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Research Article

Academia-pharmaceutical industry linkage: An academic perspective

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ABSTRACT

Background: The pharmaceutical sector in Pakistan has grown over a period, however, there are several barriers in the framework governing the growth of the country's pharmaceuticals. The lack of academia-industry linkage (AIL) is among the critical barriers; hence the focus of the study is to find out the reasons for the lack in the above collaboration. Understanding barriers may help their redressal.

Method: This qualitative phenomenology-based study has been conducted in the most prominent pharmacy institutes, located in Lahore, Islamabad, Peshawar, Sargodha, and Quetta. Academic participants, with a minimum experience of 10 years and designation of assistant professor or above were recruited with a two-stage selection process, purposive sampling and snowball sampling. The data were collected using semi-structured interviews with academic experts. Thematic content analysis was employed to conclude the data.

Results: Analysis of data yielded 8 themes with 18 codes. The main reasons for neglected AIL were explained by a partial or complete lack of industrial research and development activities. Other key factors for the scarcity of AILs were the lack of positive attitude from both industry and academia, applied research in academics, and the research and development of the new molecules in the pharmaceutical industry. Support by the government and the drug regulatory authority of Pakistan in terms of regulatory and academic policies was also perceived to be absent. New horizons in research and development could be opened by providing applied research to industry, including but not limited to new molecule development.

Conclusion: Academia-industry linkage could be boosted with government-backed funded projects and policies. Academia should focus on the industrial-demanded applied research.

KEYWORDS Pharmaceutical industry; pharmaceutical academia; research and development

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1. Introduction

Academia-industry linkage (AIL) is the interaction between industry and academic institutions or public research centers to solve technical issues, work on innovations, research and development (R&D), or collection of scientific and/or technological knowledge (Rodríguez & Bielous, 2016). The industry could get a pool of expertise from academia (Alice, 2007) while the industry scales up, commercialises, and makes accessible to public, a viable output from academic R&D (Gul & Ahmad, 2012). This linkage has a wider range of following advantages, this collaboration: (a) is a source of knowledge contribution through competitiveness and technology transfer in research and teaching – an experience acquired from developed countries (Carayannis et al., 2012), (b) supports private R&D by triggering the additional investments (Guimón, 2013), (c) provides a platform for academic and industrial R&Ds to co-evolve and develop (Cohen et al., 2002), (d) has a probability of research partnerships, academic entrepreneurship, and scientific publications (Perkmann & Walsh, 2007), (e) flourishes the academia-industry combined effects and relationships of scientific and technological abilities, (f) enhances the relevance of research carried out in public institutes, (g) increases the commercialisation of the outputs of public R&D, which is considered the main source of industrial growth and trade globally (Guimón, 2013), (h) improves the prestige and reputation of academic researchers (van Rijnsoever et al., 2008), and (i) enhances the mobilisation of the human resources of the public-private sector (Guimón, 2013). Thus, the prime aim of AIL is the certation of business platforms to bridge the gap between the above two sectors (Noor et al., 2014).

Establishing the AILs is challenging for the developing countries – the main constraints are economic and lack of technically-trained personnel. Nevertheless, AILs are evident in developing countries. A report from Chile and Colombia reflects the prosperity of industry to launch and enhance the innovative products and patents through AILs (Marotta et al., 2007). In Pakistan the pharmaceutical sector, albeit has evolved since country's independence in 1947, is still in a progressive phase. This sector is believed to have more potentials in R&D and significant contribution to the national growth (Aamir & Zaman, 2011). There is a total of 759 pharmaceutical manufacturing units, among which 29 are the multinational companies (MNCs) (DRAP, 2018). Geographically, the industrial units are distributed as 440, 183, 114, 15 and 7 in Punjab, Sind, KPK, Baluchistan and Azad Jammu-Kashmir. Pharmaceutical units, in all provinces are located mostly in the major cities, like Karachi, Lahore, Peshawar and Islamabad capital territory. The figures reflect that the majority of firms are present in the province of Punjab, however, in terms of the manufacturing capacity, volume and size of business, Karachi takes the lead (Trade Development Authority of Pakistan, 2022). The local

industry fulfills approximately 80% of the country's demand while the rest 20% depends on imports (Aamir & Zaman, 2011). Despite the increase in the number of pharmaceutical companies, their exclusive survival during COVID-19, and growth even in the recent economic recess, a meager amount is spent on the R&D sector (Khan et al., 2021). Only 5% of pharmacists have been involved in R&D (Azhar et al., 2009).

