Shaping the Engineering Qualifications for Improving Living Standards and Resources Efficiency

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Abstract

This paper aims at summarizing the results of the survey for determining the qualifications need of local industry in Palestine. It comes as an output of the first work package named "Identify stakeholders, their needs and education and training contents in Palestine" of the Tempus project called "Middle Eastern Partnership in Sustainable Engineering" with acronym (ME-Eng). The project aims to enhance the value creation of the Palestinian industries by providing qualified engineers who are able to design and develop sustainable products and processes. Master program in Sustainable Production and Quality Engineering, and Education & Training centers will be considered as demonstrator of the project. Education & Training centers will enhance the cooperation with local industries by providing Lifelong learning short courses. In order to achieve the goals of this work package, a questionnaire has been prepared and distributed in the local Palestinian industries. The results of the questionnaire showed the need for highly qualified professionals in advanced areas of production, quality, and sustainable engineering. This sits in motion the need to establish master program in sustainable production and quality engineering and Education & Training centers.

Keywords:

Engineering Qualifications, sustainability, Industrial demand, Palestine

1 INTRODUCTION

There are many potential opportunities for further growth of the industrial sector in Palestine, such as the abundant human resources and the absorptive capacity of the market [1]. More specifically Palestine can improve growth by creating an environment, which develops competitiveness, as well as services related to industry. Broadening the level of diversification will require an expansion of production towards services in maintenance, technology management, quality engineering, sustainable development, and proactive policies to support education and training in such disciplines. Nevertheless, Palestine has a number of obstacles against growth [2]. For example, industry has institutionalized problems in terms of management, production, quality, competition, and skills besides to other obstacles caused by the Israeli occupation and the extreme restrictions on imports and exports [3].

The engineers and technical staff in general do not have sufficient knowledge of the latest trends in their areas of interest [4, 5]. This problem particularly emphasized with the engineering personnel who have graduated from universities years ago. Considering rapid advances and changes in technology, it is evident that the majority of technical staff lags behind in new technologies. The problem is clearer in areas of application of modern technologies. On the other hand, the higher education institutions in Palestine have been undermined by a mismatch between education and training and the job market demands. Educational research study at Arabian region pointed out that the gap between education and training and market needs (employment) has not been bridged, and that the quality of education and training continues to be unsatisfactory [6-8]. It is that creating higher education program in parallel with an education & training centers can contribute in bridging this gap between Industry and Academia. The Middle Eastern Partnership in Sustainable Engineering (ME-Eng) project comes to address the challenges discussed above through achieving two objectives [9]:

a. Establishing a Master program in Sustainable Production and Quality Engineering at faculty of Engineering at Birzeit University with joint resources from An-Najah National University. This program will teach graduate courses related directly to the needs of the local industry and sustainable engineering.
b. Establishing Education & Training centers in both Birzeit University and An Najah University. The centers will link the higher education institutions and the local industrial sector. The main goals of the center are focused on establishing training courses for engineers and technicians from the local market. These courses will narrow the gap between industry and academic education and create real partnership between the two sectors leading to economic development.

2 PALESTINIAN INDUSTRIES

The Palestinian industry is considered as a diverse one amongst variety of products. Each sector is related to small subsectors and branches. One of the most important problems the sector faces is the lack of raw materials which reduces the sustainability of the sector. This problem is caused by the Israeli restrictions and rules. Although the lack of imported raw materials is a drawback for productivity but in certain cases in encouraged hard working and resilient business, and maximum utilization of the raw material, which are considered the main driving force of the Palestinian economy. Another advantage is that this leads to detaching the Palestinian economy from the Israeli one. It is well known that the Palestinian economy is very much related to

the Israeli economy and subjected to its priorities. This proves the necessity to have an independence for the Palestinian economy to be ready for the coming Palestinian state.

Industrial sector in Palestine plays a great role in the national economy and thus in the social situation of the Palestinian people. Industry contributes in about 13% of the total employment and 16% of GDP. The highest indication for this contribution is the export rate which had a notable growth in the nineties. In spite of this growth in exports but the general situation is always influenced hardly by the political situation and continuous turbulence [10].

Although the total production capacity of the manufacturing sector has fallen, and hence their market share, the last few years have shown a considerable increase in total exports. The following figures show clearly the growing tendency towards more exports in the major industrial sectors. Figure 1 shows the increase in exports in the West bank through the years from 2000 to 2007.

