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Abstract

In widening the horizon of academic programs offered at local universities, the compliance with international academic standards and guidelines are of utmost importance to ensure unified global recognition and accreditation for future prospects of the graduates. The Sydney Accord recognizes 4-year engineering technology programs, and assists in determining if a bachelor-level program attains the required level for purposes of licensure and registration, employment or admission to graduate school in another jurisdiction or signatories (International Engineering Alliance, 2017). As such, this paper examines the alignment of Program Educational Objectives (PEOs) and Program Outcomes (POs) of an undergraduate Civil Engineering Technology program with stipulations of the Sydney Accord. At institution and faculty levels, the objectives and learning outcomes are oriented with the vision and mission respectively, assuring consistency of the program outputs with the organizational aspirations in general. The mechanisms and processes involved to establish and then review the objectives from time to time are elaborated, showing a collaborative effort with stakeholders to keep the curriculum of the Program abreast with current industrial needs and market trends. A discourse on how the POs are put in line with the PEOs ensues, detailing the mapping of the Program's POs with the 12 standard outcomes of the Accord, as set forth in the Engineering Technology Accreditation Council (ETAC) Manual 2015, administered by the Board of Engineers Malaysia (BEM) as a provisional signatory of the Sydney Accord. Also, a graduate engineering technologist is to be equipped with the essential attributes embodied in the POs, which capture both academic and non-academic skills and competencies expected of a graduate of the Program. Similar to the PEOs, the POs underwent review and revision periodically to maintain the relevance of the Program with industrial demands. Finaly attainment of the POs from the graduates is analyzed and discussed with emphasis on the integrated monitoring and continual improvement mechanism substantiated by collective work-based evidence of staff and students alike. In a nutshell, coordination and alignment with the

Accord is meaningless lest supported by a monitoring-feedback close-loop system for continual improvement of the program implementation in the highly dynamic and driven field of technology.

Keywords: Program Educational Objectives, Program Outcomes, Engineering Technology, Attainment, Assessment, Review and Revision

Introduction

The rapid growth of international engagement among institutions of higher learning is a result of dissolving national borders, figuratively. It is also driven by inter-related factors such as demand of stakeholders for profitable and sustainable academic programs, regional and international trade activities, unified recognition of degrees awarded as well as inbound / outbound mobility or exchange of academicians and students (Stella and Woodhouse 2010). In addition, technical graduates especially are expected to complement their technical knowhow with an acute awareness of not only the professional standards, but also environmental and societal demands (Embi 2010; Ramli, Talib, Hassan, & Manaf, 2018). Mismatch of what the university teaches the students and what the industry needs would be disastrous, as exemplified by the increasingly high levels of unemployment in various fields of the job market (Bassey and Atan, 2012; Magsino & Beredo, 2017). This problem may have been further compounded by the general massification of higher education which overlooked the resulting inequalities in social mobility and teaching-practice mismatch (Mok, 2016).

In an effort to provide internationally recognised and competitive programmes, higher education providers in both the public and private sectors are obliged to adapt their respective engineering technology programmes to the requirements of Sydney Accord. Accreditation primarily derives from core operational values of an institution, which comprise of the institutional mission, autonomy and academic freedom (Eaton 2010; Gitau, Kiragu, Kamau, 2018). A successful accreditation enables smooth processes of licensure and registration, employment or admission to graduate school in another jurisdiction or signatories of the Accord. This paper describes the development of a Civil Engineering Technology program in accordance with the Sydney Accord, with emphasis on the establishment, alignment and monitoring of the program outcomes.

