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Stakeholders' Needs along Construction Materials Technology Programme for the Kingdom of Bahrain

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***Abstract*— The study aimed to determine the stakeholders' needs along construction materials technology programme. The data were obtained from thirty-four participants of six Focus Group Discussions (FGDs). The number of participants per category was as follows: twelve from the industry, five from the academe and seventeen from the learners. From the series of FGDs, thirty-three needs along knowledge were revealed, subdivided into five categories, namely, materials, material tests, quality bases, processes, and types of construction. Furthermore, six needs along skills, together with eight specific types of tests, were revealed. The skills are focused on practical skills, materials use and tests, and quality processes. Moreover, three needs along competence were revealed. The competence needs are roles involving several knowledge and skills, and these roles are related to becoming a Quality Assurance and Quality Control (QAQC) technician.**

***Index Terms*— competence, construction, knowledge, materials, programme design, qualifications framework, skills, technology.**

I. INTRODUCTION

Construction activities in the Middle East, specifically in the Gulf, are massive and surging. In the Kingdom of Bahrain, for example, a future-focused $30-Billion Strategic Projects Plan, which consists of twenty-two projects, had been announced. These include the $3-billion rail-based urban transit transportation system project, the five cities situated on newly-developed islands, the largest 'Conference City' in the Middle East, the new 25-km four-lane King Hamad Causeway, the Sports City and the Tourist City. Furthermore, the construction and engineering consultancy sector had the third biggest share in the tenders awarded during the first six months of 2021, with projects worth more than $400 Million. In addition, the kingdom's GDP from construction is projected to trend around $671.81 million in 2023, according to projections. [1] In Dubai, for instance, a fund about $17.7 billion for an Emirati housing programme had been approved. Moreover, a large number of projects worth more than roughly $6.81 billion under the public-private partnership portfolio had been announced. These include more than thirty important projects in the urban development, infrastructure and public transportation sectors. Furthermore, construction works for the about $1.44 billion Al Shindagha Corridor Project, one of the largest projects of its kind, is in progress,. Also, work on the estimated $3.27 billion Riviera, a complex of 16,000 residences spread across seventy-one mid-rise residential buildings and other amenities, is well advanced, with the fourth phase 20% complete. [2] In the Kingdom of Saudi Arabia, for example, the National Infrastructure Fund (NIF), which will invest in areas such as water, transportation, energy and health, was launched to support up to about $53.22 billion worth of projects over the next decade. Moreover, several ambitious multibillion projects had been unleashed. These include, among others, the $500-billion Neom City, the $10-billion Qiddiya entertainment city, the $20-billion Jeddah Central Project, the $20-billion Diriyah Gate, the $13-billion Asir mountain hub and four wellness projects worth $6.12 billion. In addition, it has several industrial parks and economic cities. Also, infrastructure projects such as the $7-billion Saudi Landbridge Project and the $27-billion Riyadh Metro and Bus project are under way. [3] In the State of Kuwait, for instance, the estimated $6.87 billion South Saad Al-Abdullah Town project received approval in late April 2022. The State at present has more than seven hundred active projects with a combined value of $230 billion, 20% of which are nearly completed. The State's development plan (2020-2025) focuses on economic reform and implementation of several long-stalled megaprojects, including numerous large infrastructure projects estimated at $124 billion. These include a large number of mega oil projects; further development of the Mubarak Al-Kabeer Port on Bubiyan Island; new planned cities; a $4-billion new airport; and the $7-billion rail project that will ultimately connect all member-nations of the Gulf Cooperation Council. The government is working on hospital projects worth over $4 billion. [4] In the Sultanate of Oman, for example, the $401 million Ibri Solar Project, the Sultane's largest renewable energy facility of its kind, was inaugurated in January 2022. In addition, a $3.5 billion green ammonia project would be developed in phases over the next three years. Moreover, work is ongoing on the $8-billion Duqm refinery, which will mainly produce LPG, naphtha, jet fuel and diesel. Furthermore, the Al Mouj Muscat, a $3.5-billion mixed-use waterfront development, was launched. [5]

