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Integration between industry and university: Case study, Faculty of Engineering at Rabigh, Saudi Arabia

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ARTICLE INFO

Article history:
Received 18 February 2015
Received in revised form 14 November 2015
Accepted 23 November 2015
Available online 11 December 2015

Keywords:
University–industry
Integration
Bridging model
Applied research
Technological issues
Industrial needs

ABSTRACT

Collaboration between university and industry has long existed, but the rapid increase of global knowledge has increased the demand for strategic relationships that go beyond the conventional funding of research projects. University research should be developed in future to play an important role in industry and in turn economic growth. For a successful collaboration, both sides should overcome the communication and cultural divide that impair university–industry relationships across all categories and undercut their potential. Faculty of Engineering at Rabigh (FER) – King Abdulaziz University (KAU) is strategically located near major industries and facilities such as Petro Rabigh, desalination plant, steel fabrication, and cement industries, which makes FER a nucleus to solve technological problems for all these industries. Much effort has been made at FER to collaborate with these industries through mutual reciprocal visits of university and industry personnel as well as student internships. These are aimed to solve both short- and long-term technological issues at the industrial units. This will not only improve the local knowledge base and skills, but also bring confidence and trust between the two partners. It is well known that innovation does not take place in vacuum: a context – the economy, society, and policy – determines how easy or difficult it is to innovate. In this context, the role of government is also very important to create legislations that make the university–industry relationship a win–win situation.

1. Introduction

The role of universities has become very dynamic and entrepreneurial in the 21st century. Models and indicators are available to judge the entrepreneurial orientation of a university. Universities and industries (UI) are collaborating to explore the new horizons of opportunities through research and development (Philpott et al., 2011). This mutual relationship benefits both organizations and strengthens economies of the countries involved by industrializing the obtained products. Therefore, the academia–industry relationship has become a subject of research and is continually being refined

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http://dx.doi.org/10.1016/j.ece.2015.11.001
1749-7728/

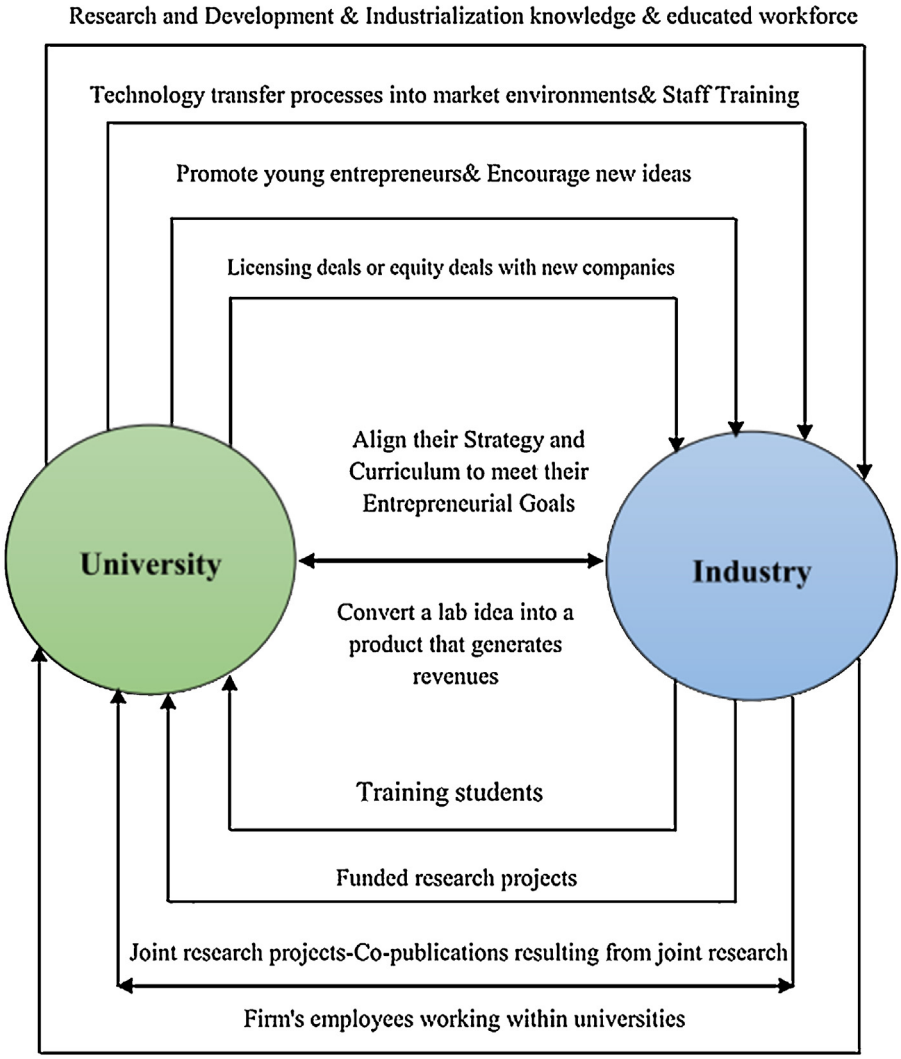

Fig. 1 – University industry links.

and consolidated. The public–private relationship between the UI is examined to study the outcomes of cooperation. One bibliometric study was conducted to analyze the relationship between the universities and the local industries. Sometimes, the number of patents coauthored by UI personnel was set as a quantitative indicator of the effectiveness of collaboration.