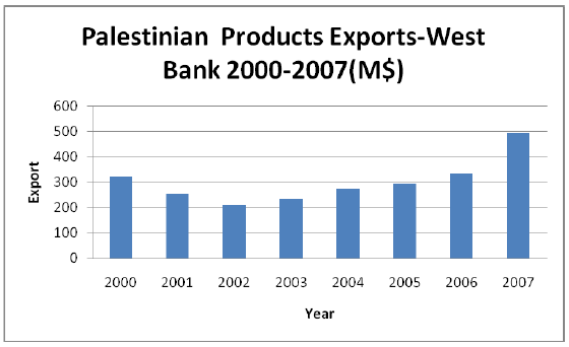

Figure 1: Palestinian Products Export - West Bank 2000-2007(M$) – Palestinian Central Bureau of Statistics Website.

Figure 2 depicts the distribution of exports of different products in Palestine. This figure shows that Stone and Marble sector has the highest contribution in production and export followed by metal industry.

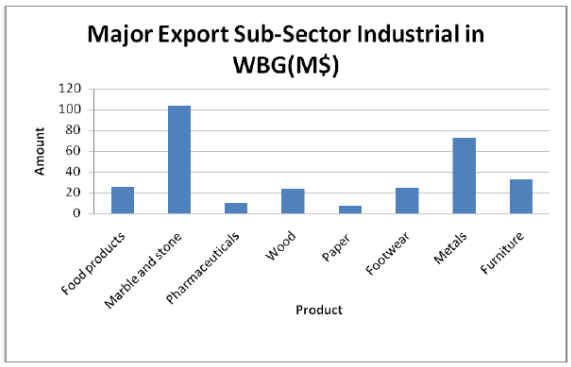

Figure 2: major export Sub-sectors industrial in WBG(M$) - Palestinian Central Bureau of Statistics Website.

As a result, it is worth mentioning that in order to improve the industrial sectors and ameliorate their contribution in the general economy, it is necessary to adopt a national programme for industrial development and relate it to the academic institutions. To ensure the success of this programme it should hold a concentrated study about the stakeholders and beneficiaries of the sector. In this case the beneficiaries vary from industry representatives from different sectors besides to representatives from the government and academic universities. The synchronization of efforts of these three partners can lead to better industrial situation.

3 ENGINEERING EDUCATION IN PALESTINE

Palestinian students have exceptionally high educational aspirations in spite of living under Israeli occupation and in dire poverty. Students work hard in school and are supported by their parents. Sadly, these youth realize that their lofty educational aspirations are not likely to be fulfilled because of their families' poverty and the disruptive influence of the Israeli occupation [11].

Engineering programs and study at the university level is the favourite choice of the society, hence engineering program along with IT attract the best students in Palestine. Very common that students with grades above 90% in high school diploma are enrolled in engineering programs. In 2010/2011 11.2% of the 40000 students accepted in the universities in the bachelor programs are accepted in engineering disciplines. Among the 103000 university students 18.1% are in engineering bachelor programs, this is higher than previous number of accepted students due to the fact that all engineering programs are 5 years while others are 4 years. On the graduation level 8.8% among bachelor degree university graduate are from engineering disciplines [12].

As mentioned in the introduction, it is clear that there is a mismatch between engineering graduates and the local market need. Such problem is alleviated by employment outside Palestine especially in the Gulf Arab countries and by graduates accepting other jobs not closely related to their field of study. No actual statistics exist about the employment of engineering graduated in local and external markets. However the low monthly salaries of fresh graduates which is around $500 monthly [Obtained from newly employed Birzeit University engineers at local engineering offices] which can be compared with teaching assistant at local universities that earn around $1000 monthly [Human resources department, Birzeit University 2012], this implies a high supply of engineers compared to the demand in the local market.

The relation between academic institutions and job market has been characterized by weak interactions and weak coordination, figure 3a and figure 3b compares this one way relationship and the integrated model. Graduates can go back to universities while on the job as part of the long-life learning process and/or for further education as graduate student in the master programs. ME-Eng project intended to support both side providing the training centre for long-life learning and establishing new master program. During their study, students have to interact with industry and market through training and internship and possible course and graduation projects. Furthermore teachers' interactions with job market include research, training, and carrying out consultations. On the other hand, experienced engineer from industry can teach certain courses related to their work at the universities.

