International Journal of Learning, Teaching and Educational Research
Vol. 19, No. 9, pp. 281-300, September 2020
https://doi.org/10.26803/ijlter.19.9.15

Analysis of Engineering Accreditation Process and Outcomes: Lessons Learned for Successful First Time Application

Tahar Ayadat
Prince Mohammad Bin Fahd University, Al Khobar, Saudi Arabia
https://orcid.org/0000-0003-4107-8544

Andi Asiz
Prince Mohammad Bin Fahd University, Al Khobar, Saudi Arabia
https://orcid.org/0000-0001-6554-5018

Abstract. The aims of the paper are to share and analyze engineering accreditation experience starting from the preparation through the outcome, and to discuss lessons learned particularly for first-time applicants. Securing accreditation from a well-recognized international body, such as the Accreditation Board for Engineering and Technology (ABET) can indicate quality of an engineering program. To qualify for an accreditation up to six- to seven-year period, an engineering program must meet a set of accreditation standards or criteria. The article is not limited only for new engineering programs outside the United States who are willing to pursue engineering accreditation from ABET, but it is applicable for an existing accredited program who will undergo next accreditation cycle. The authors presented and analyzed detail accreditation experience for a new established Civil Engineering (CE) Program at Prince Mohammad bin Fahd University (PMU) in Saudi Arabia. Although the ABET website provides detail procedure for the accreditation steps, the detail cases experienced by the PMU CE program will enrich knowledge on how to prepare and handle successful international accreditation. The authors also discussed issues raised during the accreditation activities, including program compliance with the nine ABET criteria, and presented key lessons to prepare for a smooth accreditation process. The main significant result of the accreditation exercise about continuous improvement was summarized in term of the curriculum upgrade, including adding another semester for senior design course and offering new sustainability engineering course, and adding computer aided design course at the early semester.

Keywords: Engineering accreditation; quality assurance; student outcomes assessment; continuous improvement

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1. Introduction

Actually, securing accreditation from a well-recognized international body, such as Accreditation Board for Engineering and Technology (ABET) can indicate quality of an engineering program. The definition of accreditation within an academic institution context is an evaluation process conducted by a group of educational professional to determine whether teaching and learning practice meet specified standards or criteria set by an accrediting body. The primary purpose of accreditation is to maintain quality of education and to ensure public that graduated students of an educational institution or program have a minimum level of skills and competencies ready for use in their respected professional fields (Urquizo, 2019). There are two types of accreditation level, institutional or program level and these can be a mandatory or voluntary process depending on the policy of government in the educational sector (Prados et al., 2005). For example, in the United States accreditation is a voluntarily process governed by a non-governmental body associated with educational and professional organizations. Whereas in Saudi Arabia accreditation is mandatory at both levels. The Saudi Ministry of Education through the National Commission on Academic Accreditation and Evaluation (NCAAA) evaluates and accredits universities and programs throughout the country (Onsman, 2010; Darandari et al., 2009; Abou-Zeid & Taha, 2014; Albaqami, 2019). Accreditation at the institutional level involves much border standards covering university operation in teaching, research, community service, and resource administration and management. Meanwhile program accreditation sets specific standards for preparing students to develop professional skills and competencies needed in their respective fields.

In this regards, ABET (Accreditation Board for Engineering and Technology) is one of the accreditation bodies widely used to gauge whether an engineering program meets its standard. It was initially purposed for accrediting US engineering programs with the primary objective to prepare engineering graduates to meet criteria set by respected professional engineering associations. Since mutual recognition agreements were established between ABET and various countries represented by their engineering associations. Since mutual recognition agreements established between ABET and various countries, ABET has gone international and accredited more than 4,000 programs in 32 states as of 2019-20 accreditation cycle (Prados, 2005; ABET, 2020a). In the Middle East and North Africa (MENA) alone, 358 engineering and technology programs spanning over 11 countries have been accredited by ABET with Saudi Arabia at the top getting more than 140 programs accredited (Marzouk, 2019; Elnajjar et al., 2019). Most of engineering programs in MENA and another part of the world because of its shifting philosophy from resources to outcomes-based evaluation (Al-yahya & Abdel-halim, 2013; Zahed, et al., 2007; Husain, et al., 2017; Barret, et al., 2019; Calderon, et al., 2016). Also, it is due to simplicity in the accreditation documentation, which emphasizes more on the continuous improvement criteria based on self-assessment outcomes of teaching and learning criteria (Abou-Zeid & Taha, 2014).

However, there have been challenges faced by young engineering programs outside the US to undergo an ABET accreditation process. The most common

