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A Comprehensive Approach to Establishing Programme Educational Objectives (PEOs) for Engineering Technician Programme Accreditation

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Within the field of engineering education, the identification and evaluation of Programme Educational Objectives (PEOs) are crucial components of the accreditation procedure. This procedure is required by the Board of Engineers Malaysia (BEM) to ensure compliance with international standards. The present work presents a detailed methodology for developing and assessing PEOs in the Diploma in Civil Engineering (EC110) programme at Universiti Teknologi MARA, Pulau Pinang Branch, Permatang Pauh Campus, Pulau Pinang. The goal was to develop a comprehensive and inclusive approach that encompasses the stages of planning, implementation, evaluation, and improvement of PEOs, with a strong emphasis on including stakeholders extensively. The research examines the alignment of PEOs with industry demands and accreditation requirements using various methodological techniques such as stakeholder workshops, analytical surveys, and performance metrics analysis. The key findings reveal that the cleverly developed PEOs not only align with the accrediting standards but also reflect the institution's strategic goals, supported by positive input from many stakeholders. This data demonstrates the effectiveness of a comprehensive approach to PEO development, highlighting the importance of stakeholder involvement and continual quality improvement (CQI) processes in strengthening the quality of engineering technician education. The paper presents a replicable model for establishing PEOs that emphasises stakeholder involvement and continuous programme improvement. This model significantly contributes to the discussion on accrediting engineering education.

Keywords: ETAC; Accreditation; PEOs; POs; CQI

I. INTRODUCTION

The creation of Programme Educational Objectives (PEOs) is crucial in engineering education to ensure that programmes meet national and international accreditation criteria in the changing landscape of the field. This study centres on the Diploma in Civil Engineering (EC110) programme at Universiti Teknologi MARA, Pulau Pinang Branch, Permatang Pauh Campus, Pulau Pinang chosen as a case study due to its thorough adherence to the demanding accreditation standards established by the Board of Engineers Malaysia (BEM). Although focused on a specific programme, the methods and knowledge gained can be applied to a wider range of practices in the development and evaluation of PEOs in several engineering fields. This study explores the widespread relevance of our stakeholder-driven approach, with the goal of making a substantial contribution to the body of knowledge in engineering education accreditation.

The PEOs are an essential component of any engineering programme, as they outline the expected accomplishments of graduates three years after graduation (Abbadeni, Ghoneim

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& Alghamdi, 2013; Ab-Rahman *et al.*, 2022; Basri *et al.*, 2011; Desai *et al.*, 2017; Rahimullah *et al.*, 2020; Rajak, Shrivastava & Tripathi, 2019). These objectives provide clear guidance for the academic curriculum to achieve the programme's desired outcomes (Abbadeni, Ghoneim & Alghamdi, 2013; Ab-Rahman *et al.*, 2022; Al-Yahya & Abdel-Halim, 2013; Anwar & Richards, 2018; Basri *et al.*, 2011; Desai *et al.*, 2017; ETAC, 2020; Ghaly, 2020; Kanmani, 2014; Khan, Mourad & Zahid, 2016; Mourtos, 2006b; Rahimullah *et al.*, 2020; Rajak, Shrivastava & Tripathi, 2019; Sundaram, 2013; 2015; Weisbrook & Schonberg, 2011). Under the Registration Engineers Act 1967, the Board of Engineers Malaysia (BEM) is responsible for the registration of inspectors of works, engineering technologists, graduate engineers, and professional engineers in Malaysia (Revised, 2015). The BEM has delegated the authority to accredit engineering technology degrees and engineering technician qualifications to the Engineering Technology Accreditation Council (ETAC) to ensure that the engineering programmes offered by Malaysian institutions of higher learning (IHLs) meet global standards.

The significance of ETAC's role in accrediting engineering technician education programmes in Malaysia cannot be overstated, as it serves as the authority responsible for ensuring that these programmes meet the minimum standards and comparable to global practises. ETAC Standard 2020 (ETAC, 2020) provides a comprehensive framework for IHLs to ensure compliance with accreditation requirements for both existing and new engineering technician education programmes through the inclusion of representatives from various stakeholders, such as relevant ministries, government agencies, industry employers, and the general public community. Incorporating outcomes into the curriculum is crucial to fostering a culture of Continuous Quality Improvement (CQI) and Outcome-Based Education (OBE), which are becoming increasingly important in today's rapidly evolving technological landscape. Therefore, it is essential for IHLs to adhere to the ETAC standards and continuously strive to enhance their engineering technician programmes.

The ETAC Standard 2020 provides guidelines for the accreditation of engineering technician education programmes in Malaysia and specifies the minimum requirements that IHLs offering these programmes must meet (ETAC, 2020). The ETAC Standard 2020 also includes elements of OBE to foster a culture of CQI in engineering technician education programmes. Every six years, accreditation visits are performed to ensure that IHLs are implementing CQI practices and to assess the success of the programme's PEOs. If engineering programme graduates do not meet the minimum requirements outlined in the Programme Outcomes (POs) and PEOs, then the curriculum must be revised and enhanced (Abbadeni, Ghoneim & Alghamdi, 2013).

Within the field of engineering education, it is crucial to clearly define and evaluate POs and PEOs in order to guarantee that graduates have the necessary abilities and expertise that are expected by the profession and the industry as a whole. These factors are not just academic benchmarks, but they are closely connected to the certification requirements that determine the quality and usefulness of engineering programmes. The ETAC Standards 2020 require that these objectives be both established and achieved by all graduates within a certain timeframe following the completion of their studies.

If graduates of an engineering programme fail to achieve the desired goals and objectives, it indicates a possible discrepancy between the educational content provided and the requirements of the professional area. Such a difference in information requires a thorough examination of the programme's educational content. The purpose of this review is to identify and rectify any deficiencies that may exist in the implementation of essential skills and areas of expertise. The review process is an essential element of the CQI method, which is fundamental to OBE. It guarantees that the curriculum stays dynamically synchronised with developing industry standards, technological progress, and the evolving landscape of engineering practices.