In order to improve the graduates competitiveness in the job market engineering programs in addition to its strong technical programs, they seek to empower student managerial and communication skills as well as personal and social skills [13].

Engineering curriculum at local universities contain good amount of lab and practical work. However because of difficulties imposed on importing lab equipment by Israeli occupation and adding to this the limited funding available for such equipment, some of labs and practical aspects are not covered properly in classes. Such situation assures the need for a stronger relationship between academic programs and industry in Palestine; this is to give student better opportunities to get hands-on experience in direct contact with the local industry.

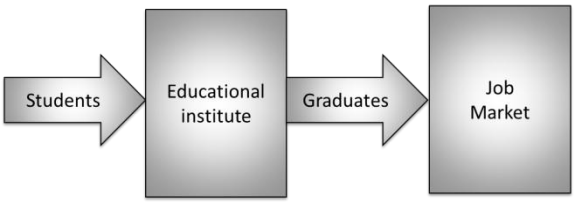

Figure 3a: Educational job market one-way model.

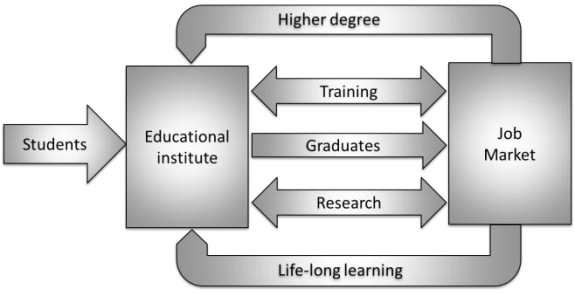

Figure 3b: Educational job market integrated model.

4 METHODOLOGY FOR DEMINING QUALIFICATIONS DEMAND

The general methodology for this study can be shown in the flow chart depicted in figure 4. The first step began with identifying the stakeholders, then data collection for determining the qualification needs for sustainable production and quality engineering. The main source for these data was the literature review for similar master program as shown in Appendix 1, and the analysis of the industrial qualifications demand as announced in the job advertisements in case of job vacancy [14].

A team formed consists of academic and industrial partners, represented by Technische Universität Berlin, Birzeit University, An-Najah National University, and Palestinian Federation of Industries. The team met in several brainstorming sessions to adapt the data collected according to the local industry demands and international accreditation like Accreditation Board for Engineering and Technology (ABET). The questionnaire has been designed to cover three main sections in addition to the introductory cover letter:

Part I. General Information about the Industry: It contains general questions about the size, type of industry, administrative and managerial structure, engineers specialty etc. This part of the questionnaire will help in the analysis by giving weight based on the size of the firm; making correlation between the type or size of industry and the qualifications demands; also will help to give the team an overview about the current status of the industries in Palestine.

Part II. Training Needs Assessment: This section is divided into three subsections; general training needs, engineering specialized training needs, and technician training needs. The long-term objective of the training center is to upgrade knowledge and skills of the target group (students, graduates, and employees) to bring it in line with world standards. The target group should gain detailed knowledge and hands-on experience in new technologies in the field of sustainable engineering and gain insight into current world norms and standards. This part was designed to determine the target groups for training, the main topics of training, the specific skills to be targeted in the training, and the training center capabilities.

Part III. Assessment of the Master program in Sustainable Production and Quality Engineering: This part of the questionnaire explored the need for master program in sustainable production and quality engineering and the output will be used to design the curriculum for this program. The master program consists of three blocks: production, quality, and sustainability, hence the questions are grouped into these three categories. In order to measure the importance of each topic or course a five-point Likert scale [15] was used to evaluate the importance and the weight of each item in the list. The questions for each section were structured using several brainstorming sessions with experts.

