Formalising and Evaluating the Assessment of Engineering Professional Skills

Hadisantono

A thesis submitted in fulfilment of the requirements for the degree of Doctor of Philosophy in Electrical and Electronic Engineering, The University of Auckland, 2020.

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CO-AUTHORS

Name	Nature of Contribution
Gerard Rowe	Advice on research direction and methodology, and proof reading of the paper
Nasser Giacaman	Advice on research direction and methodology, and proof reading of the paper

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Abstract

In engineering program accreditation, there are two areas of expertise, commonly distinguished as "hard engineering skills" and "soft engineering skills". Soft engineering skills, which are also known as Engineering Professional Skills (EPS), include skills such as communication, teamwork, ethical responsibility, professionalism, awareness of the impact of engineering solutions on society, life-long learning and understanding of contemporary issues. These EPS skills are critical for success in today's engineering careers. Assessing EPS as part of engineering program outcomes in accreditation remains problematic. It tends to be difficult and requires more labour and time than assessing hard engineering skills which perhaps is adequately done by paper-based test methods (ideally including both pre-tests and post-tests). Furthermore, for a developing country like Indonesia (and some other countries), there is an issue that the outcome of engineering program curriculum should also meet the domestic needs. Unfortunately, this requirement is not covered by the existing assessment method. This thesis addresses EPS assessment in an Indonesian setting where the curriculum must simultaneously cover both the national (core) curriculum and the local (institutional) curriculum, with the latter requiring (by government decree) awareness of and sensitivity to domestic issues. This thesis presents the modification of the existing Engineering Professional Skill Assessment (EPSA) rubric to include assessment of local cultural competency. The rubric was evaluated in two cycles of action research with Indonesian tertiary students.

Keywords: Engineering Professional Skills (EPS), Engineering Professional Skill Assessment (EPSA), Accreditation

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Chapter 1. Introduction

This chapter introduces the research starting from the background of research ideas, describes the scope within which the research problem arises, and generates the research questions that initiated this research. The stages of research are defined. The objective and expected outcomes of the research are described, and the significance and benefits of the research explained in the implications of these outcomes. Chapter 1 also addresses some limitations to the generalisation of the results of the research.

This chapter ends by describing the structure of the thesis followed by a brief explanation of each chapter's content.

1.1. Scope of the Research

This research is motivated by an awareness of the importance of assessment in the teaching and learning process of engineering education. Assessment is framed as an integrated part of course design (Xiao et al. 2012; Rompelman and Graaff 2006). Angelo (2010) defines assessment as an ongoing process aimed at understanding and improving learning. When it is embedded effectively within larger institutional systems, assessment can help focus collective attention, examine assumptions, and create a shared academic culture dedicated to assuring and improving the quality of engineering education.

There are many business managements models which have been implemented in education assessment (for example Lalovic 2002). Implementation of this (six-sigma based) model presupposes commitment by educational institutions to improve the quality of education by utilising business management techniques. Implementation of quality management in education is known as Total Quality Education (Sallis 2002). The basis of this management concept was developed from the concept of Total Quality Management, which was originally applied to the business world and later applied to the world of education. Philosophically, this concept emphasizes continuous improvement to meet customers' (students') needs and satisfaction (Fields 1994; Sun 2008).

With a common understanding of the purpose and value of assessment, the engineering community can better identify those capabilities likely to be needed by engineering graduates throughout their professional careers, and the ways to best develop those capabilities. Properly implemented programme assessment can increase student understanding (as it is known that assessment drives behaviour) thereby improving teaching and learning outcomes.

Undergraduate engineering education provides a foundation for lifelong learning, particularly in the first principles-based courses taught in first and second year (Rowe et al. 2010; Smaill, et al. 2011; Smaill et al. 2012; Smaill and Rowe 2012). As such, it has an obligation, especially to those expecting to enter a profession, to educate broadly and to develop academic literacy. This means not only creating a base for further study but enabling graduates to become thoughtful practitioners and to assume leadership in the profession. Thus, assessment of undergraduate engineering education is a significant concern for the engineering community and the profession.

In 1996, the Accreditation Board for Engineering and Technology (ABET) introduced the Engineering Criteria 2000 (ABET 2017). After a two-year pilot study and three-year phased implementation, the criteria were widely adopted in 2001. In these criteria (especially Criterion 3), there is a set of eleven outcomes. These outcomes can be divided into two areas of expertise, namely "hard skills" and "soft skills" (Shuman et al. 2005). According to Smerdon (2000), these soft skills have also been referred to as Engineering Professional Skills (EPS) by the American Society for Engineering Education (ASEE) since 1994. EPS relates to six skills namely, teamwork, oral and written communication, understanding ethics and professionalism (which are labelled as process skills), awareness of the impact of engineering solutions, life-long learning, and knowledge of contemporary issues (which are labelled as awareness skills). These EPS skills are critical for success in today's engineering careers (Kranov et al. 2013a).

Assessing EPS as part of engineering programme outcomes in accreditation remains problematic (Al-Bahi et al. 2013). It tends to be difficult and requires more labour and time than assessing hard engineering skills which perhaps is adequately done by paper-based (or online) test methods (ideally including both pre-tests and post-tests). Thus, the problem addressed here is how to determine an appropriate assessment method for EPS (McMartin et al. 2000). While a variety of methods have been developed to perform the EPS assessment as shown in the literature review in a later chapter (Chapter 2), unfortunately these methods do not necessarily assess the real EPS of students because they may reflect an inaccurate perception of knowledge about a particular engineering concept. McCormack et al. (2013)

attribute that weakness to the fact that most of these assessment methods assess only one skill at a time.

Furthermore, any engineering programme is likely to be strongly influenced by both the global and local situations faced by the country in which the engineering programme is located. This can lead to the assessment requirement becoming more specific. A recognition of the differences in local and regional needs has resulted in the development of several different accreditation standards such as ABET, the Washington Accord, and the Bologna agreement. Although they may share some features in common, there are some points of difference including the manner in which required graduate attributes are interpreted and the manner in which the societal expectations of local populations are included in the education of engineers. It is the latter point that is specifically addressed in this research.

In this research, we use an Indonesian setting as a case study. As a large developing country with a highly dispersed geographic situation, each region in Indonesia has different needs. In consequence, local content has become a mandatory part of the curriculum structure. In the research reported in this thesis, the Engineering Professional Skills Assessment (EPSA) rubric is modified to align with the local accreditation requirements (which are distinct from ABET for which the EPSA was developed). Scenarios are developed to be used as case studies when educating engineering students on how to solve local everyday problems that are influenced by local people's practices and principles.

Since this research is focussed on EPS assessment issues for engineering education in Indonesia, the scope of research is limited to the Indonesian setting. This research began with development of a customised Engineering Professional Skill Assessment (EPSA) rubric based on Curriculum 2012 of the Department of Industrial Engineering at Universitas Atma Jaya Yogyakarta, Indonesia. Via this modified EPSA rubric, new scenarios were established through which students develop their engineering professional skills and gain experience in assessment of such skills. Topics in these new scenarios are taken from daily issues of public concern in Indonesia. Furthermore, both the new EPSA rubric and the expanded scenarios are implemented and evaluated. The research findings are to be used to formalise a standard methodology for EPSA in Indonesia.

