International Journal of Engineering Education (IJEE)
e-ISSN : 2540-9808

Expectation and Satisfaction of Managers about Levels of Knowledge and Skills of Fresh Engineering Graduates: The Case of Renewable Energy

J.O. Jaber[1*], A. Bashir[2], A. Al Alawin[1], Dana Khadem Eljamei[1]
[1]Faculty of Engineering Technology, Al-Balqa Applied University, Amman, Jordan
[2]Faculty of Engineering, Abu Dhabi University, UAE
(On leave from Faculty of Engineering, Hashemite University, Zarka, Jordan)
e-mail: jojaber@gmail.com

Abstract - *This field study aimed to examine satisfaction and expectation of managers of energy service companies and related official entities of fresh engineers' basic knowledge and skills in fields of energy management and renewable energy technologies. The existing gaps between what is demanded in the market and engineering graduates' skills are explored through measuring relevant required skills from managers' point of view as well as their general satisfaction about performance and basic knowledge in related engineering fields. To achieve these goals a structured questionnaire was distributed to specialized private companies working in the installation of renewable energy systems and energy services. It was also forwarded to concerned governmental agencies and active NGOs promoting energy efficiency and environmental protection, followed by face-to-face interviews with selected experienced and specialized engineers to cross check and make sure that weaknesses and gaps in knowledge and skills required to enter the market are addressed. Statistical analysis was conducted to determine the level of satisfaction and readiness of fresh engineers to join energy companies and areas that graduates need to be improved. Results suggested that managers are not fully happy and satisfied with levels of basic engineering understanding and technical skills among newly graduated engineers from universities in Jordan. Equally important is that managers do not feel that graduates are ready to enter the market and start practical life. Main gaps identified by managers are lack of understanding of relevant engineering sciences, relatively poor technical communication skills and nearly absence of financial and managerial basics. Thus, all parties involved in engineering education, in the country, should make necessary reform in the study plans and curricula to meet the market demands.*

Keywords *– Renewable Energy, Sustainability, Engineering Education, Skills, Employment, Satisfaction.*
Submission: July 20, 2020 Correction: September 8, 2020 Accepted: October 19, 2020

Doi: http://dx.doi.org/10.14710/ijee.2.2.1-49
[How to cite this article: Jaber, J.O., Bashir, A., Al Alawin, A., Eljamei, D.K. (2020). Expectation and Satisfaction of Managers about Levels of Knowledge and Skills of Fresh Engineering Graduates: The Case of Renewable Energy. *International Journal of Engineering Education, 2*(2), 1-49. doi: http://dx.doi.org/10.14710/ijee.2.2.1-49]

1. Background

Jordan has a long tradition in energy efficiency (EE) and renewable energy (RE) and could be considered together with Tunisia as one of pioneers in the MENA region in terms of having formulated and implemented energy strategies since early 1980. In order to scale up utilizing renewable energy market, the Government of Jordan (GoJ) adopted an ambitious energy strategy (2007-2020) and important public efforts were made to implement this strategy into actions based on direct participation of the private sector. The new energy strategy, approved by the cabinet in 2016, called for a contribution of more than 10% of RE sources in the energy mix by 2020. In 2018, actual figures showed that renewable energy sources contributed by 8% in the national energy mix. Green electricity generated from RE sources exceeded 10.7%, in the same year, and expected to touch 20% by the end of 2020 [1]. Such significant transition step is due to the fact that the installed RE generation capacity exceeded 1000 MW, as of end of 2018, and on-going 1500 MW renewable energy projects are expected to be completed by 2024. This will bring the total installed capacity of RE plants to more than 2500 MW, in addition to about 600 MW of roof-top PV systems. These could substantially reduce Jordan's energy dependency and create significant fiscal benefits: generate more than 2,000 GWh annually and thereby avoid burning fossil fuels and reduce GHG emissions by more than 1.0 million ton [2]. In addition to creating new job opportunities for engineers, technicians and un-skilled workers. Such fast advancement in utilizing RE sources in power generation is due to changing official policies to advocate and encourage energy efficiency and renewable energy utilization. In 2012, the Renewable

Energy and Energy Efficiency Law (REEEL) was approved and enacted, and followed by needed Bylaws, Codes and Regulations for implementation [3].

The current research paper is a continuation of series of papers in energy research. In recently published papers, authors investigated existing barriers and levels of knowledge and awareness of renewable energy technologies among senior engineering students. In the 1st paper, comprehensive SWOT analysis was conducted, and it was concluded that lack of well-trained engineers and technicians in renewable energy technologies is a serious problem [4]. The 2nd and 3rd research papers reviewed study plans in faculties of engineering and investigated statistically differences in the level of knowledge and awareness with respect to certain demographics, such as gender; age; university; or engineering discipline [5,6]. It was found that senior students are not trained well to use various renewable energy technologies and almost all of them are not aware of the principles of sustainability. Furthermore, there is a consistent significant difference in the level of energy knowledge among students with respect to university. This simply means that there is a weakness in the current study plans of various engineering disciplines from the energy education point of view in some universities. Thus, it is important to note that without well trained and educated manpower in renewable energy, the market will remain suffer from lack of well-educated engineers and technicians. It is believed that similar situation prevailed in other Arab countries in terms of weakness of energy and renewable energy education in colleges and universities. The main objective of this investigation is to check and evaluate the level of satisfaction of managers of energy enterprises concerning basic knowledge, skills and readiness of fresh engineers started their carrier in the field of renewable energy and sustainability in Jordan. The research paper is presented in five sections, in addition to the previous short introduction which represents 1st section. The 2nd section contained the problem and literature review, while in section 3, the adopted methodology is outlined, followed by results and discussion in section 4. Finally, conclusions and recommendations are presented in section 5.

2. Introduction

A major step towards achieving the renewable energy and energy efficiency targets in Jordan was the issuance of the Renewable Energy and Energy Efficiency Law No (13). This Law provided the legal framework for renewable energy production and energy conservation incentives, and also established the Jordan Renewable Energy and Energy Efficiency Fund (JREEEF) under the umbrella of the Ministry of Energy and Mineral Resources (MEMR). The GoJ has issued several by-laws, instructions and directives to complete the regulatory framework, which are highly needed to attract local and foreign investments in renewable energy and energy efficiency. The market is currently open and absorbed large investments in PV and wind power plants that will exceed 4 billion USD by 2024 [2]. At present, there are large number of new companies, registered and working in energy management and installation of RE schemes: mainly PV systems. As a result, there is high demand on fresh graduate engineers and technicians to join these companies in Jordan and some neighboring countries. But it should be stressed here that successful completion of renewable energy projects requires well trained engineers. The availability of educated and highly skilled engineers and technicians in energy and renewable energy technologies is considered as a major obstacle, in addition to other legal and financial barriers, suffered by companies working in such field in the local market and neighboring countries. Without working hard and acting promptly to remove such barrier, the market will remain flooded with semi-educated and naive workers in the field of renewable energy [5,6]. The new streams in energy and renewable energy education are still considered as new fields of study in local universities and colleges. During the past decades, only few researchers had studied and tackled renewable energy education, since almost all researchers were concerned with renewable energy technologies, sources and applications. With clear focus on pure theoretical analysis, while development and adaptation of such technologies to suit local applications was ignored. This study is attempted to continue research work in the field of energy education and quality of fresh graduates to bridge the existing gap and assist in removing some of barriers related to domestic capacities and trained manpower. It is deemed that such approach will further enhance better utilization of renewable energy sources and applications. Nevertheless, it should be emphasized here that studying or designing new courses, curricula or study plans of various engineering disciplines are far beyond the scope of the study in hand. It is the duty of each faculty of engineering, in state and private, universities to revise and upgrade adopted study plans and programs.