Program Development

While the Faculty is officially established in year 2012, the Programme has been developed at FKAAS (Faculty of Civil & Environmental Engineering) since 2010 (Figure 1). Approval for development of the new programme was received from KPT (Ministry of Higher Education Malaysia) on 05 July 2011, while the Provisional Accreditation (PA) was awarded by MQA (Malaysian Qualification Agency) on 29 March 2012. As the Faculty was officially open in the same year (KPT's letter: 22 July 2012), the first review of the Programme (P1) was carried out and endorsed by Senate (01 August 2012) and LPU (13 September 2012), followed by KPT the following year, i.e. 14 April 2013. The review was primarily for content fine-tuning and refinement to align with the current as well as projected market trend and demand, as reflected in the updated PEOs and PLOs. With the programme refined, the Faculty welcomed its inaugural intake

of 29 BNA students in September 2013 (Sem1 Session 13/14). Note that this first batch of students undertook a total of 141 credits for the Programme.

The second review of the Programme (P2) was carried out in year 2015, with endorsements by Senate, LPU and KPT on 11 January 2015, 24 February 2015 and 30 October 2015, respectively. One of the primary review outcomes was the revision and reorganization of the curriculum, which marginally reduced the total credits from 141 credits to 140 credits. This revised curriculum was adopted by the second intake of students in September 2015 onwards. Indeed, the Faculty began a double intake of students from 2016, i.e. in February and September. This is indicative of the maturity of the Programme and firm footing made in the arena of similar technical programmes, where the number of applications and enrolment is consistently encouraging.

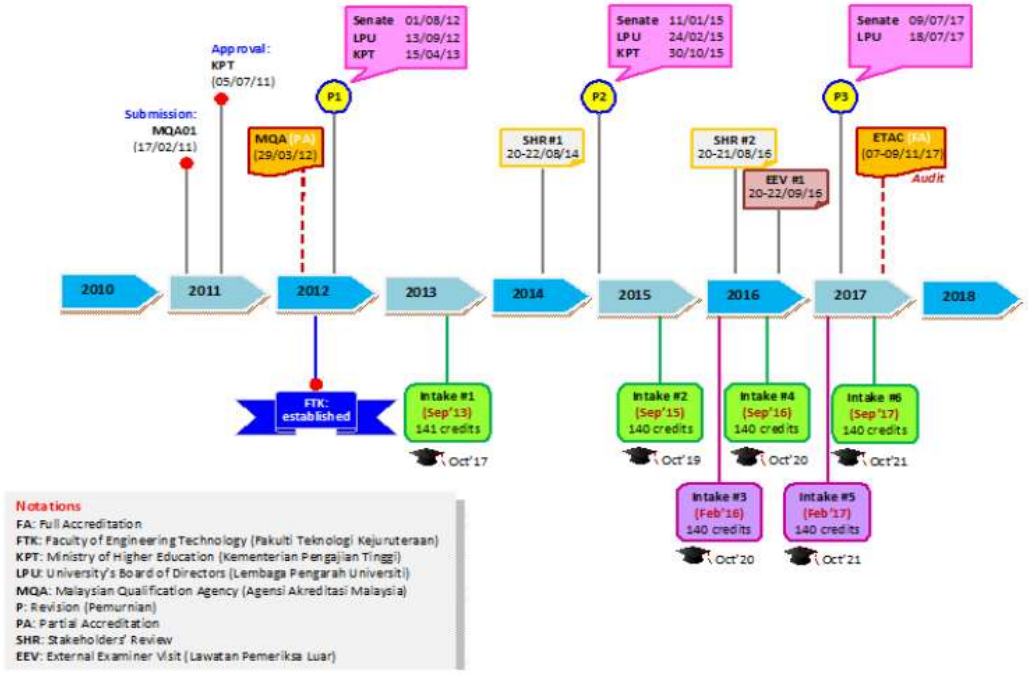


Figure 1. Chronological Development of Programme.

