal Linkages	**2**	**12.5**	**1**	**6.3**
Joint research project	1	6.3	0	0
Establishment of research contract	0	0	0	0
Engagement of university academic staff for consultancy	1	6.3	1	6.3
Funding for student's research	1	6.3	0	0
Informal Linkages	**2**	**12.5**	**2**	**12.5**
Personal contact with university academic staff	1	6.3	1	6.3
Access to specialized literature	0	0	0	0
Access to University department research	0	0	0	0
Attendance at seminars and conferences	2	12.5	1	6.3
Access to university equipment	0	0	0	0
Attendance at general education /training programs /exhibitions	2	12.5	1	6.3
Human Resource Linkages	**3**	**18.8**	**2**	**12.5**
Students' involvement in projects	2	12.5	0	0
Recruitment of fresh graduates	3	18.8	2	12.5
Recruitment of experienced professionals	1	6.3	1	6.3
Formally organized training of firms' personnel in university	0	0	0	0

Source: Mangrio (2009)

4.2.2 Informal Linkages

Informal linkages are one of the most common types of relations between companies and academic institutes (Monck et al., 1988; Massey et al., 1992; Westhead and Storey, 1994; Vedovello, 1997). However, firms may establish some informal linkages more often such as "personal contact with university academic staff", "access to specialized literature" and "attendance at seminars and conference" than the other informal linkages which require more

prearranged organizational approach for their formation.

In our study, only two firms (12.5%) reported to have informal linkages with universities at the time of the study or in the past. The linkages established were "personal contact with university academic staff", "attendance at seminars and conferences" and "attendance at general education / trainings programs/ exhibitions". Vedovello (1997) also reported the "attendance at general / training programmes" in the university as one of the most frequent linkages between industry and academia.

4.2.3 Human Resource Linkages

Like informal linkages, establishment of human resource linkages also does not require any formal agreement / contract between the two partners. Most common forms of human resource linkages are recruitment of fresh graduates and experienced professionals. As shown in the Table 5, the human resource linkages of firms with the universities were slightly higher than the other two types of linkages i.e. formal and informal linkages. At the time of study, two firms (12.5%) had these linkages, and the linkages were recruitment of fresh graduates and experienced professionals. In comparison, three firms (18.8%) reported that they had human resource linkages with the universities in the past.

4.3 Comparison of University-Industry Linkages with Selected Countries

A comparison of the results of the present study regarding university-industry linkages was made with results of some selected studies from other countries i.e. United Kingdom, Australia and Malaysia. Vedovello (1997) conducted study on Surrey Research Park, UK which is located in the Surrey University. Phillimore (1999) investigated the interaction and networking of firms at the Western Australian Technology Park (WATP) with the University of Curtin (which is adjacent to the park) as well as between WATP companies with other universities. In the case of technology park of Malaysia, Malaraja and Zawdie (2008) examined the university–industry linkages of the firms in the park with the universities located in the close proximity to the park. In the present study linkages of firms located at the STPI were studied with universities located anywhere. It may be noted that no university is located in close proximity with the STPs of Islamabad.

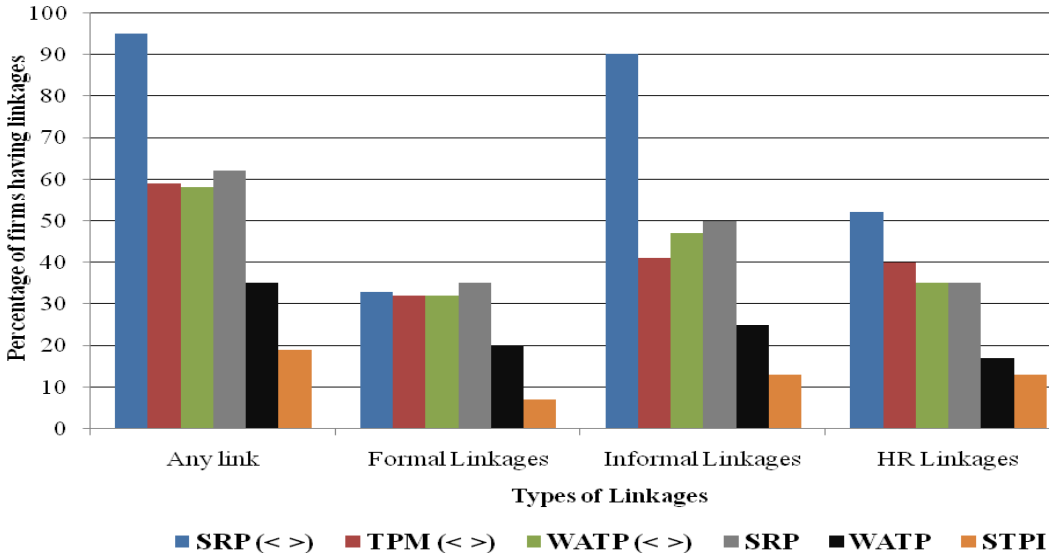

Figure 1. Comparison of university–industry linkages of STPI based firms with some selected countries

