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Analysing Existence of University–Industry–Government Linkages in Sindh, Pakistan

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Abstract: The field of Science, Technology and Innovation Studies (STIS) emerged in the developed world by the middle of the last century, is now far more than 50 years. During this time, the types of linkages amongst the three stakeholders: University–Industry–Government (UIG) of the STIS has evolved significantly. This study analyzed the status of university–industry linkages in the presence of Government policies and research programs in establishing the Triple Helix relationship in Pakistan, particularly in Sindh, Pakistan. This research, through the fully structured interviews of the three stakeholders in Sindh, explored in detail and identified reasons behind weak linkages amongst them. Different types of linkages have been identified through literature and through surveys of universities and industries in Sindh.

The existence or non-existence of these linkages has been analyzed in this study. The overall situation is presenting weak links between universities and industries in Sindh, Pakistan. Through the survey, it is identified that students' training in the industrial environment for their recruitment, and access to the feedback from industry to develop curriculum are the highly scored motivation factors. The government policy and/or societal pressure are having less significant importance. It is identified that the industries show no interest and mutual trust in establishing linkages. However, the most effective identified mechanism proposes the encouragement of university students, teachers and researchers for the industrial visits. Furthermore, the role of government as a policy-maker and fund provider for research, in the triple helix model seems to be very weak.

Key words: Triple helix, Mechanisms, Motivation, Barriers, Developing countries, Science, Technology and Innovation Studies (STIS).

INTRODUCTION

The field of Science, Technology and Innovation Studies (STIS) has emerged in the developed world by middle of the last century and is now far more than 50 years (Martin, 2000). With the span of time and after 1970's, the university-industry interactions emerged on agenda of policy institutes and researchers of several developed nations. For example, National Science Foundation funded University and Industry Cooperative Research Projects Program (Etzkowitz *et al*., 1998). As this interaction became common, different types of linkages amongst the three stakeholders: University–Industry–Government (UIG) also evolved in the literature of STIS. The developing countries, through literature, also identified the importance of linkages and it also became a major focus of the national policies of these developing nations.

The developing countries have slowly and gradually realized the need of triple helix for their economic growth and, in recent times, many of them are trying to utilize the benefits of university and industry collaborations including Thailand (Intarakumnerd and Schiller, 2008), Africa and Asia (Martin, 2000). A common characteristic of high industrialized economies is their investment in knowledge production and translating the knowledge into the innovative products (Bhattacharya and Arora, 2007).

Establishing linkages amongst various stakeholders of the innovation system, including universities, R&D organizations, industries, entrepreneurs and, local and federal governments, are very important for prosperous economy through innovation. The strong linkages amongst the university, the industry and the government not only produce the collective benefits but also contribute

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towards improved economic situation and industrial competitiveness (Quintas *et al*., 1992; Vedovello, 1997). Several successful examples are available in literature, which prove the benefits of university-industry linkages including Silicon Valley, MIT, Daedeok, Hsinschu Science based industrial park and Zhongguancun science park. In these examples, firms play an active role and enhance their R&D capabilities and acquire advance technologies to compete with other giants of the international market.

Firms acquire knowledge from R&D organizations and laboratories, research institutes, universities and even some times they learn from their competitors. Universities are unavoidable because new knowledge is created in universities through basic research. Universities also provide the human capital to industries. Therefore, universities have a significant role to play for the socio-economic development of a country (Feldman and Kelly, 2002). Several studies proved the growth of those companies which have strong linkages with academia in comparison to those which do not have such linkages (Malairaja and Zawdie, 2008).

The role of universities has become more significant with the emergence of the knowledge-based economy. Today, universities are progressively being viewed as the powerful drivers of innovation and change in science and technology and other creative disciplines (Sharma *et al*., 2006). Universities produce the qualified manpower for industries. They also conduct research, which can be applied in industries. The knowledge created through research can solve the industrial problems (Etzkowitz and Leydesdorff, 1997). Therefore, the development of industrial links with academia can promote the innovation and the production (Westhead and Storey, 1994).

There are different forms of UI linkages; universities and industries work jointly on research projects, industries engage university faculty members for consultancy and also provide funds to the research projects done by students in universities. These forms are mainly considered as the formal links. The human resource links including employment of fresh graduates and faculty members by industry is also a way of interaction between higher education institutions and firms (Quintas *et al*., 1992).

In Pakistan, over 114 universities and 85 public sector organizations are engaged in research and development in areas of their concerned interest. In addition, certain national policies have also emphasized on the UIG linkages, namely, "National Technology Policy 1993" (PCST, 1993), "National Industrial Policy 2011" (MoI, 2011) and "National Science, Technology and Innovation Policy 2012" (PCST, 2012). Alongwith the national policies, certain R&D programmes have also been executed by the Government of Pakistan emphasizing the UIG linkages. The R&D programs, like "university–industry technology support program" funded by Higher Education Commission" or "industry-academia joint development and research initiatives" funded by National ICT R&D fund, show that Government of Pakistan has also identified its role as a facilitator of the linkages for other two partners.

State-of-the-art

The interactions between universities and industries have become a topic of interest for researchers in recent years. Study of literature indicates the effective role of universities for formation of knowledge based clusters in developed countries, such as, USA, UK, Sweden, France, etc. (Quintas *et al*., 1992; Westhead and Storey, 1995; Vedovello, 1997; Vedovello, 1998). In addition, the Asian economies (particularly new industrialized countries, developing countries and in-transition countries) have also been studied by several researchers in the context of university – industry linkages, university's initiatives for research commercialization, and entrepreneur role of universities, etc. (Bhattacharya and Arora, 2007; Mathews and Hu, 2007; Wu, 2007; Malairaja and Zawdie, 2008; Saad *et al*., 2008). Most of these studies cover developed, newly industrialized countries and high income developing countries.

Keeping in view, the fact that no study of UI interaction in countries having socio-economic similarity with country, like Pakistan, is available, this study has been designed to analyze the linkages in the light of current policies of the country with regard to UI linkages. It is necessary to mention here that the countries which recently have brought reforms and boost funding for science and technology, particularly or higher education sector, were not much studied by the research community. Therefore, this research paper is an attempt to fill this gap for the developing countries focusing on Pakistan. The focus of the national policies of Pakistan and of the funded projects has remained more on university–industry relationship rather than UIG relationship. This research paper, hence, also analyzes the status of UIG linkages in the presence of these policies and research programs funded by government of Pakistan in establishing the Triple Helix relationship in Pakistan in general and in Sindh in particular.

University–industry linkages in Pakistan

In Pakistan, only a few studies are available covering the topics related to university-industry linkages and the literature shows only four such studies (Bashir, 2003; Naqvi, 2006; Qureshi, 2006 and Mangrio *et al*., 2013). There are some limitations of these studies; first few studies were based on secondary data and information collected from website of universities. Second, while other research examined the university-industry linkages only in one aspect (either academia or industry) by choosing very small sample size in their research.