Several articles have addressed the relationships between the UI to illustrate the benefits of such cooperation. For example, an interesting trend indicated by Veugelersa and Cassimanm (2005) in an analysis of manufacturing companies of Belgium was that chemical and pharmaceutical industries, which involve fewer risks, are more likely to have research and development (R&D) ties with universities. Furthermore, a study of the R&D cooperative agreements between Spanish firms and organizations of research revealed that the previous links, the key for the success of such companies, provide the definitions of aims and commitment that are confirmed by a similar study in European universities (Abramo et al., 2009a). Some studies have described an interesting aspect of knowledge spillover from university to industry and revealed that the informal contacts between UI are more than formal contacts (Panda and Gupta, 2014; Freitas et al., 2013; Muscio et al., 2013). A study has analyzed the triangle of university–industry–government relationship in South Korea and concluded that the country is in a transitional phase of industrial knowledge and national innovation system (Park and Leydesdorff, 2010). In addition, the University of Coimbra in Portugal used a triple helix model to study the effectiveness of the trilateral relationship between UI and the government and realized that the relationships developed by the university made a mesh of networks and hybrid organizations (Motohashi and Muramatsu, 2012).

It is important to know that governmental polices play an important role in establishing UI relationships. Hence, serious effort has been made in the establishment of UI relationships, and several empirical models and performance indicators are available in addition to the policy discussions. The number of patents coauthored by the UI is a direct indication of the degree of relationship between both organizations (Petruzzelli, 2011). Fig. 1 summarizes the links between UI from different perspectives.

2. UI relationships in Saudi Arabia and Gulf Region

Saudi Arabia's future innovation platforms cannot be isolated from the current changes in its economy. Saudi economy has been long known for its chronic dependence on natural resources (Al-Sultan and Alzaharah, 2012). Saudi Arabia is one of the several countries whose economy depends on natural resource wealth. The factors affecting economy of these countries include, but are not limited to, the R&D levels

(Al-Sultan and Alzaharah, 2012). The industrial development of Saudi Arabia has been affected in the past decades by the continuous reliance on natural resources. The industry landscape has been dominated by large corporations, including Saudi Basic Industries Corporation (SABIC) and Saudi Aramco, which have the monopoly of the oil development upstream. SABIC is the largest non-oil company in the Middle East and has currently been considered the seventh largest petrochemical producer of the world (Al-Sultan and Alzaharah, 2012). Despite the potential scopes of innovation, Saudi Arabia's economy has remained stable in the investment stage.

It is important for the universities in Saudi Arabia to swiftly develop and adapt to new roles. They should also promote young entrepreneurs, encourage new ideas and methodologies, financially support and mentor them, and cooperate with surrounding industries to transfer academic knowledge into commercial products. Academic entrepreneurship is a main factor to achieve economic prosperity. The developing economies of the world currently depend on human capital and knowledge-based societies. This indicates that the current role of academia is facing more challenges than those three decades ago. In addition to improving knowledge and conducting research, universities must play a pivotal role in developing the economy. Because of this structural shift in both the United States and Europe, universities have started recruiting more researchers, thus creating many opportunities for entrepreneurs to bring their dreams to reality. It was the coevolution of Stanford University and Silicon Valley in the 1980s that is still considered a role model for universities to contribute positively toward economic development. This collaboration has led to the establishment of companies like Yahoo and Google that have created thousands of job opportunities and generated billions of dollars.

The factors that led to the success of Silicon Valley are entrepreneurial attitude, legal support, venture capital, space for setting up a cluster of companies, educated workforce, research labs, risk taking, allowance for failure, and celebration of success. The same basic model has currently been adopted and modified as per local customs and culture by other countries to create Silicon Valley-type environments to ensure that universities can perform their new mandate effectively. Hence, academic entrepreneurship is not only responsible for creating knowledge, but also for taking various initiatives to facilitate the conversion of this knowledge through technology transfer processes into commercial products. In Saudi Arabia, similar types of initiatives have already been announced by various universities such as King Saud University (KSU), King Fahd University of Petroleum and Minerals (KFUPM), King Abdullah University for Science and Technology (KAUST), and King Abdulaziz City for Science and Technology (KACST). KFUPM launched Dhahran Techno Valley, KSU launched Riyadh Techno Valley, KACST initiated Al-Badir for biotechnology companies, and recently KAUST has launched its full-fledged economic development initiative. Despite these initiatives that started a few years ago, the progress of incubating and turning ideas into reality has been slower than expected. This is understandable as the corporate world and academia have completely different objectives for their existence, and a common ground must be found. Companies always work toward advancing the interests of shareholders and increasing their wealth, whereas academia focuses on developing the quality of education and research. At the same time, universities must align their strategies to meet their entrepreneurial goals and take a multipronged approach. They should introduce changes to the curriculum so that engineers and scientists can start thinking toward entrepreneurship, develop close links with industry, and ask the leading companies to set up their satellite offices near the campus. These steps would reduce the time spent on reviewing the patenting process, licensing, and hiring separate and specialized staff for technology transfer processes (e.g., filing patents, marketing, and handling post-license relationship with industry partner). New policies are required to reward those who are able to raise revenues for universities and finally link with venture capitalists. Licensing deals or equity deals with new companies that deploy university technology would boost revenues. It is very important to accommodate that the whole process of ideas, patents, and final commercial production may take several months or years.

Academic entrepreneurship is key to achieve economic development. Saudi Aramco has recently launched its Wa'ed Program, which will soon be a boon for young entrepreneurs. It is working closely with universities to promote new ideas and provide necessary funding to university projects that influence the country's economy. The program also accepts direct applications from young entrepreneurs. In brief, a close collaboration between industry and academia is currently needed for the latter to play an active role in the development of a company in Saudi Arabia. At the same time, universities need to review and improve their internal processes to have a significant impact on the country's economy.