Worldwide, business environment for engineers has changed moderately during the past few decades. Traditionally engineers focused on practical and technical issues, but recently there was a shift towards business management and communication with customers and public. Thus, once graduated and leaving faculties of engineering, their lives become more complex and they should have a balanced set of technical knowledge and professional and communication skills that are highly needed to start practical life. Equally important is that the graduate engineer should be able to work in a team of different disciplines and can continue learning process. Hence, engineering curricula must be dynamic to accommodate all these requirements and keep up with the new developments and needs of modern engineering professionals to produce capable and successful graduates. It is worth mentioning here that during the past three years, few schools of engineering managed to obtain official accreditation by the Accreditation and Quality Assurance Commission for Higher Education Institutions (AQACHEI) and Accreditation Board for Engineering and Technology

(ABET) [7-9]. As stated earlier, the principal author of this paper has completed a series of research papers related to renewable energy and education in schools of engineering in Jordan [2-6]. It was concluded that senior engineering students, about to graduate, enjoy low levels of knowledge and awareness of renewable energy systems as well as limited basic skills. This simply means that they are not fully ready to enter the market as fresh graduate. This research paper is attempted to assess their readiness and satisfaction from managers' point of view with relation to their basic knowledge and skills.

On the international level, different institutions have developed lists of needed skills for a fresh engineering graduate. For example, the Accreditation Board for Engineering and Technology (ABET), which is a non-governmental organization that accredits post-secondary education such as engineering and applied sciences in USA, has listed eleven important skills [10]. These are:

- Apply knowledge of mathematics, science, and engineering
- Design and conduct experiments, as well as to analyze and interpret data
- Ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
- Ability to function on multidisciplinary teams
- Identify, formulate, and solve engineering problems
- Understand professional and ethical responsibility
- Ability to communicate effectively
- Understand the impact of engineering solutions in a global, economic, environmental, and societal context
- Engage in lifelong learning
- Knowledge of contemporary issues
- Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

While the European Accreditation Engineer (EUR-ACE) provided six main categories of skills for graduates [11], as shown below:

- Understanding and basic knowledge
- Engineering design
- Engineering analysis and problem solving
- Investigation and research
- Engineering practice and ethics
- Transferable skills

The International Engineering Alliance (IEA) have developed guidelines and list of needed skills for modern engineers [12]. It included following major categories:

- Engineering knowledge
- Problem analysis
- Engineering design
- Investigations
- Usage of modern tools
- Engineers and society
- Sustainability and environment
- Ethics
- Teamwork
- Communication
- Projects management and finance
- Lifelong learning

Quality assurance mechanisms for engineering education may vary from one country to another. It is reported that accreditation methods used by the Washington Accord signatory countries are considered as the best and most respected systems for the accreditation of engineering education in the world [13]. On the local level, the Higher Education Accreditation Commission, in 2015, issued a National Manual of Quality Assurance Standards for Engineering Program based on the Commission's Law (No. 20 for year 2007) [14]. This manual aimed to help schools of engineering in both state and private universities obtain the quality certificate according to the local eight indicators. These are as follows:

1. Strategic planning, including vision, mission and goals of engineering program.
2. Governance with emphasis on program management, transparency and policy and internal regulations.
3. Academic program which is the most important point here and includes education output, BSc study plan, students' evaluation, development and review processes.
4. Scientific research and scholarship plan and innovation.
5. Human and financial resources required to guarantee success of the offered engineering program.
6. Acceptance policy in particular engineering program and allowed number of students in each program. In addition, academic guidance and services, and follow up of graduates.
7. Community service and national and international relations
8. Quality assurance and commitment for improvement as well as employing key performance indicators and bench marking.

When comparing the content and requirement of this manual with those internationally recognized and applied guidelines, it can be said it is a general one and does not look at the quality of graduates. Thus, it should be revised and updated with more emphasis on ensuring substantial equivalence of engineering curricula and outputs of local schools of engineering. Such manual should refer to and comply with requirements and reported milestones of international accreditation bodies. Based on what is adopted by various accrediting institutions of engineering programs concerning needed skill sets, a comprehensive list of skills, that may be considered in Jordan and other neighbouring countries in the MENA region, for employability of fresh engineers is developed and suggested by authors as shown in Table 1. Here it is stressed that such recommendation should be studied thoroughly by experts in this field in order to modify the existing national quality assurance manual to include such important skills.

Table 1. Summary of proposed set of skill for fresh engineering graduates

No	Category	Skills
1	Knowledge	Apply engineering science knowledge
		Understand engineering problems
2	Design & Problem Solving	Analyze data
		Design engineering systems and experiments
		Consider health and safety constraints
		Identify and solve real problems
		Research and investigations
3	Social Responsibility & Ethics	Engineering ethics
		Understand impacts of engineering solutions on society
		Aware of responsibilities towards local societies
4	Teamwork	Work as a member in the team
		Provide constructive feedback
		Evaluate and understand others
		Participate in discussions
5	Environment & Sustainability	Aware of environmental responsibilities
		Understand codes and laws
		Apply green solutions
6	Communication	Communicate effectively with customers and colleagues
		Speak and present clearly
		Languages
		Use of computers and modern systems
		Good writing
		Use modern technologies
7	Long Life Learning	Desire to learn continuously
		Personal learning targets
		Use of new tools and software
8	Management & Finance	Project management
		Lead a working group
		Manage time
		Basics of economics and financing
		Marketing management

Worldwide, there is rising need for academics and professionals specialized in renewable energy. Thus, different countries around the Globe developed new programs that provides students with technical and practical aspects of renewable energy and energy efficiency [15]. During the past two decades, there is a strong agreement between researchers, from different parts in the world, that engineers should possess skill sets that allow them to perform responsibilities in the workplace [16]. Some researchers suggested that current trends in globalization of the engineering profession, the desired skill sets of engineering graduates should be identified clearly in order to improve the professional mobility of graduates [17, 18]. It is stressed that higher education programs, including engineering, should find ways to integrate transferable skills for improving readiness of fresh graduate to enter the market. This is due to the fact that engineering graduates, in particular, must have basic skills that would be useful to them outside classrooms, i.e. of the nature of the field workplace differs than classrooms. A previous study by Atkins (1999) about employability of British University graduates reported a gap existed between readiness, i.e. skill sets, of fresh graduates and employers' requirements [19]. This simply means that undergraduate programs should improve the preparedness of their graduates for employment. In addition, it was found that fresh graduates must expand their transferable skills at both the undergraduate and graduate levels for improved employability. Laker and Powell (2011) defined professional skills to be ability to manage oneself and to interact effectively with others [20]. Other researchers tried to provide a global model for engineering competencies [21] reported that 'many new competencies needed by engineers today are professional skills' [22]. It is true that professional skills are necessary for engineers to function in a globalized environment and to succeed in starting practical life. In other words, technical skills remained a prominent component of the engineer's skill set, but professional skills are even more important.