Civil engineers require intense training due to the complexity of the roles they play and the difficulties they encounter. Universities and colleges play a crucial role in the

education of engineers because they offer the conditions and opportunities needed for learning, as well as work constantly with professional engineering organizations and engineering accreditation boards to stay up to date with the changing needs of contemporary society. [6] In the Gulf, civil engineering diploma graduates learn a blend of technical skills and employability skills such as professionalism, responsibility and multi-tasking [7].

However, studies around the world reveal a mismatch between education and employment skills. There is a mismatch between the perception of education providers and employers on the readiness of new graduates. While 72 % of education providers agree that new graduates are ready to work, only less than half (42%) of employers agree that new graduates are adequately prepared for entry-level positions. Furthermore, 39% of employers identify skills shortage as a major factor in entry-level vacancies. [8] American undergraduate engineering education has a strong emphasis on learning technical material, which puts it out of pace with current professional requirements [9]. In the Kingdom of Bahrain, there is a skills gap in the national labor force [10].

In the Kingdom of Bahrain, the National Qualifications Framework (NQF) was developed by Royal Decree No. 83 of 2012 to offer qualifications that are appropriate for their intended use and have closer connections to market and learner demands. A number of issues led to the decision to create a qualifications framework, including, among others, the weak connections between qualifications and the labor market, and the value of qualifications to both employers and students. [11]

The objective of this study was to determine the stakeholders' needs along construction materials technology programme. Specifically, the study aimed to determine the knowledge requirements, skills requirements and competence requirements for a construction materials technology programme.

Stakeholders refer to representatives from/of the following: construction industry, academic staff teaching construction or civil engineering programmes and civil engineering students. Stakeholders' needs refer to the knowledge, skills and competence that the stakeholders would like the graduates of the programme to achieve and develop.

The results of the study could be used to support the development of a customized *Construction Materials Technology Diploma* programme. Since the programme would be developed according to stakeholders' needs, graduates will have the knowledge, skills and competence needed in the industry.

II. METHODS

The researchers utilized the qualitative research design in their study to gain in-depth understanding of the stakeholders' needs. Moreover, the researchers needed to gain in-depth understanding of the requirements, practices and trends relative to construction materials technology.

The data on the stakeholders' needs along knowledge, skills and competence were obtained from thirty-four participants of six Focus Group Discussions (FGDs). The number of participants per category is as follows: twelve representatives from the industry, five representatives from the academe and seventeen representatives from learners.

The participants were chosen using purposive sampling wherein the participants have expertise and detailed knowledge in the subject area. The number of FGDs conducted per category is as follows: two FGDs for representatives from industry, one FGD for representatives from academe and three FGDs for representatives from learners. The chosen participants were notified for a scheduled FGD through e-mail, SMS, WhatsApp and Facebook messenger. All the FGDs were conducted in the Kingdom of Bahrain. In all the FGDs, all the participants were physically present. The six FGDs were conducted in separate days, depending on the availability of the participants.

The first FGD was conducted within 45 minutes. It was participated in by representatives from industry, particularly, eight technical employees of private and government construction and construction-related organizations in the Kingdom of Bahrain. Their number of years in the industry ranges from eighteen to thirty years. They are holding the following job titles: quality assurance quality control (QAQC) technician, senior quantity surveyor, engineering technician, senior engineer, resident engineer, structural engineer, project engineer and senior civil engineer.

The second FGD was conducted within 42 minutes. It was participated in by representatives from academe, particularly, five civil engineering instructors. Their number of years in teaching civil engineering or construction programmes ranges from seven to fifteen years.