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challenge is that culture of teaching quality based on student learning outcomes achievement is not a widespread practice among teaching staffs and university administrators (Onsman, 2010; Abou-Zeid & Taha, 2014; Anwar & Richards, 2018). Teaching quality is simply measured by overall student grade achievement without needs assessing performance attributes or indicators required in professional work. Teaching improvement are mostly dependent on stakeholder's (students, faculty, alumni, employers) comments and suggestions derived via surveys (Retnanto, et al., 2018; Kim & Song, 2017; Meyer, et al., 2016). Switching to a culture of comprehensive learning outcome assessment used as the main driving force for continuous teaching improvement takes serious commitments, efforts and time. The next challenge is that adequate resources such as qualified instructors and teaching infrastructures are always a valid concern for young engineering program during its establishment, considering budget constraints (Sriraman & Stapleton, 2012; War, et al., 2012; Barr, 2013). Maintaining numbers of faculty according to an acceptable student-faculty ratio is another issue for a program that is dependent heavily on international expatriate resources such as the case for most of GCC (Gulf Cooperation Council) universities. In other words, retention is a big issue because tenure position is non-existent for international faculty working in this region, making it more challenging to invest in a continuous commitment of improvement under the accreditation framework. Last but not least is the challenge of coordination between various levels within university administration in conducting accreditation work and quality assurance in general. Unlike Western universities, it is common practice in GCC universities to establish deanship of quality assurance and accreditation governed under vice-rector of academic, which in principle is independent of college or program leadership (Onsman, 2010; Darandari, et al., 2009). Although it could be useful resources in term of administering accreditation process, without strong coordination, this could lead to unwanted bureaucracy slowing process of curriculum upgrade.

At Prince Mohammad Bin Fahd University (PMU), all engineering programs under the College of Engineering (COE) have ABET accreditations, representing some of the earliest engineering programs in Saudi Arabia getting internationally accredited under the category of small-private universities. The civil, mechanical, and computer engineering programs have undergone ABET accreditation exercises during the 2016-17 cycle, with all the three experiencing the same time of the site visit evaluation by the end of Fall 2017 term. During that cycle, two existing programs had already been ABET-accredited a year earlier, electrical engineering by EAC (Engineering Accreditation Commission) and information technology by CAC (Computer Accreditation Commission). This paper focused on the Civil Engineering (CE) Program accreditation experience with comparative observations and lessons also taken from those of the other engineering programs under COE. The CE Program is the smallest program within COE in term of the student population. PMU established the CE Program in 2008, two years after the other engineering programs operated. Currently, the CE program has enrolled 179 students and graduated nearly 100 students since the first batch of graduates in 2011. It has seven teaching staffs (five professors and two instructors), one administrative staff and one lab engineer. Concerning the curriculum, the CE

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program offers 139 total credit hours completed within four years, excluding a preparatory year. Out of the 139 credit hours, 79 are for civil and general engineering courses and the remaining 60 credit hours are for math, science, and social science, and competency-based courses. The credit hour requirement and composition for engineering, math, and science courses followed the ABET curriculum criterion. Among the university in Saudi Arabia, PMU is considered to be unique in term of offering explicit competency-based courses such as Team Work and Leadership, Professional Development, and Critical Thinking and Problem-Solving in addition to standard communication-based courses such as writing, oral, and technical communications. Concerning the learning outcome achievement, there are three explicit courses called Learning Outcome Achievements I, II, and III offered at the end of first-year students, junior, and senior levels, respectively with the latter associated with senior (engineering) design course.

Starting from the academic year 2019-2020, the CE program has migrated to the new *1-to-7* Student Outcomes (SO) from the previous version of ABET *a-to-k* SO which was used during the program accreditation cycle 2016-17 (ABET, 2020b). In this paper, any discussion about SO and their assessments refer to the *a-to-k* SO. The program educational objectives (PEO) of the CE program were developed considering alignment with the SO and the university mission, and they were about a set of technical skills and competencies expected to achieve by young graduate within five years of their graduation. The following is the CE PEO, including their relationship with the a-to-k SO:

- *Graduates have successful and professional careers in civil engineering and related industries, and meet the expectations of the prospective employers.*
- *Graduates demonstrate leadership and effectively undertake services within their profession and contribute to sustainable development in their communities.*
- *Graduates pursue their professional development through continuous lifelong learning; advanced studies; and membership in professional societies.*

2. Methodology

The main method of the study was qualitative and analytical approach of the accreditation processes and reviews that were based on compilation of communications between PMU and ABET including the actual visit review. The communications between ABET and the CE program teams were presented and analyzed in each activity including written responses to program evaluator's comments and recommendations, and direct interaction and discussions with the EAC team during the visit and post-visit. The accreditation outcomes were critically analyzed to facilitate strategy for quality improvement in teaching and learning at the CE program. Lessons learned from these accreditation activities were summarized in the discussion section, before recommendations were given in the conclusion purposed mainly for university and its associated programs who will undergo the process of first accreditation or reaccreditation. This paper was organized according to significant milestones of ABET accreditation procedure started from pre-visit, site visit, and post-visit activities. Although the ABET website provides detail procedure for the accreditation steps, the detail cases

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experienced by the CE program will enrich knowledge on how to prepare and handle successful international accreditation.

3. Pre-visit

The official pre-visit activity started with Request for Evaluation (RFE) for the CE Program that was submitted to ABET by 31 Jan 2017 along with the other two programs at PMU, Mechanical Engineering (ME) and Computer Engineering (CompE). Also, Request for Acknowledgment from Saudi's accrediting agency (i.e. NCAAA) and one academic transcript from recent civil engineering graduate accompanied the RFE submission. ABET requires that program requesting accreditation be under a nationally recognized institution that is accredited by the highest national accrediting body (ABET, 2020c). By the time of RFE submission, PMU received full institutional accreditation by NCAAA for up to seven years. There was no need to submit Readiness Report since two PMU programs (Electrical Engineering, EE and Information Technology, IT) received ABET accreditation. During the period between RFE and Self-Study Report (SSR) submission, there were discussions between PMU and ABET about sharing biographical sketches of Team Chair (TC) and Program Evaluators (PEVs) to ensure that there was no conflict of interest. Unlike the previous accreditation review for the PMU EE and IT programs which involved regional (middle-eastern) university as one of the evaluators, all PEVs and TC assigned by ABET this time were from American university professors with substantial experience in international accreditation.

