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Addressing Generic Skills Gap for Future Civil Engineers in The 4th Industrial Revolution

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Abstract

The profession of civil engineers is listed among the 20 critical occupations ideal for the economic development of the country in facing the modern technological influx of the 4th Industrial Revolution (4IR). In order to prepare future civil engineers for the challenges of the 4IR, they need to be equipped with relevant generic skills, especially during their undergraduates studies. However, existing generic skills embedded in the civil engineering curriculum may not be relevant in the context of the 4IR. Thus, this study was conducted to compare the existing engineering skills highlighted by Engineering Accreditation Council with the 4IR skills. The results from this study revealed seven generic skills that were identified as gaps in both sets of skills. These skills include creativity, originality and initiative; critical thinking and analysis; complex problem solving; emotional intelligence; leadership and social influence. The findings from this study could mark the beginning of further research in this field, aimed at preparing civil engineers with the relevant skills needed for industry demands.

Keywords: Skills Gap, Civil Engineers, Fourth Industrial Revolution, Generic Skill

Introduction

Civil engineering is the engineering field with the broadest scope and is one of the earliest engineering disciplines to exist (Malaysian Qualification Agency, 2011; Ministry of Education, 2019). It is a discipline that involves design, planning, construction, management, and maintenance of the built environment, including construction works and infrastructure facilities such as buildings, bridges, roads/highways, canals, dams, airports, ports, water supply services, and wastewater treatment to ensure human comfort and safety (Clarke, 2007; Levy, 2009). According to the Ministry of Human Resources (2020), the profession of civil engineer is listed among the 20 critical occupations prioritized for national economic development in facing the challenges of the 4th Industrial Revolution (4IR) technology

advancements. Like other fields of work, civil engineering has also undergone changes brought about by the 4IR.

The advancements in advanced technology within the 4IR have transformed work practices and settings across all sectors, indirectly leading to significant job reductions and offerings. This situation applies to both existing and new fields of work, including the acquisition and development of skills. This can be seen in The Future of Jobs report by World Economic Forum WEF, 2016), which emphasizes that the 4IR will bring about paradigm shifts in various aspects such as jobs, skills, and job roles, regardless of industry sector or geography. According to Grugulis and Vincent (2009), the skills demanded by employers change over time and according to the needs of the job market. Skill development is one of the aspects that will be impacted and influenced by the 4IR (Periera & Romero, 2017). As a preparation measure, efforts to enhance skills and skill improvement have become a top priority for higher education institutions, skills institutions, the government, and the industry (WEF, 2016, 2017).

A study by Suprun et al (2019) on final year civil engineering students found that the level of clarity regarding digital skills or new skills is quite low. They are not clear about the use of new technologies in the construction industry today. Although the integration of digital technology in civil engineering is not as widespread as in other engineering fields (Azyaki et al., 2020), the workforce still needs to enhance, improve, or update their generic skills in order to maintain their current jobs.

The study by Fathiyah et al (2023) identified nine 4IR generic skills (GS4IR) for entry-level civil engineers based on the opinions of experts in the civil engineering (CE) field. These skills are communication skills, problem-solving skills, leadership skills, emotional intelligence skills, creativity skills, critical thinking skills, adaptability skills, digital skills, and management skills. It is important for engineering graduates to master the skills required in the 4IR because engineering knowledge alone is no longer sustainable. However, the existing skills incorporated into the civil engineering curriculum by the Engineering Accreditation Council (EAC) in higher education institutions do not emphasize these skills. Hence, this paper systematically reviews the existing skills set embedded in engineering curriculum and compare them with the new skills required for 4IR graduates to identify the gap in both sets. The findings from this study would be beneficial for all the parties (industries, institutions and graduates) to ensure that newly graduates will survive the 4IR setting.

This paper is structured as follows: brief background and introduction about the significance of generic skills among civil engineering graduates are provided in the first section. The next section summarizes similar studies. Afterward, Section 3 shows the research methodology, for data collection of the study. Section 4 presents the information from the analysis and mapping of the outcomes, followed by a discussion of the findings. Finally, conclusions from this paper are drawn in Section 5.