A comparative study, conducted in USA last decade, to examine graduate employability by Balaji and Somashekar (2009) found that employers were more likely to recruit graduates with a greater degree of professional skill competence compared with those having only technical proficiency [23]. This was confirmed by many researchers that professional skills are important for success in starting fieldwork and that these skills could be acquired by engineering students during the education process [24, 25, 26, 27]. Other researchers stated that lifelong learning will play an important role in engineers' careers [28, 29]. In addition to necessary professional skills, analytical skills may play a vital role in the advancement and future development of engineering professionals [30]. Again, fresh engineers must be able to learn on a continual basis rather than rely on their basic education since managers had great hopes for them to possess stronger interpersonal skills.

Language proficiency and communications skills are necessary and integral to engineers [31, 32]. All employers, especially international enterprises, are placing high values on abilities to speak and write in English, as second language. Communication skills play an important role in how employers, peers, customers, and other stakeholders perceive the modern engineer [18, 21, 26]. In Japan, a recent study recommended that Japanese students in engineering schools should develop their communication skills to meet the evolving needs of open world and globalized industry [33]. Moreover, utilization of new communication technologies is a must for engineers [18, 29]. A study conducted by Farr and Brazil (2009) in USA, ten years ago, found that team skills and leadership skills played an important role in engineers' careers [34]. Other studies have

reported that ability of engineers to work in multi-cultural, multi-disciplinary environments is very important [35]. Although the ability to work on multi-disciplinary and multi-cultural teams has been considered as a vital professional skill, many engineering programs, including offered engineering programs in Jordan, have neglected such an essential issue. Hence, graduates are not trained to acquire such skill. While other researchers reported that engineering graduates could develop their professional skills and performance during training and work after graduation: they should strive to improve their skills [32, 36]. However, students during their study should have minimum awareness or training regarding professional and multi-cultural skills to avoid first work-cultural shock [37, 38]. It is important here to mention that large fraction of engineering graduates from Jordanian universities are working in Gulf States, which enjoys multi-cultural work environment. Thus, local schools of engineering should consider this fact and reflect needed skills in existing study plans for different engineering disciplines.

A study aimed to explore employers' satisfaction of skill sets of engineering graduates in USA showed that ability to communicate effectively and problem solving were the most valuable skills [39]. Equally important is the ability to use modern engineering tools and techniques as well as design of solutions that meet social and environmental regulations. Other skills included the ability to apply mathematical, scientific, and engineering knowledge with special focus on economic competitiveness towards an interest in designing solutions with environmental and social issues in mind [40]. Accreditation bodies have also played an important role in this ideological shift by altering their requirements of and recommendations for engineering programs, emphasizing the importance of sustainable design, environmental issues, and social factors [41, 42, 43, 44, 45, 46, 47]. In other words, engineers should be able to connect to the business world in order to drive innovation in different sectors.

This study aimed to find answers for the following important questions and to investigate skills of engineering graduates' working in energy companies. In other words, the preparedness of engineering graduates for employment in Jordan was tested from the employers' point of view:

- Level of knowledge of basic engineering and readiness for employment in the field of renewable energy and sustainability?
- Are managers happy and satisfied with the skills level of fresh engineering graduates?
- Difference between male and female engineering graduates in terms of knowledge, skills and readiness to start their professional life?
- Existing gaps between expectations and satisfaction of engineering graduates?
- Readiness of fresh graduates to enter the market as seen by managers of energy companies and their recommendations to improve skills and capabilities of graduates?

3. Methodology

This research is a continuation of a series of previously published papers in the field of energy education and training to promote of RE technologies in the country – see Figure 1. Major activities in the current field study were divided into three main phases. The first one concentrated on designing and testing a special questionnaire to assess levels of satisfaction and expectations of managers of private energy companies working in fields of renewable energy technologies and energy management. This questionnaire was tested and verified on a preliminary sample of only three well experienced managers. Then it was distributed to a random sample of about 40 licensed energy engineering firms, official institutions (i.e. Ministry of Energy and Mineral Resources, Energy and Minerals Regulatory Commission, Jordan Engineers Association) and NGOs (i.e. Society of Renewable Energy Companies, National Energy Research Center and Association of Energy Engineers). The randomly selected sample included different categories and sizes of renewable energy contracting companies in different regions. The third step was concerned with data collection, organization and analyses.

The questionnaire consisted of five sections (as shown in Appendix A). The 1st section contained general information such as personal information about the manager, address and education. The 2nd section included 12 questions to measure basic understanding of engineering sciences, environment and sustainability and readiness to start work as fresh graduates. The 3rd section is divided into two parts: the first is about needed skills as fresh graduates, and the second part discuss the difference in levels of education and awareness based on gender. The 4th section investigates the development of capabilities and skills of engineering students in fields of energy efficiency and renewable energy technologies. Apart from the 4th section, in all questions a five-point scale (1-strongly agree, 2-agree, 3-undecided, 4-disagree, 5-strongly disagree) to evaluate managers' responses by considering previous studies in similar areas. To crosscheck the obtained data and identify current weakness and recommended actions, a series of face-to-face meetings with key stakeholders from public and private sectors were conducted based on scheduled appointments using a semi-structured questionnaire and personal contacts.

The collected data from about 40 firms were numbered, checked and evaluated, then converted to values (numbers) and recorded for each company/entity on a spreadsheet. The SPSS program and Minitab software were used in the analysis of the obtained data.

The obtained results were analyzed and tested by using full detailed descriptive analysis, graphs, boxplot and the t-test. The detailed descriptive analysis was performed to all questions. While the t-test, was performed to check if the level of knowledge is equal to the level of skills for the graduates in renewable energy sector, this will be conducted by testing the hypothesis.