The third, fourth and fifth FGDs were participated in by representatives from learners, particularly, civil engineering students taking-up international qualifications in civil engineering, particularly extended diploma or higher national diploma. The third FGD was conducted within 9 minutes and was participated in by five learners. The fourth FGD was conducted within 7 minutes and was participated in by three students. The fifth FGD was conducted within 6 minutes and was participated in by nine learners.

The last FGD was conducted within 14 minutes. It was participated in by representatives from industry, particularly, four technical employees of a government directorate whose organization is responsible in approving the materials to be used in government construction projects. They hold the following positions: senior electrical engineer, material specialist, senior general engineer and mechanical engineer.

The researcher served as the facilitator and each participant was asked to share information on the needed knowledge, skills and competence relative to the proposed programme. There were also interactive discussions among the participants about the topics. The requirements, practices

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and trends relative to the programme were the focus of the discussions. Minutes of FGDs were formulated after each FGD.

The process of how the FGDs were used to determine the stakeholders' needs is presented in Fig. 1. During the FGDs, several sub-topics may occur. The participants' inputs may be totally not related to the main topic, or may be indirectly related. Sometimes, unrelated topics will lead to related topics, and interactive exchange of information was highly encouraged. Each minute of FGD was evaluated to determine the highlights or essential points. The essential points were further evaluated to determine stakeholders' needs. The stakeholders' needs were further evaluated to determine those required in the study, particularly, the stakeholders' needs along knowledge, skills and competence.

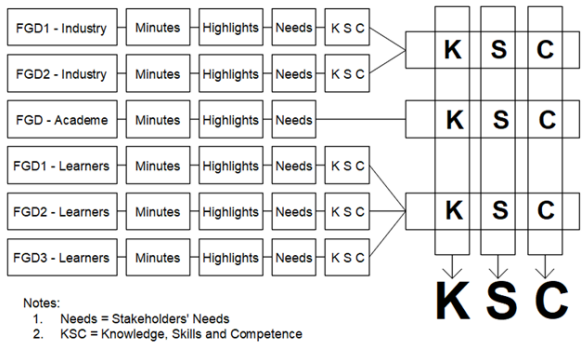

Fig. 1. Analysis of FGDs to Determine the Stakeholders' Needs

As presented in Fig. 1, the identified needs along knowledge, skills and competence from the two FGDs with industry representatives were combined to determine the industry needs. The identified needs along knowledge, skills and competence from the three FGDs with learners were combined to determine the learners' needs. The industry needs, academe's needs and learners' needs along knowledge, skills and competence were combined to determine the stakeholders' needs along knowledge, skills and competence.

III. RESULTS AND DISCUSSION

A. Knowledge

From the series of FGDs with stakeholders, thirty-three needs along knowledge were revealed, as presented in Table 1. The knowledge needs were subdivided into five categories, namely, materials, material tests, quality bases, processes, and types of construction. Four needs were disregarded considering the inputs from other stakeholders and the scope of the programme. The huge amount of identified needs along knowledge can be attributed to the expertise and variety of participants in the FGDs.

This implies that the proposed programme should include theories, principles and concepts relative to civil engineering materials and their tests, quality bases and processes, and types of construction. Learning and applying theoretical, technical and contextual knowledge is still important in engineering education [9].

B. Skills

From the series of FGDs with stakeholders, six needs along skills, together with eight specific types of tests, were revealed, as disclosed in Table 1. The skills are focused on practical skills, materials use and tests, and quality processes. This can be attributed to the fact that the work of many of the participants in the FGDs are directly or indirectly related to construction materials, thus, they know the skills needed in the discipline. This implies that the learners of the proposed programme should be able to perform tasks, such as laboratory tests and quality control, using techniques, tools and materials to address issues.

In a study conducted in Myanmar, it was disclosed that technical knowledge and skills are considered as the second most crucial attribute for the Civil Engineering Industry, after attitudes [12].