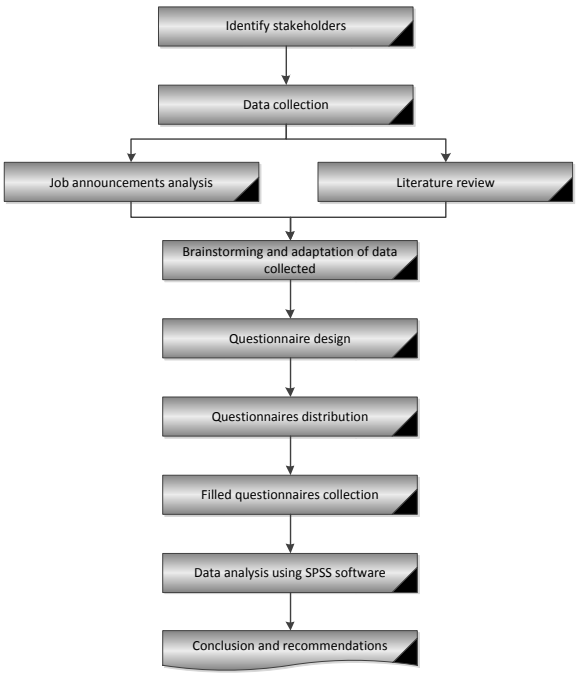

Figure 4: Study methodology

Approximately 200 faxes and emails were issued by the project team to named individuals in manufacturing firms across West Bank and for all the industrial sectors. The response rate was 34%, which can be considered acceptable due to the challenges the team faced to encourage firms to fill the questionnaire [16]. The collected questionnaires were analyzed using SPSS software.

As well as influencing the preparation of the project deliverables (training centers and Master program), the survey results also provided a valuable insight into the current needs in the areas of sustainable production and quality engineering.

5 SURVEY AND RESULT ANALYSIS

5.1 Organization Details

The sample represented all the governorates of West Bank reasonably and based on industrial sectors. Figure 5 shows the participated firms based on the industrial sector.

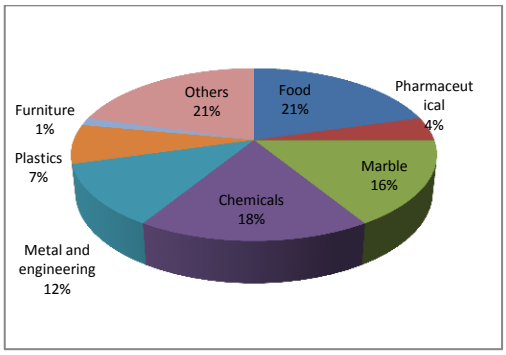

Figure 5: Sample distribution according to industrial sector

The results showed good level of organizational maturity, since 35 out of the sample 68 have been awarded different quality standards local and international quality standards. This information was essential in terms of designing the training and the master program as firms are willing to invest in organizational and institutional development.

5.2 Training needs

The analysis of the questionnaires showed that 27% of Palestinian firms participated in the survey has annual training budgets, which varied between $ 1,400 and $ 50,000.The training topics covered in the last year varies from industry to other. However, the major areas were in quality management systems, accounting and finance, production management, and technical training such as welding.

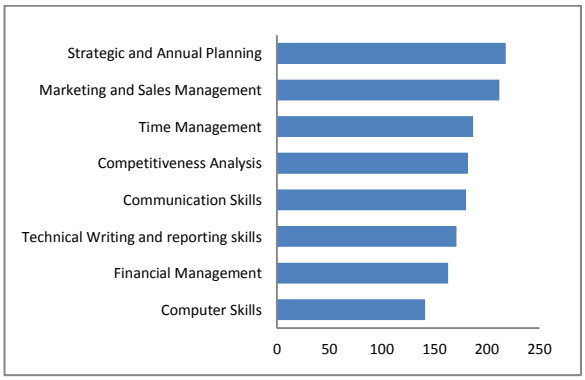

Figure 6: General Training Needs

The analysis of training section of the questionnaires gives the general view of the training needed by the local Palestinian industry. The general training needs, shown in Figure 6, highlight the importance of strategic planning and marketing and sales management while financial management and IT seem to be sufficient. Engineering specialized training themes proved to be the highest of importance according to the survey results were industrial and occupational safety, international standards and maintenance management.

The final part of the training assessment was for technicians. The needs proved to be different from the training needs for engineers. However, the proposed themes in the questionnaire were very relevant as the analysis shows that most of them were important. Nevertheless, the occupational and industrial safety, mechanical machine maintenance, hydraulics systems, control system showed the highest demand among other trainings for technicians (Figure 7)