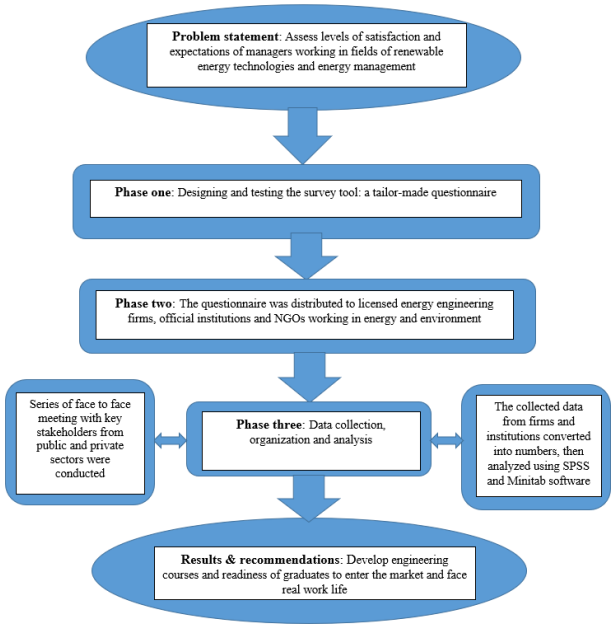

Figure 1. Summery of the current research flow

4. Results and Discussion

In this field study which targeted technical managers and/or general managers of energy service and contracting companies of renewable energy systems, a questionnaire was designed and tested and then distributed to a random sample of few entities and private companies in order to determine their levels of satisfaction and readiness of fresh graduates to start practical life. This investigation is limited to working energy companies, in Jordan, and did not include any other type of companies or activities. Private companies formed 92% of the studied sample and remaining 8% are official institutions. All managers representing companies in this study holds BSc degree in engineering, and some having (16%) MSc and (8%) PhD, with long practical experience of more than 15 years. It should be remembered here that energy and renewable energy education is relatively still a new subject, in Jordan, as a result of growing concern about energy imports and related environmental issues including global warming and renewable energy applications as feasible solutions to reduce emissions of greenhouse gases.

The managers' response to the first aspect questions about levels of understanding of basic engineering and readiness to enter the market as fresh graduates showed that the general score is slightly above average (i.e. 3.13 out of 5) with significant difference between the 12 questions as summarized in Figure 2. In fact, answers for questions (Q2.2 & Q2.3) about design and developing technical solutions were the least among the twelve questions with an average score of 2.57 and 2.41, respectively, out of 5. Such results are expected since current study plans did not include subjects related to environmental protection, sustainability and projects management [5]. This means that the average of all managers responding to such questions is below the general average with standard deviation (St. Dev.) of 0.8. As well known, the case will be much better when having small St. Dev., but cannot be a negative value. While the question for using modern computers and packages recorded the highest (3.89 out of 5). This simply means that managers are relatively happy concerning skills in computers of fresh graduates. The full results of the analysis are shown in Table 1. The results are clearly confirming that questions 2, 7 and 11, are nearly around the average and needs special attention by concerned institutions, including the Ministry of Higher Education and Scientific Research and Accreditation and Quality Assurance Commission for Higher Education Institutions as well as all universities offering engineering programs. At the same time questions 1, 6, 8, 9, 10 and 12 showed an average score more than 3.24 which is slightly above the average.

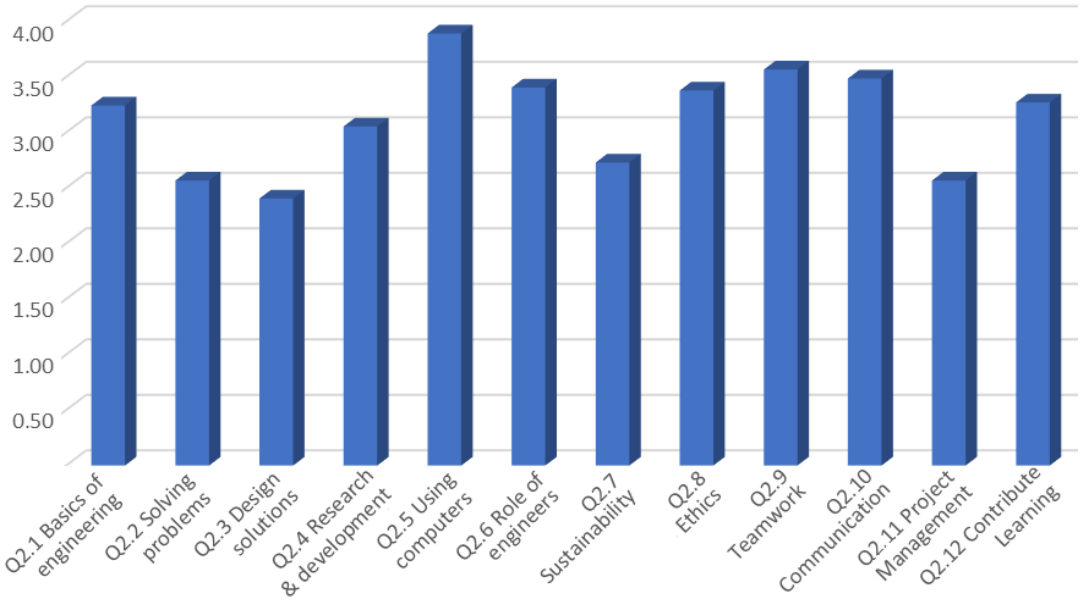

Figure 2. Level of knowledge of basic engineering and readiness to enter the market

Table 2. Average and standard deviations related to knowledge level of basic engineering and readiness to enter the market

Question	Q2.1	Q2.2	Q2.3	Q2.4	Q2.5	Q2.6	Q2.7	Q2.8	Q2.9	Q2.10	Q2.11	Q2.12
Avg.	3.24	2.57	2.41	3.05	3.89	3.41	2.73	3.38	3.57	3.49	2.57	3.27
St. Dev.	0.83	0.77	0.80	0.97	0.77	0.93	0.96	0.92	0.77	0.90	0.90	0.96

It is important to note here that more than 93% of managers appreciated the high skills of fresh graduates in using software packages and modern tools: the reported given weight is almost 4. This is considered a positive point and well represent young generation and their high skills in using electronic devices and tools. Managers should benefit and build on such high skill, in software and simulations, by providing needed training in problem solving and running technical projects through enrolment in tailored designed short courses in related professional associations [48]. This would help in developing capabilities and enhancing skills of fresh graduates. In general, managers in the field expressed their unsatisfaction about the low quality of fresh graduates from local engineering schools. More specifically, graduates lack ability to develop and design technical solutions (2.41 out of 5) for real life problems in the field. The interviewed managers stressed the importance of this issue which clearly is the least satisfactory with an average of less than 2.5. In other words, almost 50% of managers disagree that fresh graduates have basic knowledge to identify and analyze technical problems and develop suitable solutions. Such clear weakness in problem solving and analysis of technical problems is not limited to fresh graduates working in renewable energy but in other sectors such as construction and infrastructure projects. In addition, graduates lack basic understanding and importance of sustainability and environmental issues as well as project management. This is noticeably revealed that basic understanding of real technical problem(s) and probable consequences as well project organization does not exist in the curricula and/or poor and old-fashioned engineering courses in some of local universities. Such result is in full agreement with previous studies, specifically the reported grades of the Annual National Qualifying Exam that organized and supervised by the Accreditation and Quality Assurance Commission for Higher Education Institutions [49]. Unfortunately, such low achievement by fresh engineering graduates is inevitable and could be attributed to old and traditional study plans and teaching methods in engineering schools. Along with hiring unqualified and inexperienced staff members and lab-technicians, in some faculties of engineering, who are not specialized in energy conversion and management and renewable energy technologies [4-6]. Equally important is the large number of engineering students, 80 or more, in the specialized courses, during the last fifteen years, in state universities. Such large number of senior students does not enable instructors to adopted new teaching methods such as project-based and flipped learning [50], especially for senior engineering students. Unluckily, group projects are completely absent in applied courses and this is considered the most important missing point since working in a group will promote vital intellectual and social skills as well as communication skills and understanding others. It also helps students' to be ready for world work which normally requires teamwork and collaboration among team members. Similar results were obtained by other researchers but in other countries in MENA region [26]. It is extremely important to stress here that such vital issues are still ignored and did not receive enough concern by the Accreditation and Quality Assurance Commission for Higher Education Institutions.