The first External Examiner Visit (EEV) was carried out on 20-22 September 2016, with further revisions and improvements being introduced for the betterment of the Programme. This is ensued by the third Programme review (P3) as endorsed by Senate on 09 July 2017 and LPU on 18 July 2017. All in all, to date, the Programme has undergone 3 Stakeholders' Reviews and 1 External Examiner's Review from year 2012 till 2017. With the first batch of graduates to be conferred their degrees in the University's 17th Convocation (14-16 October 2017), and the on-going 5 batches of students in various stages of their respective studies (intakes September 2015, February & September 2016 and February and September 2017), the BNA programme has indeed come a long way from its inception in 2012 and first intake of students in 2013. Continuous monitoring, review and improvement exercises would be carried out to ensure regular self-check of the Programme to remain current, relevant and at the forefront of technical workforce tertiary

training, specifically in the field of environment within the wider scope of civil engineering technology.

Vision and Mission: Institutional and Faculty Levels

UTHM is a public university established as one of four of the Malaysian Technical University Network (MTUN) league, exclusively for engineering and technical education. The vision and mission of the University were specifically formulated to fulfil its purpose of establishment, and to function as beacons for charting the future development of the University, particularly in the fields of engineering and technical education. As such, it follows that the Faculty charted its own vision and mission oriented towards the University's aspirations for the present and future.

i. Vision and Mission of UTHM
   - Vision: Towards a world class university in engineering, science and technology for sustainable development.
   - Mission: UTHM is committed to generate and disseminate knowledge, to meet the needs of the industry and the community and to nurture creative and innovative human capital, based on the *tauhidic* paradigm.

ii. Vision and Mission of FTK
   - Vision: Leadership excellence in generating and applying knowledge of engineering technology for sustainable development.
   - Mission: FTK is committed to produce dynamic, creative and ethical graduates who will lead in the application of engineering technology to fulfil industrial and community need based on *tauhidic* paradigm.

Programme Educational Objectives

The Programme, Bachelor of Civil Engineering Technology (Environment), with Honours (BNA) has the Programme Educational Objectives (PEOs) as the foundation in its development. In consequence, the PEOs served as the foundation upon which the Programme Learning Outcomes (PLOs) and Course Learning Outcomes (CLOs) were formulated. Developed through a series of discussions and workshops involving both in-house staff and stakeholders from related fields, the PEOs were ensured to stay consistent with the Vision and Mission of UTHM in encapsulating the expected achievements of graduates of the Programme in their career and professional life 3-5 years after graduation.

Table 1. Programme Educational Objectives (PEO).

PEO	Statement	Key Performance Index
PEO1:	Practice with strong fundamental knowledge in Civil Engineering Technology.	At least 60% of graduates are involved in the field of civil engineering technology related to environmental engineering technology assessment, management and testing.
PEO2:	Engage in activities related to Civil Engineering Technology with technical competency.	At least 30% of graduates are registered as members in any professional bodies related to engineering technology.
PEO3:	Communicate with people in the related profession and stakeholders.	At least 30% of graduates are involved in technical, advisory or taskforce committees at national or international levels; or involved themselves in community efforts contributing to civil engineering technology issues
PEO4:	Adapt to changes related to civil engineering technology and the environment.	At least 30% of graduates are furthering or have furthered their studies; or have been attending professional development courses at least once in a year.

As listed in Table 1, the PEOs lay emphasis on equipping the students with a strong fundamental knowledge in civil engineering technology, technical competency, communication skills and adaption to changes related to civil engineering technology and the environment. Note that assessment of the attainment of PEOs would be conducted through a tracer study of graduates returning for the 17th Convocation on 14-16 October 2017. The survey results would be presented to the Auditors during the audit visit.

In order to instil awareness and understanding of the PEOs among Faculty staff and students, the Faculty has undertaken several initiatives to ensure that they are adequately published and publicized through:

i. Programme Proforma.
ii. FTK website: http://ftk.uthm.edu.my/v3/academic/peo-plo.html.
iii. Posters: A3-size posters are displayed at strategic locations including laboratories, lecturer rooms, classroom and the Faculty's main office lobby.
iv. Font cards: Handy pocket-size font cards are distributed to the Faculty staff and students for easy reference.

