Analysis of Civil Engineering Diploma Programmes in the Gulf

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This study is aimed to analyze similarities and differences among civil engineering (CE) diploma programmes. Programmes from eight higher education institutions in the Gulf were used. The following conclusions were arrived at: Qualification providers in the Gulf believe that CE education should not be concentrated only in acquisition of technical skills. They believe that graduates should acquire soft skills. However, they believe that bulk of CE education should be focused on acquiring knowledge and skills in CE, particularly in specific areas. Moreover, they believe that diploma graduates should be given the opportunity to progress their education to higher levels. **(***Abstract***)**

benchmarking, civil engineering diploma, civil engineering education, curriculum development, program design (key words)

I. INTRODUCTION

Demand for civil engineers worldwide continues to grow. In the United States of America, the projected percentage growth in the employment of civil engineers from 2014 to 2024 is 8%, about as fast as the average for all occupations. Civil engineers will be needed to rebuild, repair and upgrade infrastructures and building structures of all types. [1] Furthermore, among the fourteen engineering occupations in Canada, civil engineering has the highest number of forecasted annual job openings over the next five years, with 2,500 job openings annually. This is basically due to growth in industries that employ civil engineers and the replacement of retiring workers. [2] Similarly, civil engineering output in nineteen European countries will increase by 2% in 2017 and by 3.6% in both 2018 and 2019. This is due to increase in road construction, economic growth, environmental protection goals, and other factors. [3] In Bahrain, the leading industry for hiring expatriates is construction, with the biggest number of work permits issued, accounting for 13,073 or 33% of all permits, in the second quarter of 2018 [4].

Construction in the Gulf region is booming. For example, the current estimated cost of major infrastructure projects in Bahrain is $32 billion. In the first nine months, the government has awarded 162 tenders, totaling $704.8 million, for the construction and engineering sector. [5] Oman has made a total of 33 projects and initiatives available for local and foreign investment through public-private partnerships, totaling over $2.5 billion in investments. These include waste-to-energy projects, biogas plant, soda ash production plant, clinker manufacturing facility, quick lime production plant, hospitals, among others. [6] In Kuwait, the Kuwait National Petroleum Company has commissioned the country's largest crude distillation unit with a daily refining capacity of 264,000 barrels at Mina Abdullah Refinery. Twelve new process units from five licensees, interrefinery transfer lines, and connecting pipe rack are all now under construction. More than 15,000 people were working onsite during the peak of activity. [7] In Saudi, contracts worth $427 million have been awarded by a prominent Saudi real estate developer for its flagship community project in Riyadh featuring over 30,000 homes, supported by the Public Investment Fund [8]. According to National Water Company, the Asir region will get more than $213 million in water and environmental project development [9]. In the United Arab Emirates, it has been declared by Dubai Industrial City that major construction and infrastructure projects has been completed. Two highway extensions to Emirates Road have been finished. A 14,000-bed worker accommodation village has been inaugurated also by Dubai Industrial City. The two projects have a combined investment of more than $112 million. [10]

Universities are essential in developing the competence of engineering professionals [11]. Universities are essential for innovation. Due to the accelerating technological revolution of the 21st century, the need for training in creativity and innovation skills, "out of the box" thinking, and a learning environment that promotes divergent thinking, opinion generation, and subjective interpretations is growing in higher engineering education. Along with technical research, engineering education is a critical foundational component in fostering innovation. [12] Different skills are much needed in the construction industry, which include communication, computer, managerial, technical expertise, environmental awareness, linkages with other agencies, keeping with new technologies and soft skills. [13]

The objective of this study is to analyze the similarities and differences among civil engineering diploma programmes in terms of programme intended

learning outcomes, programme structure, duration, linkage to professional body and learning pathway.

The study will give the curriculum developers and other researchers an overview of civil engineering diploma offerings in the Gulf, thus, it could be used to support the development of a customized civil engineering diploma programme. Graduates of civil engineering diploma programmes could either enter the labor market as construction or civil engineering technicians, or they could continue their education for a Bachelor's degree in civil engineering.

II. Theory

Civil Engineering is a profession concerned with solving problems related with developing and maintaining civilized life on the Earth through application of science and mathematics [14]. Civil engineering is the profession of designing and executing structural works that serve the general public [15].

There are nine disciplines and areas of civil engineering, namely: architectural engineering; construction engineering; environmental and water resources engineering; structural engineering; utility engineering and surveying; coasts, oceans, ports, and rivers; engineering mechanics; geotechnical engineering; and transportation and development. [16]

III. Methods

Civil engineering diploma programmes from eight higher education institutions in the Gulf were used in the study. However, for confidentiality concerns, names and identities of these higher education institutions are not disclosed. Only the accredited programmes, or programmes which are recognized by main government bodies, were considered in the study. Data was obtained from the internet. The qualification providers were also contacted through e-mail or the mobile application Whatsapp. The brochures sent by these qualification providers provided additional data. Qualitative data were evaluated to determine similarities and differences among them. Frequency counts and percentages were used to give a more accurate description of their similarities and differences.

IV. Results and Discussions

A. Programme Intended Learning Outcomes

Only six of the eight programmes have available data for Programme Intended Learning Outcomes. All the six programmes include attainment of knowledge, skills and competence. This is in parallel with the *Qualifications Framework Emirates*, or *QFEmirates*, wherein its design is based on different features, including "Range of learning outcomes at each level with learning outcomes being described in terms of knowledge, skill and competence". Furthermore, the learning outcomes are stated in terms of knowledge, skills and competence. [17]

All the six programmes intend the learners to be able to acquire the skill to solve civil engineering or engineering problems. Five of the six programmes (83%) include non-engineering-related learning outcomes such as the social development of the learners.