Literature Review

The program of Civil Engineering Studies in Malaysia

The field of civil engineering can be categorized into nine categories, namely structural engineering, environmental engineering, geomatics engineering, geotechnical engineering, construction engineering, materials engineering, coastal engineering, transportation

engineering, and water resources engineering (Levy, 2009; Malaysian Qualification Agency, 2011; Ministry of Education, 2019). Figure 1 shows the different fields within civil engineering. Civil engineers are directly involved in the construction of all types of infrastructure, such as houses, buildings, highways, and more. In each project, civil engineers play the roles of planners, designers, and builders. They are qualified individuals who design, construct, and maintain public construction works such as buildings and infrastructure. The American Society of Civil Engineers (ASCE 2007) highlights in a report on the vision of civil engineers by 2025 that civil engineers should fulfil the roles of building experts, risk-taking managers, and catalysts for innovation.

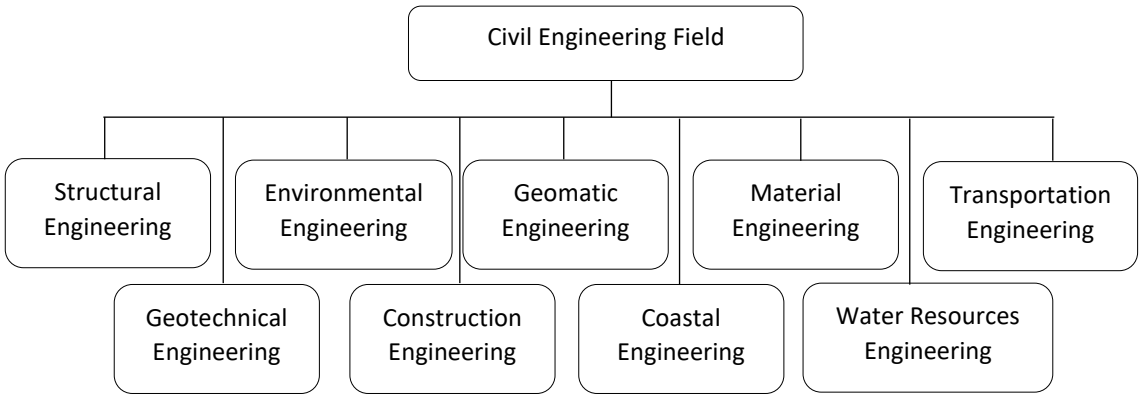

Figure 1 : The field of engineering in Malaysia
Source: American Society of Civil Engineers (2007)

Programs of engineering studies in Malaysia can be categorized into several levels, namely Certificate, Diploma, Bachelor's Degree, Master's Degree, and Doctorate. The goal of these programs is to provide graduates with a broad educational background and skills that equip them with the ability to design and produce solutions to diverse, open, and complex engineering problems (Engineering Accreditation Council, 2020; Malaysian Qualification Agency, 2011). The Standard Program Document by Malaysian Qualification Agency (MQA) provides guidelines for all certification levels of engineering and engineering technology programs, except for Bachelor's Degree in Engineering, which refers to the manual issued by EAC. The EAC manual can be referred to on the websites www.eac.org.my or www.bem.org.my. In this study, the researcher listed civil engineering bachelor's degree programs at public universities in Malaysia, as shown in Table 1.

Table 1
List of Bachelor's Degree Programs in Civil Engineering

University	Faculty	Engineering program
Universiti Malaya (UM)	Faculty of Engineering	Bachelor of Civil Engineering
Universiti Sains Malaysia (USM)	Center for Civil Engineering Studies, School of Civil Engineering	Bachelor of Engineering (Honours) in Civil Engineering
Universiti Kebangsaan Malaysia (UKM)	Department of Civil Engineering, Faculty of Engineering and Build Environment	Bachelor of Engineering with Honours (Civil Engineering)