The improvement of the curriculum may encompass various aspects, such as the incorporation of innovative teaching approaches, the revision of course content, the enhancement of industry involvement, and the integration of state-of-the-art technology resources. These revisions are crucial for ensuring that the programme not only complies with the existing educational and professional standards but also prepares for future difficulties in the field.

Malaysia signed both the Sydney Accord (SA) and the Dublin Accord (DA) for engineering technician programmes in 2018. In comparison to undergraduate engineering programmes, there is a lack of research on the process of developing and monitoring the CQI of PEOs using stakeholder survey outputs to meet engineering technician programme accreditation criteria (Abbadeni *et al.*, n.d.; Besterfield-Sacre *et al.*, 2000). This study intends to fill this void by describing how PEOs were established for a Diploma in Civil Engineering (EC110) Programme accredited in 2018 for the Civil Engineering Studies, College of Engineering, Universiti Teknologi MARA.

The commencement of engineering education, specifically in relation to PEOs, typically commences with established explanations and their functions in fulfilling accreditation criteria. Nevertheless, a thorough analysis uncovers a more intricate relationship between educational goals and the requirements of the sector. This study provides a thorough assessment of the extent to which present engineering education is in line with the quickly changing technological environment, where traditional teaching methods may no longer be adequate. This part lays the foundation for reconsidering existing PEO frameworks in order to better equip graduates for future problems by incorporating knowledge from modern industry trends, educational psychology, and pedagogical innovation.

II. RESEARCH METHODOLOGY

A. Establishment PEO's Statement

The development of PEOs is crucial in ensuring that engineering programmes comply with accreditation standards and institutional purposes (Abd Rahman, Ab-Rahman & Yusoff, 2016; Tshai *et al.*, 2014; Yahya *et al.*, 2021). The literature emphasises the significance of these objectives, which represent the goals of the institution as well as the expectations of external stakeholders like as industry and alumni (Ab-Rahman *et al.*, 2022; Fagrell, Fahlgren & Gunnarsson, 2020; Falqueto *et al.*, 2020). The aims should connect the theoretical foundations of engineering education with the practical requirements of the changing workforce, guaranteeing that graduates are adequately equipped to fulfil industry demands.

The creation of PEOs is essential for ensuring that engineering education meets accreditation standards and contributes to the long-term job success of graduates. PEOs are overarching statements that delineate the expected accomplishments of graduates within a timeframe of three to five years post-graduation. The timeline illustrates the programme's objective of developing essential professional and technical skills in order to enhance graduates' prospects for success in their chosen professions. The objectives must be explicitly connected to the educational outcomes of the programme, guaranteeing that they are quantifiable and closely aligned with the industry's requirements and the institution's mission.

Establishing PEOs is a crucial step in engineering technology education's pursuit of CQI. Typically, the establishment of PEOs involves four stages: planning, implementation, evaluation, and verification. Figure 1 depicts these phases. In the planning phase, the IHL clarifies the programme's objectives and anticipated outcomes. This includes identifying programme stakeholders, determining programme objectives, and defining the programme's scope. The development of a curriculum and instructional design that aligns with the established PEOs constitutes the implementation phase. This stage entails the development of course content, the selection of instructional materials, and the design of assessments to measure student achievement of the PEOs. During the evaluation phase, the IHL collects and analyses data to determine the programme's effectiveness in achieving the predetermined objectives. This includes conducting surveys, analysing data on student performance, and evaluating programme outcomes (POs). In the final phase, checking, the IHL implements programme modifications based on evaluation results. This phase entails revising course material, modifying assessments, and implementing new instructional strategies to enhance student learning outcomes. By establishing the PEOs, IHLs can guarantee that their engineering technology education programmes meet the minimum ETAC accreditation requirements. Moreover, the implementation of a CQI culture in the spirit of OBE will facilitate the long-term improvement of these programmes.

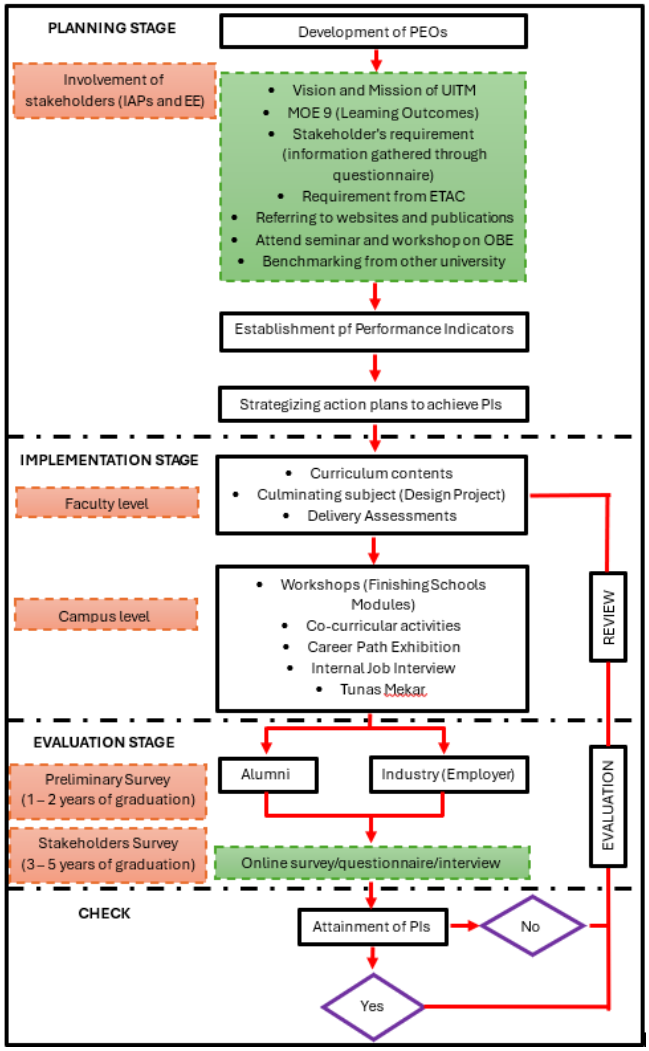

Figure 1. PEOs' Establishment Framework

Traditionally, PEOs are founded using a methodical manner with the goal of aligning educational outputs with professional requirements that arise three to five years after graduation. Nevertheless, a thorough evaluation indicates that the swift rate of technical and industry advancements necessitates a more adaptable and forward-thinking strategy. This section provides a critical analysis of the conventional approaches employed in defining PEOs. It suggests an iterative framework that integrates real-time input from the industry and adaptive learning results to consistently enhance and revise PEOs. This method guarantees that educational objectives stay pertinent and are forward-thinking in relation to future professional fields.