The history of pharmacy education in Pakistan dates back approximately 75 years when the first institute was established at the University of the Punjab, Lahore. A significant transition has been witnessed in pharmacy education over the years. According to the Pharmacy Council of Pakistan (PCP), at present there are 132 accredited public and private pharmacy institutes. Majority of the pharmacy institutes offers Doctor of Pharmacy (PharmD) degrees, while some institutes (mostly public) also offer degrees at master and doctorate levels. Among these 132 institutes, 29 are located in Lahore, 15 in Karachi, 7 in Peshawar and the rest are distributed all over Pakistan (EduVision, 2023). A couple of institutes are located in the cities with a few, if any industrial units. One such example is Kohat where there is no pharmaceutical unit against a public pharmacy institute (Business;list, 2023).

With the involvement of a third player, i.e., Government in AIL, the association is generalised as the triple-helix relations (THR) (Leydesdorff & Etzkowitz, 1996). The Government of Pakistan has a couple of initiatives to boost up the AIL and bridge scientists from universities with the professionals from industry and government (HEC, 2005). The drug regulatory authority of Pakistan (DRAP) maintains a central research fund (CRF) since 2012, with a contribution of 1% of gross annual sale before tax from Pharmaceutical manufacturers for the development of the research and growth of the national pharmaceutical industry (Khan et al., 2021). Nevertheless, the above could not contribute in accomplishing any AIL intensity. In 2005, the higher education commission (HEC) of Pakistan has also launched a university-industry collaboration program (Malik et al., 2021), including University-Industry Technology Support Program (UITSP) and introduced technology development fund (TDF). The utilisation of CRF, however has not been reported in the above or any other programs (Khan et al., 2021) and under HEC programs, among the 17 industrial problems highlighted on the HEC online portal, only one, related to diagnostics was uploaded by the health industry which remained un-responded so far (HEC, 2005).

Despite the repute, the number of pharmaceutical industrial units, teaching institutes, academic technical expertise, favourable governmental policies and HEC fundings, the academic-industrial collaboration is not practically in place. Keeping in consideration, the aforementioned facts and data scarcity in this area, there is a need to investigate the reasons, and the way forward for tapping the missing opportunity of the AIL. Henceforth, this study was conducted to gain insight into constraints from Pharmacy academia, one of

the significant stakeholders of the pharmaceutical industry (Bukhari & Ahmad, 2024) for pharmacy academia-pharmaceutical industry linkage. The study also aimed to find how AIL could help improve the R&D, that in turn could contribute to the growth of the national pharmaceutical sector. Though this is a local study, yet the findings of the study could be implacable and generalisable to the other developing countries as well.

2. Methods

2.1. Ethical approval and consent to participate

Ethical approval was obtained from the research ethical committee, University of the Punjab, Lahore (Pakistan) vide letter No. D/30/FIMS before conducting the interviews. The signed written consent was obtained from all participants for which the purpose of the study was explained to the participants. The identity of the respondents was protected by using respondent numbers.

2.2. Study setting

Study was conducted across Pakistan mainly in the major cities of Pakistan, such as Lahore, Karachi, Quetta, Peshawar, Sargodha and Islamabad. In the remote cities, the interviews were conducted through WhatsApp, and video Zoom calls, though the face-to-face interview was the preferred mode.

2.3. Study design

Qualitative methodology based on phenomenology was employed to explore the perspectives of pharmacy academic experts on the AIL. A qualitative design was employed because it provides an in-depth exploration of participants' experiences, attitudes and perceptions (Berg, 2001; Kitzinger, 1995). The phenomenology encompasses the essence of the shared experience of a particular phenomenon, as reported (Neubauer et al., 2019; Wilding & Whiteford, 2005). The study proceeded according to the schematics given in Figure 1.

2.4. Development of interview schema – the study tool

A semi-structured interview guide, focusing on the perceptions of the pharmacy academic experts and gaps in the literature (Attarwala, 2021; Fatima et al., 2019; Rashid, 2015) was developed (Kvale, 1996). The services from two academic seniors/experts from a renowned public sector university were taken to develop the questionnaire. Before data collection, the interview