Universiti Putra Malaysia (UPM)	Department of Civil Engineering, Faculty of Engineering	Bachelor of Civil Engineering with Honours
Universiti Teknologi Malaysia (UTM)	School of Civil Engineering, Faculty of Engineering	Bachelor of Civil Engineering with Honours
Universiti Islam Antarabangsa Malaysia (UIAM)	Department of Civil Engineering, Engineering Lecture	Bachelor of Civil Engineering with Honours
Universiti Pertahanan Nasional Malaysia (UPNM)	Department of Civil Engineering, Faculty of Engineering	Bachelor of Civil Engineering
Universiti Tun Hussein Onn Malaysia (UTHM)	Faculty of Civil Engineering and Environmental Engineering	Bachelor of Civil Engineering with Honours
Universiti Malaysia Pahang (UMP)	Department of Civil Engineering, College of Engineering	Bachelor of Engineering (Honours) in Civil Engineering
Universiti Malaysia Perlis (UniMAP)	**Center for Environemental Engineering Studies**	**Bachelor (Honours) of Civil Engineering**
Universiti Malaysia Sabah (UMS)	Faculty of Engineering	Bachelor of Engineering with Honours (Civil Engineering)
Universiti Malaysia Sarawak (UNIMAS)	Department of Civil Engineering, Faculty of Engineering	Bachelor of Civil Engineering with Honours
Universiti Teknologi MARA (UiTM) Kampus Shah Alam, Pulau Pinang, Pahang, Sarawak	Department of Civil Engineering	**Bachelor of Engineering (Honours) (Civil Engineering)**

Source: Kamaruzaman (2022)

Referring to Table 1.0, the Bachelor's Degree program in Civil Engineering to become a civil engineer in Malaysia is offered by 13 out of 20 public universities in Malaysia. These universities include Universiti Malaya, Universiti Sains Malaysia, Universiti Kebangsaan Malaysia, Universiti Putra Malaysia, Universiti Teknologi Malaysia, Universiti Islam Antarabangsa Malaysia, Universiti Pertahanan Nasional Malaysia, Universiti Teknologi MARA, Universiti Tun Hussein Onn Malaysia, Universiti Malaysia Pahang, Universiti Malaysia Perlis, Universiti Malaysia Sabah, and Universiti Malaysia Sarawak.

For every Bachelor's Degree program in Civil Engineering in Malaysia, including Civil Engineering, the program learning outcomes (PO) must adhere to the standards set in the EAC and International Engineering Alliance (IEA) manuals (2021). These standards align with the recommendations by ASCE (2007) to produce highly knowledgeable civil engineers with future-ready skills. Through these POs, the curriculum or program syllabus can incorporate generic skills emphasized in engineering programs. EAC (2020) and IEA (2021) establish twelve POs that need to be stated in each engineering program, which include:

1. PO1 - Engineering Knowledge: Apply knowledge of mathematics, science, engineering fundamentals, and specialized engineering principles to solve complex engineering problems.
2. PO2 - Problem Analysis: Identify, formulate, review literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. PO3 - Design/Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.
4. PO4 - Investigation: Conduct investigations of complex problems using research-based knowledge and research methods, including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions.
5. PO5 - Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modeling, to complex engineering activities with an understanding of the limitations.
6. PO6 - Engineers and Society: Apply informed thinking from the context of knowledge to assess societal, health, safety, legal, and cultural issues and the relevant responsibilities related to engineering professional practice and complex problem-solving.
7. PO7 - Environment and Sustainability: Understand and evaluate the sustainability and impact of professional engineering work in solving complex engineering problems in the context of society and the environment.
8. PO8 - Ethics: Apply ethical principles and commit to professional ethics, responsibilities, and engineering practice norms that contribute to National Aspirations.
9. PO9 - Communication: Communicate effectively on complex activities with the engineering community and the broader society, such as the ability to understand and write effective reports and documents, deliver effective presentations, and give and receive instructions.
10. PO10 - Individual and Teamwork: Function effectively as an individual and as a member or leader in diverse teams and in multidisciplinary settings.
11. PO11 - Lifelong Learning: Identify needs and readiness and have the ability to engage in independent lifelong learning in a broad context.
12. PO12 - Project Management and Financial Management: Demonstrate knowledge and understanding of engineering management principles and make cost-effective decisions and applications to assigned tasks, as a member or leader, to manage projects in a multidisciplinary environment.

The Industrial Revolution 4.0 (4IR) and 4IR Generic Skills (GS4IR)

The 4th Industrial Revolution (4IR) is accompanied by various benefits, but it also poses threats to the country's economic development and workers who are not adequately prepared for the changes that occur (Akor et al., 2020). Skill development is one aspect that is affected and influenced by 4IR (Pereira & Romero, 2017; Singh & Tilak, 2020; WEF, 2017). In the context of this study, skill development focuses on generic skills as they are highly valued by employers in addition to technical skills to be employable in their organizations.