Based on the information obtained from websites of several universities and the higher education

commission, Bashir (2003) explored the university-industry linkages. According to his study, most of the universities in Pakistan have not shared any information about the university-industry linkages on websites. The study also revealed that that apparently industries in Pakistan do not feel any need to cooperate with universities for improving their technologies. From the universities side, no evidence has been found to show that universities have commercialized their research and have gained the confidence of industry.

Based on the National IT Policy (2000), Naqvi (2006) observed that universities so far have failed to produce the relevant research for industry in the IT industry of Pakistan. It discussed some incentives offered to universities and R&D organizations in Pakistan. According to the author, government has offered some incentives to the universities, the research organizations and the individual scientists to enhance their research capacities but particularly for promoting the university-industry linkages, government has not taken much initiatives in the IT sector.

A research (Qureshi, 2006) for the triple helix model did not find a good quality linkage between the university and the industry in Pakistan. According to him, the over protected policies of the Government and strategies supporting the import substitution and a very little science and technology effort initiated within country were discussed as the main reasons behind poor and not effective linkages amongst the stakeholders of the triple helix model.

Mangrio *et al*. (2013) investigated the role of science and technology parks in promoting university-industry interactions in developing countries like Pakistan. The findings showed that the science and technology parks are not promoting university-industry linkages in Pakistan like other developed countries.

Due to a limited volume of research in Pakistan, it became important to empirically test and understand the existing status of the university-industry linkages in Pakistan and then understand the reasons hindering in the adoption of this successful model. On the basis of the study, the recommendations are drawn which are expected to contribute towards the pool of existing knowledge in the form of polices to the government of Pakistan.

The research paper, therefore, answers the following questions:

1. What is the existing status of linkages amongst university and industry in Sindh, Pakistan?
2. What types of collaboration exist between university and industry?
3. What are the motivations behind establishing the university and industry linkages?
4. What are the barriers which hinder the establishment of university and industry linkages?
5. What mechanisms should be adopted in future to strengthen the university and industry linkages in Sindh, Pakistan?

METHODOLOGY

The research methodology chosen for this study is based on fully structured interviews conducted with the university and industry representatives individually. The two separate questionnaires, one for universities and the other for industries, were designed. The reliability of the questionnaire designed for university was confirmed through the pilot study conducted in different departments of one engineering university namely Mehran University of Engineering and Technology. The reliability of the questionnaire designed for industry was confirmed through the pilot study conducted in different industries of one city namely Hyderabad. The reliability of both the questionnaires has been tested by performing the Reliability Analysis test with the help of software the SPSS (Statistical Package for Social Science) for three clusters (Motivation, Barrier and Mechanism). Through this test value of the Cronbach's Alpha has been calculated. The value of the Cronbach's Alpha normally ranges between 0 and 1. The closer Cronbach's Alpha coefficient to 1.0 offers greater internal consistency of the items of cluster. To provide the following rules of thumb: "≥0.9 = Excellent, ≥0.8 = Good, ≥0.7 = Acceptable, ≥0.6 = Questionable, ≥0.5 = Poor, and ≥0.5 = Unacceptable"[1]. It should be noted that an alpha of 0.8 is probably a reasonable goal.

RESULTS AND DISCUSSION

For universities' questionnaires the reliability analysis has produced three values of alpha. Each value represents scores for their respective clusters including motivation, barrier and mechanism respectively. The values of three Cronbach's Alphas for the reliability test of the university questionnaire are given in Table 1.

Table 1: Reliability test of the university questionnaire.

Clusters	Cronbach's Alpha	Cronbach's Alpha based on standardized items	Number of items
Motivation	0.857	0.863	8
Barrier	0.858	0.860	15
Mechanism	0.725	0.751	9

As a result of 20 fully structured interviews with 20 chairmen of various departments of Mehran University of Engineering and Technology, all three clusters have shown reliabilities between 70% and

[1] https://scholarworks.iupui.edu/bitstream/handle/1805/344/Gliem+&+Gliem.pdf?sequence=1

80%. This score is acceptable and, according to George and Mallery (2003), is considered as the good reliability. The reliability of this scale has enhanced the confidence level in all three clusters and the same questionnaires have been used for a larger number of universities.

Likewise universities, 26 interviews were also conducted with the industrial representatives. The industries chosen for pilot study include: Fateh Textile Mills, Dawlance, Rafhan Maize, Mehran Sugar Mills, Jamshoro Joint Venture Limited (JJVL), Zeal Pak Cement Factory Limited and Lakhra Power Generation Company etc. The reason behind selecting these industries is due to their existence in proximity like Hyderabad, Kotri, Jamshoro, Tando Muhammad Khan and Mirpurkhas. The values of three Cronbach's Alphas for the reliability test of the industry questionnaire are given in Table 2.

As a result of 26 fully structured interviews with the industrial representatives of different types of industries, all three clusters have shown reliabilities in between 70% and 80%. The reliability of this scale has enhanced the confidence level in all three clusters and the same questionnaires have been used for larger number of industries also.

Table 2: Reliability test of the industry questionnaire.

Clusters	Cronbach's Alpha	Cronbach's Alpha Based on standardized items	Number of items
Motivation	0.759	0.780	9
Barrier	0.702	0.726	13
Mechanism	0.814	0.816	18

Once the reliability test was performed of the pilot data of both questionnaires, the descriptive statistics have been calculated. The results of tests, including calculations for mean, mode and standard deviation, in order to find out the occurrence of the most practiced mode of linkages by university and industry, are given in Table 3-4, respectively. In tables, the data is coded as:

0 = Modes not in practice

1 = Modes in practice

Table 3: Modes of linkages by universities.

Mode of collaboration	Mean	Mode	Std_dev
Summer training of students in industry	1.00	1.00	0.00
Industry representation in boards of studies of department	0.70	1.00	0.47
Participation of industry in conferences, workshops, training programs conducted by university	0.80	1.00	0.41
Research fellowships support by industry	1.00	0.00	0.31
Endowment chair sponsored by industry	0.15	0.00	0.37
Donation of laboratory equipment by industry	0.35	0.00	0.49
Support given for infrastructure by industry	0.15	0.00	0.37
Support towards academic activities by industry	0.50	0.00	0.52
Exchange of University research and expertise to solve industrial problem	0.45	0.00	0.51
Participation in the teaching process by industry	0.30	0.00	0.47
Participation of industry personnel in curriculum design	0.70	1.00	0.47
Sponsorship of PhD students by industry	0.05	0.00	0.22
Research supervisor from industry	0.40	0.00	0.503
Selection of industrial problems as research question by the students	0.90	1.00	0.31
Department facilities (infrastructure related) used by industry	0.45	0.00	0.51
Training programs conducted for industry	0.25	0.00	0.44
Consultancy to industry	0.50	0.00	0.513
Use of specialized University database/ lab equipments by industry	0.25	0.00	0.44
Joint project/contract research	0.20	0.00	0.41
Joint patent	0.00	0.00	0.00
Joint publication	0.30	0.00	0.47

Table 4: Modes of linkages by industries.