Relating Vision, Mission, Peo and Plo

The PEOs incorporate the spirit of the Faculty's mission (refer **C1-1**), where PEO 1 relates to the desirable attributes of being 'dynamic' and 'creative', PEO2 emphasizes on effective 'application' of technical competencies in meeting 'industrial needs', PEO3 focuses on the cultivation of graduates who uphold 'ethical conduct', while PEO4 relates to a sense of responsibility of services to the 'community'. Indeed, the PEOs are a reflection of the essence of the Programme, and the motivating force for the Faculty to produce highly competent, charismatic and market-ready environmental engineering technology is for civil engineering technologist with forte in the environmental aspect. These are future leaders of the nation's technical workforce who would propel the industry towards greater heights with their firmly instilled values and cultivated skills, always striving to be at the forefront of their respective sub-fields of the profession and evident 3-5 years post-graduation.

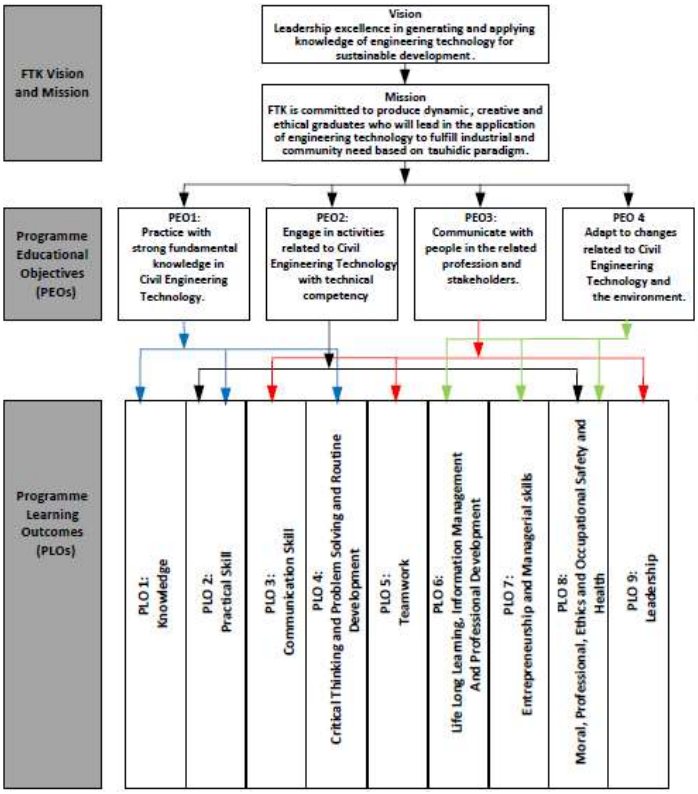


Figure 2. Relationship between vision, mission, PEO and PLO.

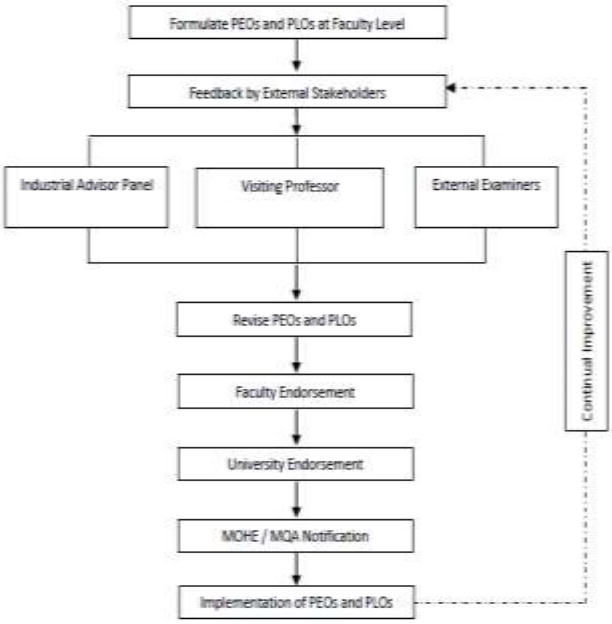


Figure 3. Establish, review and revise PEO and PLO.