3. Collaborative research between UI

Currently, universities are responsible for the development of the regional economic and cluster formation, because the economies of the industrial countries become more knowledge-based. It is not surprising that the university's role is central to the emerging knowledge-based economies. The Organization for Economic Cooperation and Development (OECD) defines the knowledge-based economies as "one in which the production, use, and distribution of knowledge and information are critical to the process of economic growth" (OECD, 1996).

With the economies of industrialized countries becoming more knowledge-based, universities have become to be viewed as important players in regional economic development. A survey conducted in "The Economist" suggested that the concept of knowledge-based economy serves to "portray the university not just as a creator of knowledge, a trainer of young minds, and a transmitter of culture, but also as a major agent of economic growth: the knowledge factory, as it were, at the center of the knowledge economy" (David, 1997).

Universities provide valuable resources to develop new technologies, such as research outcomes – basic and others; access to funding; access to the latest knowledge base; and access to physical assets (e.g., technology and specialized equipment). Spin-off of research to companies by universities to create viable products and services is a win–win situation. It sounds easy, but can be difficult to achieve, which indicates that the full potential of some technologies are never fully realized. Effective knowledge sharing between public science and industry is recognized as one of the pathways of the knowledge-based society and has been pointed out by the European Commission as one of the main features of the European research area (European Commission, 2007). Relationships between UI can take a number of different forms

Table 1 – University/industry research collaboration the global innovation index 2014.

Rank	Country/economy	Value	Score (0–100)	% Rank	Rank	Country/economy	Value	Score (0–100)	% Rank
1	Switzerland	5.84	80.67	1.00	30	Saudi Arabia	4.47	57.83	0.79
2	Finland	5.82	80.33	0.99	31	France	4.46	57.67	0.78
3	USA	5.74	79.00	0.99	32	China	4.41	56.83	0.76
4	Singapore	5.62	77.00	0.98	39	Chile	4.27	54.50	0.72
5	UK	5.58	76.33	0.97	42	Mexico	4.08	51.33	0.70
6	Belgium	5.53	75.50	0.96	43	Oman	4.00	50.00	0.67
7	Qatar	5.47	74.50	0.96	46	Spain	3.98	49.67	0.66
9	Germany	5.39	73.17	0.94	50	Turkey	3.86	47.67	0.64
11	The Netherlands	5.25	70.83	0.93	57	Italy	3.71	45.17	0.58
15	Malaysia	5.02	67.00	0.90	62	Russian Federation	3.64	44.00	0.55
16	Japan	4.96	66.00	0.89	81	Jordan	3.36	39.33	0.40
17	Canada	4.93	65.50	0.88	86	Iran	3.32	38.67	0.36
20	Hong Kong	4.86	64.33	0.86	94	Pakistan	3.25	37.50	0.30
22	UAE	4.79	63.17	0.84	109	Tunisia	3.05	34.17	0.19
25	Korea	4.68	61.33	0.82	116	Kuwait	2.97	32.83	0.15
26	Portugal	4.60	60.00	0.81	127	Egypt	2.65	27.50	0.07
28	South Africa	4.54.	59.00	0.80	134	Yemen	2.12	18.67	0.01
29	Indonesia	4.49	58.17	0.79	135	Algeria	2.11	18.50	0.01

Source: World Economic Forum, Executive Opinion Survey 2013–2014

such as (Perkmann et al., 2013; Rast et al., 2012; Balconi and Laboranti, 2006; Abramo et al., 2009b; Bekkers and Freitas, 2008; Calvert and Patel, 2003; Klitkou et al., 2007):

- Companies fund research projects at public research organizations;
- Development of joint research projects with participants from the firm and the university;
- Copublications resulting from joint research projects;
- Collaborative technology development resulting in inventing and/or assigning competent people;
- University scientists working at firms;
- Firms' employees working in universities;
- Companies licensing university patents;
- University scientists undertaking short-term consultancies;
- Participation in formal and informal networks.

Copublishing between UI must be understood against the background of the university publishing specialization and also the role the university plays in the national context. "Top universities" are important players in relation to UI copublications. One of the problems with the use of the data on copublications and patenting only is the lack of detailed evidence on how good a proxy they are for measuring UI linkages.

It is important for university professors and students to conduct research related to the industry and publish their results, because the dissemination of knowledge is the essence of academic research. This is the main way for the professors' peers to judge professors' achievement, advancement, and tenure, and obtain future grants and recognition. For students, it is essential to publish their research results to obtain postdoctoral positions and jobs. Some compromise has to be made to remove the fear of industrial partners that publication may endanger their intellectual property that may arise from such collaboration. It usually takes 30–60 days for the company personnel to examine the manuscript and determine whether the research results contain any patentable item, and, if so, the writing of the patent starts (Demain, 2001). Table 1 shows the results of a questionnaire examining the extent of universities and businesses to collaborate on R&D in different countries of the world. It shows the UI research collaboration on the global innovation index. Answers to the survey ranged from 1 (do not collaborate at all) to 7 (collaborate extensively).