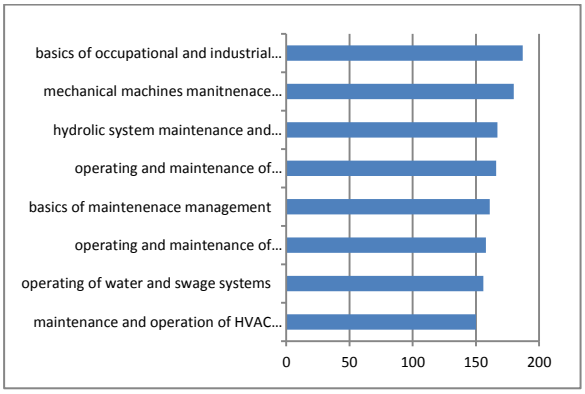

Figure 7: Technician Training Needs

The results with regard training needs of the industrial sector were different from the current available trainings offered by the market. This partially covers the industrial sector training needs. Thus, there is a demand for education and training center to cover part or all of the uncovered training needs. However, the focus of the proposed two education and training centers in An-Najah National University and Birzeit University shall cover the key themes that deemed to be relevant and important from the participated firm's perspectives. The results also showed that food industry's key need in strategic and annual planning while marble and stone key needs in industrial and occupational safety. Metal and chemical industry's key needs were in maintenance management in addition to strategic planning.

The above confirms the results of the random meetings and interviews with industrial association executive manager who emphasizes that the industrial training needs varies based on sector.

5.3 Sustainable Engineering Master Degree Needs

The third part of the questionnaire covers the potential needs for Master degree in Sustainable Production and Quality Engineering. Based on the analysis, a postgraduate program in quality and sustainable engineering should address the gaps identified in analysis of the questionnaire. It will advance and elevate the competencies of the engineers who are working within the Palestinian industrial sector.

The analysis of this part was divided into three subparts representing three themes (production, quality, and sustainability).

- **Production part**

Generally, the Palestinian firms replied positively on most of the proposed detailed topics as depicted in Figure 8. However, the highest rank in the production related topics was the product design and development. R&D comes next and this illustrates the need to introduce new techniques to

support the entire process of new product development. This emphasizes the contemporary awareness of the importance of innovation in manufacturing sector in Palestine.

The other important topics were in the areas related to, increasing the value added through the improvement of production techniques and the automation system. Thus, the Palestinian firms are already realizing the need for new master degree in engineering with the emphasis on production engineering courses.

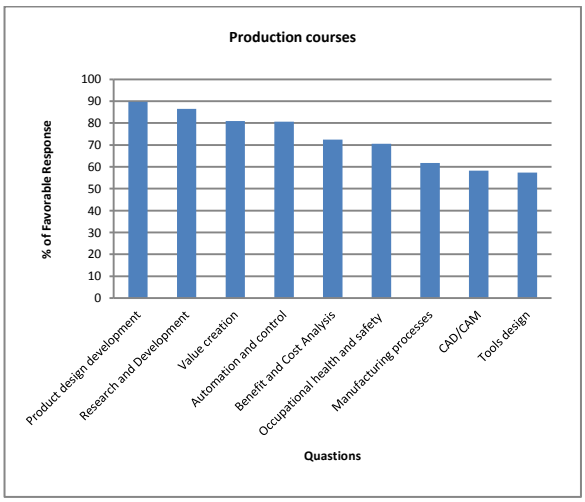

Figure 8: Topics in Production

➢ **Quality part**

For quality part, the responses were not very different from the production part in terms of positive replies on the proposed topics. The responses were various on specific quality topics, however, the evidently top rated topics were continuous improvement, documentation of work procedures, management skills and leadership (Figure 9).

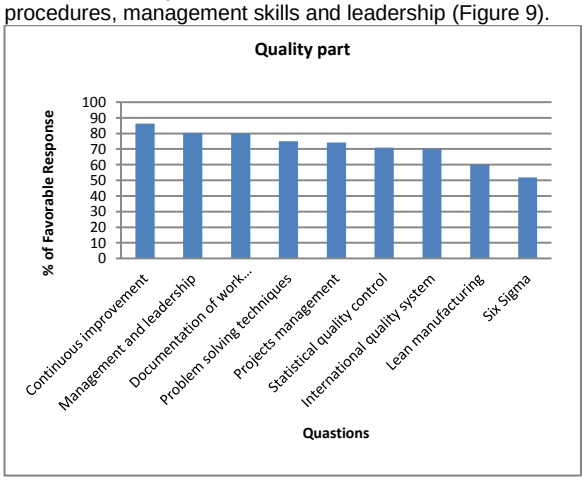

Figure 9: Topics in Quality

➢ **Sustainability part**

For sustainability, the industrial response on this section also was favorable for all questions of this part too. While the response was varied from question to another, the highest ranked items were the energy-saving production techniques, fuel and electricity consumption efficiency, use of renewable energy, innovations in production, and reduction in production cost (see Figure 10). This shows that the focus is driven by improving efficiency and being more environmental friendly where costs reduction and saving can materialize.