B. Planning Stage

In order to plan PEOs effectively, it is necessary to engage stakeholders in a comprehensive manner to acquire diverse views. These insights then inform the relevance and feasibility of the objectives. Yahya *et al.* (2021) states that incorporating the strategic vision of the institution at this stage guarantees that PEOs align with long-term educational and operational objectives. In addition, (Mourtos, 2006a) supports the use of a systematic approach in this phase to ensure that PEOs are in line with established industry standards. This will help meet accreditation requirements and improve educational results (Hairi, Affandi & Nasri, 2019; Tshai *et al.*, 2014).

In the planning phase of establishing the PEOs, it is essential to consider the institution's overall philosophy, vision, and mission, as well as the Ministry of Higher Education's (MOHE) Programme Learning Outcomes requirements (PLOs). As shown in Table 1, four PEOs were designed and developed for the Diploma in Civil Engineering (EC110) programme in accordance with the stakeholder requirements, programme objectives, and ETAC Standard 2020 guidelines. The PEOs encompass all the essential skills and knowledge an engineering technician is expected to acquire within three to five years of graduation. The International Engineering Alliance (IEA) Student Attributes was used as the primary basis to ensure compliance with the Dublin Accord (DA) student criteria. To ensure a comprehensive and inclusive development process, workshops were held to collect feedback from a variety of stakeholder groups, including the university itself, other local universities, professional engineers, and alumni. The received feedback was taken into account during the development of the PEOs, POs, updated curriculum, and syllabus.

These PEOs have been created after comprehensive discussions with a wide range of individuals and groups involved in the field, guaranteeing that they accurately represent the industry and community's real requirements and expectations. The usefulness of training students for successful occupations quickly after graduation is supported by empirical evidence, such as high employment rates and significant professional advancements of graduates. Furthermore, upholding these PEOs ensures the stability of the curriculum and enables a reliable evaluation of educational achievements over time. This is crucial for ongoing enhancement and preserving compliance with

accreditation requirements. The current PEOs are confirmed to be strategically significant and well accomplished, justifying their retention within the present educational framework.

In addition, recommendations from the Industrial Advisory Panel (IAP) and External Examiner (EE) of the Civil Engineering Studies, College of Engineering, Universiti Teknologi MARA were sought before the PEOs and POs were established. The IAP and EE are essential to the development of PEOs during the planning phase, and they were chosen after rigorous screening. The IAP requires a candidate with a minimum of five years of extensive construction site experience, who is a Professional Engineer (P.Eng), and the designation is supported by the administrative committee of the university. Likewise, the EE must have an academic background with more than ten years of teaching experience and a minimum title of Associate Professor from one of Malaysia's renowned IHLs.

It is essential that the PEOs align with the institution's vision and mission in order to ensure a coherent and well-structured programme. Table 2 and 3 presents the institution's vision and mission, and Table 4 provides a direct mapping of the institution's mission and vision to the PEOs, illustrating how the programme's direction is intended to align with the institution's vision via PEOs.

During the planning phase of PEO development, it is customary to engage in stakeholder consultation in order to establish the objectives. However, this approach frequently falls short in capturing the subtle and specific requirements of various industry sectors. This study advocates for a data-driven approach in analysing this stage, wherein stakeholder expectations are measured using sophisticated analytics to forecast future skill demands. Moreover, incorporating a broader range of individuals with a vested interest, such as recent graduates and emerging tech companies, could offer novel perspectives that question conventional curricular structures.

Table 1. Programme Educational Objectives (PEOs) (Revised, 2018)

PEO	Description
PEO 1	Civil engineering technician who is competent in applying knowledge and practical skills in civil engineering and pursuing further knowledge for higher qualification.
PEO 2	Civil engineering technician who can apply various scientific skills in solving variety civil engineering problems.
PEO 3	Civil engineering technician who can demonstrate good teamwork, social skills and responsibilities with positive values, ethics, moral and professionalism.
PEO 4	Civil engineering technician who can lead and demonstrate effective information management, lifelong learning, and entrepreneurial skills

Table 2. UiTM's Mission (Universiti Teknologi MARA (UiTM), n.d.)

UiTM's Mission	Description
No. 1	To enhance the knowledge and expertise of Bumiputeras in all fields of study through professional programmes.
No. 2	To enhance the knowledge and expertise of Bumiputeras in all fields of study through research work.
No. 3	To enhance the knowledge and expertise of Bumiputeras in all fields of study through community service based on moral values and professional ethics.

Table 3. UiTM's Vision (Universiti Teknologi MARA (UiTM), n.d.)

UiTM's Vision	Description
No.1	To establish UiTM as a premier university of outstanding scholarship and academic excellence.
No. 2	To provide leadership to Bumiputeras' dynamic involvement
No. 3	To produce globally competitive graduates of sound ethical standing.