The next critical step was about updating Self-Study Report that the CE Program have well developed since the beginning of the academic year 2016-17. The SSR document, along with eight student academic transcripts under the CE Program, was submitted to ABET headquarter in Maryland before the dateline July 1, 2017. The student academic transcripts were selected based on a recommendation from the PMU Registrar Office after input from the CE Program since there was no specific request from ABET about the selection criteria. By that time, the CE Program had graduated 44 students since the first graduate in the academic year 2011-12. The SSR was developed according to the nine general criteria for an accrediting engineering program, as follow: Background Information; Criterion 1 (Students) Criterion 2 (Program Education Objectives); Criterion 3 (Student Outcomes); Criterion 4 (Continuous Improvement); Criterion 5 (Curriculum); Criterion 6 (Faculty); Criterion 7 (Facilities); Criterion 8 (Institutional Support); Program Criteria; Appendix A (Course Syllabi); Appendix B (Faculty Vitae); Appendix C (Equipment); and Appendix D (Institutional Summary). The Program Criteria was not Criterion 9, but it was as important as the other eight criterions. Among all these criteria, Criterion 4 (Continuous Improvement) was arguably the most critical chapter in the SSR (Estes & Ressler, 2007). This chapter described assessment strategy, data collection and analysis of the SO and PEO assessments, and summary of findings for improvement strategy. Figure 1 illustrates the cycle of the continuous improvement practised at the CE Program. The CE Program conducted assessments using one academic year data (Fall 2016 and Spring 2017), including a summer internship course. Performance indicators for each SO were carefully measured and analyzed for ten courses representing

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key civil engineering subjects. Detail method for the assessment is available in a journal paper developed by the CE Program team (Ayadat, et al., 2020). It was very challenging to propose improvement steps in the teaching and learning practice based on one academic year assessment. However, the authors proposed restructuring key curriculum change including: offering important senior design project course in two semesters; offering new courses either as required ones or technical electives; upgrading laboratory facility; and improving student-to-faculty ratio.

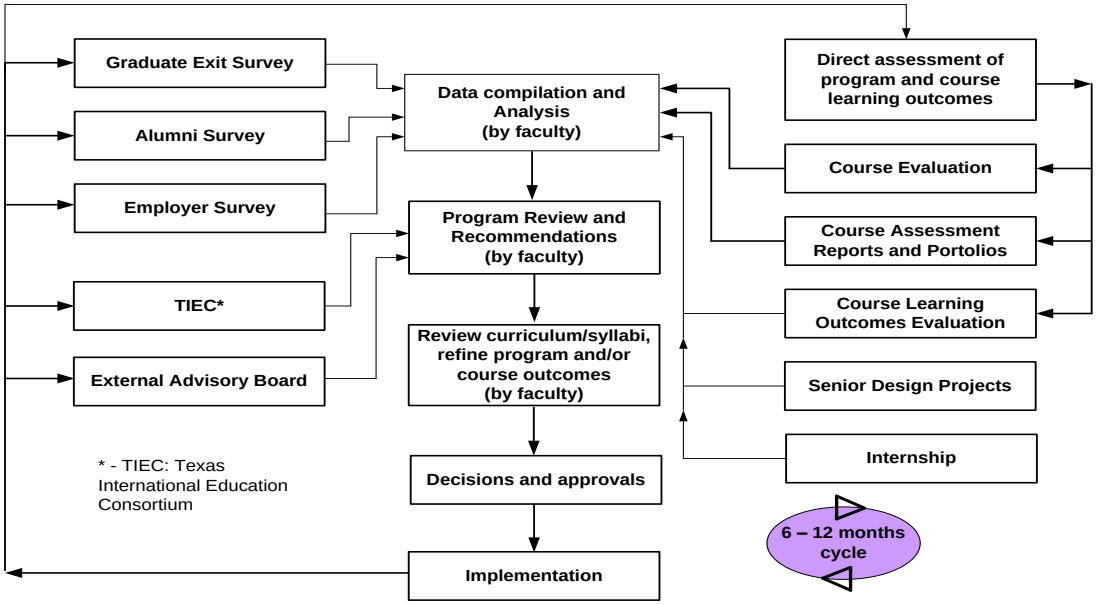

Figure 1: Continuous improvement cycle (PMU Civil Engineering, 2017)

The CE Program anticipated that PEV would give review results including comments and suggestions during initial or mid-fall term. Timeline receiving comments from the EAC visit team varied between programs. Among the three reviewed PMU programs, CE received the comments around two months before to the site visit, while the other two programs (ME and CompE) received around three months before the visit. The EAC Team expected responses from the reviewed program before to the site visit. There was no formal requirement from ABET to submit the answers. However, the reactions were a very important way of communication between the reviewed program and the EAC visit team to ensure compliance with all criteria. If there were issues raised by PEV or TC, the program would have taken immediate actions. After careful review, the CE Program submitted the responses two weeks after receiving the PEV comments. Table 1 showed the review and comments given by PEV about the submitted SSR and corresponding responses by the CE Program. the authors provided summary of the comments and responses without losing their important contexts. TC also sent separate reviews to the COE Dean, but they were mostly about general comments such as updating website content about program enrollment statistics since the first batch of graduates (e.g. the number of enrollments for each level, graduated students per cohort).