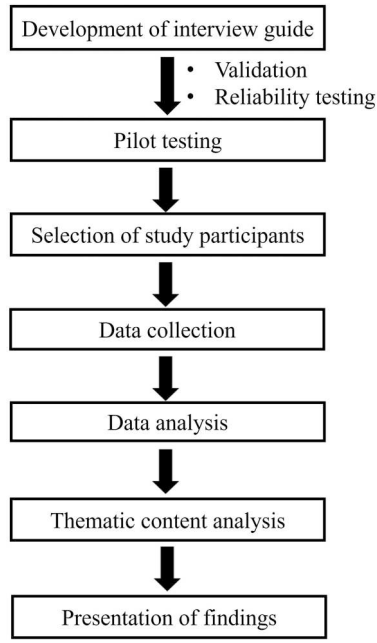

Figure 1. Schematics for study.

guide was assessed for validation and reliability. Two experts other than those input for questionnaire from the same pharmacy institute validated the guide by employing a blend of argumentative and cumulative approaches. The former employs a squabble source to address one contradictory stance (Bittmann & Thomas, 2013), while the later uses cross referencing through available literature for matching of the results of the study. The reliability of work was executed with saving the records the face-to-face interviews of the study participants. The validated interview guide was piloted on two participating academic experts in study and was amended accordingly, where need and was made available for real-time study. The final interview schema (Attached as additional file 1) had total eleven questions (with additional sub questions). The question included on the current status of pharmaceutical industry, status of domestic pharmaceutical R&D, barriers to and the perceived benefits of AIL. A question on the compliance of current good manufacturing practice (cGMP) by the pharmaceutical industry was asked to imply its willingness to invest, particularly for R&D activity.

2.5. Study participants

The study samples comprised the academics experts with the knowledge of the local pharmaceutical policy and practice, minimum experience and

qualifications, respectively 10 years and PhD and position of assistant professor or above. The participants were expected to provide the neutral perspective on the questions asked. The names of the participants were enlisted during February 2023 and started recruiting them during first week of March, 2023. No patient or public were involved in design and conduct of this research.

2.6. Sampling methods

Purposive sampling technique was used resulting in snowball and the later was used for sampling to reach the experts. Since, most of the academic experts were difficult to reach because of their busy schedules and duties, thus, a convenient sampling was deemed the most appropriate for recruiting the participants who were easier to find and also consented to participate. The initial state of the convenient sampling followed a snowball sampling strategy with the recommendations of the existing study participants.

2.7. Sample size

Sample size was determined by applying the Morse's saturation point criteria (Morse, 2000).

2.8. Data collection

Face to face interview of the participants for data collection, where possible was conducted by author 1 during 4th March–17th April, 2023 based on the guide prepared and accessed simultaneously. She was trained on the qualitative research before start of the study. Previously she has completed M. Phil in pharmacy and a working pharmacist for last 12 years. All interviews were conducted in English and Audio were recorded with consent of the participants (Mubarak, et al., 2024). Pharmaceutical academic experts who were unable to hold a face-to-face conversation, or belonging to remote cities were contacted through Zoom or WhatsApp video calls at home or workplace. Questionnaires were also shared through email or WhatsApp as well for the collection of data where required during the same duration.

2.9. Data analysis

The data was analyzed using thematic content analysis (TCA). Together, these insights have been described to help explain the main hurdles faced for establishing the pharmacy AILs in Pakistan and for business growth of the national pharmaceuticals. The analytical method followed the steps for thematic analysis as described earlier (Braun & Clarke, 2006). First, all the

audios were transcribed (in English) on a paper to get familiarised with the data findings and generate initial notes. Secondly, a code was assigned to a single sentence, several sentences or larger segments summarising the actual sense of a phenomenon described by the interviewee that are relevant for answering the research questions. Cross checking was done by the two co-researchers to ensure credibility and trustworthiness of the data (Lincoln & Guba, 1985). The list of codes was organised on word to help identify connections among them. Codes describing the similar phenomena were grouped together under themes. Finally, the main findings were presented as the identified themes.

3. Results

A total of 20 academic experts were initially contacted, while 18 academic experts consented to participate (90% response rate). Remaining 2 refused to participate due to their busy schedules. After reaching saturation point at 14th interview one additional interview was conducted to confirm the saturation in emerging data, as reported (Morse, 2000). Demographic details of the study participants are given in Table 1. Out of 15 participants, 12 were males and 3 were females. All of the academic experts were holding PhD degrees, mostly were at professor level and had experience of $\geq$ 12 years. Age of the respondents varied from 30 to 65 years. Though the retiring age in academia was 60, yet 3 retired but re-employed professors, with vast academic, industrial or regulatory experience were also recruited in this study. The average interview duration was 19.4 min.