Table 4. UiTM's Vision Mapping to the PEOs EC110 (2020)

UiTM's Vision	PEO1	PEO2	PEO3	PEO4
No. 1	√		√	√
No. 2	√	√		
No. 3		√	√	
No. 4	√		√	√
No. 5				√
No. 6		√	√	

C. Implementation Stage

Incorporating PEOs into the curriculum necessitates a deliberate operational approach, wherein the objectives are integrated into the design of courses and methods of evaluation (Gouëdard *et al.*, 2020; Pak *et al.*, 2020). Research on outcome-based education indicates that it is essential to ensure that teaching methods and student assessments are in line with clearly established PEOs (Zhao, Zhao & Li, 2023). This alignment guarantees that the programme follows

accrediting criteria and promptly adapts to technology trends, thereby ensuring its relevance and effectiveness in a continually changing educational environment (Mohd Said *et al.*, 2013).

Critical to the establishment of PEOs, the implementation phase involves the execution of planned activities at both the Civil Engineering Studies, College of Engineering and campus levels. At the level of Civil Engineering Studies, College of Engineering, the emphasis is on the effective implementation of the curriculum, including the design of capstone courses, teaching methods, and assessment strategies that are aligned with the designated PEOs. Table 5 presents the list of POs for the diploma programme. To ensure achievement of the desired PEOs, the programme curriculum for all courses is designed with specific POs assigned to each course, which are then directly mapped to each PEO, as shown in Table 6. This method ensures that each PEO is implicitly measured by the POs assigned to each course. To ensure effective instruction, specific teaching methods or approaches are assigned based on the taxonomy domain for each PO assigned to each course, as shown in Table 6.

At the campus level, the emphasis shifts to co-curricular activities designed to aid the attainment of the PEOs. Finishing school workshops, co-curricular activities, career path exhibitions, internal job interviews, and Tunas Mekar are all implemented on campus to provide a comprehensive learning environment that assists students in achieving the desired outcomes. Tunas Mekar is a one-of-a-kind entrepreneurship training program for Bumiputera graduates of public and private universities. Its goal is to produce entrepreneurs among graduates of IHL, particularly Universiti Teknologi MARA. These activities provide students with opportunities to develop their skills and knowledge outside of the traditional classroom, thereby contributing to the development of graduates with a well-rounded education. Although organised techniques are commonly used to incorporate PEOs into curricula, the real-time scrutiny of the success of these implementations is typically lacking. This section provides a thorough evaluation of the implementation phase, examining the effectiveness of current teaching methods that support the integration of PEO into curricula. The article presents case studies that demonstrate the effectiveness of innovative teaching approaches, such as project-based learning and digital tool integration, in reaching desired educational outcomes. These findings imply the need to reassess current teaching practices.

Table 5. List of Programme Outcomes (PO's)

Program Outcome's (PO's)	**Description**
PO1	Apply knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization to wide practical procedures and practices.
PO2	Identify and analyse well-defined engineering problems reaching substantiated conclusions using codified methods of analysis specific to their field of activity.
PO3	Design solutions for well-defined technical problems and assist with the design of systems, components or processes to meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.
PO4	Conduct investigations of well-defined problems; locate and search relevant codes and catalogues, conduct standard tests and measurements.
PO5	Apply appropriate techniques, resources, and modern engineering and IT tools to well-defined engineering problems, with an awareness of the limitations.
PO6	Demonstrate knowledge of the societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to engineering technician practice and solutions to well-defined engineering problems.
PO7	Understand and evaluate the sustainability and impact of engineering technician work in the solution of well-defined engineering problems in societal and environmental contexts.
PO8	Understand and commit to professional ethics, responsibilities and norms of technician practice.
PO9	Function effectively as an individual and as a member of diverse technical teams.
PO10	Communicate effectively on well-defined engineering activities with the engineering community and with society at large by being able to comprehend the work of others, document their own work, and give and receive clear instructions
PO11	Demonstrate knowledge and understanding of engineering management principles and apply these to one's own work as a member or leader in a technical team and manage projects in multidisciplinary environments
PO12	Recognise the need for and have the ability to engage in independent updating in the context of specialised technical knowledge.

Table 6. PEO Mapped with POs and Courses

PEO	PO EC110	Course Code	Bloom's Domain	Types Of Assessment
PEO 1	PO1	ECM157, ECS226, ECG253, ECG243, ECW231, ECG345, ECW241, ECM346, ECS248,	Cognitive	Test and Final Examination
	PO4	ECM256, ECG253, ECM346, ECS268, ECG263, ECS338, ECG344, ECW341, ECS358 and ECM377	Psychomotor	Practical and Industrial Training Report
	PO5	ECM157, ECM256, ECG345, ECS246, ECM367, ECM366, ECS358 and ECM377	Psychomotor	Practical and Industrial Training Report
PEO 2	PO2	ECS226, ECG243, ECW231, ECW241, ECS248, ECS246, ECS338 and ECM366	Cognitive	Test and Final Examination
	PO3	ECG353, ECS338, ECW331, ECS358 and ECM377	Cognitive	Test and Final Examination
	PO10	ECM256, ECG345, ECG344, ECS358 and ECM377	Affective	Assignment, Oral Presentation and Project Report.
PEO 3	PO7	ECG253 and ECW331	Affective	Assignment, Oral Presentation and Project Report.
	PO8	ECS358 and ECM377	Affective	Assignment, Oral Presentation and Project Report.
	PO9	ECM157, ECM346 and ECG263	Affective	Assignment, Oral Presentation and Project Report.
PEO 4	PO6	ECS268 and ECW341	Affective	Assignment, Oral Presentation and Project Report.
	PO11	ECS246 and ECM367	Affective	Assignment, Oral Presentation and Project Report.
	PO12	ECM366 and ECM377	Affective	Assignment, Oral Presentation and Project Report.

D. Evaluation Stage

Assessment techniques are crucial for evaluating the effectiveness of implemented PEOs. Rajak *et al.*, (2019) explain that the utilisation of both direct and indirect evaluation instruments is crucial in order to validate the achievement of educational objectives. In addition, Lipnevich & Panadero (2021) emphasise the need for ongoing feedback methods, such as surveys conducted with graduates and employers, which play a crucial role in the continuing improvement of quality. These systems collect vital data that can be utilised to improve PEOs, guaranteeing that the programme consistently matches industry requirements and educational best practices (Hairi, Affandi & Nasri, 2019).