1.2. Problem Statement

While the assessment of hard engineering skills is perhaps adequately achieved through a series of written tests (perhaps including both pre-tests and post-tests), assessing EPS as part of engineering programme outcomes in accreditation remains problematic. Furthermore, for a developing country such as Indonesia (and some local populations in other countries), there is the issue of whether the outcomes of engineering programme curricula adequately meet the domestic/local needs. Unfortunately, this requirement is not well covered by existing EPS assessment methods. Thus, the problem addressed here is how to determine an appropriate assessment method for EPS that covers both the global and domestic requirements.

1.2.1. Objective Statement

The objectives of this research are:

- to establish a method for formal assessment and evaluation of EPS based on terms and conditions in engineering education in the Department of Industrial Engineering, Faculty of Industrial Technology, Universitas Atma Jaya Yogyakarta, Indonesia;
- to extend the EPSA method to include local/domestic competency, especially in the customised rubric and in the locally relevant scenarios; and
- to evaluate the modified EPSA method in two cycles of action research with the students of the Department of Industrial Engineering, Faculty of Industrial Technology, Universitas Atma Jaya Yogyakarta, Indonesia

1.2.2. Research Questions

A novel feature of this research is the development of an assessment of EPS that could meet the needs of both a developing country like Indonesia (and some other countries) and the general engineering programme requirements. Thus, the main question to be addressed is how the assessment can measure the level of skills achievement by the students (RQ1). A secondary question is how this assessment can be extended to include assessment of local/domestic competency (RQ2).

1.3. Stages of the Research

The main goal of this research is to develop a method for formal assessment of EPS in order to meet specific Indonesian requirements. The research was carried out in seven stages. These stages are:

- Stage 1: Conduct a literature review.
  The literature review explores the recent research in EPS related applications. International accreditation systems including those of ABET, the Washington Accord, ENAEE-EURACE, and the Bologna Accreditation System were reviewed with a view to identifying a relevant approach for the Indonesian Accreditation System. The review also examined Graduate Profiles as examples of engineering education programme outcomes that cover both global and (Indonesian) domestic requirements.
- Stage 2: Establish a criterion for EPS assessment of local engineering programme outcomes.
  In stage 2, a new criterion that specifically addresses local engineering programme outcomes was identified and adopted as a criterion for EPS assessment. The selection of an appropriate criteria was guided by ABET EC-2000, Decree No. 232/U/2000 and Universitas Atma Jaya Yogyakarta curriculum contents.
- Stage 3: Building a customised EPSA rubric.
  In this stage, a customised EPSA rubric was developed incorporating the new criteria, which were identified in stage 2.
- Stage 4: Creating locally relevant scenarios.
  Before running an EPSA rubric class administration, locally relevant scenarios are required. These locally relevant scenarios must be designed to integrate both global and local engineering issues faced by the local community.
- Stage 5: Running a series of EPSA rubric class administrations.
  The EPSA rubric class administration was applied in two cycles. The first cycle, which took place in Semester II Academic Year 2015/2016, was intended to evaluate the customised EPSA rubric. In the second cycle, which took place in Semester II Academic Year 2016/2017, a revised version of the customised EPSA rubric was applied to the assessment process. Data were collected by audio-recording in EPSA discussions along with feedback from students in the form of questionnaires, focus group discussions and researcher observations.

- Stage 6: Analysing and reflecting the findings.
  The results obtained from the first cycle were evaluated and then used to revise the process in the next cycle where the whole process was repeated. The findings of both cycles were then used to develop a final version of customised EPSA rubric in order to meet specific Indonesian requirements.
- Stage 7: Developing a final version of customised EPSA rubric for an Indonesian setting.
  The last stage consisted of a development of the final version of the customised EPSA rubric for an Indonesian setting. This stage also investigated the possibility of how this assessment method could be extended to become a formal assessment tool for EPS in the accreditation process in Indonesia.

1.4. The Significance and Benefits of the Research

The participants of this research (students) may not benefit from participation in the research directly. However, in general, this research will help the Department of Industrial Engineering, Faculty of Industrial Technology, Universitas Atma Jaya Yogyakarta, Indonesia to assess the EPS of their students and develop a better curriculum. There may be an indirect benefit in that this research may help Universitas Atma Jaya Yogyakarta maintain their degree accreditation. Furthermore, the research potentially has considerable significance to Indonesia in improving the quality of engineering education and is generally applicable to engineering programmes internationally for developing countries and some other countries which have similar education characteristics to Indonesia.

1.5. Limitations

The following limitations to the generalisation of the results of the research were recognised:

1. The assessment is done by participants who know each other in a group discussion so the results may reflect bias due to subjectivity of participants.
2. The findings and conclusions drawn from the research were based on the data gathered from participants.
3. The population studied is the undergraduate students of Industrial Engineering (a four-year programme) who are enrolled in the classes of IND3852 Technopreneurship (3rd Year), IND4264 Integrated System Design (3rd Year), or IND5172 Engineering Ethics

(4th Year), Department of Industrial Engineering, Faculty of Industrial Technology, Universitas Atma Jaya Yogyakarta, Indonesia.

4. These courses were selected because they are integrative courses which are taught in the two final years of the degree. At this stage of their education, it was reasonable to assume that the students already had sufficient engineering knowledge to analyse the engineering issues arising in the scenarios of this research.
5. In this research, a threat to validity was identified as the assessors potentially incorrect understanding of each skill interpretation. While each skill has different characteristics, students with a lack of experience on this kind of assessment as assessors will face some difficulties in understanding of each skill interpretation, especially in a time restricted situation. To anticipate this limitation, each discussion was recorded (voice recording). These audio recordings gave the opportunity to the assessors to review and clarify their assessments later before submitting them to the researcher.
6. In this research, the performance ratings were assessed in the context of a team-based rating, therefore the number of members of each sub-team can be flexible. The assessment sub-team can be smaller as the assessment process did not depend on the number of members of the discussion sub-team.
7. The EPSA process in this research was designed and developed from the researcher's perspective.

1.6. Thesis Organisation

The thesis is written in eight chapters as presented in **Error! Reference source not found.**Table 1.

Table 1. Thesis Chapters.

Chapter	Title
1	Introduction
2	Literature Review
3	Research Methodology
4	The Customised EPSA Rubric
5	The Field Work Cycle 1
6	The Field Work Cycle 1
7	Formalising the EPSA Method
8	Conclusions and Future Work

Figure 1 describes more details of the thesis structure through a flow chart. Each arrow represents the relationship between the chapters. The green boxes represent the background work which initiated and motivated the research, while the blue boxes represent the original contribution of the research.