As representation of the cumulative learning outcomes of all courses within the Programme's curriculum, the PLOs are necessarily derived from the PEOs and are measurable immediately upon completion of the Programme. Therefore there must appear a link threading through the PEOs and PLOs, demonstrating a trickle-down mechanism from a long to short term expectations of the graduates. Relationship and alignment of the Faculty's vision and mission, PEOs and PLOs are shown
In Figure 2.

The PEOs were initially formulated by the Faculty, based on specific requirements of the Ministry of Higher Education (MOHE) and stipulations in the Malaysia Qualification Framework (MQF). As part of the initial steps in the Programme development, a market survey was conducted to ascertain the relevance, need for and expectations of the Programme among the related industries. The survey results were also referred to in designing the PEOs while not diverging from the Faculty's aspirations. The PEOs were then presented to the stakeholders (e.g. Industrial Advisor Panels, Visiting Professor, External Examiner and lecturers) for inputs, feedbacks and their respective requirements. Upon the review exercises, necessary and relevant inputs were adopted to revise the PEO. Revision to the PEOs, if necessary, was carried out in accordance to the procedures stated in **RPK-02 – Curriculum Review Procedures**. The revised PEOs were then forwarded to relevant in-house committees for further debate and refinement, i.e. Faculty

Academic Committee, Faculty Management Committee and Senate for endorsement. The process of establishing, reviewing and revising the PEOs and PLOs at the Faculty level as illustrated in Figure 3. As in a trickledown mechanism mentioned earlier, implementation of the revised PEOs was followed through attainment of the PLOs, with subsequent periodic reviews by the stakeholders to ensure continual improvement.

Mapping and Detailing of Peo-Plo

Accruement of skills and knowledge throughout the 4-year programme, as illustrated in the 9 PLOs, are to be further enhanced and developed within the subsequent 3-5 years in the job market to fulfil the 4 PEOs. The relationships between outlined PLOs with the Programme Education Objectives (PEOs) are summarised in Table 2.

Table 2. PEO-PLO mapping.

Programme Educational Objectives (PEO)		Programme Learning Outcomes (PLOs)								
		PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9
		Knowledge	Practical Skill	Communication Skill	Critical Thinking & Problem Solving	Teamwork Skill	Life Long Learning & Professional Development	Entrepreneurship Skill	Moral & Professional Ethics	Leadership Skill
PEO 1	Practice with strong fundamental knowledge in Civil Engineering Technology.	✓	✓		✓					
PEO 2	Engage in activities related to Civil Engineering Technology with technical competency.		✓						✓	
PEO 3	Communicate with people in the related profession and stakeholders.			✓		✓		✓		✓
PEO 4	Adapt to changes related to civil engineering technology and the environment.						✓		✓	

Note that PLO and PO (Programme Outcomes) refer to the same item in this report, where PO is the term adopted in the ETAC Manual (2015). Briefly, POs are statements that describe what students are expected to know and be able to perform or attain by the time of graduation. The desired attributes relate to the skills, knowledge and behaviour students acquire and accrue throughout the duration of the programme. Referring to Section 5.0 of the Manual (2015), ETAC highlighted 12 outcomes that should be achieved by an engineering technology student upon graduation.