4. Faculty of Engineering at Rabigh

FER was established in 2009, which belongs to KAU with the main campus located in Jeddah. It consists of five engineering departments: electrical, mechanical, industrial, chemical and materials, and civil. FER was established away from the university main campus to serve the surrounding region in Rabigh, which is a famous city with its historical heritage located on the western coast of Saudi Arabia (Red Sea). It lies in the province of Makkah. Rabigh has several industries such as petrochemical, cement, desalination, and electricity and been attached to King Abdullah Economic City. Its location extends to 150 km south of Yanbu Industrial City, the largest industrial city in the region. Fig. 2 shows the locations of Rabigh and FER.

5. FER gap-bridging model

FER was established in 2009 with a mission that is in line with that of the university. The university's mission is "to enrich society through cultural prominence, scientific acumen and pioneering research." During this short period, significant contact has been made between the FER and the industrial sector through a combination of factors. FER is strategically located at the center of major industries, and also close to Yanbu Industrial City. This makes FER a nucleus to solve technological problems of all these industries. As a new engineering institution, a real challenge has been faced by the faculty to approach its local and surrounding environment in an unusual way. The uniqueness of FER as a single and developing engineering school in its region made it possible to establish its gap-bridging model to approach the local industrial community. Effective communication and use of its internal personnel expertise are the key elements for the model to reach and include the local industry. One of the main challenges of FER is to approach its surrounding community and build the necessary relations. New industrial relations and community service unit (IRU) were formed to achieve the FER strategy. Significant contact has been made between the FER

Fig. 2 – Rabigh and FER locations.

and the industrial sector through effort and activities of this unit. The role of the IRU and the additional effort made by the departments are the core elements of FER gap-bridging model (Fig. 3).

The FER combination of factors model consists of three main axes:

A. Internal resources and strategy;
B. Local potential; and
C. Communications.

The internal resources include several items such as staff members, expertise, knowledge, and industrial units.

The local potential depends on the surrounding and nearby industries. The surrounding industries include, but are not limited to, the following companies:

1. Saudi Aramco	2. SABIC	3. Petro Rabigh
4. Halliburton	5. Arabia Cement	6. Electricity Co. in Rabigh
7. SAFOLA	8. PETROMAINT	9. Al Rajhi Steel
10. Desalination Plant	11. King Abdullah Economic City	12. TAQNIA
13. Energia	14. Zamil Steel	

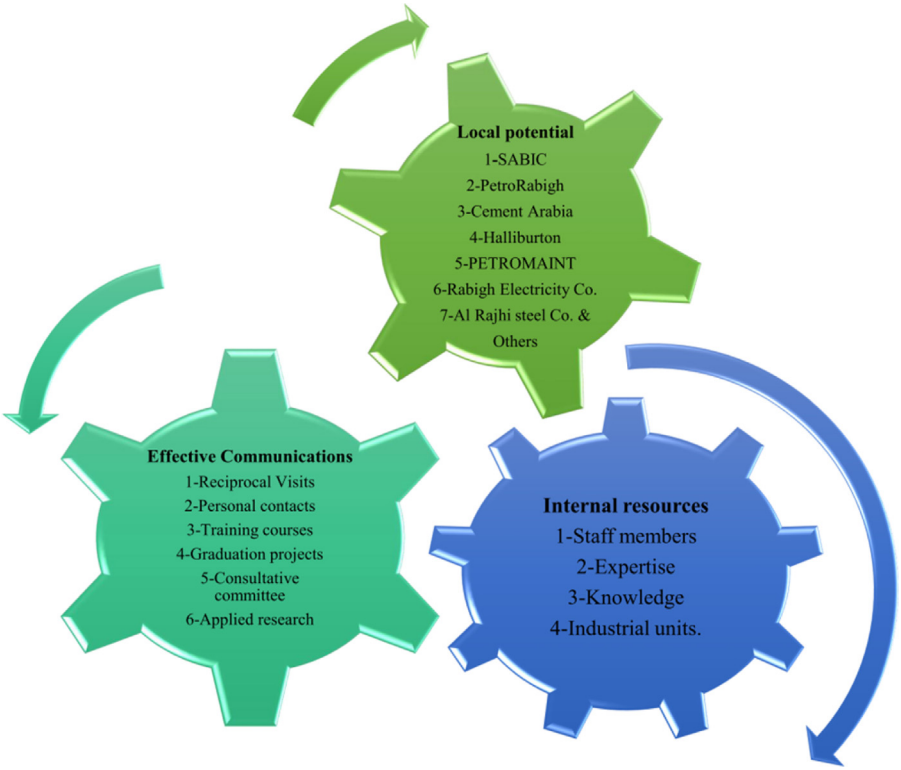

Fig. 3 – FER combination of factors model.