Note: (< >) Linkages with the university hosting the Science and Technology Park or with the university adjacent to the park

SRP: Surrey Research Park, UK (Vedovello, 1997) (Sample Size: 21 Firms)

TPM: Technology Park of Malaysia (Malaraja & Zawdie, 2008) (Sample Size: 22 Firms)
WAPT: Western Australian Technology Park (Phillimore, 1999) (Sample Size: 58 Firms)
STPI: Software Technology Parks of Islamabad (Mangrio, 2009) (Sample Size: 16 Firms)
Source: Vedovello (1997), Malaraja & Zawdie (2008), Phillimore (1999) and Mangrio (2009)

Comparison of the linkages of firms with the universities located away from the S&T Park shows that Surrey Research Park (SRP) has the highest percentage of firms (62%) which has linkages with the universities followed by Technology Park of Malaysia (TPM) (35%). While Software Technology Parks of Islamabad (STPI) have the lowest number of firms (19%), which have any sort of linkages with the universities.

In general, less than 36% firms at the parks had established formal linkages with the universities in all the countries (Fig. 1). Similar percentage of firms (about 35%) located at SRP, TPM or WATP have interaction with academia. In comparison, percentage of STPI based firms which had formal linkages with the universities was very low (about 7%) (at present or in the past). The highest number of firms in all the countries had this type of linkages (Fig.1). Number of SRP based firms which had informal linkages with the university were much higher (90%) than those based at WATP (47%) or TPM (41%). Again, in the case STPI based firms; very few firms (about 13%) had these linkages. Human resource linkages were the second highest type of linkages developed after informal linkages in all four countries (U.K, Australia, Malaysia and Pakistan). The highest number of firms (more than 52%) in SRP had these linkages with universities. While 40% and 35% firms located at TPM and WATP, respectively, had human resource linkages with the universities. In our study (STPI based firms) only two firms (about 13%) had this type of linkages with universities.

As evident from the above discussion that very low percentage of firms based at STPs of Islamabad had linkages with universities as compared with firms at the S&T Parks of the other countries. Fig. 1 clearly shows that the firms located at the same S&T Park had much higher linkages with the host university or university in close proximity to the park than those with other universities (cases of SRP and WATP). Therefore, a possible explanation of the phenomenon, that firms as STPI have lower interaction with academia, may be the fact that Science and Technology Parks of other countries are located in a university or in a very close proximity to the university. While in case of Pakistan (STPs of Islamabad), Software Technology Parks were established by the government in existing buildings which are not close to any university.

5. CONCLUSIONS

The development of science and technology parks in the developed and developing countries have increased during the last three decades. In Pakistan, Software Technology Parks (STPs) have been introduced during the last ten years to enhance the development of new businesses in information technology sector. The main aim of the present study was to investigate the role of these STPs in establishing the university-industry linkages.

This study did not find any evidence that the STPs of Islamabad have been successful in promoting and strengthening linkages between the industry and academia. Only 3 firms (about 19%), out of total 16 firms surveyed, had linkages with the higher education institutions. This interaction was much lower compared to that reported by studies from other countries i.e. United Kingdom, Australia, and Malaysia. The results of the present study are consistent with that of a previous study on university and industry interaction (conducted by Qureshi, 2006) which also found that the relationship between university and industry in Pakistan is very limited. Less number of firms in STPs of Islamabad having linkages with universities may be due to the fact that these STPs are not located in or adjacent to any university. In comparison to the number of firms (19%) which had linkages with universities, 5 firms (31%) had alliances with the other firms located at the STPs. However,

even greater number of firms (44%) had linkages with the firms outside the parks.

The results showed that the establishment of STPs could be helpful in the development of new businesses as half of the firms located at the STPs were startup companies. Therefore, these STPs, to some extents have achieved the objective set by Pakistan Software Export Board while developing these parks. However, as the actual number of firms at the parks was very small, for STPs to have a real impact on the Information Technology sector of the country, we need to establish larger parks with much greater number of firms and close proximity to higher education institutions.

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