The above results and topics highlighted shall constitute a key part of the courses contents of the curriculum of the Master Degree in Sustainable Production and Quality Engineering.

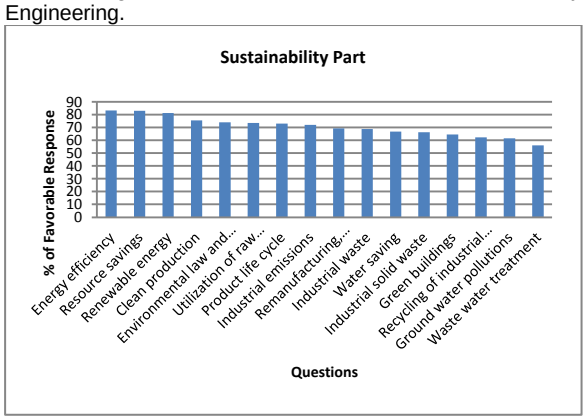

Figure 10: Topics in Sustainability

6 CONCLUSION

This paper comes to document an important study as part of a Tempus project. The aim was to identify the qualifications required to equip industrialists with the state of the art concepts related to quality, production, and sustainability. The plan is to achieve the above objective through providing a Master Program and training centers based in West Bank. The core component was the approach followed in designing and realizing the results of the survey.

It is appropriate to establish one education and training center in the north of West Bank at An-Najah National University to serve the northern part and one in the middle to serve the middle and the southern part of West Bank at Birzeit University. Considering the analysis and key findings, these centers should provide specialized and targeted training courses in strategic planning, marketing, sales management, industrial & occupational safety, international standards, and maintenance.

Finally, the results of the survey showed low percentage of highly qualified professionals, although the need is apparent remarkably in the advanced areas such as new product development and sustainable engineering. This confirms the need for a joint master program in the key themes of production, quality and sustainability. The current staff at both universities ANU and BZ complements each others with regard several of the modules that will be developed to address the needs discussed above.

Inexpensive resources are required to support the primarily soft skills training and particular simulated work which involves computer-based systems and software. In addition, a video conference system is considered necessary to facilitate communication between all parties and provides distance training when needed.

7 ACKNOWLEDGMENTS

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Appendix1: Sustainable engineering education worldwide

Sr.	University	Name of program	Degree
1	Arizona State University	Sustainable Engineering	M.Sc., Ph.D
2	Rochester Institute of Technology	Sustainable Engineering	M.Sc., Ph.D
3	University of Michigan	Engineering Sustainable Systems	M.Sc.
4	Princeton University	Sustainable Energy	M.Sc.
5	Carleton University	Sustainable Energy Engineering and Policy	M.Sc.
6	Villanova University	Sustainable Engineering	M.Sc.
7	Royal Institute of Technology	Sustainable Energy Engineering	M.Sc.
9	Technical University of Berlin	Sustainable Energy	M.Sc.
10	Stuttgart University of Applied Science	Sustainable Energy Competence	M.Sc.
11	University of Calgary	Sustainable Energy Development	M.Sc.
12	University of Sarajevo	Sustainable Energy Engineering	M.Sc.
14	Eindoven University of Technology	Sustainable Energy Technology	M.Sc.
15	Purdue University	– Environmental and Ecological Engineering BS – Ecological Sciences and Engineering	B.Sc, M.Sc.
16	University of Strathclyde	Sustainable Engineering	M.Sc.
17	University of Cambridge	Engineering for Sustainable Development	MPhil
18	University of Bras Sweden	Sustainable Engineering	M.Sc.
19	Glasgow Caledonian University	Sustainable Energy Technologies	M.Sc
20	Delft University of Technology	Sustainable Energy Technology	M.Sc
21	University of California, Berkeley	Engineering and Business for Sustainability	M.Sc
22	University of California	Sustainable Engineering	M.Sc
23	Cardiff University	- Sustainable Energy and Environment - Geoenvironmental Engineering	M.Sc
24	Loughborough University Leicestershire	Sustainable Engineering	M.Sc
25	University of Colorado- Denver	Environmental and Sustainability Engineering	M.Sc