Chapter 1 provides a description of the background that motivated this research and outlines the research objectives. It describes the planned stages of the research, the problems and questions central to the research, the significance and expected benefits of the research, and some limitations to the generalisation of the results of the research. The chapter ends with a brief overview of the thesis organisation.

Chapter 2 contains a systematic review of a number of related topics of interest in this research including EPS and its assessment methods. In particular, the review examines the Engineering Professional Skills Assessment (EPSA) method and its related publications, applications and improvements. The chapter also reviews international accreditation systems such as ABET, the Washington Accord, ENAEE-EURACE, and the Bologna Accreditation System and applies special focus to the Indonesian Accreditation System. The chapter concludes with a discussion of Graduate Profiles as examples of engineering education programme outcomes that cover both global and (Indonesian) domestic requirements.

Chapter 3 describes the research methodology to be adopted in this research. The action research methodology was applied since the research consists of a series of iterative processes or cycles. The chapter provides the step-by-step research design for each cycle, starting from customising the existing EPSA rubric in order to meet both the specific Indonesian and the general engineering programme requirements. Locally relevant scenario development designed to include the local engineering issues faced by the local community, and the plan for the EPSA rubric class administrations. The chapter ends by discussing ethical issues that arose in this research.

Chapter 4 presents the Customised EPSA method in detail. The chapter starts by considering the process required to establish unique criteria for local curriculum content. These criteria are then integrated into the customised EPSA rubric. Seven locally relevant scenarios are developed to complement the rubric. The chapter concludes with the generation of the EPSA Scoring Sheets as a tool for EPSA rubric class administration.

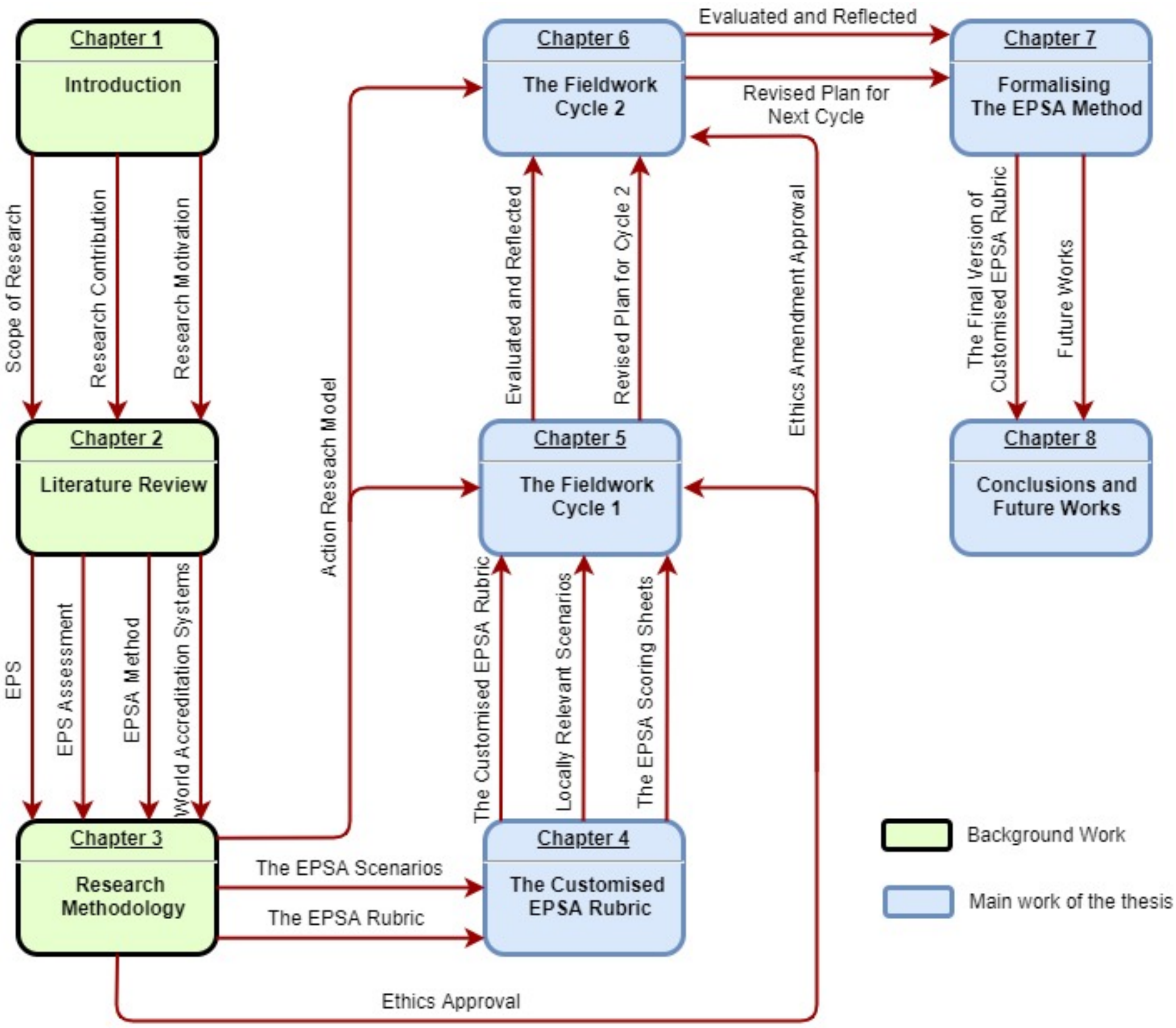

Figure 1. Thesis Flow Chart

Chapter 5 describes the first action cycle as the first cycle of fieldwork. The chapter discusses the first cycle of fieldwork's experiences including the obstacles and findings. The results were evaluated and then used to revise the process in the next cycle.

Chapter 6 describes the second action cycle as the second cycle of fieldwork. The chapter ends by presenting the final version of the customised EPSA rubric. The process mirrored that of the first cycle. Some adjustments based on the results of the first cycle's findings were made and then applied. The results of the second cycle are evaluated and then used to develop the next cycle (latest EPSA implementation).

Chapter 7 describes the formalising of the final version of the customised EPSA rubric for an Indonesian setting. The chapter integrates the new accreditation criteria (the IABEE Graduate Outcomes) and the new IE-UAJY 2017 Curriculum Learning Outcomes into the new EPSA rubric. The chapter also describes the development of a new EPSA standard rating using the SOLO Taxonomy.

The thesis concludes with Chapter 8, which summarises the research findings and their contribution. The thesis ends with recommendations for some future works.

Chapter 2. Literature Review

This chapter reviews related publications. The purpose of conducting this literature review was to demonstrate where this study sits in the body of knowledge relating to assessment of Engineering Professional Skills (EPS). Current understandings of EPS assessment and practice are examined. Current research on EPS assessment methods is discussed. The literature review further considers international accreditation systems and in particular probes the extent to which EPS assessment is considered in the accreditation process.