Mode of collaboration	Mean	Mode	Std_dev
Summer training of students in industry	0.462	0.00	0.51
Member in boards/committees of the university department	0.077	0.00	0.27
Participation of industry personnel in conferences, workshop and training programs organized by university	0.19	0.00	0.42
Research fellowships support to faculty member or student	0.12	0.00	0.33
Endowment chair sponsored by industry	0.00	0.00	0.00
Donation of laboratory equipment for university department/institute	0.00	0.00	0.00
Support given for infrastructure to university	0.38	0.00	0.19
Support towards academic activities	0.00	0.00	0.00
Engagement of University research / expertise to solve industrial problem	0.00	0.00	0.00
Participation in the teaching process in university	0.12	0.00	0.33
Involvement in curriculum design	0.00	0.00	0.00
Sponsorship of PhD students in university	0.00	0.00	0.00
Supervisor/ research guide for university students	0.77	0.00	0.27
Use of laboratory facilities belonging to university for industrial activity	0.77	0.00	0.27
Use of specialized database / lab equipment for industrial activity	0.04	0.00	0.19
Attendance in training programs conducted by university	0.15	0.00	0.37
Engagement of university academic staff for Consultancy	0.04	0.00	0.19
Exchange of information, literature, data etc with university academic	0.12	0.00	0.33
Joint patent	0.00	0.00	0.00
Joint publication	0.00	0.00	0.00
Personal contacts with university academics	0.23	0.00	0.45
Exam / Thesis Evaluation	0.00	0.00	0.00

The frequency of these variables can be seen in two Pareto charts for university and industry in Figs. 1-2, respectively.

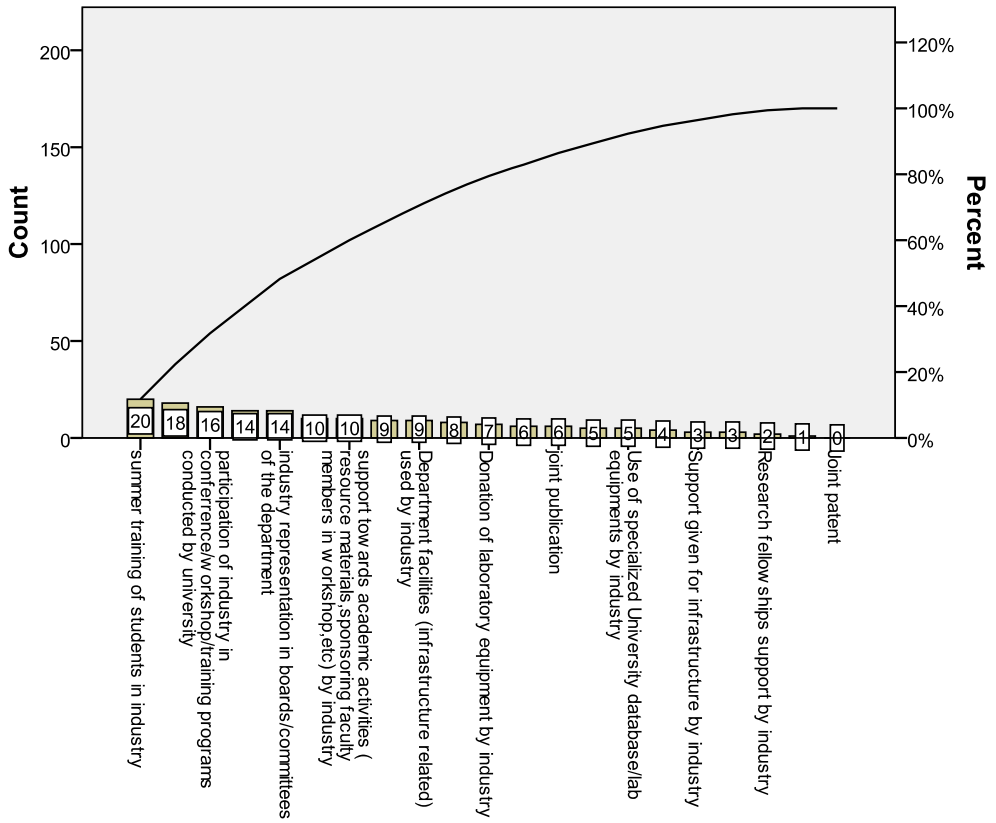

Fig. 1: Modes of linkages practiced by university.