C. Competence

From the series of FGDs with stakeholders, three needs along competence were revealed, as disclosed in Table 1. The competence needs are roles which involve several knowledge and skills. These roles are related to becoming a Quality Assurance and Quality Control (QAQC) technician. This implies that learners of the proposed programme should be able to perform series of tasks with independence, responsibility and accountability.

Competence is an important aspect of a curriculum. For example, the Polytechnic University of the Philippines enjoys a good image since its graduates are preferred by employers due to their competence, patience and industry [13].

D. Possible Alignment with Modules

Possible alignment of the stakeholders needs with modules are presented in Table 1. Some of the listed needs served as basis in identifying modules to be included in the proposed programme. These modules could be new modules or could be adopted from existing programmes. The other listed needs could be used to further develop the modules, particularly, they could be used to develop the Learning Outcomes and contents of the modules.

Based from Table 1, thirteen modules were identified, namely, 1) Concrete Technology; 2) Fundamentals of Structural Design; 3) Health, Safety and Welfare in Construction; 4) Highway Construction in Civil Engineering; 5) Materials Science; 6) On-the-Job Training; 7) Quality Control for Soil, Aggregates and Fresh Concrete; 8) Quality Control for Hardened Concrete, Steel and Other Materials; 9) Quality in Construction Projects; 10) Soil Mechanics; 11) Substructure construction; 12) Superstructure construction; and 13) Sustainability.

E. General Recommendations

Based from the series of FGDs with stakeholders, the following general recommendations were observed: 1) For learners to know concepts and principles; 2) For learners to

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perform processes; 3) For learners to use tools; 4) For learners to understand that processes are based from standards; and 5) For learners to be able to interpret results of processes.

IV. CONCLUSION

The stakeholders' needs, the thirteen identified modules, as well as the observed general recommendations, could be used to develop the programme design and content of a customized *Construction Materials Technology Diploma* programme. Since these items were basically derived directly from stakeholders, the said programme will reflect the construction industry needs along the area of construction materials technology. Teaching and learning needs are also considered in the programme since the academics and the learners were also consulted. However, other factors should still be considered in the development of the programme such as requirements from national regulatory bodies, international standards, institutional policies, benchmarking analysis, feasibility studies, among others.

Table 1. Stakeholders' Needs and Possible Alignment with Modules

No.	Stakeholders' Needs	Possible Alignment with Modules
	A. Materials	
1	All types of materials [2]	*Disregard. This contradicts with the recommendations of the other stakeholders to establish the focus of the programme*
2	Civil engineering materials such as concrete, reinforcing bars, formworks, cement, precast concrete, reinforced concrete and new materials [2, 4, 5]	• Materials Science • Highway Construction in Civil Engineering • Concrete Technology
3	Uses of construction materials [4, 6]	• Highway Construction in Civil Engineering • Soil Mechanics • Concrete Technology
4	Quality of materials [2, 3, 4]	• Quality in Construction Projects • Quality Control for Soil, Aggregates and Fresh Concrete • Quality Control for Hardened Concrete, Steel and Other Materials
5	Properties of materials [3, 5]	• Materials Science • Soil Mechanics • Concrete Technology
6	Components of materials [3]	• Concrete Technology • Soil Mechanics • Highway Construction in Civil Engineering
7	Suitability of materials in terms of the types of construction and types of structure [4, 6]	• Substructure construction • Superstructure construction
8	Sustainability of materials [1]	• Sustainability
9	Cost of materials [4]	*Disregard. This is outside the scope of the target jobs for the programme*
	B. Material Tests	
10	Procedures and verification of all types of material tests [1]	*Disregard. This contradicts with the recommendations of the other stakeholders to establish the focus of the programme. Instead of considering all types of material tests, focus should be established on tests for construction materials*
11	Construction material tests [3]	• Highway Construction in Civil Engineering • Soil Mechanics • Concrete Technology
12	Types of tests in the stages of the construction process [2]	• Highway Construction in Civil Engineering
13	Test for spacers [1]	*Disregard. This is already an advanced topic. It can be included in the design of higher qualifications.*