During the evaluation phase of this study, we utilised a comprehensive strategy to evaluate the attainment of the PEOs. The main approach was PIs that were carefully constructed to assess the degree to which educational goals have been achieved by graduates three to five years after completing their studies. The assessment of these variables was conducted statistically using surveys sent to alumni and industry professionals. These surveys gathered data on multiple elements of graduate performance in the workforce.

PIs play multiple essential roles in the field of academic assessment. They primarily enable the comparison of the program's results with specified standards set by accreditation authorities. Ensuring alignment is crucial for meeting external standards of quality assurance and effectiveness. Moreover, these indicators serve as a responsive feedback mechanism for the educational institution. By analysing these indicators, the institution may discover the programme's strengths and limitations, which in turn informs the necessary adjustments and enhancements.

Furthermore, PIs play a crucial role in strategic decision-making processes. They offer a data-centric basis for making decisions about curriculum development, teaching methods, and resource distribution. The strategic use of performance data guarantees that the training offers stay up-to-date and closely connected to industry demands and the changing

professional environment. Moreover, PIs not only promote openness and accountability but also bolster the trust and confidence of all stakeholders, such as students, employers, and accrediting organisations.

Each PIs was associated with distinct outcomes that were anticipated from the graduates. These outcomes included the employment rate in related fields (PI 1), the capability to solve engineering problems (PI 2), the demonstration of professional and ethical behaviour (PI 3), the pursuit of lifelong learning (PI 4), and the engagement in entrepreneurial activities (PI 5). The questionnaires were created to collect both explicit and implicit feedback from participants, offering a thorough understanding of the graduates' skills and their compatibility with the PEOs.

Statistical approaches were utilised to analyse the responses in order to guarantee the reliability and validity of the survey results. The research involved computing the proportion of participants who achieved each PIs, in addition to using confidence intervals to evaluate the accuracy of these estimations. In addition, the survey results were enriched by incorporating qualitative feedback from industry stakeholders, which provided contextual insights and enhanced the evaluation's depth.

This rigorous technique not only emphasises the comprehensive nature of the performance evaluation but also demonstrates the ongoing process of enhancing quality that is essential to meeting the programme's certification standards. Through a comprehensive analysis of these indicators, the study not only verifies the success of the PEOs but also indicates areas where improvements may be made. This ensures that the programme continues to adapt to the changing needs of the business and the professional environment.

In the evaluation phase of the PEOs, preliminary and stakeholder surveys are utilised as inputs for continuous improvement. The preliminary survey is administered one and two years after students' graduation, during the convocation ceremony, in order to collect feedback on students' employability upon graduation. The stakeholder survey, on the other hand, is divided into two parts: one for students who graduated three to five years ago, and the other for employers (industry) who have hired graduates of the programme within the same timeframe. According to the ETAC Standard, PEO must be measured for students who graduated between three and five years ago. The responses to these surveys are essential for the institution of higher education to reevaluate all PEO PIs that measure the PEO of the programme. This ensures that the programme remains sustainable and that the PEOs remain aligned with industry demands so that graduates are equipped with the necessary skills for the field. All the PEO PIs for this current programme is presented in Table 7.

Table 7 in this study presents a detailed Action Plan for each PEOs based on the outcomes evaluated using specific PIs. The purpose of these programmes is to improve the educational and professional results of those who have completed the Diploma in Civil Engineering (EC110) programme at Universiti Teknologi MARA, Pulau Pinang Branch.

The action plan for PEO1, which seeks to achieve a minimum of 50% employment of graduates in civil engineering-related industries, includes a curriculum requirement of 80% concentrated on civil engineering courses. This is enhanced by the use of OBE across teaching and learning procedures, utilising assessments specifically designed to accurately evaluate each POs. Furthermore, there is a notable focus on problem-solving and engineering activities aimed at improving practical abilities.

The objective of PEO2 is to ensure that a minimum of 50% of graduates secure positions as assistant engineers or supervisors, where they are required to effectively solve technical problems and demonstrate proficient communication skills. The action plan proposes implementing course designs that integrate individual and group assignments, encourage active student participation in both internal and external activities, and provide a well-organised 17-week industrial training programme in the third year of study. This is reinforced by hands-on laboratory sessions and collaborative assignments centred around civil engineering projects.

PEO3 aims to cultivate ethical ideals and promote effective teamwork, with a goal of having a minimum of 60% of graduates embodying these qualities. Planned actions consist of boosting engagement in community service, incorporating a 17-week industrial training programme, facilitating hands-on laboratory sessions, and fostering comprehension of ethical principles, including debates on plagiarism.

PEO4 is designed to promote continuous learning and entrepreneurial abilities. The objective is for a minimum of 50% of graduates to pursue higher education at the degree level, and for at least 5% to be involved in business activities linked to civil engineering. In order to substantiate this, the proposed strategy involves integrating the significance of continuous education through self-directed investigation in flexible laboratory sessions, as well as providing specialised entrepreneurship classes specifically designed for civil engineering.

These action plans attempt to fix the gaps discovered through PIs evaluation and match the educational programme with industry needs and the professional landscape. By implementing these specific measures, the programme improves its ability to meet both accreditation standards and market needs, guaranteeing that graduates are adequately equipped for prosperous employment in civil engineering.

Typically, the assessment of PEOs involves evaluating the achievements of graduates by conducting surveys and analysing job placement rates. This section presents a sceptical perspective on these assessment instruments, suggesting that they may have a narrow focus and may not accurately reflect the skills and abilities of graduates in a challenging labour market. The proposal supports the utilisation of longitudinal research and the incorporation of machine learning models to examine the lasting effects of educational goals on career paths, thereby offering a more thorough evaluation of the success of PEOs.