The literature review is structured into four major sections, each with a number of subsections. The first section concerns the concept of EPS which is discussed in relation to graduate profiles and accreditation systems and includes consideration of issues of EPS integration in curricula design. The second section is concerned with the existing methods of EPS assessment. The advantages and disadvantages of each assessment method are discussed. The third section outlines all related publications on the Engineering Professional Skills Assessment (EPSA) rubric. While this method is still new and needs considerable improvement, this section maps the issues observed in EPSA implementation experiences and considers the possibility of customising the EPSA in order to meet both the specific Indonesian and the general engineering program requirements. The fourth section compares international accreditation systems, especially with regard to how EPS are assessed. This chapter ends with a summary of what are the gaps in the body of knowledge about engineering professional skills assessment and what the important open research questions are.

2.1. Engineering Professional Skills (EPS)

According to the Accreditation Board for Engineering and Technology (ABET 2017), the process of accreditation of education institutions generally requires an assessment of two areas of expertise, namely "hard skills" and "soft skills" (Shuman et al. 2005). Hard skills are a part of the skill set that is required for a job. They include the expertise necessary for an individual to successfully do the job. They are job-specific and are typically listed in job descriptions. Hard skills are acquired through formal education and training programs, including college, apprenticeships, training classes, online courses, certification programs, as well as by on-the-job training. While hard skills then are those that can be easily learned, defined, evaluated and measured, soft skills, on the other hand, are subjective skills that are intangible and much harder to quantify. Soft skills relate to people management skills and are therefore important to many professions and job positions (Matteson et al. 2016). There are many different names for these skills including core skills, employability skills, essential skills, generic skills, key competencies, and transferable skills (McEwen 2010), and emotional quotient (EQ) skills (Sigmar et al. 2010). In some engineering programmes, these soft skills are also known as Engineering Professional Skills (Shuman et al. 2005). EPS relates to teamwork, oral and written communication, understanding ethics and professionalism (labelled as process skills), engineering within a global and societal context, life-long learning, and knowledge of contemporary issues (labelled as awareness skills). These EPS skills are critical for success in today's engineering careers (Kranov et al. 2013a).

The results of research and studies in Indonesia (Sailah 2008) shows that industry and education providers have distinctly different viewpoints with regard to the required hard and soft engineering skills, the balance to be struck between them and the path to be followed to develop these skills. Specific differences of opinion centre on:

- The ratio of soft and hard engineering skills required in engineering careers is perceived by industry to be inversely proportional to the time allotted to their development in higher education curricula. Sailah's research describes an industry perception that for success in engineering careers, 80% is determined by the employee's mind-set (soft engineering skills) and 20% is determined by the employee's technical skills (hard engineering skills). However, industry perceives that in practice the development of soft engineering skills (by the higher education system) occupies only an average of 10% of the curriculum, while the remaining 90% of the curriculum is associated with the development of hard engineering skills.
- Sailah's research further describes that from the point of view of a higher education provider, a "highly competent" graduate is a graduate with a high GPA who completes a 4-year undergraduate program in 4 (or fewer) years. By contrast, for employers, a "highly competent" graduate is one who has an appropriate balance of technical and professional skills. For higher education providers a key criterion of a good study program is that its graduates are able to gain employment quickly after graduation, while for employers the key criterion is the motivation and commitment the new graduate brings to their employment.

Soft skills development is important in the student learning process (Chou 2009; Dixon et al. 2010; Glenn 2011; Kermis & Kermis 2010; Klaus 2008; Mitchell & Crawford 2010; Stevenson & Starkweather 2009; Stitt-Gohdes 2011; Stovall & Stovall 2009; Wilhelm et al. 2002). The importance of soft engineering skills for graduates was actually realised some time ago by Indonesian educators (Sofyan 2006). However, these soft engineering skills are often presented as merely additional issues in curricula design and are not always well integrated in the teaching and learning process. In addition, there is a limited space available for inclusion of soft engineering skills as the curriculum must simultaneously cover both the national (core) curriculum and also the local (institutional) curriculum (based on a Decree of the Minister of National Education of the Republic of Indonesia No. 232/U/2000 about Guidelines for Proposing of Higher Education Curriculum and Assessment of Student Learning). Compromises in the design of a curriculum may result in the education process being slanted toward a knowledge delivery process. The education system must provide balance between short-term needs (hard engineering skills) and long-term needs (soft engineering skills). In the process of learning, soft engineering skills must be integrated in all teaching and learning activities (Sofyan 2006).

Issues with EPS development have also been experienced by other developing countries. Schoepp & Danaher (2016) identified similar issue experienced within the United Arab Emirates (UAE) and the Gulf region. Employers valued the EPS more than specific disciplinary knowledge. Unfortunately, the EPS were perceived as being insufficiently developed in the region, and the UAE in particular (Arab Thought Foundation 2013).

Suskie (2014) also identified similar issues. Establishing EPS as learning outcomes is a crucial element of accountability and accreditation. Suskie highlighted the danger of being enmeshed in the details of assessment and then Suskie described accreditation and accountability as consisting of five dimensions or cultures: relevance, community, focus and aspiration, evidence, and betterment. She established the context for the importance of the five dimensions and explained why higher education is seemingly under attack. She also clearly identified three general issues that have driven the desire for accreditation and accountability: economic development, return on investment and the changing college student. She concluded that there is a growing perception and evidence that U.S. Colleges are no longer meeting the United States' needs effectively.

Another point of view concerning the importance of EPS is demonstrated by the National Association of Colleges and Employers (NACE) report. NACE is a professional association that connects more than 9,500 college career services professionals; more than 3,100 university relations and recruiting professionals; and more than 300 business solution providers. NACE is an American non-profit professional association established in 1956 in Bethlehem, Pennsylvania. Every year, NACE releases the results of a survey of national employers regarding the attributes/skills they are looking for in their new college hires. The NACE Job Outlook Survey 2019 results show that more than 80 percent of employers will seek proof of written communication skills along with problem solving skills. Table 2 presents the twenty attributes/skills sought by employers along with their importance rating. Data were collected from 1 August 2018 until 8 October 2018 with a total of 172 returned surveys (at 18.5% rate of response).

Table 2. Attributes Employers Seek on a Candidate's Resume

Rank No.	Attribute	% of Respondents
1	*Communication skills (written)*	*82.0%*
2	*Problem-solving skills*	*80.9%*
3	*Ability to work in a team*	*78.7%*
4	*Initiative*	*74.2%*
5	Analytical/quantitative skills	71.9%
6	*Strong work ethic*	*70.8%*
7	*Communication skills (verbal)*	*67.4%*
8	*Leadership*	*67.4%*
9	Detail-oriented	59.6%
10	Technical skills	59.6%
11	*Flexibility/adaptability*	*58.4%*
12	Computer skills	55.1%
13	*Interpersonal skills (relates well to others)*	*52.8%*
14	Organizational ability	43.8%
15	Strategic planning skills	38.2%
16	Tactfulness	25.8%
17	*Creativity*	*23.6%*
18	*Friendly/outgoing personality*	*22.5%*
19	*Entrepreneurial skills/risk-taker*	*16.9%*
20	Fluency in a foreign language	11.2%

Source: NACE Job Outlook Survey 2019 (2018)

From the table above, there are eight attributes/skills that are related to hard engineering skills (no. 5, 9, 10, 12, 14, 15, 16, and 20) and the others are related to EPS (no. 1, 2, 3, 4, 6, 7, 8, 11, 13, 17, 18, and 19 – written in italics). These skills are necessary to help students be competitive when they start applying for internships, permanent employment or graduate school in the future. Students need to evaluate their attributes/skills, identify strengths and areas of needed growth, and establish a plan to continue to further develop these critical attributes/skills.