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Table 1: PEV review and CE responses

Comments	Responses
Criterion 1: • *Requesting to provide written documentation of advising records that might show the rationale and conscious decision-making process for allowing students to take courses out of proper sequence.* • *Requesting to address career advising and how to accomplish this and by whom* • *Requesting to address unanswered section titled "Have and enforce policies for awarding academic credit for work instead of courses taken at the institution".*	• Giving sample of advising records showing justification about allowing students to take courses out of sequence for the submitted student transcripts. • Describing general policy that the Department of Career Services under Deanship of Student Affair provided for students from freshman through senior levels with services that promise students a brighter career. • Describing that currently there was no policy within department for substituting course credit with vocational, placement, or dual enrollment etc. The only exception to this was the Internship module which is a 3-Credit Hour course attended as 8 full-time weeks with a company (typically in the summer). SSR report was updated to include this section.
Criterion 2: • *Asking whether published PEOs in the College or University catalogue.* • *Requesting documentation during the visit that meeting with the program constituents (External Advisory Board, Employers, Alumni, Faculty, Staff) was conducted in the creation, review and revision process of PEOs, and these could be in the form of meeting minutes that show the discussion and approval of PEOs.*	• Updating College and University catalogs to include PEOs and posted in the departmental website with the link information provided to PEV. • Describing the process of developing PEO to reassure that the CE Program follows ABET criteria. • Providing hard copies of various recorded minutes between PMU and constituents during the visit.
Criterion 3: *No comments were given*	
Criterion 4: • *Commending about summarizing the KPI scores for each outcome for the academic year 2016-2017 with given examples of course reports and other measures for the assessment.* • *Requesting during the visit to display examples of the direct measure instruments and the assessment rubrics used, and to organize them by student outcome* • *Requesting to showcase and discuss further senior design projects and their assessment rubrics.*	• Appreciating PEV for the commendation and highlighting key course assessment. • Stating availability during the visit about sample of direct measure instruments (exams, assignments, projects and others) according to 'outcomes' in the displayed room. • Displaying samples of senior design project report and (rubric-based) assessment methods separately.
Criterion 5: • *Requesting course syllabi for Learning Outcome Assessment II, Material Engineering and all MATH courses to assess curricular compliance.*	• Submitting all requested course syllabi in separate files quoted and linked to the responses.

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• *Suggesting courses Engineering Geology and Material Engineering to cover three credit hours short of Basic Math and Science requirement, and cannot assume Introduction to Computing as a Basic Math or Science since it is neither of those under the EAC definition of Math and Basic Science.*	• Appreciating PEV for the valuable suggestion. After revising the curriculum to include Engineering Geology (3 credit hours) and Materials Engineering (2 credit hours), Basic Math and Science requirement amounted to 34 credit hours which was more than minimum requirement of 32 hours. • Updating and submitting SSR.
Criterion 6: • *Requesting evidence of technical professional development of faculty (attendance at conferences, workshops, etc.) that would demonstrate currency in their field as well as any financial assistance the department or university might provide them for attendance*	• Giving statement describing about budget allocated to support faculty travel to present at national, regional and international conferences. • Describing each faculty member entitled to receive funding for up to two Scopus conferences with limited funds allocated for professional training and workshops. • Submitting a list of attendance and participation for each faculty member in various conferences, seminar, and workshop.
Criterion 7: *No comments were given*	
Criterion 8: *No comments were given*	
Program Criteria: • *Correcting inconsistency of the credit hour requirement between Curriculum and Program Criteria.* • *Requesting to include faculty requirements of the program criteria.* • *Requesting to incorporate program criteria and how they are met in the curriculum, these include: (1) Laboratory experimentations; (2) Design of a system, component or process in at least two civil engineering contexts; (3) Principles of sustainability in design; (4) Basic concepts of project management, Public policy, Leadership, Ethics, and Professional licensure.*	• Correcting credit hour requirements to be consistent with those mentioned in Criterion 5 (Curriculum) of the SSR. • Addressing faculty requirements of the program criteria and incorporating them in the SSR. • Addressing all program criteria to incorporate four laboratory-based courses, six design-based courses including senior design project, three sustainability-based courses, and six courses covering basic concepts of management, public policy, leadership, ethics, and professional licensures. • Updating the syllabus of those courses to reflect the program criteria.

The CE Program sent twenty- page written response including the original comments via email to PEV and carbon-copied to TC and COE Dean. Before to the submission, Dean and the other program chairs conducted general meeting to ensure consistency in the responses since some of the comments were similar, particularly those concerning the institutional support queries. As can be seen in Table 1, the PEV review and comments covered verification or clarification of statements described in the criteria, requesting more information, and correcting some statements. No comments were provided in Criterion 3 since the SO were precisely similar to the *a-to-k* SO outlined by ABET. The mapping between the SO and PEOs was provided to indicate that PEOs were attainable by assessing the