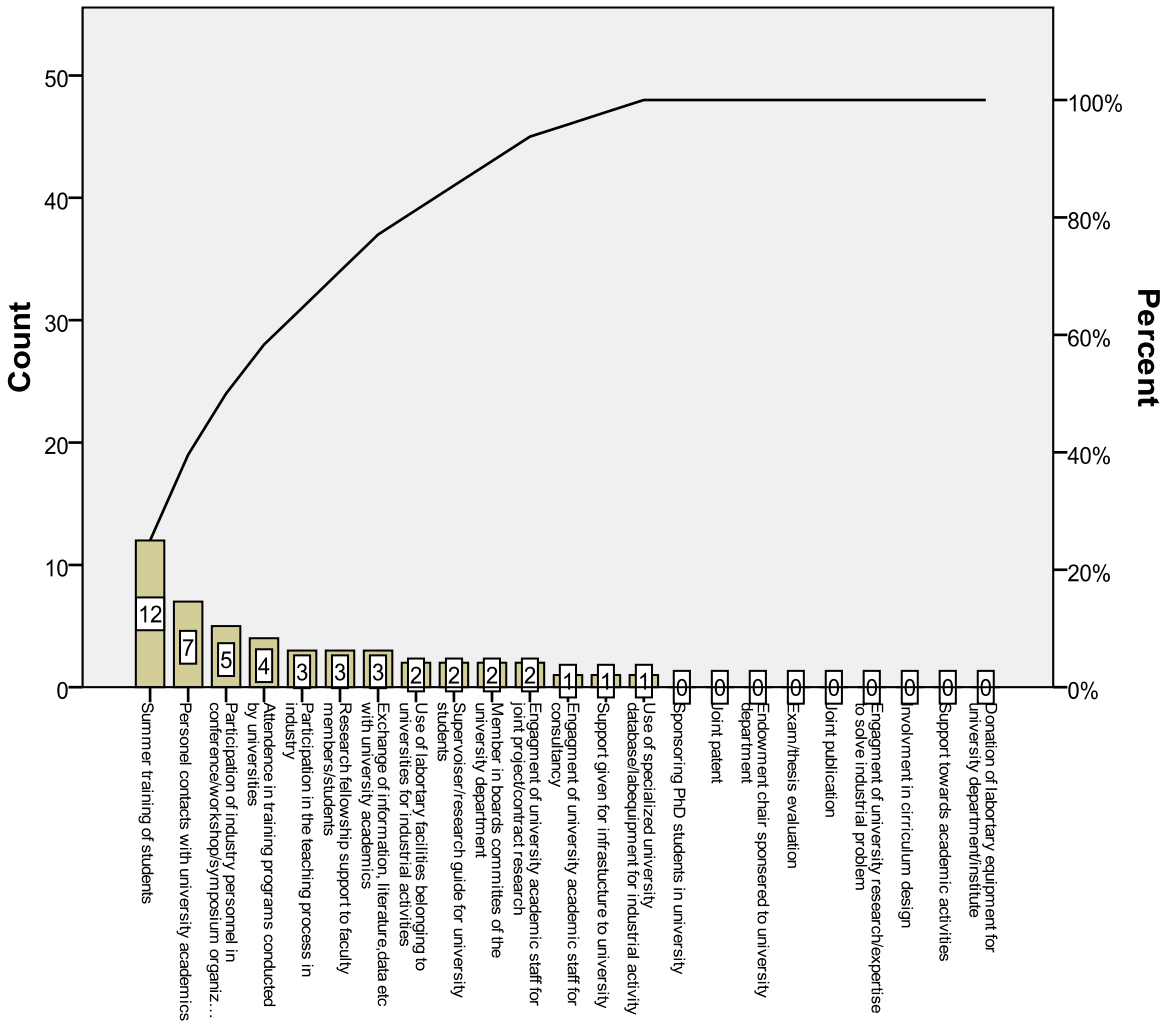

Fig. 2: Modes of linkages practiced by industry.

After pilot study the scope of the survey was enhanced. On the basis of simple random selection the data was collected from 140 representatives of 22 universities in Sindh, Pakistan. Similarly, for industries the data was collected from 111 representatives of 111 industries from Textile, Information and Communication Technology (ICT), Pharmaceutical, Cement, Food and Chemical sectors. The results of the data collected are analyzed below with respect to the five research questions discussed earlier.

Findings and interpretation

In order to understand the existence of triple helix in the developing country, particularly in Pakistan, 21 types of linkages are assessed in this paper. These types are evolved from literature and also from the pilot study conducted for the sake of this research. In order to discuss the existence of university industry linkages they are divided in three types.

Types of linkages

The literature has offered different types of linkages amongst the three stakeholder of the triple helix model. Some of the debates on university-industry linkages have also categorized them in terms of physical facilities and services including trainings, meetings, consultancy etc. This study is focused on three types of linkages which facilitate the process of capitalizing knowledge. These linkages are presented in Fig. 3. The flow of these types directs the innovation from the knowledge transfer to the technology transfer.

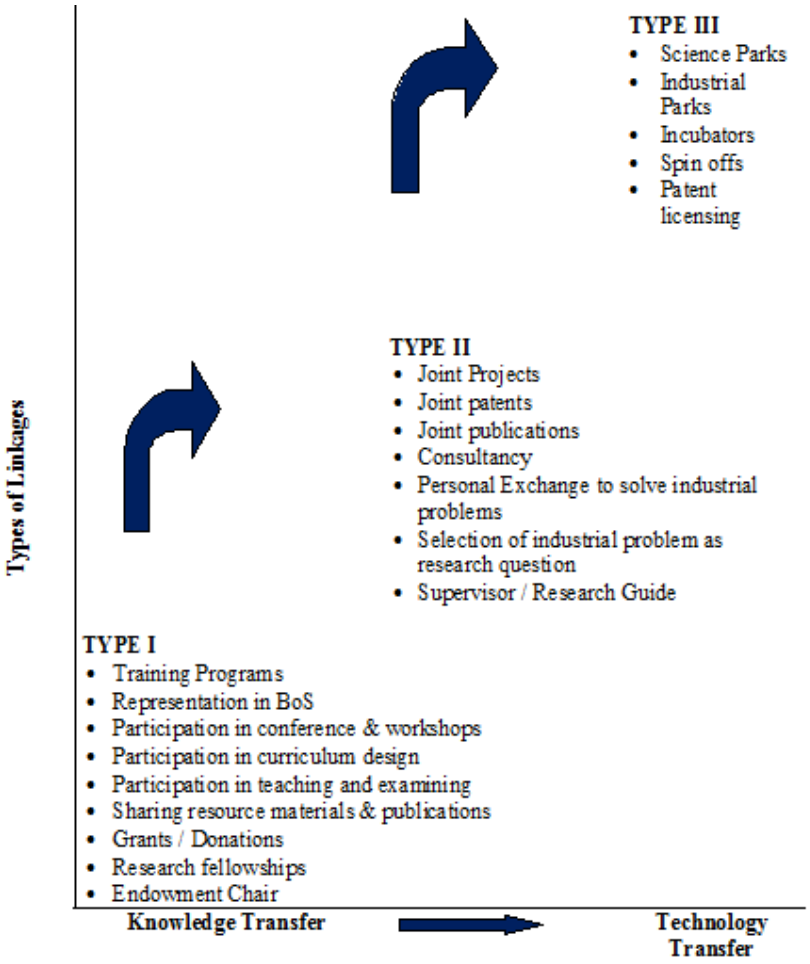

Fig. 3: Types of university–industry linkages.

In Fig. 3, the following different modes of collaboration are given. These include:

TYPE I: Organizing and delivering training sessions by universities to industries and vice versa, keeping industry persons in meeting of Board of Studies (BoS) of universities, industrial participations in conferences and workshops managed by universities, inviting industry to design curricula for university, participation of industry in teaching and evaluation, sharing of literature and other resources, offering grants to university by industry and creating endowment chair of industry in university.

TYPE II: Working jointly on projects and contract research, working together to publish the research work and registering patents, offering consultancy to industry by university experts, engaging industry personnel in PhD and Master dissertations, and selecting industrial problem as a research question for PhD and Master level research project.

TYPE III: Establishing incubators, science parks and industrial parks closer to university, facilitating spin offs, commercializing inventions originated in university, academic inventors become entrepreneurs, and licensing patents.

Types of linkages practiced by university and industry in Sindh, Pakistan

The data was collected through random sampling of universities and industries in Sindh, Pakistan. The purpose was to identify modes of collaborations mostly in practice and categorize them under their respective three types of linkages as shown in Fig. 3. The university and industry representatives were asked to score the types of linkages being in practice on a scale of 0-1, with score of 0 being counted as "Not in practice" and 1 as "In practice". The answers are summarized in Figs. 4-6, respectively, for three types of linkages.