2.2. Assessment of Engineering Professional Skills

Although ABET EC-2000 was introduced in 1996 and widely adopted by 2001, some concerns still exist regarding the challenges of teaching and assessing the EPS effectively (Shuman et al. 2005). Furthermore, Shuman et al. suggested that while most faculty members within ABET accredited programmes understand how to develop students' technical skills many lack confidences in teaching and assessing the EPS. Moreover, for some EPS (such as teamwork) there are complexities inherent in the assessment itself. These complexities arise because the skill was developed through working in teams both inside and outside the classroom, projects, internships, and extracurricular activities, so the assessment becomes complicated. Not all lecturers have the patience and perseverance to incorporate the concept of developing EPS in their teaching process. This finding was supported by Barakat & Plouff (2014). Their research demonstrated that EPS are not easily integrated in a traditional USA engineering lecturing format. Al-Bahi et al. (2013) describe a similar issue in the Arabian Gulf region.

Shuman et al. (2005) identified three obstacles that have hampered the development of appropriate tools to assess the students' achievement of the EPS: a consensus about definitions, the scope by which the EPS is assessed, and the nature of the EPS outcomes themselves.

The first obstacle arises because of disagreement between educators regarding the definition of the EPS. In the case of technical skills, educators more easily reach an agreement on the definition so that they are also more likely to agree on methodology for assessment as well. For example, Matson et al. (2007) proposed an Industrial Engineering Body of Knowledge (IE-BoK), the outcomes of industrial engineering (IE) that distinguish IE from other engineering disciplines. The IE-BoK is likely to be widely accepted because all IE educators have the same understanding of IE educational objectives, outcomes and curricula programs. This is very different to the case of assessing students' EPS achievement, for example, to assess students' ability to evaluate and resolve ethical dilemmas. The problem here is that educators have not reached an agreement on the definition of this outcome, in terms of solving engineering ethics problems. The solutions obtained for a particular case may not be applicable to other cases. Engineering ethics is an open-ended problem, where the solution obtained can be vary according to the creativity of the problem solver, and the solution may not be applicable to other similar cases. An understanding of ethics (and the other fields of professionalism) will vary between engineering educators depend on the situation and conditions faced. This may lead to imprecise EPS assessment.

The second obstacle is the scope by which the EPS is assessed. Shuman et al. (2005) suggest that hard skills are mostly taught and learnt through traditional classroom teaching; the learning outcome assessment is therefore limited to the material that has been learned by students in a classroom. This is different from assessing students' EPS. For example, the skill related to teamwork is developed through working in teams both inside and outside the classroom, through projects, internships, and extracurricular activities. The assessment scope for this skill is thus quite broad and can even cover other related subjects. This issue makes the EPS assessment considerably more complicated than assessment of hard skills.

The third obstacle is the nature of EPS outcomes itself. Shuman et al. (2005) argue that (for many engineering programme designers) EPS outcomes are principally centred on awareness issues, to position the students for future practice, and lack specificity. For instance, students are made aware of the importance of EPS (e.g. life-long learning) in the practice of their professionalism in the future. This awareness of the importance of EPS will affect their aims, attitudes and values when they engage in the engineering profession in the future. The question is how best to assess something that will happen in the future? To assess the success or level of awareness of the importance of EPS is thus very complicated.

If these three obstacles can be overcome, then the EPS can be assessed effectively. This will lead to an even more interesting challenge; namely what assessment methods are considered more effective. While a number of methods have been developed to assess the EPS, the challenge of finding effective assessment methods remains an open problem.

A literature review conducted as a part of this research has shown that educators and faculty members have used many methods to assess students' EPS. The best known are:

- Qualitative Methods such as questionnaires and interviews for gathering student opinions (Aglan & Ali 1996; Yokomoto et al. 1995).
- Statistical Analysis (Larpkiataworn et al. 2003)
- Comprehensive Assessment Program (McGourty et al. 1998)
- Mixed-Method Approach (Leydens et al. 2004)
- Concept Maps (Besterfield-Sacre et al. 2004; Gerchak et al. 2003; Turns et al. 2000)

- Attitudes Assessment (Besterfield-Sacre et al. 1998)
- Peer Assessment (El-Mowafy 2014; Falchikov & Goldfinch 2000; Topping 1998; Zhang 2012)
- Collegiate Learning Assessment (CLA) which utilizes an open-ended scenario-based performance task methodology and purports to assess problem-solving, critical thinking and written communication (Arum & Roksa 2010)
- The standardized Collegiate Assessment of Academic Proficiency and the Miville-Guzman Universality/Diversity Scale (Pascarella & Blaich 2013)
- E-portfolio in first-year courses as a way to allow students to demonstrate attainment of professional skills and for faculty to assess them using developmental rubrics (McNair et al. 2006).
- Online System to Teach and Assess the Professional Skills During the Student Internship (Barakat & Plouff 2014)
- Open-ended, take-home, written exam to assess the professional skills (Lopez et al. 2011)
- An indirect method of assessment by utilising a portfolio in which students identified instances where they demonstrated the professional skills (Richerson et al. 2007)
- Internships evaluated by rubrics (Al-Bahi et al. 2013)

Unfortunately, these assessment methods do not necessarily assess the real EPS achievement of students because they may reflect an inaccurate perception of knowledge about a particular engineering concept. Furthermore, most of these assessment methods assess each skill separately, distinctly from each other at a specific time, and evaluate the skills indirectly (McCormack et al. 2013). Danaher et al. (2016) demonstrated that assessing the skills simultaneously increased the efficacy of the assessment and such a direct assessment increased trustworthiness. This finding was also supported by Suskie (2009).

Assessing EPS as part of engineering program outcomes in accreditation remains problematic and challenging (Al-Bahi et al. 2013; Shuman et al. 2005). It is based on the premise that employers prioritise EPS, but most of students are weak in EPS, and they are considered difficult to assess. Thus, the problem addressed here is how to determine an appropriate assessment method for EPS (McMartin et al. 2000). It is a topical problem to address as the manner in which EPS are assessed is a frequently asked question by the National Accreditation Board in the accreditation process.