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SO. The other reason was that PEV focused on Criterion 4 that discussed the SO assessment and analysis, which was used as one of the main input for continuous teaching improvement. PEV comments were not given also in Criterions 7 (Facilities) and 8 (Institutional Supports), since presumably the ABET team would verify them during the site visit. The CE Program obtained helpful recommendation for Criterion 5 (Curriculum), to adjust math and essential requirement by incorporating specific existing courses (Engineering Geology and Materials Engineering). ABET requires that program must offer 32 credit hour math and science courses, and in the Curriculum Criterion of the CE Program, they were short of three credit hours before including those two suggested courses. One of the crucial remarks from PEV was on the Program Criteria which asked the CE Program to provide undescribed several Program Criteria in the curriculum. The issue emerged due to insufficient information received by the CE Program about utilizing recent Program Criteria issued by the American Society of Civil Engineering (ASCE). After reviewing all syllabi, including courses offered by other departments, the CE curriculum met the program criteria. To comply with the PEV query, several contents in the course syllabi were modified to reflect ASCE requirement of the Program Criteria such as sustainability, project management, public policy, professionalisms, ethics, and licensure. For examples, sustainability topics were covered explicitly in Materials in Civil Engineering and Environmental Engineering courses; public policy in Construction Management course; professionalism, ethics and licensure in Introduction to Engineering, Professional Development, and Leadership and Teamwork courses.

The PMU team made detailed arrangement around a month before to the visit. COE Dean and the Program Chairs (CE, ME, and CompE) communicated about detail scheduling with TC and PEVs. The schedules were proposed first by the dean and the program chairs and adjusted by TC and PEVs according to ABET standard needs and their own planned ones. At minimum, the PMU team must arrange PEV meetings with the program chair, faculty members, supported staffs, and students. In addition to meeting with representative faculty and students, the PMU program team scheduled TC activities to meet with the university administrators and support staffs (rector, vice-rector for academic affairs, deans, registrar and admission officers, librarians, and budget and accounting director). A specific meeting with representative math and science professors was requested by the CE PEV. All schedules must fit with the ABET standard visit of two and a half days. Days before the visit, the PMU team arranged display materials including the SO assessment rubric and tools, samples of course portfolio, samples of senior design project report, and meeting minutes about PEOs development, and civil engineering textbooks in a room intended for the EAC visit team. Since there were three programs under review, the room selected was spacious to accommodate display materials for each program and to facilitate a meeting for various parties.

4. During the visit

After the arrival of all four EAC members by Friday, informal activity was started on Saturday by conducting social meeting between the EAC Team and the university representatives (Public Relation, Deans, and Program Chairs). This

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social activity was optional and intended to get to know each other better before the accreditation review started. Table 2 shows the final official schedule for the CE PEV. In general, the program falls into three primary activities: Day 0 was about evaluating teaching facility and materials, Day 1 interviewing personnel involved in teaching, and Day 2 reporting evaluation results. PEV and, or TC debriefed preliminary findings with the program chairs and COE Dean at the ends of Day 0 and Day 1 before the EAC team constructed draft statements of the accreditation review in Day 2. At the end of Day 0, the CE PEV discussed with the CE Chair about findings that needed further clarification, and these included issues related to adequacy of laboratory equipment for teaching, assessment method for specific outcome *h*, and senior design project. The CE PEV recommended that inexpensive testing apparatus for geotechnical and material engineering labs replicated to avoid idleness for students conducting experimental exercises, despite the CE Chair clarified about creating another section to avoid the issue. Based on the course material review, the CE PEV asked clarification about assessment method and tool for outcome *h*, which was soft skill about understanding the impact of engineering solution in a global and societal context. The PEV and CE Chair agreed from the discussion that this particular outcome was very challenging to assess, and the CE Chair showed more examples of rubric-based scoring of senior design project assessment (Chowdhury, et al., 2020). The CE PEV raised another issue about the senior design course that did not apply multiple realistic constraints and applicable design standards as required in the curriculum criterion. Samples of the displayed senior design report did not discuss economic constraint (i.e. simple cost estimate). Also, one of the senior design samples was about research-based project with conceptual design work only, and ABET did not recommend this practice.

At the end of Day 1, the PEV and CE chair discussed findings obtained from the meetings with faculty, staffs and students. The PEV raised a concern about student-over-faculty ratio was raised considering the projected number of students within next few years. The original design of the program aimed to have a student-faculty ratio less than 20 with a projected enrollment of 300 students. In comparison, at the time of accreditation review, the ratio was 25 with 174 students. With seven teaching staffs, the PEV anticipated the ratio to increase and potentially led to teaching performance issue. Another issue detected by PEV based on meeting with students was the availability of essential computer software for civil engineering design courses. Parallel with this, Dean and CE Chair gave clarifications about student transcripts that were out of sequences by showing the actual advisement forms approved by respected program administrators. This included the additional issue in a transcript about transfer student raised at the last minute of Day 1. Again, the CE program confirmed justification allowing transfer student to take courses without normal pre-requites using recorded advising document. Around mid-morning of Day 2, the PEV briefed draft statements to the Chair and Dean before the final exit meeting with the university rector. The authors of this paper observed that some of these issues raised during the pre-visit comments by PEV was due to incomplete information and justification in the pre-visit responses (Table 1).