No.	Stakeholders' Needs	Possible Alignment with Modules
14	Tests for the evaluation of old existing structures [1]	• Materials Science • Concrete Technology
15	Universal compressive strength test [1]	• Concrete Technology
16	Geotechnical tests and foundation tests [1, 2]	• Soil Mechanics • Highway Construction in Civil Engineering
17	two types of tests, namely laboratory tests and field tests [1]	• Highway Construction in Civil Engineering • Soil Mechanics • Concrete Technology
18	Structural field tests [1]	• Highway Construction in Civil Engineering
19	Tests of soil and water for laying of sewer pipes [1]	• Soil Mechanics
20	Operation of new technology which include nuclear test and concrete x-ray [1]	• Materials Science • Highway Construction in Civil Engineering • Soil Mechanics • Concrete Technology
21	Type and availability of equipment [1]	• Highway Construction in Civil Engineering • Soil Mechanics • Concrete Technology
	C. Quality Bases	
22	Specifications [1, 3]	• Materials Science • Highway Construction in Civil Engineering • Quality in Construction Projects • Quality Control for Soil, Aggregates and Fresh Concrete • Quality Control for Hardened Concrete, Steel and Other Materials
23	Regulations in Bahrain, such as the Ministry of Works' Standard Specifications for Construction Works [2, 5]	• Highway Construction in Civil Engineering • Quality in Construction Projects • Quality Control for Soil, Aggregates and Fresh Concrete • Quality Control for Hardened Concrete, Steel and Other Materials
24	Codes and Standards such as ASTM Codes and British Standards [1, 2]	• Highway Construction in Civil Engineering • Soil Mechanics • Concrete Technology • Quality in Construction Projects • Quality Control for Soil, Aggregates and Fresh Concrete • Quality Control for Hardened Concrete, Steel and Other Materials
	D. Processes	
25	Design [3]	• Fundamentals of Structural Design
26	Quality checks [3]	• Quality in Construction Projects • Quality Control for Soil, Aggregates and Fresh Concrete • Quality Control for Hardened Concrete, Steel and Other Materials
27	Materials Control [3]	• Quality in Construction Projects • Quality Control for Soil, Aggregates and Fresh Concrete • Quality Control for Hardened Concrete, Steel and Other Materials
28	Materials approval for construction projects [1, 3]	• Quality in Construction Projects
29	Renovation of concrete [1]	• Materials Science
30	Safety practices [6]	• Health, Safety and Welfare in Construction

	E. Types of Construction	
31	Construction and expansion joints [1]	• Highway Construction in Civil Engineering
32	Infrastructures [2]	• Highway Construction in Civil Engineering
33	Drainage [2]	• Highway Construction in Civil Engineering
1	Apply practical skills through On-the-Job Training [1]	• On-the-Job Training
2	Perform materials tests [1, 2, 3, 6]	
2a	Perform gradation test or sieve analysis test [1]	• Soil Mechanics
2b	Perform Atterberg limit tests [1]	• Soil Mechanics
2c	Perform California Bearing Ratio (CBR) test [1]	• Soil Mechanics
2d	Perform compaction test using nuclear density gauge [1]	• Highway Construction in Civil Engineering
2e	Perform asphalt tests such as asphalt content, wearing course and temperature tests [1]	• Highway Construction in Civil Engineering
2f	Perform concrete tests [1, 2]	• Concrete Technology
2g	Operate new technology such as the radiation test or nuclear test [3]	• Highway Construction in Civil Engineering • Soil Mechanics • Concrete Technology
2h	Perform non-destructive tests [3]	• Concrete Technology
3	Interpret test results and determine material properties [2, 3, 6]	• Highway Construction in Civil Engineering • Soil Mechanics
4	Carry-out quality checks [3]	• Quality in Construction Projects • Quality Control for Soil, Aggregates and Fresh Concrete • Quality Control for Hardened Concrete, Steel and Other Materials
5	Carry-out materials control [3]	• Quality Control for Soil, Aggregates and Fresh Concrete • Quality Control for Hardened Concrete, Steel and Other Materials
6	Use construction materials [5]	• Concrete Technology
1	To become hands-on technicians who could perform tests [1]	• Highway Construction in Civil Engineering • Soil Mechanics • Concrete Technology
2	To become QAQC technicians and QAQC inspectors [3]	• Quality in Construction Projects • Quality Control for Soil, Aggregates and Fresh Concrete • Quality Control for Hardened Concrete, Steel and Other Materials
3	To supervise properly roads activities [3]	• Highway Construction in Civil Engineering