From the perspective of demand for generic skills, 4IR requires specialized skills based on information technology as the driving foundation. This is different from the existing skills in previous industrial revolutions. A study by Gray (2016) found that over 35% of relevant skills for the current workforce will become obsolete. By the year 2020, 4IR has introduced advanced automation and robotics, advanced materials, artificial intelligence and machine learning, genomics, and biotechnology. All these innovations will transform lifestyles and the way humans carry out work, as some existing jobs will disappear while new jobs that don't exist now will emerge. Furthermore, there is a demand for adaptable workforce who possess generic skills to help them acquire and retain employment.

In the context of engineering, the implementation of generic skills in engineering curriculum has been established by the EAC in the EAC Manual and the IEA. EAC is a body represented by the Board of Engineers Malaysia (BEM) as the accreditation body responsible for assessing the accreditation of engineering degree programs offered in Malaysia. Therefore, higher education institutions as providers or suppliers of engineering graduates need to adhere to the curriculum requirements and generic skills outlined by EAC. Additionally, higher education institutions play a role in implementing generic skills that align with the industry's needs in accepting engineering graduates to work in their organizations. As such, EAC, higher education institutions, and the industry are key stakeholders for engineering graduates.

Skills are defined as the ability to apply knowledge and known methods to perform tasks and solve problems (CEDEFOP, 2008). Organisation for Economic Co-operation and Development (2019) defines skills as the ability and capacity to responsibly use one's knowledge to achieve a goal. The technical element measures technical skills or basic knowledge, while the generic skills element encompasses attitudes and approaches used by individuals in their work, such as teamwork, communication, and more (Salina et al., 2012). Generic skills are also defined as a set of skills equipped with attributes for an individual's generic skills for each job, where each job requires its own set of skills (National Skills Council, 2020). In another study by Fathiyah et al (2022), the concept of 4IR Generic Skills (GS4IR) focuses on generic skills that experience changing demands in the 4IR job market, where existing generic skills of graduates or job seekers need to be enhanced (upskilling), improved (reskilling), or renewed (new skills).

A literature review study conducted on 64 articles related to 4IR skills across various disciplines found that 90% of 4IR skills encompass generic skills such as communication, creativity, and problem-solving, while only 10% are technical skills (Chaka, 2020). This indicates that industries prioritize generic skills over technical skills for graduates to master across various disciplines. Additionally, Chaka (2020) emphasizes that 4IR emphasizes the importance of applying and mastering generic skills alongside technical skills. Therefore, conducting a development study on 4IR skills focused on 4IR Generic Skills is a relevant research approach to ensure that graduates are equipped with GS4IR during their university studies.

Methodology

In conducting this study, a systematic literature review (SLR) was used as its methodology. According to Boland, Cherry and Dickson (2018), a systematic review methodology is applied to track, evaluate, and synthesise the best studies on issues related to research problems by providing evidence and informative answers. Previous researchers have utilised systematic

review methodology in their studies such as Rosli and Rasul (2013) in exploring high income community education in Malaysia; and Mohamed Ashari, Rasul and Azman (2014) in identifying students' career choice in Malaysian skill certification system. Particularly, the systematic review methodology follows the guidelines proposed by Hussain, Hussien, Dahr and Naemah (2015). There are five procedures to conduct systematic literature review (SLR) as follow:

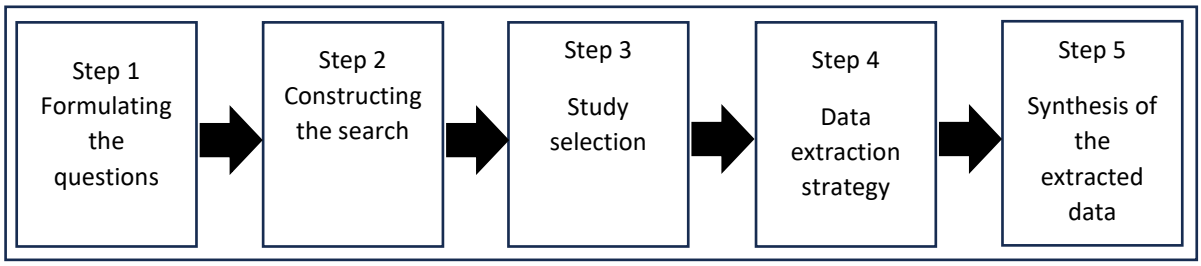

Figure 2: Procedures to conduct SLR
Source: Hussain, Hussien, Dahr and Naemah (2015)

Formulating the Questions

The aim of this study is to answer the following objectives:
1. To enhance the understanding on the skills set embedded in civil engineering curriculum.
2. To investigate the skills necessary for 4IR graduates.
3. To compare the skills of engineering graduates with the skills necessary for 4IR.