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Table 2: CE PEV schedule

Sunday (Day 0)	Monday (Day 1)	Tuesday (Day 2)
12:30 EAC Team Departs Hotel to PMU **1:00 – 1:15 PM** Meet and Greet **1:15 – 1:30 PM** Tour Administration Building **1:30 – 3:00 PM** Visit CE Facilities (labs, classrooms, lecture hall) **3:00 – 5:00 PM** Review Course Related Materials, Outcomes Assessment, Recorded Minutes, and Senior Design Reports.	**8:00 – 8:30 AM** COE Dean Presentation **8:30 – 9:00 AM** EAC Team Conference with COE Dean, and Program Chairs **9:00 – 10:30 AM** CE PEV Conference with CE Chair **10:30 – 11:50 AM** CE PEV Conference with math and science professors **12:00 – 1:00 PM** Luncheon: EAC Team with Deans, Chairs, Invited Administrators, Students, Staffs, Alumni and Industrial Advisory Board Members **1:00 – 3:30 PM** CE PEV Meetings with CE Faculty and Staffs **3:30 – 4:30 PM** CE PEV Meetings with Senior Graduating Students, ASCE Student Club Representatives. **4:30 – 5:00 PM** EAC Team Out brief CEO Dean and Chairs	**8:30 – 11:30 AM** PEVs/TC Works on Statements and Seeks Clarifications as Needed **11:30 – 11:50 AM** EAC TC and PEVs Debrief COE Dean and Chairs **12:00 – 2:00 PM** EAC Team Closed Meeting and Lunch **2:00 – 3:00 PM** Exit Meeting with Rector and Selected University Officials **3:30 PM** EAC Team Depart Campus to Hotel

The initial statement issued by EAC Team at the end of the visit was called Program Audit Form (PAF). It contained information about the shortcomings of the program concerning criteria, policies, or procedure. Shortcomings can be in the form of concern (C), weakness (W), and the deficiency (D) with the following definition:

- *A concern indicates that a program currently satisfies a criterion, policy or procedure; however, the potential exists for the situation to change that the criterion, system, or practice may not be sufficient.*
- *A weakness indicates that a program lacks the strength of compliance with a criterion, policy, or procedure to ensure that the quality of the program will not be*

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compromised. Therefore, remedial action is required to strengthen compliance with the criterion, system, or practice before the next evaluation.

- *A deficiency indicates that a criterion, policy or procedure is not satisfied. Therefore, the program is not in compliance with the criterion, system, or practice* (ABET, 2020d).

During the exit meeting, TC gave general summaries about ABET EAC activities during the visit, their findings, responses required to address shortcomings, and timeline for accreditation effort. TC also cited two institutional strengths including: (1) the educational facilities that were above international benchmarks, and (2) the articulation of student outcomes implemented in six core competencies: communication, teamwork, leadership, technological competence, professional competence, and critical thinking. Although they were not written directly in the PAF, the CE PEV cited two strengths of the CE Program. These included: (1) mandatory eight-week professional internship course attesting the use of technical and professional skills in the engineering workplace, and (2) solid ties of the CE faculty members to engineering and business professional in local community-enhancing student learning opportunities. Five shortcomings observed for the CE Program included three weaknesses and two concerns. The CE Program needed to provide responses during the due-process period, which began after the departure of the EAC visit team. The following is a summary of five shortcomings:

- *Student* (W): Issues detected were four transcripts containing the pre-requisites violations with incomplete documentation for justification, including transfer students who took upper-level engineering courses out of sequence. *This criterion requires the program to have and enforce policies for awarding academic credit for courses taken at other institutions and to have enforced procedure to ensure and document that students who graduate meet all graduation requirement [21].*
- *Curriculum* (W): Some senior design projects were research-based and no design elements associated with them, and for those with design-oriented, students did not consider or document any set of realistic constraints. *This criterion requires that students be prepared for engineering practices through a curriculum culminating in a significant design experience based on knowledge and skills acquired in earlier course work and incorporating engineering standard and realistic constraints [21].*
- *Facilities* (W): Insufficient replicates for test setups in the geotechnical and material engineering labs were not adequate to accommodate all students during the lab period. Also, engineering software used in teaching was not available on campus. *This criterion requires that modern tools, equipment, computing resources, and laboratories to be open, accessible, and systematically maintained and upgraded to enable students to attain the student outcomes and to support program needs [21].*
- *Faculty* (C): Despite having moderate of student-to-faculty ratio (1:27), the current number of faculty were not acceptable for a planned target population of 320. *This criterion requires that there be sufficient faculty to accommodate adequate levels of student-faculty interaction, student advising and counselling [21].*

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- *Program Criteria* (C): The curriculum did not cover explicitly principles of sustainability, basic concepts of business, public policy, professional ethics, and licensure as topical coverage in a course or as course learning objectives.

5. Post-visit

ABET provided immediate post-visit activity mostly allocated to provide a seven-day response to the EAC initial findings in case of errors of fact, and to document due-process (30-day) response after receiving a draft statement that was composed by two ABET editors. After revisited the PAF, the CE Program did not submit seven-day response. The draft statement saying about the official review result was received three months after the visit, around mid-March. From this point onward, the CE Program communicated with TC and two editors appointed by ABET EAC. The CE Program submitted the 30-day response highlighting actions taken to correct the shortcomings mentioned in the draft statement (Table 3). The CE Program provided written responses about most of the five shortcomings stated at the end of the visit without too many editorial changes, except for the weakness cited in Criterion 1 (Student) about transcripts showing courses taken out of the program sequence. The CE program gave clarifications to Editors about courses taken out of sequence in those transcripts. All justifications for the course pre-requisite overrides shown in the advisement records seemed not accordance to initial PEV finding.