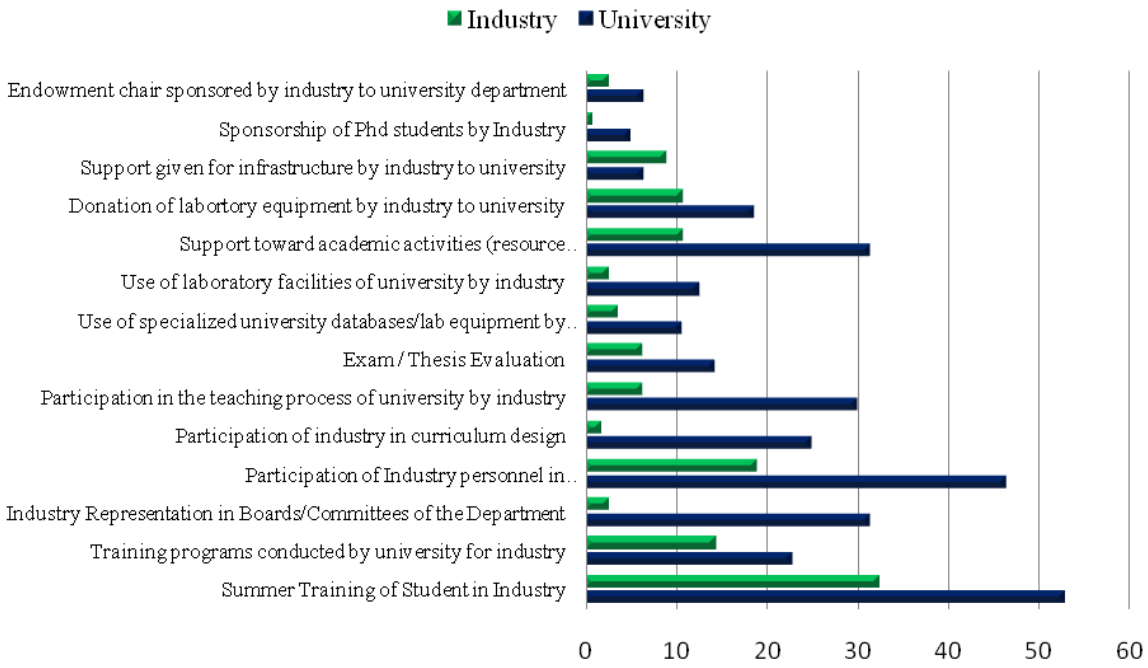

Fig. 4: TYPE I of linkages between university and industry.

Figure 4 shows that both universities and industries in Sindh, Pakistan, are practicing almost all modes of collaboration classified as "TYPE I" of linkages. The modes of collaboration, like internships and summer trainings, are mainly practiced by both universities and industries. The preference is given to the participation in conferences and workshops. Industries also offer some forms of support for the academic activities to universities. Industrial personnel also teach in universities. However, when asked about the funding preference for the PhD students, the response rate came out to be very poor. Industries also do not create the endowment chairs in universities to facilitate the funding process for research. The percentage of overall modes of collaborations which are in practice by both have failed to cross the maximum level of 50% and unfortunately those practices which scored low have hardly achieved a score of 5%. This shows that though both the university and the industry have identified importance of different modes of "TYPE I" of linkages but have partially achieved their benefits.

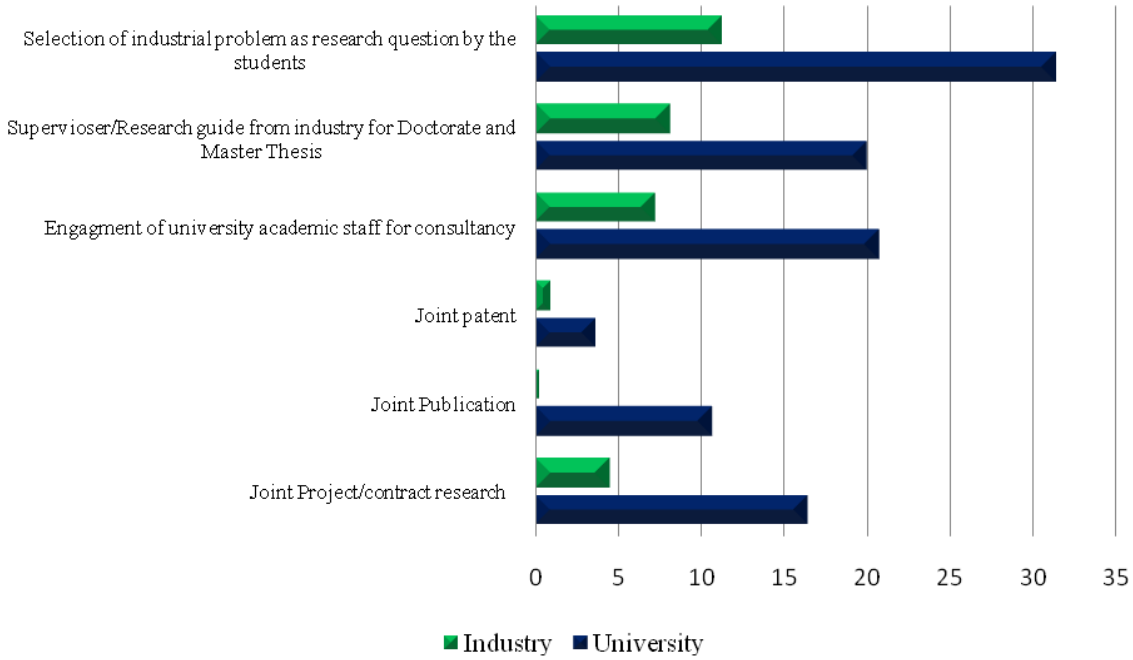

Fig. 5: TYPE II of linkages between university and industry.