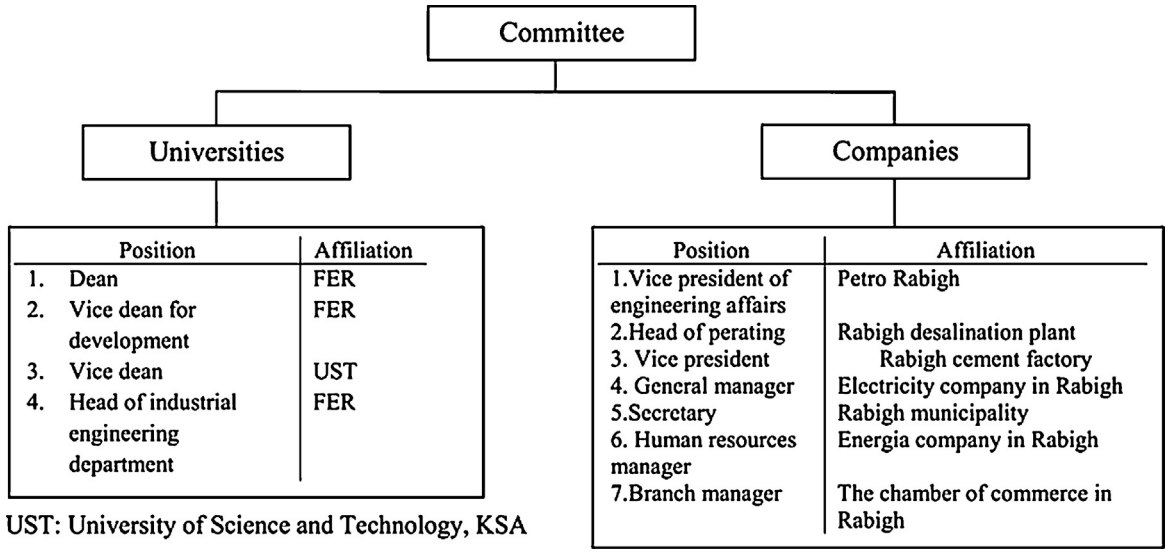

Fig. 4 – Consultative committee members.

These companies have key characteristics that help promote UI interaction such as financial support, multinational expertise, devices, and instruments UI partnership is adopted using funded research projects, scientific chairs, and providing training opportunities.

Communication between the FER and the surrounding industrial companies was made via

⇒Reciprocal visits	⇒Personal contacts
⇒Consultative committee	⇒Training courses
⇒Graduation projects	⇒Summer training
⇒Engineering day	⇒Applied research

6. Activities used in the implementation of the FER model

Since its inception, FER has played an active role in collaborating and supporting the industries around the Rabigh region. A number of activities have been done to promote dissemination of knowledge.

6.1. *Establishing a consultative committee*

One of the important beneficial results of cooperation between the FER and the industrial sector was the formation of a consultative committee. Fig. 4 shows the combination of the committee members.

The main tasks of this committee are

(1) Strengthening the link between the FER and the community;
(2) Contributing to the support of scientific research;
(3) Expressing an opinion on the curriculum; and
(4) Presenting proposals of development projects and programs to serve students.

As a result of the collaboration between UI in the FER model and according to the recommendations of this committee, all departments at the FER added a new course to their curriculum, which is called selected topics in engineering. This course was added to keep pace with developments in engineering and modern technology.

6.2. *Training courses for industry personnel*

Since 2012, FER offered extensive training courses for engineers in the industrial sector as listed in Table 2 based on a survey of the demands of the surrounding companies. The courses have been evaluated and have met the desirability of the trainees. The evaluation form included several points such as the course contents, course time, facilities used, and familiarity of the trainer with the course contents. The number of courses offered by the FER is supposed to be increased in the near future, according to the recommendations and the needs of the companies.

6.3. *Summer training for students*

In collaboration with the industrial sector, the FER has established mandatory training programs for students after completing the required credit hours, while the FER is in continuous communication with the industrial companies to provide more training opportunities, according to the specialization of the student. The student's behaviors, skills, and achievements are evaluated during the training period by supervisors from the FER and the companies. The student training programs help to correlate academic knowledge and industrial applications, which in turn helps to graduate market-level engineers.

The students are allowed to start the mandatory summer internship after passing 110 credit hours (after 4 years of academic study) of the curriculum. The summer internship is 2 out of 155 credit hours, and the students are not allowed to graduate without completing it. The training period is 40 h weekly for 10 weeks, and during this period, the students are followed up by one of the faculty members responsible for training. A weekly progress report (Table 3) is submitted by the students to the faculty member who has direct contact with the training supervisor at the training organization. At the end of training, the students are requested to submit a final technical report. This report highlights and documents the learning points of the students during the training period, and includes a description of the students' record and observation.

Table 2 – Training courses offered by the FER in 2012–2013.

Training course	Objectives	Companies	No. of trainees
Safety and loss prevention	The main objectives are to introduce the concept of process safety as it takes place for all industrial processes, explain the degree of hazards, know the fundamentals of HAZOP study, and understand the applications together with the software program.	Petro Rabigh Arabia Cement Desalination Plant	26
Design and operation of heat exchangers	Give an overview on the different types and uses of heat exchangers. Application of the basics of heat transfer in the design and selection of heat exchangers for a specific process. Heat exchanger problems.		22
Introduction to CFD and its importance in industry	Starting with the basic principles and science of CFD, the scope of the workshop extends to the applications of commercial CFD codes and meaningful interpretation of results.		30

6.3.1. *Training evaluation*

The evaluation of the trainee is conducted in two stages: the first stage is during the training period and conducted by the training organization, where the direct supervisor of the training fills out an assessment model prepared by the training department at the university (Table 4). If the student achieves a satisfactory result at this stage, the evaluation proceeds to the second stage, and if he/she does not get a satisfactory result, the training is canceled and the student must be re-trained. The second stage is the evaluation of the technical report submitted by the student to the concerned department by the faculty members. The distribution of grades is 25% for the training organization, 50% for the technical report, and 25% for the presentation with the concerned department.

Fig. 5 shows the distribution of eligible students in the surrounding industries in Saudi Arabia during the period from 2012 to 2014. The number of students is supposed to increase in the future, according to the offers of the companies. Regular annual meetings are organized with members from the companies during the so-called engineering day. All students are invited and the companies offer their training and job opportunities.