2.3. The Engineering Professional Skills Assessment (EPSA) Method

The method, which is being studied in this research, the Engineering Professional Skills Assessment (EPSA) method was firstly introduced in 2007 in the Faculty of Engineering, Washington State University (Kranov et al. 2008). This method is based on performance of a task with an accompanying marking rubric to assess ABET professional skills outcomes. The performance task is a student discussion of an open-ended, unresolved, discipline-related problem, held face-to-face and subsequently analysed using a rubric. Support for the development of the EPSA methods was obtained from the National Science Foundation (NSF). The NSF funded the research project on the EPSA for four years, starting in 2011 and finishing in 2015. Since its introduction in 2007, a number of EPSA publications have appeared including mini workshops (Beyerlein et al. 2011), a validity study (Kranov et al. 2011; Kranov et al. 2013b), EPSA best practice and evaluation (Kranov et al. 2013a; Schmeckpeper et al. 2012; Schmeckpeper et al. 2014a; Schmeckpeper et al. 2014b; Schmeckpeper et al. 2015), scenario and scoring strategy (McCormack et al. 2013; McCormack et al. 2014; Zhang et al. 2015), a case study module (Schwartz & Kranov 2012) and a book chapter (Mazumder 2016).

The original version of the EPSA method consists of a series of performance tasks, including:

- reading a 1-2-page scenario about a contemporary, interdisciplinary engineering problem intended to prompt discussion among a group of 5-6 students;
- a 45-minute discussion period where students are asked to address a series of generic questions about the scenario;
- an analytical rubric; and
- a set of scenario-specific notes about what constitutes exemplary performance.

The EPSA is used to assess the students' performance in responding to a given scenario using as criteria six learning outcomes from ABET (2017). The EPSA assesses students' EPS with six standard ratings (0-missing, 1-emerging, 2-Developing, 3-Practicing, 4-Maturing, and 5-Mastering). This method is holistic, can assess multiple skills at a time and explores the students' EPS assessment in depth. The studies have shown that this method is valid and reliable. It is a very valuable tool for professional skills outcomes assessment. (Kranov et al. 2011; Kranov et al. 2013a).

Furthermore, this method and assessment tool can be used at course level in order to develop EPS and provide feedback, as well as at program level for data collection and inclusion in an accreditation report (McCormack et al. 2014). A particular advantage of the EPSA is a customisation possibility (Schmeckpeper et al. 2014a). There is thus an opportunity for enhancing and adapting the EPSA to the particular conditions of engineering education in Indonesia.

The customisation of the EPSA to align with the local requirements can be seen from Zayed University's experience (Kranov et al. 2014; Danaher et al. 2016; Schoepp et al. 2016). In 2014, Zayed University in the United Arab Emirates (UAE) modified and applied the EPSA method. This two-year pilot project was funded by the Zayed University Research Incentive Fund. The EPS method was adapted to a Computing Programme and UAE's Learning Outcomes namely Computing Professional Skills Assessment (CPSA). In this pilot project, the EPSA which was developed in the USA previously, was customised to an UAE setting. The customisation was done by redesigning the analytic rubric, developing new scenarios related to the field of computing programmes and generating an implementation program. The new scenarios provided real-world examples of problems in an UAE setting. Students were challenged to find solutions and strategies for accommodating each stakeholder's interests in the UAE region.

The analytic rubric for assessing the achievement of students was then modified to include UAE learning outcomes. The discussion of open-ended Information Technology related issues was undertaken via an online discussion board. The main objective of this pilot project was to evaluate the feasibility of CPSA and its application. The project result demonstrated that the CPSA method was feasible and successfully applied with UAE students. The final conclusion of this pilot project was that the EPSA can be applied to Computing and Information Technology communities widely.

2.4. Accreditation Systems

Local and regional differences have resulted in the development of several different accreditation standards e.g. ABET, Washington Accord, Bologna agreement. While they share many features in common particularly in inclusion of EPS in their graduate attributes, points of difference include the manner in which required graduate attributes are interpreted and the manner in which the societal expectations of local populations are included in the education of engineers. It is the latter point that is specifically addressed in this research.

Inclusion of local concerns and practices into engineering core curricula was also demonstrated by Leigh et al. (2014). While engineering is a problem-based practically oriented discipline, an emerging challenge for engineering educators is ensuring that graduate engineers find effective solutions to local everyday problems that are influenced by local people's practices and principles. Examples of engineering case studies in which the engineering decision making process was influenced by local peoples' practices and principles are treated in Hikuora, et al. (2011); Morgan (2008); Morgan (2011); Morgan et al. (2013); Peacock et al. (2012) and Voyde & Morgan (2012).

While not all accreditation systems include EPS as explicitly in their graduate profiles as do ABET, Washington Accord and the Indonesia Accreditation Board for Engineering Education (IABEE), EPS are nevertheless included as compulsory elements in all accreditation systems, e.g. Eur-Ace which integrates EPS into their eight programme outcomes in graduate profile. All accreditation systems require that the EPS achievement must also be assessed and (often) also evaluated. Unfortunately, all accreditation systems do not provide a standard method for assessing the EPS achievement. Thus, they recognise and support the prerogative of each education provider seeking accreditation to adopt and use the most appropriate EPS assessment method.

2.4.1. ABET

The Accreditation Board for Engineering and Technology (ABET) was founded in 1932 as the Engineers' Council for Professional Development (ECPD), an engineering professional body dedicated to the education, accreditation, regulation and professional development of engineering professionals and students in the United States. ABET began its international activities in 1979, when the ECPD signed its first Mutual Recognition Agreement with the Canadian Engineering Accreditation Board. By the early 1990s, ABET served as consultants to both fledgling and established international accreditation boards, a substantial equivalence evaluator of international programs and a founding signatory of the Washington Accord.

The ABET board of directors approved the Engineering Criteria 2000 (EC2000) on 2 November 1996. After a two-year pilot study and a three-year phased implementation period, this new standard was then accepted as an accreditation criterion in many countries in 2001. EC2000 was considered at the time a revolutionary approach to accreditation criteria. In particular, EC2000 focused on outcomes (what is learned) rather than what is taught. At its core, EC2000 affirmed the importance of institutions establishing clear objectives and assessment processes to ensure that each program provides graduates with the technical and professional skills employers' demand. By eliminating the inflexibility of earlier accreditation criteria, EC2000 empowers program innovation rather than stifling it, as well as encouraging new assessment processes and subsequent program improvement.

EC2000 requires the program seeking accreditation to demonstrate clearly that the program meets eight general criteria. The criteria related to student outcomes is Criterion 3. Criterion 3 (Student Outcomes) consists of 11 outcomes (ABET 2017) as follows:

(a) an ability to apply knowledge of mathematics, science, and engineering

(b) an ability to design and conduct experiments, as well as to analyse and interpret data

(c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability

(d) an ability to function on multidisciplinary teams

(e) an ability to identify, formulate, and solve engineering problems

(f) an understanding of professional and ethical responsibility

(g) an ability to communicate effectively

(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context

(i) a recognition of the need for, and an ability to engage in life-long learning

(j) a knowledge of contemporary issues

(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

In this set of 11 outcomes, there are six outcomes referred to as the EPS (in italics) namely (d), (f), (g), (h), (i) and (j). When these are taught within an engineering faculty, quality control of assessment practices is straightforward. However, these outcomes might be learned by students through non-engineering courses such as in the humanities and social sciences. In these cases (engineering faculty) quality control of assessment is not possible. However, ABET accreditation requires that the achievement of the outcomes be assessed and evaluated by an institution seeking accreditation (Skvarenina 2008). Thus, the possibility of use of out-of-faculty courses to develop EPS is problematic.