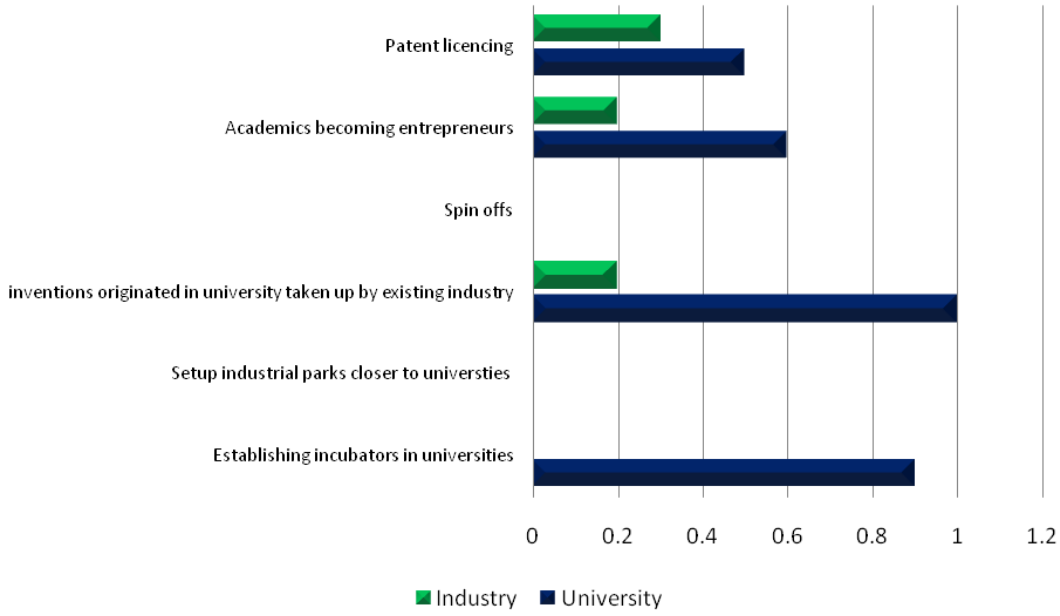

Fig. 6: TYPE III of linkages between university and industry.

For "TYPE II" of linkages (Fig. 5), the adoption of all modes by universities and industries is evident. The most frequent mode of linkage is the "Selection of industrial problem as a research question". It is then followed by the second most in practice, the mode of linkages which is "offering consultancy to industry by university faculty and researchers". The modes like "registering patents" and "publishing research papers jointly" are amongst the activities which are least in practice. The range shown for mostly occurring practices in TYPE II of linkages is 20–30% and for least occurring practices is 0–1%. This shows that both university and industry have hardly understood the importance of these modes and, therefore, have not really achieved their benefits.

Finally, Fig. 6 shows the modes of TYPE III of linkages. This type of linkages is almost showing no existence in Sindh, Pakistan. The modes like "commercializing research of university research by industry" and "establishing incubators in universities are those modes which may be in practice. The modes like "establishing the industrial parks closer to universities" and "facilitating the spin off" are amongst those which are least in practice. Unfortunately, all practices are in the range of 0-1%. This shows that both university and industry have failed to even understand the importance of these types of linkages.

This discussion is clearly visible in Fig. 7. The "green portion" shows types of linkages which are mainly "In Practice" and "red portion" shows types of linkages which are "Not in Practice". It shows that linkages of TYPE I category are mainly in practice and the linkages in TYPE III category are mainly not in practice. However, the overall situation shows weak level of linkages between the universities and the industries in Sindh, Pakistan.

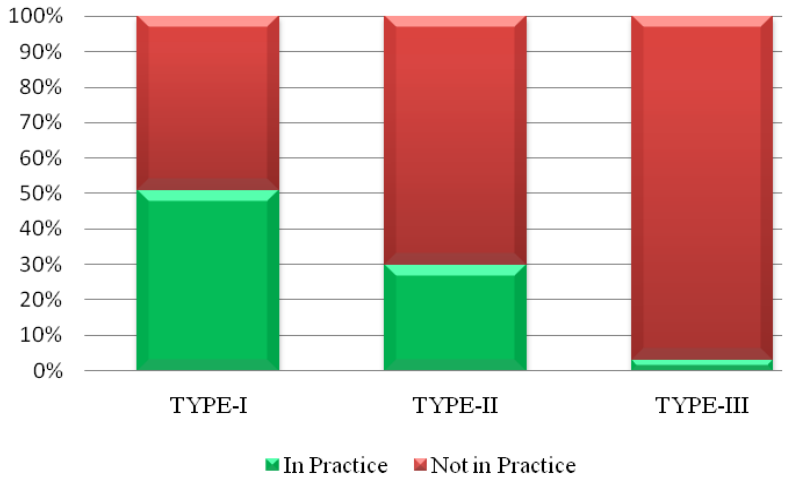

Fig. 7: Types of linkages in practice by university and industry in Sindh, Pakistan.

Motivations behind establishing university-industry linkages

Once, it was identified that there was a weak level of university–industry linkages that existed in Sindh, Pakistan; it also became necessary that respondents must also identify the importance of those motivating factors which caused them to establish the university-industry linkages. In order to understand the motivations behind establishing the university and industry linkages in the developing country particularly in Pakistan, 7 kinds of motivations are assessed in this study. These kinds have evolved from literature and also from the pilot study conducted for the sake of this research. The importance of these factors is accessed on a scale of 1-5, with scores of 1 being counted as "Least Significant" and 5 being counted as 'Highly Significant'. The answers are presented in Fig. 8.

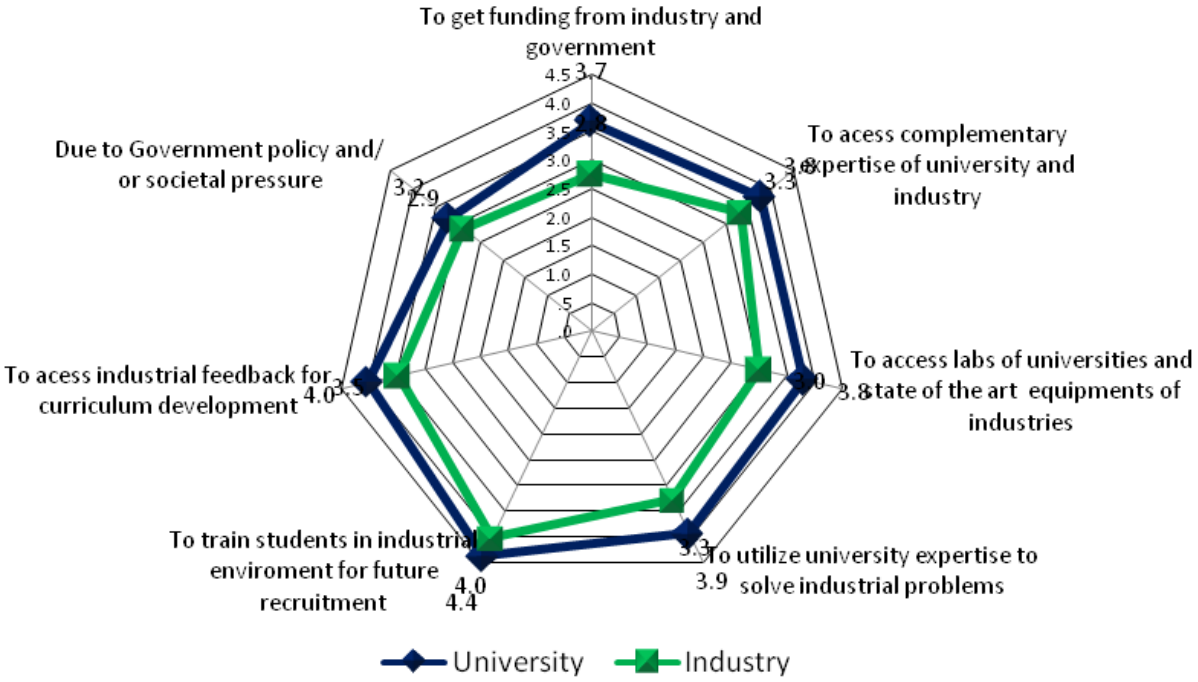

Fig. 8: Motivation factors behind university-industry linkages.