Legend:

1. Minutes of First Focus Group Discussion (FGD) with Representatives from Industry for Program Formulation
2. Minutes of Second Focus Group Discussion (FGD) with Representatives from Industry for Program Formulation
3. Minutes of Focus Group Discussion (FGD) with Representatives from Academe for Program Formulation
4. Minutes of First Focus Group Discussion (FGD) with Representatives from Target Learners for Program Formulation
5. Minutes of Second Focus Group Discussion (FGD) with Representatives from Target Learners for Program Formulation
6. Minutes of Third Focus Group Discussion (FGD) with Representatives from Target Learners for Program Formulation

REFERENCES

[1] "Towards a Sustainable Future". *Gulf Construction*, Vol. 43, No. 01, pp. 31-35, January 2022. Manama, Bahrain.

[2] "Enticing Realty Investors". *Gulf Construction*, Vol. 43, No. 04, pp. 6-10, April 2022. Manama, Bahrain.

[3] "Unleashing a Giant". *Gulf Construction*, Vol. 43, No. 05, pp. 6-10, May 2022. Manama, Bahrain.

[4] "Housing Push". *Gulf Construction*, Vol. 43, No. 06, pp. 7-10, June 2022. Manama, Bahrain.

[5] "Targeting Tourism". *Gulf Construction*, Vol. 43, No. 02, pp. 30-33, February 2022. Manama, Bahrain.

[6] Peter Schiavone. (2007). Engineering Success, 3rd Edition. UK: Pearson.

[7] Aldrin B. Bangud, Bryant S. Arante, and Maria Teresa Y. Acantilado. (2022 October 31). "Analysis of Civil Engineering Diploma Programmes in the Gulf". Journal of Multidisciplinary Engineering Sciences and Research, Vol. 1, Issue 4, pages 30-33, October 2022, London, UK.

[8] Mona Mourshed, Diana Farrell, and Dominic Barton. (2013). "Education to Employment: Designing a System that Works", McKinsey Center for Government, informational material.

[9] Sheri D. Sheppard, Kelly Macatangay, Anne Kolby, and William M. Sullivan. (2009). Educating Engineers: Designing for the Future of the Field. CA: Jossey-Bass.

[10] Magdalena Karolak. (2012). "Bahrain's tertiary education reform: a step towards sustainable economic development". Review of the Muslim Worlds and the Mediterranean, 131. DOI: https://doi.org/10.4000/remmm.7665

[11] Education and Training Quality Authority. (2022). "The National Qualifications Framework", https://www.bqa.gov.bh/en/qaaetunits/nqfu/pages/nqf.aspx

[12] S. N. Aung, M. H. Mee, and K. M. Ohn. (2020). Self-Assurance of Civil Engineering Students on Skills and Attributes Crucial for the Civil Engineering Industry. DOI: 10.6084/m9.figshare.12456605.v1

[13] Raul Roland Sebastian. (2015). "Organizational Culture of the Polytechnic University of the Philippines: Basis of Proposed Change Initiatives", Polytechnic University of the Philippines, Manila, Unpublished