Table 7. PEOs and PIs

Programme Educational Objectives (PEOs)	Performance Indicator (PI)	Action Plan
PEO1: Civil engineering technician who is competent in applying knowledge and practical skills in civil engineering and pursuing further knowledge for higher qualification.	PI 1: At least 50% of graduates are able to work in civil engineering-related industry.	• The curriculum requirement of civil engineering covers 80% of total credit hours. • Implementation of OBE in teaching and learning • Assessments are designed for each course based on OBE approach in measuring each POs • Well-defined problem-solving and well-defined engineering activities.
PEO2: Civil engineering technician who can apply various scientific skills in solving various civil engineering problems.	PI 2: At least 50% of graduates can work in civil engineering-related industries such as assistant engineers, supervisors, etc., which are able to solve engineering problems and communicate effectively.	• Design the courses with the appropriate individual and group task. • Encourage students to be involved with the activities inside and outside the university. • Initiate industrial training framework for 17 weeks in the third year. • Laboratory practical session is conducted through laboratory courses. • Group assignment through civil engineering design project.
PEO3: Civil engineering technician who is able to demonstrate good teamwork, social skills and responsibilities with positive values, ethics, morals and professionalism.	PI 3: At least 60% of graduates are able to grasp the positive values of civil engineering technicians and have good teamwork.	• Encourage students to be involved with community service activities. • Initiate industrial training framework for 17 weeks in the third year. • Laboratory practical session is conducted through laboratory courses. • Awareness of positive values such as explanations of plagiarism.
PEO4: Civil engineering technician who able to lead and demonstrate effective information management, lifelong learning and entrepreneurial skills	PI 4: At least 50% from the graduates are pursuing to degree level PI 5: At least 5% of the graduates involved in business related to civil engineering fields.	• The need for lifelong learning is embedded through open-ended laboratory sessions, where students are required to carry out independent research. • Through courses such as fundamentals of entrepreneurship, students will be exposed to and equip themselves to become civil engineering entrepreneurs.

III. RESULTS AND DISCUSSION

In the optimal configuration of stakeholder feedback mechanisms for PEOs, a diverse range of perspectives is essential to gain a comprehensive understanding of the educational outcomes and their alignment with industry standards. Ideally, this would include insights from students, educators, parents, and representatives from governmental bodies, all of whom provide critical context and depth to the

evaluation process. However, the scope of the current study was primarily constrained to feedback from alumni and employers, a decision dictated by several pragmatic factors.

Firstly, the accessibility of data from alumni and employers is generally superior due to well-established communication channels through alumni networks and corporate partnerships. These stakeholders are integral to systematic follow-up studies and provide a reliable stream of feedback essential for the longitudinal assessment of educational effectiveness.

Secondly, the immediate post-graduation employment outcomes, which are directly influenced by alumni experiences and employer satisfaction, offer tangible metrics for assessing the applicability and efficacy of the educational programmes in question. As such, focusing on these groups provides direct indicators of the success of PEOs in preparing graduates for professional endeavours.

Thirdly, conducting expansive stakeholder engagement incurs significant resource expenditures and logistical complexities. Given the resource constraints of this study, it was deemed necessary to limit the scope to readily available and strategically significant data sources.

In order to evaluate the effectiveness of the programme, the results of the questionnaire were analysed through the preliminary and stakeholders survey, to determine whether the PEOs are being met. To assess this, the PIs were used as a basis for evaluating the PEOs. It was decided that the PIs of graduates who have been in the programme for at least three years would be measured. The alumni survey provided information on PI 1, 4, and 5, while the industry survey provided information on PI 2 and 3. The number of respondents for alumni was 76, while the number of respondents for the industry was 13, which can be attributed to the small number of students in this particular cohort.

The reason for concentrating the evaluation on individuals who completed their studies three years ago is two-fold. Firstly, this time span enables graduates to move from theoretical learning to practical application in their specific professions, giving them a more comprehensive understanding of how well the programme has prepared them for professional problems. At this point, graduates are expected to have faced many situations that challenge their technical expertise, problem-solving skills, and ability to adapt. These are important qualities that the program tries to develop in its students.

Furthermore, evaluating graduates after a period of three years is in accordance with the typical demands of the industry and accreditation organisations. These entities commonly seek proof of ongoing professional development and the capacity to make valuable contributions to the field. During this timeframe, graduates are anticipated to progress from initial job positions to jobs that need more responsibility and independence, providing a more evident demonstration of their professional growth and the practical relevance of their degree.

Additionally, this evaluation period enables educational institutions to collect data on the enduring achievements of their graduates, which is vital for CQI. These assessments assist in identifying the strengths and areas for growth in the educational programme, guaranteeing that the curriculum stays pertinent and efficient in addressing both present and future industry requirements.

The survey sample consisted of civil engineering diploma programme alumni who graduated between April 2014 and October 2017. Of the total 76 respondents, 40 are employed in industries related to civil engineering, while 30 are employed in unrelated industries. The remaining five alumni are currently enrolled in a Master's or PhD in civil engineering programme, while one is unemployed. On the basis of the five PIs, a comprehensive analysis of the survey responses was conducted to evaluate the PIs. Figure 2 provides an overview of the five PIs' accomplishments.

Notable is the fact that while the majority of respondents are employed in industries related to civil engineering, a sizeable proportion of graduates have found employment in unrelated industries. “Unrelated industries" refers to sectors that are not directly involved in civil engineering operations or do not require civil engineering expertise as a fundamental aspect of their job functions, namely the financing sector, healthcare sector and the food and beverage sector, as mentioned in the survey data. This indicates that the skills and knowledge acquired through the diploma programme are not limited only to the field of civil engineering, but it can also be applied to a wide range of industries. According to the results of the survey, the diploma programme has successfully met its PEOs. The alumni's high performance on

the five PIs suggests that they possess the necessary skills and knowledge to excel in the field of civil engineering. In addition, the responses reveal that the alumni have been successful in applying their scientific and practical skills to engineering problems and that they have sufficiently been equipped with teamwork and social skills.