3.1. Thematic content analysis

The analysis of the acquired data yielded 8 themes with 18 codes representing the prospectives of the study participants about AIL and of

Table 1. Relevant demographic details of the respondents (n = 15).

Characteristics	Frequency	Characteristics	Frequency
Location		**Age**	
Lahore	7	35–45	4
Bahawalpur	3	45–50	6
Islamabad	1	50–60	3
Sargodha	2	60–65	3
Quetta	1	**Educational status**	
Peshawar	1	PhD pharmacy	15
Gender		**Experience**	
Male	12	12–15 years	3
Female	3	15–30 yeras	10
Academic positions		More than 30 years	2
Assistant professor	1	Professor	11
Associate professor	3		

pharmaceutical R&D. The emerging themes, categories/codes and supporting quotations are highlighted in Table 2.

3.1.1. Theme 1: lack of research and development

Regarding the question on the comparison of national pharmaceutical R&D status to that of the developed countries, all the 15 participants uniformly opined. According to them, the national pharmaceutical industry does not work for the development of the new molecules and moieties, instead, generic based formulation is the main focus of the industry. Therefore, the focus of the industry on R&D is almost negligible. Thus, the academic institutes do not coordinate with the industry as no innovative work is being carried out in domestic pharmaceutical industry.

3.1.2. Theme 2: poor or no current good manufacturing practice compliance

Almost all the respondents (15) were in view that the national pharmaceutical industry has little or no compliance with the cGMP. Use of non-validated equipment and working standards were mainly perceived. A few participants opined that a continuous manufacturing process should be adopted to avoid contamination. It was suggested that DRAP should ensure the implementation of the cGMP through regular audits and inspections, which according to them would, ultimately promote the positive image of the industry and, thereby could enhance growth of pharmaceutical business.

3.1.3. Theme 3: lack of professional and positive attitude

Three respondents stated a lacking of the positive attitude from academia and the industry. Many respondents (11) suggested that as industry does not intend to invest on R&D, because it is comfortable with the development of the generic products due to a lesser cost, therefore a great business opportunity is being missed. Thus, the academia cannot get benefit from the industry in research and vice versa. Three study participants highlighted the deficiency of the trained and skilled academic personnels.

3.1.4. Theme 4: drug regulatory authority role in improving academia industry linkage

Ten out of fifteen respondents stated that the DRAP could play the major role in developing the AIL. It can facilitate collaboration for the practical knowledge sharing and stipend-based projects. Further, the DRAP could bound the industry for a mandatory consultation from any academic experts in any industrial research activity. Industrial research should be supervised by academic experts under the strict policies form DRAP. Research-based

Table 2. Emerging themes and supporting quotations.

Theme	Respondent	Supporting quotations (selected)
Theme 1: Lack of research and development		
Generic based manufacturing	1	In Pakistan there is no research and development only focus is on product development.
	8	Only focus of Pakistani industry is to get business with a small investment.
No use of latest technology	11	There is no use of latest technology in Pakistani pharmaceutical industry, no concept of continuous manufacturing.
Theme 2: Poor CGMP compliance.		
No or very less compliance with cGMPs.	2	Pakistani industry does not follow cGMP guidelines or cGMP are implemented very less.
Working standards are being used	4 and 5	In Pakistan working standards are being used for analysis in pharmaceutical industries, Drug Regulatory Authority of Pakistan should make a library for primary standards and provide the standards on subsidised rates from authentic sources.
Theme 3: lack of professional and positive attitude		
	1, 2 and 6	There is lack of academia-industry linkage due to lack of positive attitude form both groups and due to unavailability of applied research in academia.
Theme 4: Role of DRAP in improving academia industry linkage		
DRAP has major role	2, 6 and7	DRAP has a major role in collaboration by utilisation of the research funds submitted to it by industry through announcement of funded research projects.
Research should always be supervised by academicians	4, 5 and 9	All the research in industry should be supervised by academic experts no matter what and DRAP should bound industry for this purpose.
Theme 5: value of the academic research on time tested drugs		
No value until research is applied type	8	There is no value of academic research until or unless the projects are applied type and are scaled up and marketed by the industries.
Can be valuable	4 and 5	This research cab be valuable if could do perform bioequivalence and stability studies over such drugs this will benefit industry.
	10 and 11	Development of SR, DR products can produce products with lesser dosage frequency and reduce cost.
Theme 6: Ways to improve research and development		
	5	The only way to improve research and development is by bringing academia and industry together and DRAP should mediate for this purpose.
Theme 7: Reasons for lesser acceptance of Pakistani pharmaceuticals products at international level		
Comparison to India	1, 2, 13 and 15	India is biggest manufacturer of Raw materials that is why it can provide products at lesser cost as compared to Pakistan also labour and regulatory

(*Continued*)

Table 2. Continued.