Table 3: Summary of the 30-day response

Shortcoming (type)	**Issue**	**Responses**
Criterion 1: Student (W)	Student transcripts: - Course overrides	- Submitting documentation for allowing students taking courses out of sequence for the mentioned transcripts, including justifications recorded in the student advisement forms. - Submitting information about the university general policy for course pre-requisite overrides, and the procedure for awarding credit transfer, along with enforcing them with computer-based advisement practice.
Criterion 5: Curriculum (W)	Senior design project: - research-oriented - not applying realistic constraints	- Updating syllabus for senior design project to explain about applying multiple realistic design constraints and associated design standards. - Submitting samples of senior design project proposal (reports and presentation) for the spring semester.
Criterion 7: Facility (W)	Facility: - The not adequate test replicates	- Submitting a copy of the proposal and quotation from lab suppliers for the test equipment replicates.

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	- No software available for engineering design teaching	- Submitting a copy of the purchase order issued to a local vendor to acquire the mentioned engineering software.
Criterion 6: Faculty (C)	Not an adequate number of faculty based on future enrollment	- Submitting approval from the upper-level university administration about recruiting three more teaching staffs under the CE Program. An explanation was given about the recruitment process, including the timeline for job offering and contract signing.
Program Criteria (C)	Not addressing explicitly sustainability concepts, basic concepts of project management, business, public policy, leadership, professionalism and ethic in the curriculum	- Updating syllabi for civil engineering and general university courses related to the mentioned topics including course outlines, topics, and learning outcomes.

Because of ongoing processes, the CE Program gave updates on the faculty recruitment and lab equipment acquisition to TC during the due-process period and before the July 2018 ABET meeting. The CE Program supplied all senior design final reports to TC and ABET EAC to demonstrate compliance with the curriculum criterion about the culmination of design experience. ABET issued the final statement to the three PMU Programs around mid-September 2018 summarizing the actions taken to overcome the shortcomings and the final conclusion about the accreditation results. For the CE Programs, two issues out of five shortcomings were still not resolved, one weakness and one concern. The remained weakness cited was about the incomplete acquisition of the lab equipment replicates recommended by ABET EAC, and the concern was about the number of faculty which was still under the recruitment process. From these evaluation results, ABET recommended that the CE Program be accredited up to the following year (September 2019) and be required to initiate a reaccreditation process by January 2019. The accreditation was extended retroactively three years from the announcement (October 01, 2015). The authors of this paper anticipated the accreditation result since the CE Program was still in the process of correcting those remaining shortcomings and had developed a rigorous action plan to undergo the reaccreditation process.

The main reaccreditation exercise was about providing an interim report addressing the shortcomings, particularly the remained weakness, and ABET did not recommend another visit. The process was the same as the regular accreditation steps, started by submission of RFE by the end of January 2019. Then, ABET assigned a new TC who would evaluate the interim report and concluded with another final statement issuance by early fall term. The CE Program submitted the temporary report to TC and ABET EAC before end of June 2019. The report mostly contained documented actions to correct the weakness in criterion 7 (facility) and the concern in criterion 6 (faculty). The CE Program submitted the interim report with documented evidence including purchase

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order acquisition of the test equipment replicate, photos of those installed equipment, courses and their schedule for lab sessions, and pictures of students working with the equipment in a lab experimentation course. Also, signed and redacted contract letters of new faculty recruits were incorporated in the temporary report to indicate there were additional faculty joining the program. The CE Program also updated all CE departmental websites such as new enrollment figures, lab facilities, and faculty profiles, and provided their respected links in the report. By around mid-fall term, a final statement was issued by ABET EAC that the CE Program resolved all the shortcomings and accredited to September 2022 retroactively from October 01 2015.

6. Results

Technically, the PMU CE Program has been accredited for a seven-year period (Oct 2015-Sept 2022) and will restart another cycle of accreditation on January 2021 with RFE submission followed by ABET visit near the end of fall 2021 term. It has not resulted in Next General Review (NGR) with a seven-year period from the year of review. However, according to the ABET policy, the period of accreditation does not indicate the accreditation quality, since ABET does not recognize the level of accreditation. In other words, all ABET-accredited programs met the quality and fulfil the accreditation criteria set in the accreditation policy (ABET, 2020d). Furthermore, ABET did not recommend exposing the accreditation period in a program website and required to publish only the final official statement saying a program accredited by EAC. Each program has unique accreditation experience due to the nature of evaluator's background, and the accreditation process experienced by the PMU CE program was considered normal for the first time application. The following paragraphs will discuss lessons learned from ABET accreditation exercise, particularly for the first time applicant.

Accreditation Training. It is suggested for the first time application to get the information about the accreditation policy and procedure by actively participating in its various training, workshops, seminars or conferences sponsored by ABET. Sharing information about the accreditation exercises between multiple programs around the world is one of the best strategies to prepare the accreditation. Learning from the PMU CE Program experience trained internally by the previouly accredited programs (EE and IT) in the university, there were different aspects of accreditation criteria that a reviewed program can learn by looking directly the accreditation exercises experienced by another similar program. Accreditation training can be a good source for those who are involved in the quality and accreditation work. After receiving the training, they can conduct an internal workshop to spread the knowledge to the other faculty members within a program. If a program has more budget allocated for the accreditation spending, it is not a bad idea to hire a consultant to advice on developing strong SSR and responding to evaluation reviews. In addition, the reviewed program needs to have mock up review and visit by another similar program within a similar region to improve readiness for the actual accreditation visit.