Constructing the Search

Accordingly, research papers were obtained from five journals and articles databases namely ProQuest, Science Direct, Wiley, Taylor & Francis and IEEE. These following databases were chosen as the researchers get a free access under Universiti Kebangsaan Malaysia. Related information was obtained from various government agencies' reports, journals, books and electronic references from relevant websites. Three keywords were used in the information search, which are the industrial revolution 4.0, generic skills, and civil engineering.

Study Selection

In order to get the relevant and best articles to review, the following criteria were used to search these sources and select the papers: 1. Duplicated papers were removed and relevant studies were selected by judging titles. 2. One of the keyword search terms was employed to search for the titles and abstracts of the articles. 3. The studies had results or findings.

Data Extraction Strategy

According to Hussain et al (2015); Kitchenham (2007), this step is necessary to design data extraction forms for accurately recording the information obtained from the primary studies. Information extraction involves drawing up a nitty gritty table depicting each investigation checked in detailed. In other words, this step is a filtering process where only articles that meet the specified criteria are selected. Typically, the number of these selected articles are less than the original taken from the journal database.

Synthesis of the Extracted Data

n reporting the data synthesis, this study classified the findings of data to certain sections including the distribution by year of publication, journal, type, subject area and research approaches.

Data Analysis and Findings

Through this program, the types of generic skills highlighted in the curriculum or syllabus of the bachelor's degree in engineering can be obtained. Generic skills are considered fundamental skills needed to acquire, maintain, and perform work effectively (Robinson, 2000). Table 2 shows the comparison of learning outcomes in civil engineering programs with technical skills and generic skills.

Table 2

Comparison of learning outcomes (LO) to skills

Code	Learning outcomes	Technical skills	Generic skills
PO1	Engineering knowledge	•	
PO2	Problem analysis		•
PO3	Design/ Development of solutions	•	
PO4	Investigation	•	
PO5	Use of modern tools	•	
PO6	Engineers and society	•	
PO7	Environemnt and sustainability	•	
PO8	Ethics		•
PO9	Communication		•
PO10	Individual and teamwork		•
PO11	Lifelong learning		•
PO12	Mangement and Finance		•

Source: Fathiyah Mohd Kamaruzaman (2022)

According to EAC (2020) and IEA (2021), there are six recommended generic skills for civil engineering graduates. These skills include problem analysis, ethics, communication skills, individual and teamwork skills, lifelong learning, and project and financial management skills. By applying these relevant generic skills to their learning outcomes, civil engineering graduates can be trained to master these skills during their academic journey. This will not only help them secure employment but also excel in their academic and technical abilities.

Based on Table 2.0, the comparison between the six generic skills implemented in civil engineering programs in Malaysia and the 4IR skills mentioned in the WEF (2018).

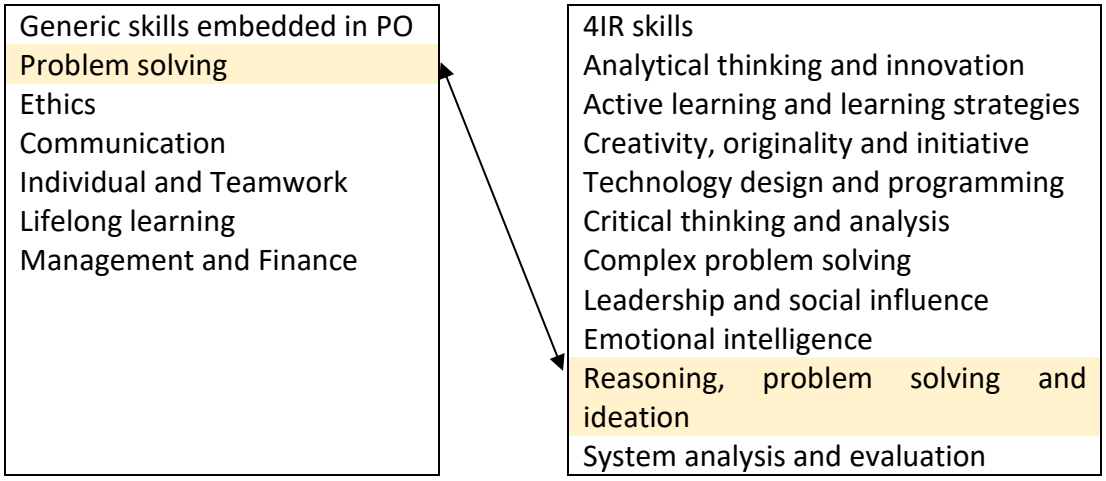

Figure 3: Comparison of generic skills embedded in PO with 4IR skills
Source: Authors