The respondents from both university and industry were asked what motivated them to establish the university–industry linkages. There is a remarkable similarity in view of both stakeholders regarding their motivation. In Fig. 8, the pattern is almost identical, but scores given by universities representatives are overall higher than the scores given by the industries representatives. This clearly shows that the university is more willing to establish linkages with universities in comparison to industry. The most effective motivation identified from both the stakeholders is the "training of students in the industrial environment for future recruitment". In addition, one important motivation is "to access industrial feedback for curriculum development" is also scored high. The "government policy" and "societal pressure" have shown less significant importance for both stakeholders. The other factors are in the middle. This clearly shows that the purpose of establishing university–industry linkages was never the technology transfer. However, a very small portion for knowledge transfer is evident. The most striking feature of this figure is, according to both stakeholders, that so far government could not play a vital role in this triple helix model existing in Pakistan. However, it is also evident that government has launched various programs through which universities and industries can join their hands but these programs are not very effective. The details of these programs are given in Table 5. During interviews conducted with the representatives of the organization given in Table 5, it was also identified that these programs were launched at several organizations but even these government organizations do not possess any collaboration amongst themselves. In additions, the launched programs also miss some proper planning and, therefore, the funding, that is given by government to universities and industries, is causing proper motivation in them and, therefore, the linkages are weak and some fruitful responses are not coming out from these weak linkages.

Table 5: R&D programs initiated by the government of Pakistan to facilitate university–industry linkages.

Government organization	Programs offered
Pakistan Engineering Council	• Academic Industry Linkages (AIL) Committee • Academia-Industry-Government Roundtable (AIGR) • Continuing Professional Development (CPD)
Higher Education Commission	• ORIC (Office of Research, Innovation and Commercialization) • Business Incubation Centres • University – Industry Technology support program • Knowledge Exchange initiatives • Patent filing
ICT R&D Fund	• Industry academic joint development and research initiatives • Internship programs
Ministry of Science and Technology	• Focus group meeting with R&D organizations and Industries
Pakistan Scientific and Technology Information Centre	• UIP seminars and symposia • UIP technology exhibitions
Pakistan Software Export Board	• NCEAC (National Computing Education Accreditation Council) • Knowledge Sharing Session • Internship Program • Incubator Program • Science and Technology Parks
Pakistan Science Foundation	• R&D Industry program • Natural Science Linkage Program (NSLP)

Barriers in establishing university–industry linkages

Once it was identified that even a huge list of programs initiated by government failed to motivate university and industry linkages in Sindh, Pakistan, it also became necessary that respondents must also identify those major barriers which hurdle them in establishing the University–Industry linkages. In order to understand the barriers in establishing the university and industry linkages in the developing countries, particularly in Pakistan, 13 different kinds of barriers are assessed in this study, which have evolved from literature and also from the pilot study conducted for the sake of this research. The importance of these factors is accessed on a scale of 1–5, with scores of 1 being counted as "Least Significant" and 5 being counted as 'Highly Significant'. The answers are presented in Fig. 9.

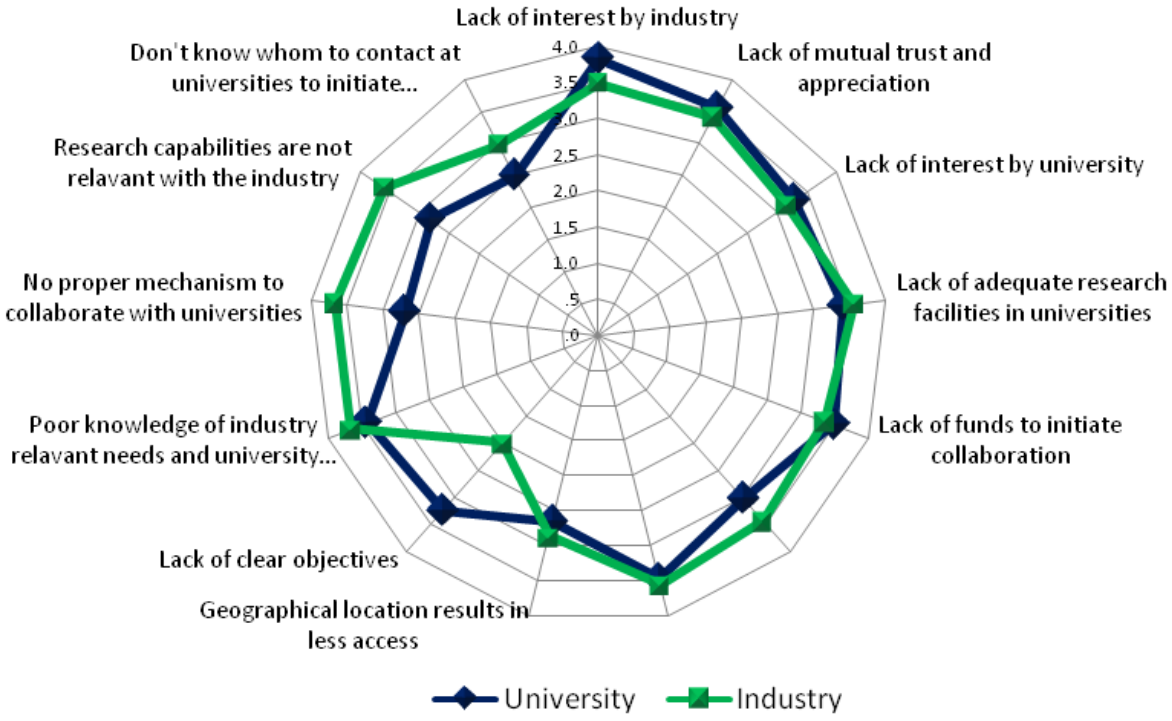

Fig. 9: Barriers causing hinderance for university-industry linkages.

This time the question from both university and industry was; *what they experienced as barriers in establishing the university–industry linkages?* Again, a good level of similarity in the views of both stakeholders' was observed. In Fig. 9, the pattern is almost identical with some exceptions. For some kind of barriers, the university respondents feel barriers, are higher and for other kinds of barriers the industry respondents feel barriers are higher. From the university point of view, "lack of interest by industry", "lack of mutual trust", "lack of funds" and "lack of knowledge of industrial needs" are highly influential barriers. The "geographical location" is not identified as highly influential barrier. According to the respondents in the world of IT and communications, the distances are no longer seen as barriers. Though, the spokesperson agrees with the benefits of communication technologies but most of the barriers identified them clearly show the communication gap between university and industry.