Theme	Respondent	Supporting quotations (selected)
		requirements in India area very relax as compared to Pakistan.
Comparison to Bangladesh and Malaysia	9 and 14	Bangladesh and Malaysia both have very relax regulatory requirements and also easy export policies as compared to Pakistan.
Theme 8: Strategies to increase international collaborations		
Trainings	2,5,7 and 13	Training programs should be there for industries and industries should be convinced for participation in export.
Collaboration from Government and DRAP	1–15	Government of Pakistan and DRAP should participate in this drive with the industries, DRAP should help industries to improve their deficiencies and should play a positive role in this regard by providing one window operation for such kind of activities.
Better marketing strategies	5 and 8	DRAP should arrange pharmaceutical expos and international exhibitions where the generics being manufactured in Pakistan should be presented and displayed in a nice way to improve their sale and hence international market share.
Accreditation with Pharmaceutical Inspection Co-operation Scheme (PICS) and World Health Organization (WHO)	3	DRAP should get PICS and WHO accreditations so that export can be targeted in PICS approved and also SRA countries.
	2	Notorious media campaigns for political purposes should be stopped.

projects should be announced by DRAP and funded by industry. Trainings and country wise regulatory requirements should be learnt by signing memorandum of understandings (MOUs) with the regulatory bodies of the other developed countries. Exchange of academic research scholars should be there between industry and academia for R&D.

3.1.5. Theme 5: measures to improve research and development and role of DRAP

Total 6 out of 15 respondents suggested that the industrial R&D could be improved only with the DRAP's initiative for collaborative research with clinical research-based organizations and coordination with industry. Gap of research can be covered by collaborating with pharmaceutical companies of the developed countries. According to the 3 respondents, the collaboration should be made with industry in the developed countries by MOUs with the research-based companies or public research centers in the developed countries. Once research and development in formulation of the innovative products is established it would lead to interact between the industry and researchers and improvement of AIL.

3.1.6. Theme 6: value of academic research on time tested generics

Two out of fifteen respondents expressed that the academic research could not be valued by the stakeholders including industrialists unless it is of applied nature. Opinion of 3 participants was that the academic research could be valuable if the stability data and bioequivalence testing were under taken. Further, the sustained and delayed release and the logical fixed dose preparations of the existing drugs could be of worth as they could reduce the frequency of administration (beneficial for patients), thereby would cost lesser (an advantage for industry). One participant suggested that the industry should start bioequivalence testing and the academic scholars could be recruited for such studies on the time-tested drugs in place of merely the comparative dissolution profile studies being carried out at present. The pharmacokinetic and bioequivalence studies could help in achieving pharmacokinetic optimisation of the formulations. This could facilitate pharmaceutical product placement in the global market.

3.1.7. Theme 7: redressal of a poor international acceptance of domestic pharmaceutical products with academic-industrial collaboration

Almost all 15 respondents were of view that the local pharmaceutical products are much better in quality compared to products manufactured in the neighbouring country. They also pointed out a cheap labour in the neighbouring developing countries, relative to Pakistan where the production cost was high due to high rates of electricity and use of the imported active pharmaceutical ingredients (APIs) and raw materials. Instability of the local currency is a major issue in Pakistan. Further, the strict regulatory requirements of Pakistan are also the hurdle in achieving greater international market share. However, through academia-industrial collaboration, Pakistan could produce APIs and raw material, that would facilitate achieving the international market share. Joint academia-industry expos and participation in the international conferences would help to commercialise the generic based formulations. There could be learning on the new techniques of pharmaceuticals manufacturing and testing which would ultimately lead to production of more quality products and gaining, ultimate the global market share.