For skills of fresh engineering graduates and their readiness to enter the market and work in energy enterprises and/or renewable energy contracting companies, Figure 3, summarizes main results of the 1st part. The average score is slightly above average (3.05 out of 5) but with significant variation between different questions. It is well noticed that the level of graduates' in technical writing (Q3.1.4) is very low (2.57 out of 5). There is a common agreement of almost all managers that fresh graduates are very poor in writing, in both of Arabic and English, even in using electronic mail. Almost two thirds of the participated managers, in the study in hand, are disappointed about financial and administrative skills of fresh graduates (Q3.1.7) since the score was 2.3 out of 5. This is true due to the fact that existing engineering study plans' do not include courses dealing with such important subjects except the traditional and standard course "Engineering Economy" [5]. Unfortunately, the recently developed guidelines, for engineering study plans, by the Accreditation and Quality Assurance Commission for Higher Education Institutions did not include, or even allow, special courses in financial or accounting or even administration [14]. This is considered as one of weak points, in addition to technical writing, presentation skills and projects management, in all engineering programs offered by schools of engineering in both state and private universities in Jordan. Ability to participate in teamwork and commute with other collogues in work gained the highest score (Q3.1.2), of more than 3.5 out of 5: majority (86%) of managers are relatively satisfied by the non-technical personal communication skills of fresh graduates. True and full accreditation process should provide graduates with more confidence to find jobs and start their professional life [51].

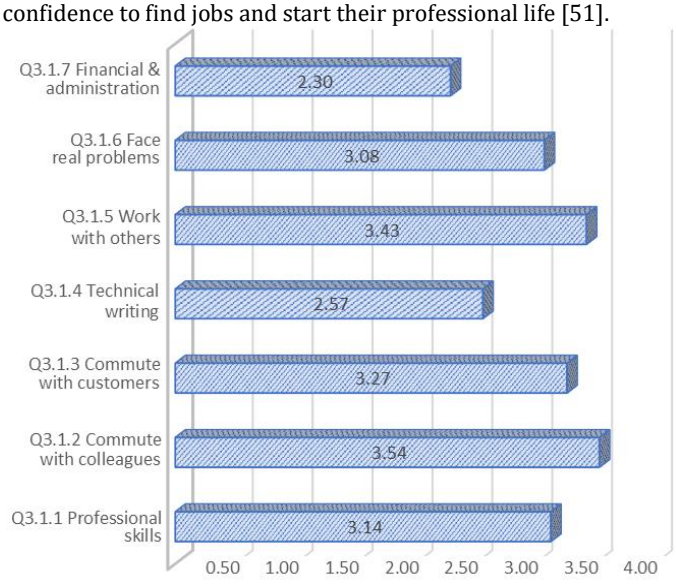

Figure 3. Skills and readiness to enter the market

The full results of the analysis are shown in Table 2. It is clear that the score of questions related to technical writing (Q3.1.4) and

financial administration (Q3.1.7) are below average and should receive special attention by the administration of schools of engineering in Jordan. At the same time questions about professional and communications skills (Q3.1.1, Q3.1.3, Q3.1.5, & 3.1.6) showed a score of more than the average, ranging from 3.08 to 3.54, but still considered not too good. Unfortunately, senior engineering students do not pay enough attention to the graduation project and training during study. Main reasons behind such unhealthy situation are large number of students and poor follow up by staff members due to shortsighted policies aiming to save expenses in state and private universities. Equally important is the incongruous environment in most universities resulting from direct and indirect interference of government through the appointment of top management and lack of incentives for both of teaching staff and recognized students. In addition, high level of bureaucracy, paperwork and centralized decisions and power: it is a one-man show business with no real follow up from concerned authorities.

Table 2. Average and standard deviations related to level of skills to enter the market

Question	**Q3.1.1**	**Q3.1.2**	**Q3.1.3**	**Q3.1.4**	**Q3.1.5**	**Q3.1.6**	**Q3.1.7**
Avg.	3.14	3.54	3.27	2.57	3.43	3.08	2.30
St. Dev.	1.03	0.77	0.84	1.04	0.90	0.98	0.81

It is important to mention here that all international and regional ranking institutions, such as Academic Ranking of World Universities, QS World University Rankings, Times Higher Education World University Rankings and other global rankings, are giving high weight to internationalization, graduate employment, industrial linkage and historical reputation. Thus, all concerned local authorities and institutions should review existing engineering programs in order to develop and improve the quality of graduates. Accreditation and quality assurance will assist to get graduates qualification recognized outside Jordan, since it relies on human resources export to Gulf states. The professional accreditation should provide engineering graduates good opportunity to find professional employment outside the country or with international firms. This is in full agreement with the analysis revealed in this research: managers felt that engineering fresh graduates are not well trained to used modern communication technology as well as business skills and time management. It is important to stress here that graduates should have the ability to present their ideas in writing and conservation with collogues and others, in English and native languages. This is a killing point for fresh graduates from local schools of engineering since large fraction of them heading to work in Gulf states.

At this stage, the following question should be answered; are the means of the knowledge level of basic engineering and skills for fresh graduates are similar? To answer this important question, a well-known statistical examination, t-test, was performed on obtained results. This is aimed to compare the averages of two groups, i.e. knowledge and skills, and determines whether the difference is statistically significant. In other words, it lets you know if those differences (measured in means/averages) could have happened by chance. The analysis of t-test is shown below to clarify the situation:

μ_1: mean of knowledge
μ_2: mean of skills
Difference: $\mu_1 - \mu_2$

Descriptive Statistics

Sample	N	Mean	St. Dev.
Knowledge	37	3.131	0.578
Skills	37	3.046	0.702

Where:
N: sample size for each group
Mean: average responses for the knowledge aspect
St. Dev.: standard deviation of the mean

We will introduce the hypothesis that the two means are equal as H0 and H1 for the hypothesis that the two means are not equal.

Null hypothesis	H_0: $\mu_1 - \mu_2 = 0$; where H_0 is the null hypothesis
Alternative hypothesis	H_1: $\mu_1 - \mu_2 \neq 0$; where H_1 is the alternative hypothesis

T-Value	DF	P-Value
0.56	69	0.575

T-Value	DF	P-Value
0.56	69	0.575

Where:
T-Value: statistical test to be compared with critical value of Student's t distribution corresponding to the significance level
P-Value: lowest level of significant at which we can decide on the hypothesis (0.05)
DF: is the degree of freedom DF = 2N-1

Since the p-Value is >0.05, we will reject H_0: $\mu_1 - \mu_2 = 0$, and conclude that there is a difference between the mean of knowledge and mean of skills for the graduates in renewable energy sector, and the mean level of knowledge is greater than the mean level of skills. This is illustrated in Boxplot as shown in Figure 4.