Referring to Table 2 and Figure 3, there is indeed a significant difference between the generic skills embedded in the program outcomes of civil engineering studies and the 4IR skills mentioned in the (WEF, 2018). Figure 1 illustrates the similarities and differences between these skill sets. The comparison shows that only problem-solving skills have similarities with the 4IR skills identified by (WEF, 2018). However, it is suggested that the other five generic skills, namely ethics, communication, individual and teamwork skills, lifelong learning, and project and financial management, be replaced with 4IR skills such as creativity, originality and initiative; critical thinking and analysis; complex problem solving; emotional intelligence; as well as leadership and social influence. These findings serve as a guide for the integration of new skills in alignment with the industry's demand for future-proof graduates, as suggested by (Ministry of Higher Education, 2018).

Based on the analysis above, the seven identified generic skills, namely creativity, originality and initiative; critical thinking and analysis; complex problem solving; emotional intelligence; leadership and social influence; serve as a guide for EAC to incorporate these skills into the existing EAC manual.

In this context, there is indeed a growing need to reskill and upskill in order to keep up with the technological changes brought about by the Fourth Industrial Revolution. Higher education institutions play a crucial role in integrating and enhancing the development of generic skills among graduates. The insights from this study can be utilized to improve the existing curriculum of civil engineering studies by incorporating 4IR-aligned generic skills that meet industry demands. To ensure that civil engineering graduates are equipped with 4IR generic skills throughout their studies, the provision of a portfolio as evidence can assist graduates in assessing their own abilities and achievements in these skills.

Conclusion

The advancement of technology in the Fourth Industrial Revolution has indeed changed the demand for jobs and the required skills, including the need for new or 4IR generic skills. To ensure that graduates are employable upon completing their studies, it is crucial for them to equip themselves with generic skills that align with employers' expectations. Furthermore, 4IR generic skills are seen as tools to help graduates and job seekers secure and maintain

employment. Previous researchers have identified and proposed various types or sets of 4IR generic skills, which serve as a guide for higher education institutions, employers, and relevant stakeholders involved in the development of graduates' skills, not only in the field of engineering but also in other fields. Therefore, the identification of the skills gaps between the existing generic skills in the civil engineering curriculum and the 4IR skills obtained from this study can serve as a guide for graduates or entry-level engineers to work in the field of civil engineering within the context of the 4IR job environment. It is suggested that all stakeholders, especially the Engineering Accreditation Council, revise and incorporate these generic skills such as creativity, originality and initiative; critical thinking and analysis; complex problem solving; emotional intelligence; as well as leadership and social influence, as they are relevant to the 4IR.

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References

Akor, T. S., Tyav, D. A., Iorbee, M. M., & Nande, K. B. (2020). Developing fourth industrial revolution ready electronics engineers in a problem-oriented project-based learning environment: a theoretical framework. *International Journal of Scientific & Engineering Research*, *11*(3), 1209-1217.

Akyazi, T., Alvarez, I., Alberdi, E., Oyarbide-Zubillaga, A., Goti, A., & Bayon, F. (2020). Skills needs of the civil engineering sector in the European Union countries: Current situation and future trends. *Applied Science*, *10*(20), 1-24.

American Society of Civil Engineers. (2007). *The Vision for Civil Engineering in 2025*. Reston, Virginia: American Society of Civil Engineers (ASCE).

Boland, A., Cherry, M. G., & Dickson, R. (2018). *Doing a systematic review: A student's guide*. London: Sage Publications Ltd.

Chaka, C. (2020). Skills, competencies and literacies attributed to 4IR/industry 4.0: Scoping review. *International Federation of Library Associations and Institutions, 46*(4), 369-399.

Clarke, B. G. (2007). Introducing students to professional practice in civil engineering. *Journal of Professional Issues in Engineering Education and Practice, 133*(2), 107–115.