In our expanding effort to continuously improve the quality of our curriculum (including student training) and hence provide the market with graduating engineers having the right skills and knowledge necessary to accomplish the tasks to serve the requirements of the industry, we seek an assessment and feedback from the industry by completing a survey, which includes an evaluation of the skills listed in Table 5. The evaluation scale ranges from 1 to 5 (1 – weak, 2 – fair, 3 – good, 4 – very good, and 5 – excellent), and the results of the survey are analyzed using the analysis of variance (ANOVA) test.

The results show feedback of the trainees about the trained students during their training session. These results will help the university to put more effort to improve the involved courses and change the teaching strategies, if needed. Sometimes, the university is pushed to add more specific and/or special scientific/training courses to overcome the lack/shortage of specific students' skills. These changes are

Table 3 – Weekly training progress report.

Student Progress Report	
Students Name: Students Number: Specialization: Organization:	
Reporting Period: From ---------- to ---------- Week No. ---------- Total hours worked: ----------	
For the mentioned period please report the following:	
1. List your responsibilities or duties on the job.	
2. List new technical skills that you learnt on the job.	
3. What have you learnt in class that you have applied or observed on the job?	
4. Was the organization supportive/helpful in your training? What difficulties, if any, did you face on the job?	
5. What other skills could you use to improve your performance in your training?	
6. What interesting or challenging relationship did you have during this period with the supervisor or any other employee?	
7. Areas where you think you need improvements.	
8. Additional comments if any.	

Table 4 – Training evaluation form.

Training Evaluation Form To be filled by the On-Job training supervisor after reading the attached information
A. Information about the Student Students Name: Students Number: Specialization:
B. Information about the Training Organization: **Name of Training Organization:** **City:** **Name of the On - job training Supervisor:** **Position: Phone: Fax:**
C. General Information about Training: 1. Indicate the specific areas of the students training? (Use extra sheet if necessary) …… …… …… …… 2. Was the student assigned a specific job? (Yes/No) ……In case yes, please state it below. (Use extra sheet if necessary) …… …… …… …… 3. Overall impression about the training of the student: …… …… …… 4. What are your suggestions to improve the training? (Use extra sheet if necessary) …… …… …… ……
D. Evaluation of Students Performance **Please select the appropriate grade (5=excellent, 4=v.good, 3=good, 2=fair, 1=poor).**
1. Attendance and punctuality Please do not allow the student to continue the training if he is absent for five days or more. 2. Enthusiasm of the student regarding training 3. Cooperation of the student with others 4. Productivity and quality of assigned work 5. Application of theory to job problems
Total Grade (out of 25 points)

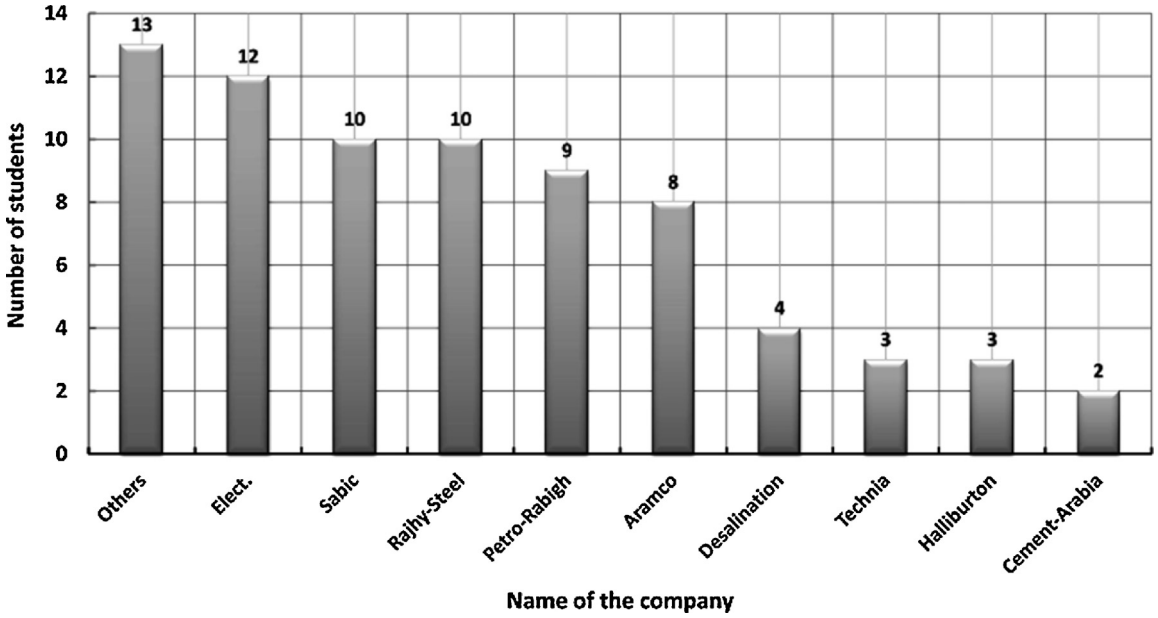

Fig. 5 – Distribution of FER students training at the industrial companies in Saudi Arabia from 2012 to 2014.

very important because they will prepare the students with better skills levels, which will be very beneficial to the industry. Furthermore, by using such surveys, the industry directs the development of academic teaching and its output. The surveying feedback provides the university its actual needs of the scientific knowledge and skills. It is clear from the survey results that item #5 in Table 5, "Working autonomously", needs more attention and this can be enhanced by assigning more individual tasks to the student. Furthermore, the results of item #9, "Identify, formulate, and solve engineering problems", show that the students still need more practices on how to read the problems and how to formulate and solve them. This can be achieved by applying more tutorials and training the students in different ways to understand the problems correctly. Increasing such student skills will help them identify problems easily in the industry and find the suitable solution. The results of item #16, "Laboratory skills", doubtlessly show that the students still need more laboratory practices and the university must add more laboratory hours and more practices in different disciplines. Filling this gap will help the students serve the industry with their experiences gained through the laboratory practices.