Students of an engineering technology programme are expected to attain the following in a practice-oriented learning environment:

i. **Knowledge:** Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialisation to define and applied engineering procedures, processes, systems or methodologies.
ii. **Problem analysis:** Identify, formulate, research literature and analyse broadly defined engineering problems reaching substantiated conclusions using analytical tools appropriate to their discipline or area of specialisation.

iii. **Design/ development of solutions:** Design solutions for broadly-defined technology problems and contribute to the design of systems, components or processes to meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.
iv. **Investigation:** Conduct investigations of broadly-defined problems; locate, search and select relevant data from codes, data bases and literature, design and conduct experiments to provide valid conclusions.
v. **Modern Tool Usage:** Select and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to broadly defined engineering activities, with an understanding of the limitations.
vi. **The Engineer and Society:** Demonstrate understanding of the societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to engineering technology practice.
vii. **Environment and Sustainability:** Understand the impact of engineering technology solutions in societal and environmental context and demonstrate knowledge of and need for sustainable development.
viii. **Ethics:** Understand and commit to professional ethics and responsibilities and norms of engineering technology practice.
ix. **Individual and Team Work:** Function effectively as an individual, and as a member or leader in diverse technical teams.
x. **Communications:** Communicate effectively on broadly-defined engineering activities with the engineering community and with society at large, by being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
xi. **Project Management and Finance:** Demonstrate knowledge and understanding of engineering management principles and apply these to one's own work, as a member and leader in a team and to manage projects in multidisciplinary environments.
xii. **Life Long Learning:** Recognize the need for, and have the ability to engage in independent and life-long learning in specialist technologies.

It is worth noting that while the POs are defined and numbered in different forms between the Manual (2015), MQA standard and the Faculty, they really encompass the same fundamental attributes expected of an engineering technology graduate who successfully undergoes the Programme. For ease of comparison, the 9 PLOs formulated by the Faculty are mapped against the ETAC's PO and MQA's LO in Table 3.

Table 3. Alignment of PLO to ETAC PO, MQA LO and learning domains: cognitive (C), psychomotor (P) and affective (A).

PLO	DOMAIN	ABBRV.	PRIMARY LEARNING DOMAIN			UTHM/ FTK	ETAC	MQA (Eng.Tech.)
			C	P	A			
1	Knowledge	K	x			1	1	1
2	Practical Skill	PS		x		2	2,5	2,5
3	Communication Skill	CS			x	3	10	7
4	Critical Thinking, Problem Solving & Routine Design	CTPS & RD	x			4	3,4	3,4
5	Teamwork Skill	TS			x	5	9	6
6	Life Long Learning Information Management and Professional Development	LL, IM & PD			x	6	6,12	12
7	Entrepreneurship & Managerial Skills	ES & MS			x	7	11	11
8	Moral, Professional Ethics & Safety	M, PE & OSH			x	8	7,8	8,9,10
9	Leadership Skill	LS			x	9	11	6

In Table 4, the Programme's original 9 PLOs (FTK) are listed on the left most column while the ETAC's 12 POs are on the right most. The middle 2 columns indicate the overlapping Learning Outcomes of the FTK and ETAC domains, as demonstrated in Table 3 and explained in the previous paragraph. Nonetheless there are a couple of key matters to be noted from the map in Table 4. Firstly, 4 of the PLOs (i.e. PLOs 2, 4, 6 and 8) correspond with a pair each of the ETAC's POs. Secondly, ETAC's PO9 appears to be separately covered by FTK's at PLOs 5 and 9 respectively. This elaboration further proves the compatibility of the Programme's original Learning Outcomes with those stipulated in the Manual.

Table 4. Mapping of FTK PLO (9PLOs) to ETAC PO.

FTK Domain (9)	Mapping of Outcomes		ETAC Domain (12)
	FTK(9)	ETAC (12)	
PLO1. Knowledge	PLO1	PO1	PO1. Knowledge
PLO2. Psychomotor / Practical Skills	PLO2	PO2 & PO5	PO2. Problem Analysis
PLO3. Communication Skills	PLO3	PO10	PO3. Design / Development of Solutions
PLO4. Critical Thinking, Problem Solving & Routine Design	PLO4	PO3 & PO4	PO4. Investigation
PLO5. Teamwork Skills	PLO5	PO9	PO5. Modern Tools Usage
PLO6. Lifelong Learning, Information Management & Professional Development	PLO6	PO6 & PO12	PO6. Engineering Technologist & Society
PLO7. Entrepreneurship & Managerial Skills	PLO7	PO11	PO7. Environment & Sustainability
PLO8. Moral, Professional Ethics& Safety	PLO8	PO7 & PO8	PO8. Ethics
PLO9. Leadership	PLO9	PO9	PO9. Individual & Teamwork
			PO10. Communications
			PO11. Project Management & Finance
			PO12. Lifelong Learning