3.1.8. Theme 8: ways to improve collaboration

All respondents suggested that the research activities should be performed by academic experts under the strict supervision of DRAP. The DRAP should bound pharmaceutical companies for the development of new molecules in collaboration with academia. The training of industrial experts on development of the new molecule in collaboration with industry of other developed countries can be beneficial for bringing innovation. DRAP

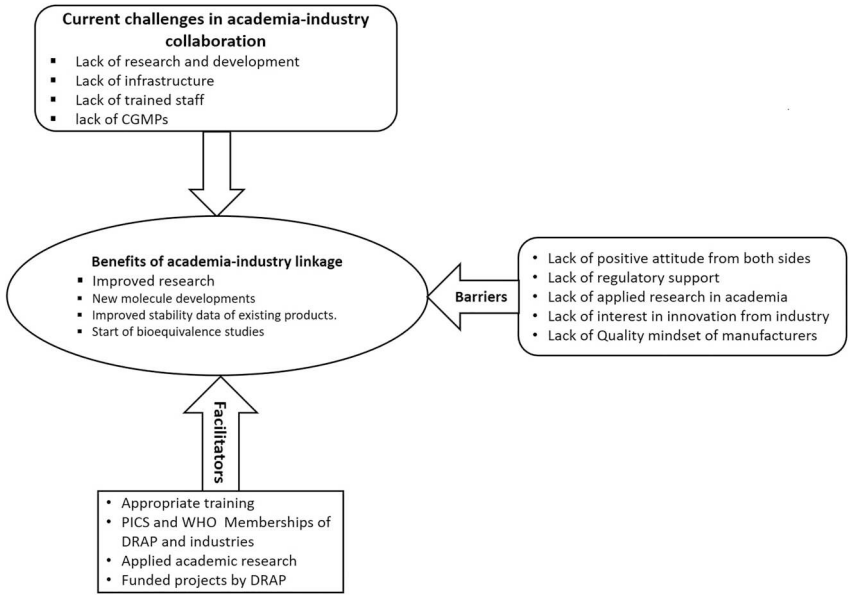

Figure 2. The challenges, barriers, facilitators and benefits of pharmacy academia-industry linkages.

should get pharmaceutical inspection co-operation scheme (PICS) and World health organization (WHO) certifications which could open ways to collaborate with PICS member or WHO approved countries. Better and improved marketing strategies for the generic products through organisation of industrial expos and exhibitions can lead to improved image of Pakistani pharmaceuticals which can then increase chances of international collaboration. DRAP and government of Pakistan should facilitate the interested companies in terms of trainings on new techniques, policies and regulatory requirements. The challenges, barriers, facilitators and benefits of Pharmacy academia industry linkage in Pakistan have been summarised in Figure 2.

4. Discussion

To our best knowledge, local studies and data on pharmacy AIL are scarce and so far, no report that has exclusively highlighted the issue has been published. The studies, if any are mostly related to the social sciences or information technology (Noor et al., 2014). The AIL has been a neglected area in the pharmaceutical research. In general, some forms of academia-industry cooperation do exist which indeed is not a linkage in its true sense. Pharmaceutical industry offers industrial attachments to PharmD students of 4th year, though majorly as non-paid and with undefined internees' roles. Further, industry provides, on demand the APIs and raw materials to the

postgraduate research scholars (Ijaz et al., 2023). Some pharmaceutical units have entered into relatively defined but still non-research-based collaborations with the non-pharmacy academic institutes (NUST, 2018) for biosimilar products, capacity building and trainings with special emphasis on the bioequivalence and clinical trials (NUMS, 2021, 2022). University College of Pharmacy, University of the Punjab, Lahore has launched a unique program, industrial PractiSim (industrial practice simulation) to provide an interaction from industrial experts along with joint faculty-expert supervised industrial visits and preceptor-based industrial internships. The above undefined forms of cooperations have the potentials to be transformed into the true AIL with the help of the identification of the barriers to this collaboration – one of the reasons for this study.

The current study revealed 8 themes and 18 codes. Nearly all the respondents perceived that the domestic pharmaceutical industry lack academia-industry collaborations. There was not even a single example of a joint project that could be cited as academia-industry collaboration. Lack of trained staff for industrial R&D was also highlighted by the respondents as a hurdle in the academia-industry collaboration.

The current study has shown absence of a positive and professional attitude from the academia beside that of the industry. The academic institutes are way behind in practical approach in drug research, relevant to pharmaceutical industry (Gul & Ahmad, 2012). It was noted that for establishing collaboration, the academia should improve itself by adopting a professional approach and bringing a positive attitude. The academic R&D needs to be focused on the applied research in medicine manufacturing (Hadzović, 1997), as it could help industry in improving the quality of medicines and, hence uplift the image worldwide of the national pharmaceutical sector. The local pharmacy institutes, particularly that are well-established have potentials to expand the theoretical knowledge for the practical capacity building and enhance the experience of young researchers for innovation in pharmaceutical sciences through research projects on drug design and new formulations (Gul & Ahmad, 2012).