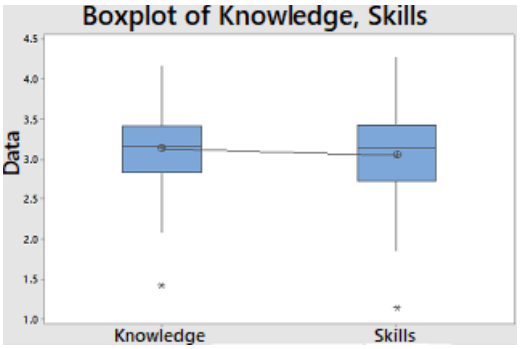

Figure 4. Boxplot for level of knowledge and level of skills

Box plots are a good way to visualize the differences among groups. They achieve to convey a lot of statistical details without looking bullying.

They represent the range, interquartile range and outliers but without consideration to standard deviation values. It is clear that the boxes are overlapping with each other but with significant difference in deviations; which means that we cannot judge that they are equal until we have more investigations. The testing of hypothesis which took into considerations the standard deviation values was conducted and showed that the two means of basic knowledge and skills to enter the market are indifferent.

Table: 3 Differences in knowledge and skills between male and female fresh graduates

Item	Male	Female
Knowledge	-Prefer field work -Like adventure and learn fast -Better understanding of work	-Better in theory and basic sciences -Prefer office work
Personal skills	-Better communication skills enable them to understand the market -Work under extreme conditions -Ready to leave looking for better salary or conditions	-Careful and precise -Shy and suffer from self-confidence -Excellent in using computers -Loyal and committed

From the gender point of view, more than half of managers confirmed that there is no big difference between male and female graduates with reference to their basic knowledge and skills as illustrated in Figure 5. However, the other half stressed on many important differences, including knowledge and skills, as summarized in the following Table 3.

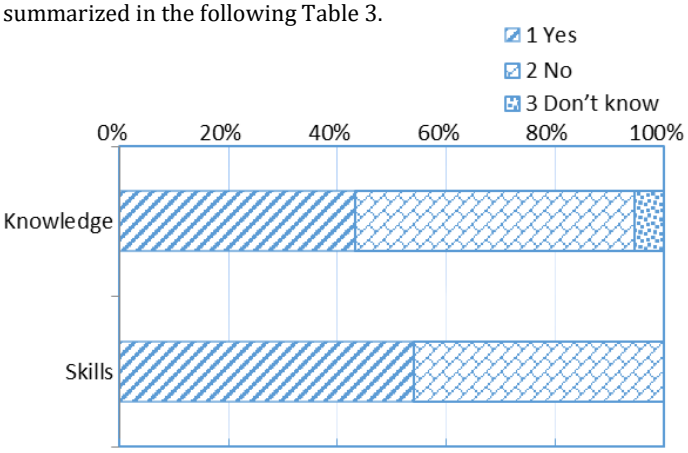

Figure 5. Difference between basic knowledge and skills according to gender

There is a full agreement between managers that existing engineering study plans should be modified and updated to include new subjects such as financial management and accounting, projects management, communication skills with focus on technical writing. Figure 6 illustrates the opinion of managers on highly needed courses during study in faculty of engineering. Such result is in full agreement with previous research on students' intention to start up [26, 52].

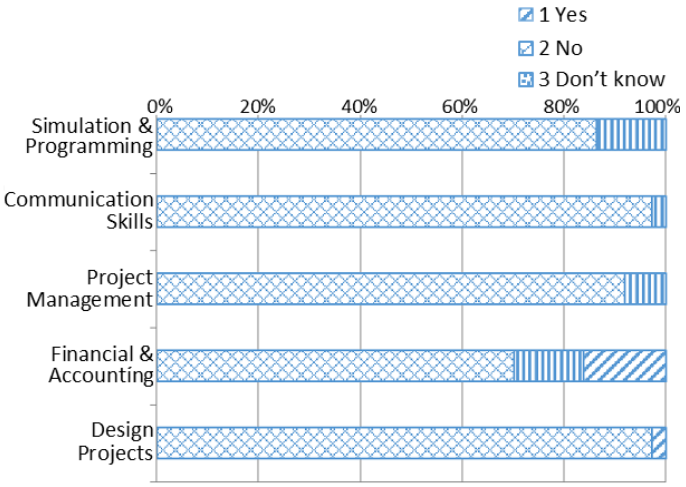

Figure 6. Opinion of managers on highly needed courses during study in faculty of engineering

In a question about recommended measures to improve capabilities and readiness of graduates from schools of engineering, in Jordan, managers agreed that a set of recommended measures should be taken by universities soon to enhance the quality of fresh graduates. Such recommendations include, but not limited to, the followings:

- Run joint projects with students from different departments with emphasis on teamwork.
- Provide more weight to engineering applications and practical problems for senior students. It is very important to connect with local industries and engineering enterprises by allowing experts to teach some practical courses and or supervise graduation projects for senior students.
- Improve practical training during study and should be before preparation of graduation project. Here it is important to develop genuine partnerships with Jordan Engineers Association and other NGOs aiming to improve training and graduation projects to reflect more actual problems from the field.
- Introduce project management, accounting and financial analysis instead of dry economics.
- Concentrate on communication skills, technical writing and English language.

It is clear from the obtained results in this research and conducted analysis that there is a gap between graduate attributes

and employers' requirements. To bridge this wide gap some actions are highly needed by all concerned stakeholders, including the Ministry of Higher Education and Scientific Research:

- Enhancing capabilities of students on problem-solving techniques through investigations and group projects to provide different solutions for the problem.
- Increasing experimental and field activities to improve their competences on design and technical solutions.
- Project management, financial and accounting and estimation and cost control are must and should be considered as core courses.
- Technical writing and presentation should be improved and given more attention and considered as pre-requisites for graduation project.

To sum up, in Jordan as in other developing countries, the utilization of renewable energy sources is growing rapidly since such sources are considered as good solutions to many problems, i.e. concerns about oil depletion and prices, climate change, etc. On other hand, most of fresh graduate engineers are not well trained according to managers in the field. They lack deep understanding of basic engineering theories and principles of sustainability [4-6]. Equally important, poor performance in handling problems and engineering sense. In addition to complete absence of skills in technical writing, project management and accounting. Therefore, there is an urgent need to develop current study plans and introduce new courses that will ensure better quality and readiness of graduates to start practical life. Finally, the results of this field investigation could be useful for other countries within the MENA region and others enjoying similar weather and economic conditions.