Moreover, nineteen strands were identified by at least half of the six programmes. From these strands, three are knowledge, twelve are skills and four are competence. The following knowledge strands were identified: 1) Understand the professional and ethical responsibility; 2) Know contemporary issues relating to civil engineering; and 3) Analyze issues logically and creatively. The following skills strands were identified: 1) Solve civil engineering or engineering problems; 2) Communicate effectively; 3) Apply knowledge of mathematics, science, and engineering; 4) Use the techniques, skills, and modern tools necessary for civil engineering or engineering practice; 5) Apply the concepts and principles of structural analysis and design; 6) Apply the basic concepts of land surveying; 7) Utilize different construction materials; 8) Present designs; 9) Construct plans to meet time-constrained targets; 10) Use the concepts of soil mechanics in Civil Engineering; 11) Produce structural drawings; and 12) Accurately interpret structural drawings. The following competence strands were identified: 1) Function in multi-disciplinary teams; 2) Recognize the need for and ability to engage in lifelong learning; 3) Conduct standardized field and/or laboratory tests; and 4) Inspect site work, after gaining sufficient experience under the supervision of professionals.

The strands found in the programmes imply that aside from the acquisition of civil engineering skills, the programmes also intend their graduates to be professional, responsible team members and can perform multi-tasking.

The importance of benchmarking is highlighted in a study which exposed that improvements to the Digital Signal Processing (DSP) course of a university in the Philippines in terms of course content, methods of instruction and methods of assessment were based on the benchmarking of the course with the DSP courses of twelve universities. [18]

B. Programme Structure

Only seven programmes have available data for programme structure. All the seven programmes include specialized units, with percentage of the total units ranging from 40% to 80%. All the seven programmes include communication or commercial studies, and math and science. Four of the seven programmes (57.14 %) include information technology, and social/cultural studies.

This implies that the programmes are holistic. They are not only focused on the attainment of

specialized knowledge and skills. Non-engineering fields are also incorporated in the curriculum. This can be attributed to the fact that learning engineering effectively necessitates prerequisite knowledge and skills.

Twenty-six specialized units were found from the seven programmes. A total of eight specialized units were included in at least half of the seven programmes. All the seven programmes include the following two specialized units: 1) Drawing/Graphics/Computer drafting; and 2) Mechanics/Strength of Materials. Six of the programmes (85.71%) include the following specialized unit: Construction/Civil Engineering Materials. Five of the programmes (71.43%) include the following three specialized units: 1) Construction Methods; 2) Structural Analysis and/or Design; and 3) Surveying. Furthermore, four of the programmes (57.14%) include the following two specialized units: 1) Geotechnical Engineering; and 2) Project.

This implies that the programmes intend their learners to acquire knowledge and skills in civil engineering, particularly in the following areas: drawing, mechanics, civil engineering materials, construction methods, geotechnical engineering, structural analysis and design, surveying, and project.

C. *Duration*

Only seven of the eight programmes have available data for duration. The duration for the programmes ranges from four semesters to six semesters. This implies that the duration for the programmes vary slightly and it is around five semesters.

D. *Linkage to Professional Body*

All the programmes are accredited by their respective governments. Only two of the programmes are accredited by an international organization, particularly by a professional society.

This implies that the quality of the programmes is monitored by external organizations, leading to more transparent and more objective audit reports. This also implies that compliance to standards is at higher levels.

Each of the countries in the GCC (Gulf Cooperation Council) has established bodies to ensure quality standards in their higher education systems [19]. They aim to ensure effective administration and clear supervision of higher education institutes [20].

Engineering schools continually collaborate with professional engineering organizations and engineering accreditation boards to develop engineering programmes that are timely and relevant with the needs of modern society [21]. Accreditation bodies have improved the quality of education of most higher education institutions in the GCC that are pursuing national and international accreditations for some programs, including engineering and engineering technology [22].

Similarly, most of the GCC countries have private and state educational institutions that are increasingly obtaining accreditations or partnerships with international universities in the United States, the United Kingdom, Australia, the Netherlands, and India so that their programs are more recognized internationally. The Kingdom of Bahrain follows the “twinning model” where the learners study for a part of the course in the Kingdom and another part of the course in the host country. [19]

E. *Learning Pathway*

All the programmes offer a vertical progression. All of them offer progression to a baccalaureate degree. Four of them (50%) require the learners to take first Higher or Advanced Diploma before they can proceed to a baccalaureate degree. This implies that graduates of the programmes can continue their education to higher levels. This also implies that the programmes serve as foundation for more effective learning in the higher levels.

V. Conclusions

Qualification providers in the Gulf believe that civil engineering education should not be concentrated only in the acquisition of technical skills. Rather, the other aspects of the learner should also be developed such as his or her personal and social aspects. They also believe that graduates should acquire soft skills which include professionalism, responsibility and multi-tasking. However, qualification providers in the Gulf still believe that the bulk of civil engineering education should be focused on acquiring knowledge and skills in civil engineering, particularly in the following areas: drawing, mechanics, civil engineering materials, construction methods, geotechnical engineering, structural analysis and design, surveying, and project. Moreover, qualification providers in the Gulf believe that diploma graduates should be given the opportunity to progress their education to higher levels.

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