The themes suggested that the pharmacy academia industry linkage could be beneficial, with many respects to the both stakeholders. Such a linkage is essential for industrial growth and scaling up and commercialisation of the academic research outputs. Historically, the first pharmaceutical collaboration between Basel University and Mayo Clinic and another between Rutgers University and Merck resulted, respectively in Nobel prize winning discovery of corticosteroids (Kendal et al., 1950) and streptomycin (Waksman, 1952). Large scale corticosteroids preparation method was developed in Merck with academic collaboration (Patchett, 2002).

Initiation of joint training program of academic faculty by the pharmaceutical industry and academia was also emphasised to strengthen their

practical skills. In education such joint ventures have been reported. Merck offered courses in drug discovery and development and also initiated the training program for the regulatory science (Rosenblatt, 2013). The mobilisation of personnel, academic conferences, contacts and commercialisation of intellectual property rights are the few channels of interactions between industry and academia. Extra income for academicians, research funds and access to industrial resources can be gained through such interactions (De Fuentes & Dutrénit, 2012).

The medical practitioners generally accept the generics, though hesitant to prescribe routinely, mainly due to perceived issues regarding their safety and reliability (Sharif et al., 2016). The domestic generics are not studied for the bioequivalence for their original branded counterparts, a requirement of the Food and Drug Administration (FDA) for ensuring their match in safety, potency and quality (Jamshed et al., 2009). The DRAP Act 2012 also required insurance of safety, efficacy and quality of drug in registration process (Iffat et al., 2014). However, the quality and safety of original brands and generic medicines should be studied to address the misunderstandings of the domestic medical professional and/or enhance the quality of generics (Anand et al., 2011). Such studies will create evidence-based foundation for healthcare professionals, institutions, and regulatory bodies to develop and implement informed policies (Malik et al., 2020).

DRAP can motivate industry for a paradigm shift from generic manufacturing to research-based products' manufacturing. R&D for new and innovator products could be initiated with the help of AIL under DRAP's guidance and supervision. Currently, HEC contributing in R&D at a very basic level and without a coordination with the DRAP. The organised efforts between the above two stakeholders could increase the opportunities for academics in terms of innovation and knowledge contribution for industry.

This study participants also highlighted the intention of the industrialists to invest more for business growth, mainly by adopting cGMPs and following the ICH guidelines. However, the small industries were found reluctant to follow the cGMP as it increased the production cost. Two respondents stated that working standards were assumed in the majority of the companies though they also deviated from cGMPs guidelines. One respondent stated that the manufacturers lack a mindset for quality operated manufacturing, in line with a past study highlighting the barriers in implementation of the quality assurance and cGMP guidelines (Fatima et al., 2019).

All the pharmacy academic institutes are being run under administrative rules of the Pharmacy Council of Pakistan (PCP, 1967), the council may also play its role, at least for the inclusion of the some concepts on the academic-industry linkage in the national pharmacy curriculum.

The highlighted barriers to the collaboration in this study could be consolidated, also in line with the literature as: (a) production mostly of generics by

the national companies, (b) product development in focus, instead of R&D, (c) lack of the infrastructure for R&D, (d) unavailability of the trained staff for industrial R&D, (e) deficiency of the motivation of industrialists for R&D (Khan et al., 2021), (f) tendency to invest only in the projects profitable for industry in a short span, (g) paucity of positive and professional attitude from academia, (h) deficiency of trained staff for R&D and (i) absence of the unorganised efforts of DRAP, HEC and PCP. Nevertheless, what may be reasons for the lack of R&D, this lacking limits the future growth of the national companies (Ahmed et al., 2020), despite a tremendous potential of research in academia and industry.

Surprisingly, none of the respondents of this study highlighted certain expected responses. For instance, inclusion of AIL as a part of pharmacy syllabus of the under- or post-graduate level has not been stated by any participants. Role of the HEC to devise syllabus, or bound pharmacy institutes to collaborate with the industry and industrial training of pharmacists through rotations was also neglected. None of the participants pointed out that the pharmacy institute should prepare their graduates for R&D tasks by the practical training on research methodology – which is necessary to familiarise students with the basics of the research. Similarly, the role of PCP for the promotion of academia-industry collaboration was also neglected by the respondents.