5. Conclusions

Today, engineering graduates are required to work within multicultural and multinational workplace environments, and thus need to possess adequate professional attributes and competencies. In fact, engineering education, in Jordan, is following the western system but still engineering graduates are not well recognized and accepted, in some countries, mainly due to the absence of quality assurance and accreditation processes. For example, graduates would like to pursue post-graduate studies, or work, in USA, and other developed countries, should pass certain tests, such as TOFEL (English language) and GRE (assessment of critical thinking, analytical writing, verbal reasoning, and quantitative reasoning skills) tests. In Jordan, the Accreditation and Quality Assurance Commission for Higher Education Institutions was created recently to develop and implement accreditation process, but still in its beginning. This research paper elaborates on the missing links between engineering graduate attributes and employers' expectations. Unfortunately, there is a clear gap in basic skills and knowledge of most of fresh engineering graduates, from managers point of view, since they do not possess important skills required by employers or managers. These skills include but not limited to problem-solving, leadership, communication, decision-making and ability to work with people of different backgrounds. Thus, falls behind employers' satisfaction and expectations. Such research for the evaluation of readiness of fresh engineering graduate to enter the market from the managers' point of view is still scarce in the region and not available in Jordan, yet. Therefore, it is highly needed to understand what skills are missing, weakness points and recommend actions to improve the quality of graduates from schools of engineering. Finally, all concerned local authorities and universities should understand and check how far managers of private companies and governmental institutions, working in energy management and renewable energy in Jordan, are not satisfied with the quality, level of knowledge, skills and reediness of fresh graduates to start real work, in order to develop offered programs. This implies that existing bureaucracy exerted by ill and old-fashioned management should not continue in the near future and replaced by a modern, flexible and wise model that simulates highly ranked universities in developed countries. Such research could be applied to neighboring Arab countries.

References

[1] Anon, Ministry of Energy and Mineral Resources, Annual Report 2018, Amman, Jordan, 2019.

[2] J.O. Jaber, Ghazi Marahleh, Ali Dlabeeh, Emissions reduction resulting from renewable energy projects in Jordan, Journal of Energy Technologies and Policy, (2019), Vol. 9, No. 6, pp. 42-51.

[3] Tayseer Abu Rahmeh, Ahmad Abbas, J.O. Jaber, Aimen Alalawin, Prospects of repowering of old thermal power stations by integrating CSP systems, Jordan Journal of Mechanical and Industrial Engineering, (2016), Vol. 10, pp. 85-98.

[4] J.O. Jaber, F. Elkarmi, E. Alasis, A. Kostas, Employment of Renewable Energy in Jordan: Current Status, SWOT and Problem Analysis, Renewable & Sustainable Energy Reviews, (2015), Vol. 49, pp. 490-499.

[5] Aiman A. Alawin, Taieseer Abu Rahmeh, Jamal O. Jaber, Suliman Loubani, Sameh Abu Dalu, Wael Awad, Ali Dalabih, Renewable energy education in engineering schools in Jordan: existing courses and level of awareness of senior students, Renewable & Sustainable Energy Reviews, (2016), Vol. 65, pp. 308-318.

[6] Jamal O. Jaber, Wael Awad, Taieseer Abu Rahmeh, Aiman A. Alawin, Suliman Loubani, Sameh Abu Dalu, Renewable energy education in faculties of engineering in Jordan: relationship between demographics and level of knowledge of senior students, Renewable & Sustainable Energy Reviews, (2017), Vol. 73, pp. 452-459.

[7] Jordan University of Science and Technology, ABET – Accredited Programs, Irbid, Jordan, Next date of comprehensive review 2020-2021, (State University). (http://main.abet.org/aps/AccreditedProgramsDetails.aspx?OrganizationID=687&ProgramIDs=).

[8] The University of Jordan, School of Engineering, ABET – Accredited Programs, Amman, Jordan, (State University). (http://engineering.ju.edu.jo/Pages/ABETAccreditedPrograms.aspx).

[9] Applied Science University, Faculty of Engineering and Technology, Amman, Jordan, (Private University). (https://www.asu.edu.jo/en/engineering/Pages/About-Faculty.aspx).

[10] The Accreditation Board for Engineering and Technology (ABET), USA, (https://www.abet.org/).

[11] European Network for Accreditation of Engineering Education (ENAEE), Best Practices in Accreditation of Engineering

Programs: An Exemplar, 13 April 2015, International Engineering Alliance (IEA), (https://www.enaee.eu/wp-content/uploads/2018/11/best_practice_2017_online.pdf).

[12] International Engineering Alliance, Educational Accords, 3 June 2016, (https://www.ieagreements.org/assets/Uploads/Documents/Policy/IEA%20Rules%20and%20Procedures%20(3%20June%202006).pdf).

[13] Becker, F.S., 2006. Globalization, curricula reform and the consequences for engineers working in an international company, European Journal of Engineering Education 31(3), pp. 261-278.

[14] High Education Accreditation Commission, Manual of Quality Assurance Standards for Engineering Program (in Arab language), Amman, Jordan, 2015, , (http://www.heac.org.jo/?page_id=5402).

[15] Hen Friman, New Trends in the Higher Education: Renewable Energy at the Faculty of Electrical Engineering, Energy Procedia, Volume 115, June 2017, Pages 18-28.Hugo Lucas, Stephanie Pinnington, Luisa F. Cabeza, Education and training gaps in the renewable energy sector, Solar Energy, Volume 173, October 2018, Pages 449-455.

[16] Crebert, G., M. Bates, B. Bell, C. J. Patrick, and V. Cragnolini. 2004. "Ivory Tower to Concrete Jungle Revisited." Journal of Education and Work 17 (1): 47–70.

[17] Gustavo R. Alves, Maria T. Restivo, Juarez B. da Silva, Special issue on Engineering Education: Challenges for Innovation, European Journal of Engineering Education, (2015), Vol. 40 (No. 1), pp. 451-458.

[18] Atkins, M. J. 1999. "Oven-ready and Self-basting: Taking Stock of Employability Skills." Teaching in Higher Education, 4 (2): 267–280.

[19] Laker, D. R., and J. L. Powell. 2011. "The Differences Between Hard and Soft Skills and their Relative Impact on Training Transfer." Human Resource Development Quarterly 22 (1): 111–122.

[20] Lohmann, J. R., H. A. Rollins Jr., and J. Hoey. 2006. "Defining, Developing and Assessing Global Competence in Engineers." European Journal of Engineering Education 31 (1): 119–131.

[21] Shuman, L. J., M. Besterfield-Sacre, and J. McGourty. 2005. "The ABET "Professional Skills" – Can they be Taught? Can they be Assessed?" Journal of Engineering Education 94 (1): 41–55.

[22] Balaji, K. A., and P. P. Somashekar. 2009. "A Comparative Study of Soft Skills Among Engineers." Indian University Press Journal of Soft Skills 3 (3/4): 50–57.

[23] Back, W. E., and S. R. Sanders. 1998. "Industry Expectations for Engineering Graduates." Engineering Construction & Architectural Management 5 (2): 137–143.

[24] Beder, S. 1999. "Beyond Technicalities: Expanding Engineering Thinking." Journal of Professional Issues in Engineering and Education Practice 125 (1): 12–18.