However, from the industry point of view "missing mechanisms to facilitate the establishment of linkages with university", "no knowledge of available expertise in universities", "no knowledge of existing facilities in universities" and "poor experience of universities in commercializing the research" are highly influential barriers. The lack of clear objectives by industry is identified as less influential barrier. This clearly shows that the barrier in establishing university–industry linkages is mainly the non-existence of some facilitating institute which can create a systemic link between universities and industries and may share knowledge of expertise and resources available in university to the industry and knowledge of the industrial needs to the universities and also sharing the knowledge of available channels of funding the research projects.

Proposed mechanisms for improving university–industry linkages in future

After understanding the existing status and types of linkages, motivations and barriers behind establishing university–industry linkages, the final objective is to understand those mechanisms which in future will be preferred by both the stake holders in strengthening the university and industry linkages in Sindh, Pakistan. The respondents were asked to propose the importance of some mechanisms which they feel can facilitate the process of establishing the university–industry linkages in future. The importance of these factors is accessed on a scale of 1–5, with scores of 1 being counted as "Least Important" and 5 being counted as 'Highly Important'. The answers are presented in Fig. 10.

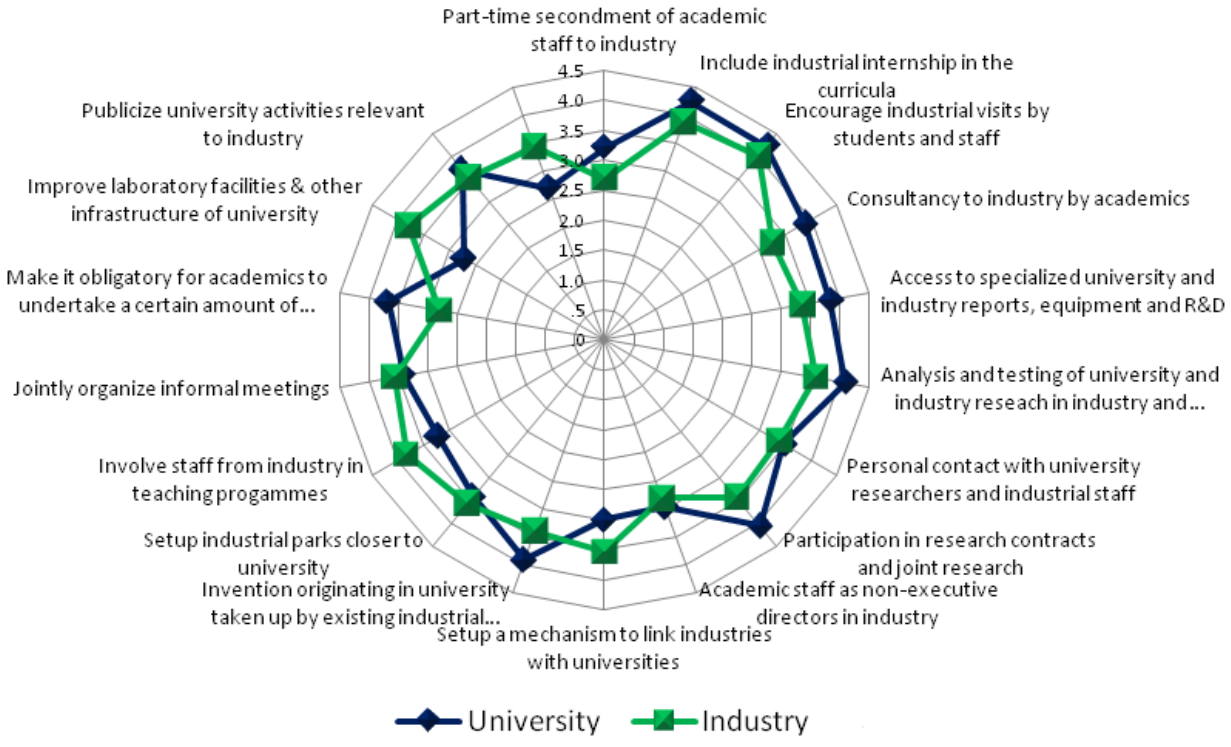

Fig. 10: Mechanisms for improving university-industry linkages.

Both the university and industry respondents were asked to propose effective mechanisms to improve the university–industry linkages. Some similarities have been found in both stakeholders' point of views. In Fig. 10, the pattern is almost identical with some exceptions. Collectively, both the university and industry's point of views, the most effective mechanism is "encouraging students and staff for

industrial visits". Frequent visits allow interaction between stakeholders and due to these interactions the knowledge about university expertise and industrial needs can be shifted to the stakeholders. In addition, university also propose "inclusion of industrial internship in the curricula", "analysis and testing of university research in industry and industrial research in university, "participation in research contract" and "joint research" as highly effective mechanisms to promote the university–industry linkages in future. The "improvement of laboratory facilities and other infrastructure of university" are found less effective mechanisms for university–industry linkages.

On the other hand, industry also proposes the inclusion of "industrial internship in the curricula", "active participation of industrial representatives in class teaching", "analysis and testing of university research in industry and vice versa", "setting up industrial park near university" and "establishing and strengthening personal contacts between university researchers and industrial practitioners" as highly effective mechanisms. In addition, industry has also pointed towards the role government may play by "offering tax concession for industries that work with universities for research". However, "part time working of university researcher in industry and contributions of academic staff as non-executive directors in industry" are identified as less effective mechanisms. All other factors are in the middle. This clearly shows that as human capital of both institutes will move across universities and industries frequently there are chances of establishing the university–industry linkages. It was also identified that universities need to play a proactive role in establishing these linkages.

CONCLUSION

The research paper presented the existing status of UIG linkages in Pakistan. The purpose behind this study was to assess the understanding and application of triple helix model in Pakistan. The study revealed that, like other developing countries, Pakistan has also identified the potential benefits which this model can bring for the economic upgradation of the country. During this research, many similarities have been found in the views of representatives from Universities and Industries under three types of linkages in practice; motivation behind establishing linkages, barriers causing hurdles, and proposed effective mechanisms to be implemented in future. Despite some differences in their priorities, both agree on growth opportunities which may be attained from successful university–industry linkages with a support from government. During current study, the role of government, as a policy maker and provider of funds, in the triple helix model has so far been identified as weak. However, if Pakistan, as a developing country, needs to receive what has already been achieved by the developed world through establishing strong UIG linkages, the question, *What are the appropriate polices government of Pakistan should make for knowledge capitalization,* needs to be answered very clearly.

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