With the advent of review exercises and as part of the University-wide effort towards standardisation of the OBESys for all academic programmes, the Programme's 9 PLOs have presently been expanded to 13, with no omission of any of the original components. As can be seen in Table 5 with the same layout as previously discussed, the compatibility between the Learning Outcomes of FTK and ETAC are now individually represented without co-sharing any of the components. However ETAC's PO9 remains unchanged and is shared between FTK's PLOs 5 and 9. Note that the 13 PLOs are applicable for the new intake of Sem1 Session 17/18 in September 2017.

Table 5. Mapping of FTK PLO (13PLOs) to ETAC PO.

FTK Domain (13)	Mapping		ETAC Domain (12)
	FTK (13)	ETAC (12)	
PLO1. Knowledge	PO1	PO1	PO1. Knowledge
PLO2. Psychomotor / Practical Skills	PO2	PO5	PO2. Problem Analysis
PLO3. Communication Skills	PO3	PO10	PO3. Design / Development of Solutions
PLO4. Critical Thinking, Problem Solving & Routine Design	PO4	PO4	PO4. Investigation
PLO5. Teamwork Skills	PO5	PO9	PO5. Modern Tools Usage
PLO6. Lifelong Learning, Information Management & Professional Development	PO6	PO12	PO6. Engineering Technologist & Society
PLO7. Entrepreneurship & Managerial Skills	PO7	PO11	PO7. Environment & Sustainability
PLO8. Moral, Professional Ethics & Safety	PO8	PO8	PO8. Ethics
PLO9. Leadership	PO9	PO9	PO9. Individual & Teamwork
PLO10. Design Solutions	PO10	PO3	PO10. Communications
PLO11. Problem Analysis	PO11	PO2	PO11. Project Management & Finance
PLO12. Environment & Sustainability	PO12	PO7	PO12. Lifelong Learning
PLO13. Engineering Technologist & Society	PO13	PO6	

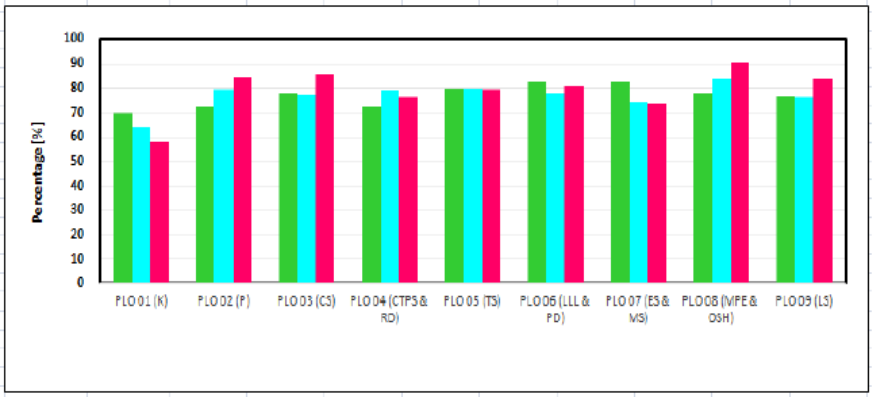
The formulation of PLOs follows the same processes as undergone by the establishment of the PEOs (refer **4-5**). With strict adherence to the PEOs, the PLOs were subjected to reviews and revisions by relevant stakeholders and academic committees or authorities in-house and externally. These processes ensured impartiality in the review exercises to avoid the 'silo effect' of excessive self-indulgence and tunnel vision which could impair the all-roundedness of the Programme often visible only through the eyes of outsiders, so to speak. In a nutshell, the processes of establishing and reviewing the PLOs in conjunction with the PEOs were carried out according to the workflow illustrated in Figure 2. Note that reviews of the PLOs were conducted simultaneously as the PEOs from time to time to maintain the relevance, timeliness and compliance to current industrial demands.