[25] Eric Ramadi, Serge Ramadi & Karim Nasr (2016) Engineering graduates' skill sets in the MENA region: a gap analysis of industry expectations and satisfaction, European Journal of Engineering Education, 41:1, 34-52.

[26] Sharma, G., and P. Sharma. 2010. "Importance of Soft Skills Development in 21st Century Curriculum." International Journal of Education & Allied Sciences 2 (2): 39–44.

[27] Guest, G. 2006. "Lifelong Learning for Engineers: A Global Perspective." European Journal of Engineering Education 31 (3): 273–281.

[28] Rosanna Martin, Bryan Maytham, Jennifer Case, Duncan Fraser (2005) Engineering graduates' perceptions of how well they were prepared for work in industry, European Journal of Engineering Education, 30:2, 167-180.

[29] R. C., and B. S. Oberst. 2003. "Are Current Engineering Graduates being Treated as Commodities by Employers?" European Journal of Engineering Education 28 (3): 395–402.

[30] Riemer, M. J. 2002. "English and Communication Skills for the Global Engineer." Global Journal of Engineering Education 6 (1): 91–100.

[31] Greenwood, P. 2007. "Helping Small Businesses Survive the Skill Shortage – An Australian Perspective." IDEAS 14:17–25.

[32] Danielewicz-Betz, A., and T. Kawaguchi. 2014. "Preparing Engineering Students for Global Workplace Communication: Changing the Japanese Mindsets." International Journal of Engineering Pedagogy 4 (1): 55–68.

[33] Farr, J. V., and D. M. Brazil. 2009. "Leadership Skills Development for Engineers." Engineering Management Journal 21 (1): 3–8.

[34] Nair, C. S., A. Patil, and P. Mertova. 2009. "Re-engineering Graduate Skills – A Case Study." European Journal of Engineering Education 34 (2): 131–139.

[35] Shelby, R., F. Ansari, E. Patten, L. Pruitt, G. Walker, and J. Wang. 2013. "Implementation of Leadership and Service Learning in a First-year Engineering Course Enhances Professional Skills." International Journal of Engineering Education 29 (1): 1–14.

[36] Erkan Kacan, Renewable energy awareness in vocational and technical education, Renewable Energy, Volume 76, April 2015, Pages 126-134.

[37] Alia Assali, Tamer Khatib, Angham Najjar, Renewable energy awareness among future generation of Palestine, Renewable Energy Volume 136, June 2019, Pages 254-263.

[38] Loyalka, P., M. Carnoy, I. Froumin, R. Dossani, J. B. Tilak, and P. Yang. 2014. "Factors Affecting the Quality of Engineering Education in the Four Largest Emerging Economies." Higher Education. Advanced online publication. doi:10.1007/s10734-014-9755-8.

[39] Aadu Ott, Lars Broman, Konrad Blum, A pedagogical approach to solar energy education, Solar Energy, Volume 173, October 2018, Pages 740-743.

[40] Lucena, J., and J. Schneider. 2008. "Engineers, Development, and Engineering Education: From National to Sustainable Community Development." European Journal of Engineering Education 33 (3): 247–257.

[41] Wallen, M. R., and A. S. Pandit. 2009. "Encouraging Undergraduate Engineering Students Towards Civic Engagement." European Journal of Engineering Education 34 (2): 141–148.

[42] Martin, R., B. Maytham, J. Case, and D. Faser. 2005. "Engineering Graduates' Perceptions of how Well they were Prepared for Work in Industry." European Journal of Engineering Education 30 (2): 167–180.

[43] Nguyen, D. Q. 1998. "The Essential Skills and Attributes of an Engineer: A Comparative Study of Academics, Industry Personnel and Engineering Students." Global Journal of Engineering Education 2 (1): 65–76.

[44] Birch, J. 2007. "The FEANI Position on European Support for Innovation." IDEAS 14: 26–31.

[45] Goh, S., W. Coaker, and D. Thorpe. 2008. "How Engineers Become CEOs: Implications for Education and Training." Paper presented at the 9th Global Congress on Manufacturing and Management (GCMM2008), Surfers Paradise, Australia.

[46] Childs, P.W., and P. Gibson. 2010. "Graduating Professional Engineers and Management Skills – Are they Adequate for the Workplace?" Paper presented at the 3rd international symposium for engineering education, Ireland.

[47] Cristian-Dragoș Dumitru, Adrian Gligor, Designing of a Renewable Energy Training Programme for Engineering Education, Volume 12, Procedia Technology, 2014, Pages 753-758.

[48] High Education Accreditation Commission, Results of Competence National Exam (in Arab language), Amman, Jordan, 2018-2019, (http://www.heac.org.jo/?page_id=4966).

[49] Elnaz Safapour, Sharareh Kermanschachi, Piyush Taneia, A Review of Nontraditional Teaching Methods: Flipped Classroom Gamification, Case Study, Self-Learning & Social Media, Education Science, Vol. 9 (4), 2019, pp. 273-293.

[50] Harun Chowdhurya, Firoz Alama, Shyamal Kanti Biswasb, M. Tazul Islamb and A.K.M. Sadrul Islamc, Quality assurance and accreditation of engineering education in Bangladesh, Procedia Engineering 56 (2013) 864 – 869.

[51] Rim Badri, Nejib Hachicha, Entrepreneurship education and its impact on students' intention to start up: A sample case study of students from two Tunisian universities, The International Journal of Management Education, Volume 17, Issue 2, July 2019, Pages 182-190

Appendix A (Questionnaire)

1- General Information (Company, Private or Public, Address, Qualification)

2- Level of basic engineering knowledge and readiness to enter the work market

No.	Question
1	Understand basics of engineering science related to energy conversion and utilization of renewable energy technologies
2	Ability to solve problems and resolve technical obstacles
3	Develop and design technical solutions
4	Research and development spirit
5	Readiness to employ advanced computers and software packages
6	Believe in the role of engineers in society
7	Understand importance of environment and sustainability
8	Comply with work ethics
9	Ability to teamwork
10	Capability to commute with others
11	Understand project management
12	Ability to continuous learning

3- Skills and readiness to enter the market

1- Skills

No.	Question
1	Do you believe that he/she has basic skills to start professional life
2	Capability to commute with work colleagues
3	Capability to commute with customers

4	Technical writing skill
5	Ability to work with others from different disciplines, background and experience
6	Does he/she have the capability to face real problems in the field
7	Having financial and administrative skills

2- Are there noticeable differences in capabilities and performance between male and female engineers

- Basic engineering knowledge and ability to work

- Basic skills to enter the work market

(if yes list main differences)

4- Develop and enhance skills and capabilities of fresh graduates in energy and renewable energy, in your opinion do you believe it is important to develop and upgrade study plans and programs to include the followings:

No.	**Question**
1	Design and team projects
2	Principals of financial analysis, accounting and administration
3	Projects and personnel management
4	Communication skills, technical writing and seminar
5	Simulations and programming

4-5 what is your recommendation to develop engineering education and readiness of graduates to enter the market and face real work life?