On the other hand, very striking information was provided by one of the respondents. The DRAP did not register new molecules, or new logical fixed dose combinations of drugs until there was evidence of registration of such moieties/formulation by any of the European, Japanese or USA regulatory authorities. A few protein-based formulations, such as interferon and insulin, developed by the center for applied molecular biology (CAMB), University of the Punjab, Lahore could not be scaled up and commercialised (Gul & Ahmad, 2012), possibly due to the regulation's impediments in registration process and lack of scale up facilities in the country. Therefore, it further strengthened the perception that basic level research for new drug development was of no value for the regulatory authority and of no utilisation for the industry and academia. The academic proactiveness and involvement in collaboration with industry can be significant, as reported (Callaert et al., 2015).

4.1. Recommendations for different stakeholders

4.1.1. Recommendations for industry

- The current weak academic-industry cooperations could be the basis for the advancement of true academia-industry collaboration.
- The R&D-based projects are required to be started immediately by collaboration of academia and industry.

- Industry should start the manufacturing of active and inactive raw materials locally to save the manufacturing cost of the raw materials that will reduce product cost and the national industry will be able to compete for price and can get a better share of export.

4.1.2. Recommendations for academia

- The academia should announce applied research projects in conjugation with DRAP and HEC.
- Academia industry linkage can further be enhanced by changing attitude of the experts involved in both areas. Memorandum of understandings should be signed between academia and industry.

4.1.3. Recommendations for DRAP

- A portion of the central research fund deposited to DRAP by industries should be utilised in bringing the academia and industry together.
- There are many benefits associated with examining the academia-industry collaboration in developed countries, as it gives an insight into the motivations, barriers of cooperation and influence of public policy in developing such linkages. Thus, DRAP should focus on getting registration from PICS and WHO to facilitate covering the gap with the PICS approved countries for export. This is expected to improve the level of research work by the domestic pharmaceutical industry.
- DRAP should ensure that the cGMP guidelines are being observed in the pharmaceutical industry with true spirit with the repeated surprise audits and inspections.

4.1.4. Recommendations for government

- The policies should be formulated and advertised well to foster AILs.
- Government should stop negative media campaigns on the spurious and counterfeit medicines for saving the image of Pakistani industry.
- The government should support the start the manufacturing of active and inactive raw materials locally to reduce the material and manufacturing costs, mandatory for a better share of export.
- The government should offer incentives, such as the tax rebate, flexibility of product price fixation for the companies involved in the research and development.

- Government should provide subsidised units of electricity to the industries reducing the labour cost and should relax the policies of export for pharmaceuticals.

4.2. Limitations of the study

Though at least one participant was recruited from every province, yet the mode of interviews varied, such as face to face interviews, and use of WhatsApp, video calls and Zoom. Some of the participants demanded the written questionnaires. The above different modes of data collection might cause variations. However, such shortcomings are possible in such types of studies (Hashmi et al., 2017). Nevertheless, instant clarification was called for the ambiguous responses, if needed when any methods other than face to face interviewing was employed. Thus, we believe that our findings could be generalisable. Furthermore, the perspective in this study was only studied for academic experts while other side of the participants from the pharmaceutical industry and governmental policy makers was not included in this study. Therefore, the inclusion of the above stockholders is recommended for future studies.

5. Conclusion

There is a serious need of academia and industry linkage for the growth of pharmaceutical sector and academic research. Academia industry linkage will open the opportunities for pharmacists to work in research and development. Drug regulatory authority of Pakistan should announce the funded research projects for the postgraduate students of the universities where the academic expert should be involved for supervision and guidance. The drug regulatory authority should also ensure the implementation of the cGMP guidelines in the industry through regular audits and surprise visits. Academia should focus on the industrial-demanded applied research that can benefit the pharmaceutical industry, as well as the academia. International marketing campaigns and expos for the launch of generic products should be arranged to increase the growth of pharmaceutical industry.

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Disclosure statement

No potential conflict of interest was reported by the author(s).

Ethic statement

Ethical approval was obtained from Institutional research ethical committee. Before conducting the interviews, the purpose of the study was explained to every participant. Signed written consent was taken from all participants.

Author contribution

Nadeem Irfan Bukhari, Zia Husnain: Conceptualization, Zobia Mubarak, Nasir Abbas: Data curation, Zobia Mubarak, Furqan Khurshid Hashmi, Nadeem Irfan Bukhari: Formal analysis, Nadeem Irfan Bukhari, Furqan Khurshid Hashmi, Zobia Mubarak: Methodology, Nadeem Irfan Bukhari: Supervision, Zobia Mubarak: writing manuscript Furqan Khurshid Hashmi, Nadeem Irfan Bukhari. Editing and writing.

Data availability statement

The original contributions described it this study are included in the article. further inquiries can be directed to the corresponding author.

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