The survey provides insightful information about the diploma programme in civil engineering's effectiveness. The results indicate that the programme has achieved its goals and prepared its graduates for successful careers in the field. The findings of the study indicate that graduates of the Diploma in Civil Engineering (EC110) programme have achieved the targeted PIs scores, indicating that the PEOs have been met, as illustrated in Figure 2. During the evaluation stage of our engineering programme, it was concluded that certain PIs failed to fulfil their pre-established targets. This deficit signifies crucial aspects within the programme that necessitate improvement to better fit with our PEOs. The PIs are measurable benchmarks that objectively assess the effectiveness of the program in preparing graduates with the essential skills and abilities needed for professional achievement. The inability to achieve these standards in specific domains indicates that although the programme has its merits, there are clear prospects for enhancement. It is essential to address these shortcomings in order to ensure that the programme can adapt to the changing needs of the business and maintain high educational standards. Potential enhancements could involve modifying the curriculum to incorporate additional practical and current skills, improving teaching methods to promote greater comprehension and involvement, and broadening cooperation with industry experts to ensure the continued relevance of educational programmes. Implementing proactive measures will not only improve educational achievements but also boost the overall quality and effectiveness of the programme, ensuring that graduates are well-prepared to succeed in their professional pursuits.

Specifically, only 53% of graduates achieved PI 1, which measures the percentage of graduates who are capable of finding employment in the civil engineering industry. This indicates that the programme may need to provide graduates with more skills and knowledge that are highly valued by the industry. Positively, graduates were able to meet the requirements of PI 2, which evaluates the ability to solve engineering problems and communicate effectively, and one hundred per cent of those who applied were hired as assistant engineers, supervisors, or in other comparable positions. Similarly, all graduates who participated in the survey achieved PI 3, which measures the capacity to work effectively in a team and embrace positive values. This demonstrates that the programme has successfully instilled teamwork and moral principles in its graduates. PI 4 evaluates the proportion of graduates pursuing postsecondary education; the study found that 91 per cent of graduates are pursuing postsecondary education to advance their engineering knowledge. This demonstrates that EC110 graduates have a strong commitment to lifelong learning and professional development. Lastly, PI 5 evaluates the percentage of graduates engaged in civil engineering-related business activities after graduation. Despite the fact that only 5% of graduates achieved this PI, it is important to note that entrepreneurship may not be a career objective for all graduates and that this PI may not be directly tied to the programme's core competencies. The study highlights the strengths of the Diploma in Civil Engineering (EC110) programme in producing graduates who are well-prepared to enter the civil engineering industry and exhibit strong teamwork and ethical values. It also identifies areas for improvement, such as preparing graduates to meet industry demands and encouraging entrepreneurialism.

Over 79% of respondents to the survey of 76 alumni agreed with PEOs 1 through 4, with less than 2% disagreeing and less than 20% remaining neutral, as illustrated in Figure 3. Notably, PEO 3 received the highest percentage of agreement (86%), followed by PEOs 1 and 2. In contrast, PEO 4 had the highest proportion of respondents who disagreed or were neutral, at 2% and 20%, respectively. During their diploma studies, the graduates were equipped with a diverse set of scientific and practical skills, and they were also well-prepared in terms of teamwork and social skills.

In Figure 4, thirteen employers responded to the industry survey, providing valuable feedback on the graduates' performance in the workplace. The majority of employers were pleased with the accomplishments of the graduates, with 92% of respondents agreeing with PEO 1 to PEO 4. Only 8% of respondents gave a rating of neutral. These results

indicate that graduates of the Diploma in Civil Engineering (EC110) programme possess the knowledge and skills necessary to address a variety of civil engineering challenges, exhibit positive work values, and have a commitment to lifelong learning, making them valuable contributors to the workforce.

Our survey findings reveal that 75% of graduates have secured employment in positions closely connected to their area of study. This suggests a significant correlation with PEO1, which emphasises the importance of industry relevance. In addition, a significant 65% of participants indicated their engagement in activities related to professional development, which is consistent with the focus of PEO4 on lifelong learning and ongoing professional advancement.

Nevertheless, the poll also highlights areas that may be enhanced. For example, just 55% of participants stated that they participate in activities that necessitate sophisticated problem-solving abilities, which is a crucial aspect of PEO2. This may indicate the necessity for curriculum improvements that prioritise the development of certain competencies.

Our evaluation of PEOs has mostly relied on surveys to gather feedback from alumni and industry stakeholders. Although these surveys are crucial for collecting self-reported data on how well the graduates believe they fit with the PEOs, we recognise that there may be some subjectivity associated with these tools. In order to mitigate any biases and validate the survey results, it is crucial to place this input within a broader framework that is supported by research.

Hence, in addition to survey data, we suggest implementing a comprehensive evaluation plan that includes both qualitative and quantitative metrics. This may involve examining employment rates, career progression, and contributions to the field, as supported by independent data sources such industry records, certifying agencies, and academic progression figures. Furthermore, it is important to analyse performance metrics obtained from these data sets in order to provide a more evidence-based and unbiased evaluation of PEO achievement.

Combining data from surveys with objective metrics enhances the evaluation of PEOs by making it more reliable and thorough. Future research should focus on broadening the range of assessment techniques used to evaluate PEOs, incorporating diverse sources. This will improve the accuracy of the accreditation process and promote ongoing quality enhancement in engineering programs.