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Curriculum familiarity. It is crucial to understand the program curriculum comprehensively. In addition to the civil and general engineering courses, the accreditation committee needs to be familiar with courses that are taught by other departments such as mathematics, sciences and competency courses. The reviewed program needs to coordinate with those departments to perform assessment of course-learning outcomes strongly correlated with those of the ABET SO. Although not required in the SSR, the reviewed program need to perform curriculum benchmarking with other similar accredited programs, nationally and internationally. This is to anticipate providing critical findings in the SSR, particularly in the continuous improvement criterion, which can be in term of curriculum upgrade when there are significant differences in the course offering and sequence.

Assessing competency-based outcomes. Assessment of the ABET competency-based outcomes such as communications, teamwork, leadership, professionalism and ethics, understanding the impact of engineering solutions, and life-long learning skills is challenging task to measure and document. These skills are typically assessed comprehensively in the introduction to engineering and senior engineering design courses using what so-called rubric-based scoring (Felder, et al., 2003; Ghaly, 2019). The reviewed program can use regular engineering courses to assess such skills, for example, laboratory based courses where students conduct learning exercises involving teamwork, written lab report, and oral presentation. Again, the rubric is as one of the assessment techniques to obtain quantitative values for these skills. Some non-engineering courses offered by English and social science departments sometimes cover these competency skills explicitly in their syllabi, and coordinating learning outcome measure with the instructors from those departments would be helpful in supplying part of the overall SO assessment.

Adequacy of resources. Despite shifting to outcome-based, teaching resources and infrastructure including faculty, facility and institutional supports, must meet acceptable ABET criteria concerning the quality and quantity. As the acceptable student-to-faculty ratio is one of the indicators to fulfill the faculty criterion, the criteria for infrastructure (equipment) and institutional supports are not immediately apparent. Lesson learned from the EAC recommendation given to the PMU CE Program about providing more test replicates despite modern and up-to-date equipment available for student lab experimentations is that adequacy of the facility concerning the number of students is needed. Solutions to create more lab sections or sifting experimentation module are not acceptable practice according to the facility criterion. As was suggested in the curriculum, benchmarking of teaching facility and infrastructure with other similar accredited programs is critical here.

Senior design course. Is arguably the most important course in the engineering programs, and ABET will evaluate thoroughly the course practice including assessment tools and methods, grading policy, and samples of final report and prototype as well as a final oral presentation. It is crucial to provide high-quality samples for a senior design project since this will be the first item to be evaluated

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by the EAC visit team. The project must be design-oriented and comply with the criterion stating that project must capture previous student design experiences (i.e. capstone based courses) and be as realistic as possible by applying actual (practical) constraints and design standards. Assessment tools and methods must capture the requirements stated in this criterion by using comprehensive rubric-based scoring for the project design constraints and specifications (Chowdhury, et al., 2020; Felder, et al., 2003).

Continuous improvement. For the first time application, the period of data collection for the SO assessment is not a crucial factor as the PMU CE Program had performed assessment using two-semester data. It was considered too early to propose essential continuous improvement such as curriculum upgrade based on a limited period of evaluation. The ABET message here was that a program must develop a robust method for assessing the SO that can conclude the assessment cycle at some point. The PMU CE Program upgraded the curriculum based on the ABET accreditation outcomes and has implemented a new CE degree starting from Fall 2019 term. Fundamental curriculum changes included the following: (1) splitting senior design course into two semesters to boost the quality of student ability in mastering culminating design experience; (2) offering a new course in sustainable engineering to cover ABET Program Criteria set by ASCE; and (3) adding computer-aided design course to improve student ability in math (geometry) application in civil engineering. The new curriculum applies to incoming 2019 student at the freshmen level with the anticipation that during the ABET next evaluation visit in fall 2021 the CE Program will document and report progress assessment, since there will be no graduating student by that time under the new curriculum. The next SSR under the old curriculum practice will still be significant content in the SO assessment with expected continuous improvement on reinforcing rolling the new curriculum.

7. Discussion and Conclusion

Accreditation process and outcome is analogous to a professor assessing student performance in a course using a set of criteria; it is always stereotyped with subjectivity due to various factors including the background of the accreditation evaluators. However, the accreditation standard and criteria are the same and should be applied relatively to either new or existing programs, national or international programs with different cultural education practices. Regardless of the criteria and the associated evaluators who will interpret the criteria based on his or her background knowledge and experience, a program must prepare to demonstrate that its educational practice meets all criteria set by the accreditation body. Based on the experience of the PMU engineering programs having first ABET accreditation evaluation during two different span periods, ABET has acted relatively in assessing the quality of the programs. Various recommendations given by ABET EAC to varying programs at PMU have resulted in enriched knowledge on how to continuously improve teaching and learning efficiently using collaborative actions. To experience a smooth and successful accreditation process, small universities with new established engineering programs requires strong support from and good coordination with the upper-level administrations. The decision by university or college quality assurance committee to submit the

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program accreditation process either as individuals or as a group along with other programs within a college requires consideration. It is important decision for a small university offering various engineering programs considering budget constraint and collaborative work benefit gained for doing accreditation processes at the same time.

Acknowledgments

The authors appreciated the contributions by PMU civil engineering professors, instructors, technician, and staffs for the successful ABET accreditation of the CE Program. In addition, the authors appreciated strong supports from the PMU COE Dean and Senior Management.

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