Engineering Accreditation Council. (2020). *Engineering Programme Accreditation Standard 2020*. Malaysia: Boards of Engineers Malaysia.

Kamaruzaman, F. M. (2022). *Kerangka Kemahiran Generik Revolusi Perindustrian 4.0 bagi Graduan Kejuruteraan Awam* [Framework of 4th Industrial Revolution Generic Skills for Civil Engineering Graduates] (Unpublished doctoral dissertation). Universiti Kebangsaan Malaysia.

Grugulis, I., & Vincent, S. (2009). Whose skill is it anyway? soft skills and polarization. *Work, Employment and Society, 23*(4), 597-615.

Hussain, A. B., Hussein, R. M., Dahr, J. M., & Neamah, M. A. (2015). Existing trends in usability evaluation method (Uem) for the M-learning apps: A systematic review. *ARPN Journal of Engineering and Applied Sciences, 10*.

International Engineering Alliance (IEA). (2021). Graduates attributes and professional competencies. Version 3. Retrieved from http://www.ieagreements.org.

Levy, S. (2009). *Construction Process Planning and Management: An Owner's Guide to Successful Projects*. 1st Ed. USA: Elsevier Inc.

Malaysian Qualification Agency. (2011). *Standard Program: Kejuruteraan dan Teknologi Kejuruteraan* [*Program Standard: Engineering and Engineering Technology*]. Malaysia: Malaysian Qualification Agency.

Ministry of Human Resource. (2020). *Senarai Pekerjaan Kritikal Malaysia* [*List of Critical Occupation Malaysia*]. Malaysia: Ministry of Human Resource.

Ministry of Education. (2019). *Pengajian Kejuruteraan Awam Tingkatan 4* [*Civil Engineering Studies Form 4*]. Malaysia: Ministry of Education.

Ministry of Higher Education. (2018). F*raming Malaysian Higher Education 4.0: Future-Proof Talents*. Malaysia: Ministry of Higher Education.

Ashari, M. Z. H., Rasul, M. S., & Azman, N. (2014). Hubungan individu, persekitaran dan kebolehsesuaian terhadap pemilihan kerjaya pelajar Sistem Persijilan Kemahiran Malaysia (SKPM): Suatu analisis kandungan [Relationship between individual, environment and adaptability to the career choice of Malaysian Skills Certification System students: A content analysis]. *Sains Humanika, 2*(1), 135-44. https://doi.org/10.11113/sh.v10n3-2.1492

National Skills Council. (2020). *Building Future Skills: The Demand for Skills in Ireland's Built Environment Sector to 2030*. Dublin: National Skills Council.

Organisation for Economic Co-operation and Development (OECD). (2019). *OECD Future of Education and Skills 2030: Conceptual learning framework*. Paris: OECD.

Periera, A. C., & Romero, F. (2017). A review of the meanings and the implications of the Industry 4.0 concept. *Procedia Manufacturing, 13*(2017), 1206-1214.

Robinson, J. P. (2000). What are employability skills? *The Workplace, 5*(3), 1-3.

Rosli, A., & Rasul, M. S. (2013). *Exploring the high income community education programme in Malaysia*. Paper presented at the 6th International Conference on Educational Reform (ICER 2013).

Singh, D., & Tilak, G. (2020). Implementation of education model 4.0: developing industry 4.0 skills in graduates engineers for improving employability skills. *Humanities & Social Sciences Reviews, 8*(2), 601-613.

Suprun, E., Perisic, N., Stewart, R., & Mostafa, S. (2019). Preparing the next generation of civil engineering graduates: identifying and combating the digital skills gap. *Proceedings of 30th Annual Conference for the Australasian Association for Engineering Education (ASEE 2019),*700-708.

Kitchenham, B. (2007). *Guidelines for performing systematic literature reviews in software engineering*. EBSE Technical Report.

World Economic Forum. (2016). *The Future of Jobs: Employment, Skills and Workforce Strategy for the Fourth Industrial Revolution*. Geneva: World Economic Forum.

World Economic Forum. (2017). *Realizing Human Potential in the Fourth Industrial Revolution: An Agenda for Leaders to Shape the Future of Education, Gender and Work*. Geneva: World Economic Forum.

World Economic Forum. (2018). *The Future of Jobs 2018: Centre for the New Economy and Society*. Geneva: World Economic Forum.