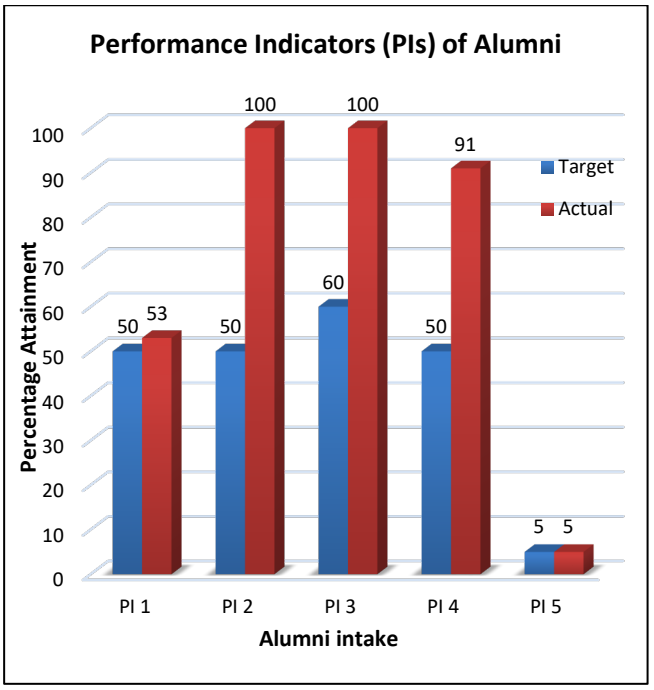

Figure 2. Attainments of the PIs.

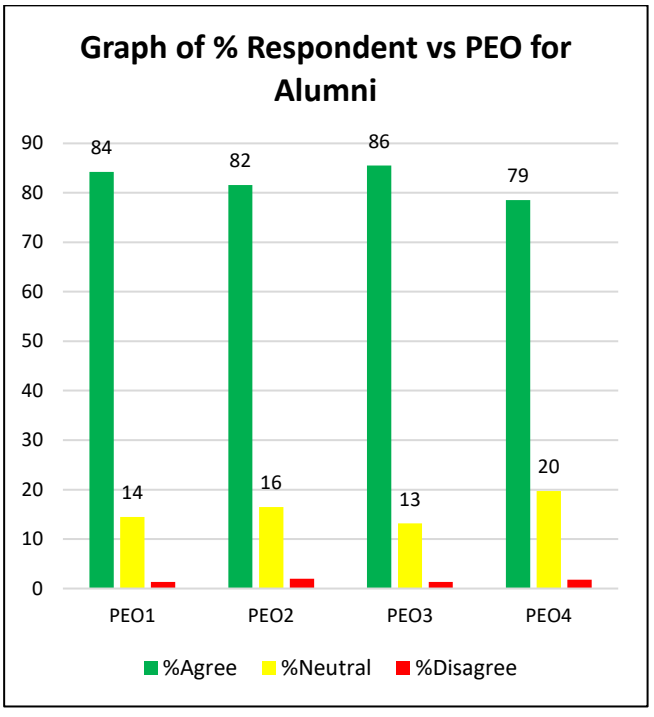

Figure 3. Graph of % Respondent vs PEO for Alumni.

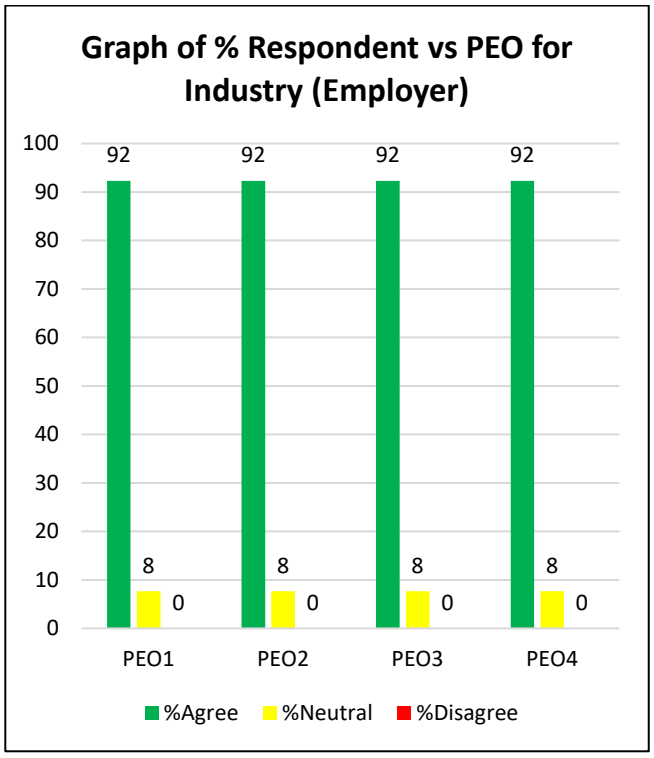

Figure 4. Graph of % Respondent vs PEO for Industry (Employer).

IV. CONCLUSION

This study has conducted a thorough analysis of the process of defining and evaluating PEOs for the Diploma in Civil Engineering (EC110) programme at Universiti Teknologi MARA, Pulau Pinang Branch, Permatang Pauh Campus, Pulau Pinang. By employing a systematic strategy that included significant engagement with stakeholders and CQI, the research is not only met but also exceeded the stringent requirements established by the BEM for accrediting engineering programmes.

The results illustrate a distinct congruity between the programme's PEOs and the objectives of the industry as well as the academic prerequisites. The connection was demonstrated through the favourable feedback received from alumni and industry stakeholders, who expressed high satisfaction with the skills and abilities of graduates, as indicated by the thorough examination of survey data. The survey found that a large majority of graduates are effectively utilising their knowledge and abilities in professional environments, hence confirming the efficiency of the stated PEOs.

Moreover, the study revealed crucial areas for enhancement, including augmenting the curriculum to more effectively equip graduates for the requirements of the civil engineering industry. This observation highlights the need for a repetitive evaluation procedure in the establishment of PEOs, guaranteeing that the educational goals consistently align with changing industry norms and technological progress.

Overall, this study's results not only confirm the effectiveness of the stakeholder-driven strategy in creating meaningful and strong PEOs, but also provide significant knowledge on programme evaluation and enhancement methods. These contributions are crucial for maintaining the significance and rigour of engineering education programmes in a swiftly evolving global environment. Subsequent studies should expand upon these discoveries by investigating novel approaches to include immediate industry input into the creation and evaluation of educational programmes.

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