In view of the above discussion, surveys are always useful to the university–industry interaction as they represent the actual status of the lack/shortage of any student's skills. The surveys provide the university an indication of the success of its teaching program and any additional action that may be needed to improve its output. On the contrary, results of such surveys will make industries gain better-educated and skilled engineers who will enrich the industry by enhancing its quality as well as productivity.

It is highly recommended that the university always seek surveys of its students from the industry during the training session to improve its output and serve the industry in a better manner. It is better to share the results to design such surveys that cover all items that are important to both university and

Table 5 – Evaluation of student training survey results.

No.	Item	Average of survey results	Variance
1	Personal skills	3.08	0.44
2	Learn new skills	3	0.65
3	Develop new or innovative ideas	2.72	0.65
4	Operate in international and multicultural environment	2.36	1.17
5	Work autonomously	1.6	1.35
6	Analyze and interpret data	2.22	0.79
7	Apply knowledge of mathematics, science, and engineering	2.78	0.7
8	Function on multidisciplinary teams	2.72	0.94
9	Identify, formulate, and solve engineering problems	2.22	1.28
10	Understanding of professional and ethical responsibility	2.66	0.8
11	Communicate effectively	2.88	0.8
12	A recognition of the need for, and an ability to engage in life-long learning	3.14	1.02
13	A knowledge of contemporary issues	3.265	0.95
14	Use of techniques, skills, and modern engineering tools necessary for engineering practice	2.34	0.92
15	Safety skills	2.84	0.79
16	Laboratory skills	2.04	1.26
17	Employability skills	2.76	1.12
18	Oral presentation skill	3.1	0.87
19	Software skills	3.06	0.79

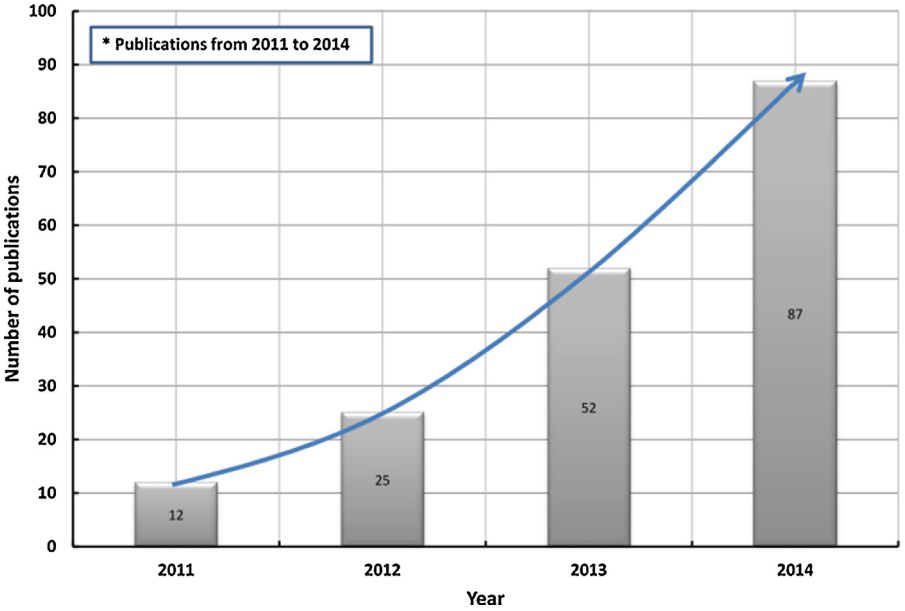

Fig. 6 – FER publications from 2011 to 2014.

industry. This will assure that all the university questions and industry needs are covered and taken into consideration.

6.4. *Applied research activities at FER*

The applied research activities are an effective way to transfer knowledge from the universities to companies (Gübeli and Doloreux, 2005; Zucker et al., 2002; Landry et al., 2010) that have a higher priority in FER. The staff members at FER are in continuous contact with the industrial companies. Funded research projects are offered by the university and the companies such as SABIC and Saudi Aramco. As an indication of the success of the FER model for UI interaction, the outcomes are presented in Figs. 6 and 7.

Fig. 6 shows the publications of FER until April 2014. As the results are until April 2014, we added those of years 2014 and 2013. Fig. 7 shows the distribution of funded research projects until the same date. One of the most important criteria for accepting projects for funding is its validity for application in industry. All the publications and project submissions are independently related to the UI interaction. Each publication has its own proposal related to the industry, which is a part of the FER model. The industry considers these publications, and the results and recommendations by the time are applied, and whenever is possible, according to their capabilities and strategies.

6.5. *Reciprocal visits*

The FER has configured an Industrial Relations Committee among the faculty members. The mission of this committee is to support communication between the university and the industrial sector through visits to/from the companies to explore their requirements and display them to the other members of the faculty.