2.4.2. Washington Accord

The Washington Accord is one of the constituents of the International Engineering Alliance (IEA) alongside the Sydney and Dublin Accords. The IEA is a global not-for-profit organisation, which comprises members from 36 jurisdictions within 27 countries, across seven international agreements. These international agreements govern the recognition of engineering educational qualifications and professional competence. The Washington Accord was signed in 1989 by six bodies responsible for accreditation or recognition of tertiary-level engineering qualifications within their jurisdictions who had chosen to work collectively to assist the mobility of professional engineers. It provides external accreditation to tertiary educational programmes which deal with the good practices of engineering at the professional level.

The Washington Accord (WA) provides for mutual recognition of programmes accredited for the engineer track (qualifications for four years duration post-secondary school). The Sydney Accord (SA) establishes mutual recognition of accredited qualifications for engineering technologists (qualifications for three years duration post-secondary school). The Dublin Accord (DA) provides for mutual recognition of accredited qualifications for engineering technicians (qualifications for two years duration post-secondary school). These accords are based on the principle of substantial equivalence rather than exact correspondence of content and outcomes. Further discussion of the accreditation in this thesis is focused on the Washington Accord only because the Sydney and Dublin Accords are not relevant to this research.

In the Washington Accord, student outcomes are referred to as Graduate Attributes (GA). The GA adopted by the Washington Accord signatories are generic to the education of professional engineers in all engineering disciplines. They categorise what graduates should know, the skills they should demonstrate and the attitudes they should possess. The Washington Accord Graduate Attribute Profile has 12 headings (WA1-WA12), supported by eight elements of the Knowledge Profile (WK1-WK8), seven definitions of the Range of Problem Solving (WP1-WP7), and five definitions of the Range of Engineering Activities (EA1-EA5). These are provided from Table 3 to Table 6.

Table 3. Washington Accord Attribute Profile

Differentiating Characteristic	Attribute Profile
Engineering knowledge	WA1: Apply knowledge of mathematics, natural science, engineering fundamentals and an engineering specialisation as specified in WK1 to WK4 respectively to the solution of complex engineering problems.
Problem analysis	WA2: Identify, formulate, research literature and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences (WK1 to WK4).
Design/development of solutions	WA3: Design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal and environmental considerations (WK5).
Investigation	WA4: Conduct investigations of complex problems using research-based knowledge (WK8) and research methods including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions.
Modern tool usage	WA5: Create, select and apply appropriate techniques, resources and modern engineering and IT tools, including prediction and modelling, to complex engineering problems, with an understanding of the limitations (WK6).
The engineer and society	*WA6: Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice and solutions to complex engineering problems (WK7).*
Environment and sustainability	*WA7: Understand and evaluate the sustainability and impact of professional engineering work in the solution of complex engineering problems in societal and environmental contexts (WK7).*
Ethics	*WA8: Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice (WK7).*
Individual and teamwork	*WA9: Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.*
Communication	*WA10: Communicate effectively on complex engineering activities with the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations and give and receive clear instructions.*
Project management and finance	*WA11: Demonstrate knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work as a member and leader in a team, to manage projects and in multi-disciplinary environments.*
Life-long learning	*WA12: Recognise the need for, and have the preparation and ability to engage in, independent and life-long learning in the broadest context of technological change.*

Source: The International Engineering Alliance (2013)

In Table 3 the GA related to the EPS are written in italics. They are WA6, WA7, WA8, WA9, WA10, WA11 and WA12. This generic GA allow an engineering educator planning a programme to gauge the further learning and experience. It provides flexibility for engineering programmes in each jurisdiction to examine their specific requirements and then integrate them into their own GA.

Table 4. The Washington Accord Knowledge Profile

WK1	A systematic, theory-based understanding of the natural sciences applicable to the discipline.
WK2	Conceptually based mathematics, numerical analysis, statistics and formal aspects of computer and information science to support analysis and modelling applicable to the discipline.
WK3	A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline.
WK4	Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline.
WK5	Knowledge that supports engineering design in a practice area.
WK6	Knowledge of engineering practice (technology) in the practice areas in the engineering discipline.
WK7	Comprehension of the role of engineering in society and identified issues in engineering practice in the discipline: ethics and the professional responsibility of an engineer to public safety; and the impacts of engineering activity – economic, social, cultural, environmental and sustainability.
WK8	Engagement with selected knowledge in the research literature of the discipline.

Source: The International Engineering Alliance (2013)

Table 5. The Washington Accord Range of Problem Solving

Attribute	**Range of Problem Solving**
Depth of knowledge required	WP1: Cannot be resolved without in-depth engineering knowledge at the level of one or more of WK3, WK4, WK5, WK6 or WK8 which allows a fundamentals-based, first principles analytical approach.
Range of conflicting requirements	WP2: Involve wide-ranging or conflicting technical, engineering and other issues.
Depth of analysis required	WP3: Have no obvious solution and require abstract thinking and originality in analysis to formulate suitable models.
Familiarity of issues	WP4: Involve infrequently encountered issues.
Extent of applicable codes	WP5: Outside problems encompassed by standards and codes of practice for professional engineering.
Extent of stakeholder involvement and needs	WP6: Involve diverse groups of stakeholders with widely varying needs.
Interdependence	WP 7: High level problems including many component parts or sub-problems.

Source: The International Engineering Alliance (2013)

Table 6. The Washington Accord Range of Engineering Activities

Attribute	Complex Activities
Range of resources	EA1: Involve the use of diverse resources (and for this purpose resources include people, money, equipment, materials, information and technologies).
Level of interactions	EA2: Require resolution of significant problems arising from interactions between wide-ranging or conflicting technical, engineering or other issues.
Innovation	EA3: Involve creative use of engineering principles and research-based knowledge in novel ways.
Consequences to society and the environment	EA4: Have significant consequences in a range of contexts, characterised by difficulty of prediction and mitigation.
Familiarity	EA5: Can extend beyond previous experiences by applying principles-based approaches.

Source: The International Engineering Alliance (2013)

2.4.3. ENAEE-EURACE

The European Network for Engineering Education (ENAEE) was founded in 2006 (in Brussels) by 14 European Associations concerned with engineering. It is an international non-profit association arising from the European Standing Observatory for Engineering Profession and Education (ESOEPE), which was established in 2000. The ENAEE members are professional organisations concerned with education and formation of engineering professionals. It is the European body responsible for awarding authorisation to accreditation agencies to award the EUR-ACE label (at first and second cycles) to engineering programmes.