Attainment of Po via Student Assesment

In order to identify the attainment of POs via student assessment, it is necessary to first illustrate the overall academic performance management system adopted in the University. A comprehensive and interlinked online data capture and monitoring system was developed in-house to record, manage and measure individual student's academic achievement. The online system consists of 3 independent but connected sub-systems, namely Student Assessment System (SAS), Outcome-based Education System (OBESys) and Student Information System (SMP).

Essentially, all formative and summative assessments for each course of the Programme form the inputs for SAS, enabling measurement of the CLO attainment for the respective courses. Linked to OBESys, the cumulative attainment of PLOs, as contributed by the respective courses via the CLOs, are analysed and retrievable throughout the student's period of study at the University. The OBESys is accessible only by academic staff and authorities for reference and adoption in CQI of the Programme, for instance. On the other hand, students can access their academic performance via SMP for self-monitoring and improvement where applicable. To ensure CLOs of the specific course is properly assessed and achieved, the Table of Specification (TOS) and cognitive, psychomotor and affective (C, P, A) guidelines are used as instruments to assist in the planning of lecture delivery and assessment.

The key performance index (KPI) for all CLOs were set to 50% students achieving at least 50% marks or above. With each CLO is mapped to a specific PLO, the CLOs of selected courses would contribute to a particular PLO in an accumulative manner. Thus, with the assessment of CLOs completed, attainment level of the respective PLO mapped to the CLO is assessed. Figure 4 shows the results of the average PLOs attainment for each cohort of the Programme. PLO attainment is measured at the end of the 4-year programme, however, OBESys enables the current attainment of each cohort at the end of every semester.



Cohort	PLO 01 (K)	PLO 02 (P)	PLO 03 (CS)	PLO 04 (CTPS & RD)	PLO 05 (TS)	PLO 06 (LLL & PD)	PLO 07 (ES & MS)	PLO 08 (MPE & OSH)	PLO 09 (LS)
20132014	69.63	72.43	77.80	72.17	79.79	82.66	82.33	77.95	77.06
20152016	63.92	79.40	77.34	79.03	79.95	77.74	74.40	83.91	76.40
20162017	58.03	84.22	85.43	76.22	79.36	80.93	74.03	90.53	84.10

Figure 4. Average attainment of PO by different cohorts of students.

Conclusions

In line with the Sydney Accord programme accreditation requirements, the Programme Educational Objectives (PEO) and Programme Outcomes (PO) have been defined, reviewed and translated into implementation of the Programme. Students undergo a structured learning process, achieving the targeted outcomes in a cumulative manner over the 4-year period of study, i.e. becoming qualified professional civil engineering technologists with the competencies

and skills expected of them. While the standards prescribe recommendations of best practices, minimum academic parameters and requirements as well as projection of the programme's future development pathway, adherence and implementation of the individual elements in the programme must be kept relevant to the current institutional and local context. The former involves resources availability, cultural sensitivity and university's aspirations, among other factors to be taken into consideration. Local context wise, the programme administrator needs to ensure that the programme is always aligned with the nation's economic direction, which has a direct and impactful consequential link to the industrial needs, market demands and global outreach. At the end of the day the standards remain but a guide at best, while the combined in-house potential and field rules at institutional and national levels would determine the relevance, and hence survival or sustainability of an academic programme such as this.

Acknowledgement
Thank you and bravo to the Faculty's **AA Team** (academic and supporting staff) for the successful ETAC accreditation of programmes in late 2017.

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