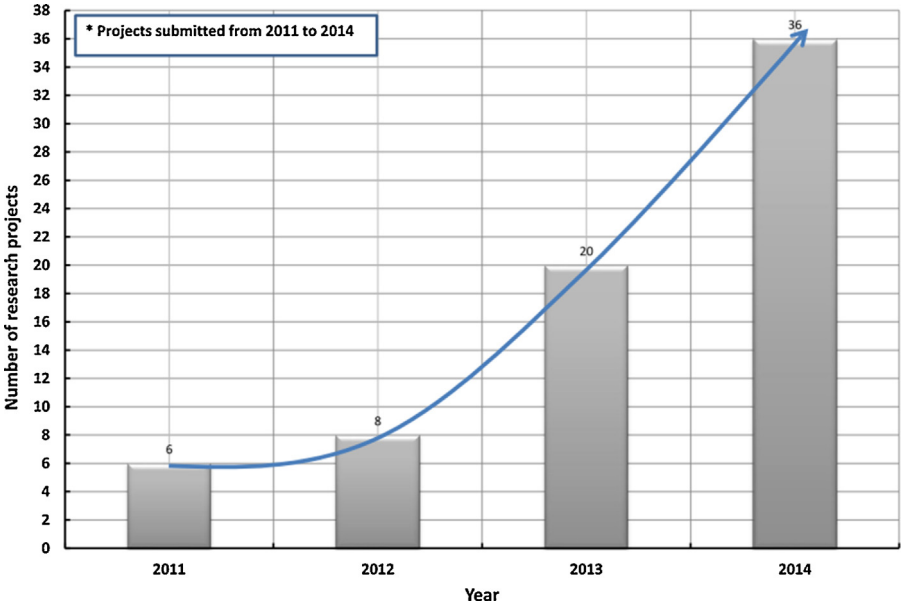

Fig. 7 – FER-funded projects from 2011 to 2014.

7. Obstacles to strengthen the relationship between universities and the industrial sector

There are some obstacles and difficulties in achieving the desired goal for cooperation between FER and the industrial sector. The most important ones among them are as follows:

- Some companies depend on their experts and technicians to solve problems.
- The difficulty in obtaining the required information for research purposes from several companies.
- Preoccupation of the universities with the academic side at the expense of the practical side.
- Lack of specialized laboratories in universities to convert the results of scientific research to the initial product (prototype) before the production phase.

8. Recommendations

Because of the absence of cooperation between UI, and by personal composition of the regional community, the companies believe that they can solve the problems of the industry within the company without the aid of scientific approaches. Furthermore, the universities believe that they can teach the students theoretically and through labs and the students will gain experiences throughout their life. This concept is against community development. Therefore, UI partnership needs to be strengthened effectively as it has an important effect on the performance and output of both UI. This can be achieved through help from both sides in the following ways:

- Intensifying mutual meetings and understanding the importance of the relationship between UI to serve the community;
- Providing the university access to all information required to facilitate its mission to fulfill the needs of the companies such as specialized human resources, knowledge, and skills, and to what they need from consulting teams, scientific research, and specialists;
- Developing a program for the university members to visit the plants in all stages of the industry to find out the techniques that have already been used by the company to develop a scientific vision of the stages of manufacturing and conducting the necessary scientific research for improving it;
- Contributing to the processing of workshops and research centers with equipment, programs, and resources necessary to activate their performance;
- Providing and facilitating scientific courses for the company members according to a scheduled program based on the needs of the industry;
- Providing and facilitating practical training possibilities for university students during the summer, according to the system and regulations to be agreed between the parties;
- Contributing to the funding of scientific research at the universities.

Future research in FER and engineering colleges in general should focus on the weak points of the surveys, searching for reasons and methods of improvements through curriculum development, development of knowledge, teaching methods, and faculty member performance. This study will help engineering colleges to self-evaluate and improve their performance.

9. Conclusions

Collaboration between UI has long existed, but the rapid increase of global knowledge has increased the demand for strategic relationships that go beyond the conventional funding of research projects. Universities in Saudi Arabia should swiftly develop and adapt to new roles. They should also promote young entrepreneurs, encourage new ideas and methodologies, financially support and mentor them, and cooperate with surrounding industries to transfer academic knowledge into commercial products. Academic entrepreneurship is a main factor to achieve economic prosperity. Saudi Arabian industries should launch such programs for young entrepreneurs. It should work closely with universities to promote new ideas and provide necessary funding to university projects that influence the country's economy. This case study represents a model guide for other universities and industries either as a reference for a start or for evaluation by comparison between their model and the FER model.

Since the establishment of the FER, it has cooperated with the surrounding industrial sectors through the following activities:

•Reciprocal visits	•Personal contacts
•Establishing consultative committee	•Training courses
•Graduation projects	•Summer training
•Engineering day	•Applied research

FER should continue playing its pivotal role more aggressively to bring the industry closer to the university.

The importance of strengthening cooperation and partnership between universities and the industrial sector is represented by the following factors:

- The development of new sources of funding for universities to enable them to activate their academic performance;
- Conducting applied research and scientific training for university students, who develop their practical skills and thus increase the opportunity to enter the market after graduation;
- The development of educational and qualifying plans and postgraduate studies in universities;
- Cooperation with companies to solve their problems and improve their performance will lead to the exploitation of the universities' potential in the service of economic development in the country;
- Companies obtaining their needs from specialized human personnel with the output of the university;
- Preoccupation of universities with the academic side at the expense of the practical side.

The FER is continuing its cooperation with the surrounding industrial sector in strengthening the desired solid and sustainable relationships and partnerships. The performance of the proposed FER gap-bridging model has been successfully measured by the results and achievements of the predetermined objectives. Continuous improvement is needed on a regular basis to enhance the functionality and efficiency of this model.

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