The ENAEE recognises the higher education framework in terms of the European Credit Transfer System (ECTS) as follows:

- First Cycle: Bachelor's Degree [180 – 240 ECTS credits]. Full time bachelor's degree can be earned in three years (180 ECTS credits) or four years (240 ECTS credits).
- Second Cycle: Master's Degree [60 – 120 ECTS credits]. Full time master's degree can be earned in one year or two years.
- Third Cycle: Doctoral Degree [Number of ECTS credits are not specified].

Eur-ACE System

Eur-ACE is the European quality label for engineering programmes at the level of bachelor's and master's degrees. It is a framework and accreditation system that provides a set of standards that identifies high-quality engineering degree programmes in Europe and abroad. The Eur-

ACE label is a certificate awarded by an authorised agency to a higher education provider according to each engineering degree programme which it has accredited.

The Eur-ACE system was developed from the views and perspectives of the main stakeholders (students, higher education institutions, employers, professional organisations and accreditation agencies) for professions such as engineering, medicine, architecture and others that carry out work that highly impacts the lives of the public. The graduates must have a set of specific competencies to ensure the public that all actions and decisions are carried out safely and ethically. Engineering education programmes must demonstrate that they produce graduates with these competencies.

The Programme Outcomes for a bachelor's degree are represented by eight learning areas as described in Table 7.

Table 7. Eur-ACE System Programme Outcomes for a Bachelor's Degree

Attribute	Learning Outcomes
Knowledge and understanding	• knowledge and understanding of the mathematics and other basic sciences underlying their engineering specialisation, at a level necessary to achieve the other programme outcomes; • knowledge and understanding of engineering disciplines underlying their specialisation, at a level necessary to achieve the other programme outcomes, including some awareness at their forefront; • awareness of the wider multidisciplinary context of engineering.
Engineering Analysis	• ability to analyse complex engineering products, processes and systems in their field of study; to select and apply relevant methods from established analytical, computational and experimental methods; to correctly interpret the outcomes of such analyses; • *ability to identify, formulate and solve engineering problems in their field of study; to select and apply relevant methods from established analytical, computational and experimental methods; to recognise the importance of non-technical – societal, health and safety, environmental, economic and industrial - constraints.*
Engineering Design	• *ability to develop and design complex products (devices, artefacts, etc.), processes and systems in their field of study to meet established requirements, that can include an awareness of non-technical – societal, health and safety, environmental, economic and industrial– considerations; to select and apply relevant design methodologies;* • *ability to design using some awareness of the forefront of their engineering specialisation.*

Attribute	Learning Outcomes
Investigations	• ability to conduct searches of literature, to consult and to critically use scientific databases and other appropriate sources of information, to carry out simulation and analysis in order to pursue detailed investigations and research of technical issues in their field of study; • *ability to consult and apply codes of practice and safety regulations in their field of study;* • laboratory/workshop skills and ability to design and conduct experimental investigations, interpret data and draw conclusions in their field of study.
Engineering Practice	• understanding of applicable techniques and methods of analysis, design and investigation and of their limitations in their field of study; • practical skills for solving complex problems, realising complex engineering designs and conducting investigations in their field of study; • understanding of applicable materials, equipment and tools, engineering technologies and processes, and of their limitations in their field of study; • ability to apply norms of engineering practice in their field of study; • *awareness of non-technical -societal, health and safety, environmental, economic and industrial - implications of engineering practice;* • awareness of economic, organisational and managerial issues (such as project management, risk and change management) in the industrial and business context.
Making Judgements	• *ability to gather and interpret relevant data and handle complexity within their field of study, to inform judgements that include reflection on relevant social and ethical issues;* • *ability to manage complex technical or professional activities or projects in their field of study, taking responsibility for decision making.*
Communication and Team-working	• *ability to communicate effectively information, ideas, problems and solutions with the engineering community and society at large;* • *ability to function effectively in a national and international context, as an individual and as a member of a team and to cooperate effectively with engineers and non-engineers.*
Lifelong Learning	• *ability to recognise the need for and to engage in independent life-long learning;* • *ability to follow developments in science and technology*

Source: The European Network for Engineering Accreditation (2015)

Unlike ABET and the WA which clearly separate EPS in formulating their programme outcomes, the Eur-ACE integrates EPS (shown in *italics* in Table 7) into the eight learning outcome areas.

2.4.4. Bologna Agreement

The Bologna Declaration (also known as the Bologna Accord) was signed in 1999 by 29 European countries. The total number of signatories is now 48. The Bologna Accord (BA) simplifies degree qualifications and nomenclatures and offers more educational choice and mobility within European countries. The BA brought uniformity in European higher education. Prior to the accord, different European countries' universities awarded different degrees in similar programs so that the equivalency was not clear. This difference made it difficult for postgraduate program admissions offices and potential cross-border employers to assess the applicant's level of education. The BA is not solely applicable to European Union (EU) members but may be used by both EU and non-EU countries.

The BA also provides a clear degree definition by dividing the level of higher education into undergraduate and postgraduate study and introducing the bachelor's and master's framework for education providers in European countries. The BA Framework recognises European higher education in three cycles (Bachelors, Masters and Doctoral) and associated generic descriptors that help writing of learning outcomes. These generic cycle descriptors (adopted in 2005) are used in The Framework of Qualifications for EHEA (Bologna Framework) and are commonly called the "Dublin Descriptors".

The Dublin Descriptors are general statements of the ordinary outcomes that are achieved by students after completing a curriculum of studies and obtaining a qualification. They are not to be considered and limited to specific disciplines or professional areas. The qualifications that signify completion of the first cycle of higher education are awarded (Dublin Descriptors, 2004) to students who:

- have demonstrated knowledge and understanding in a field of study that builds upon general secondary education and is typically at a level supported by advanced textbooks; such knowledge provides an underpinning for a field of work or vocation, personal development, and further studies to complete their study;
- can apply their knowledge and understanding in occupational contexts;
- have the ability to identify and use data to formulate responses to well-defined concrete and abstract problems;
- can communicate about their understanding, skills and activities, with peers, supervisors and clients;
- have the learning skills to undertake further studies with some autonomy.

One of the main features of this process is the need to improve the traditional ways of describing qualifications and qualification structures. Each country must develop its own National Framework of Qualifications which map on to the Bologna Framework. Although the BA does not explicitly specify the EPS in the standard qualification, this framework gives flexibility to each country in integrating the EPS in their qualifications.

2.4.5. Indonesia Accreditation Board for Engineering Education (IABEE)

The establishment of the Indonesia Accreditation Board for Engineering Education (IABEE) was motivated by the awareness of the importance of quality assurance in higher education, particularly in engineering education. The legal basis refers to:

- Law No. 20/2003 on National Education System
- Law No. 12/2012 on Higher Education
- Ministerial Regulation of Education and Culture No.50/2014 on Quality Assurance System of Higher Education
- Ministerial Regulation of Education and Culture No. 87/2014 on Accreditation of Study Program and Higher Education

IABEE was inaugurated in November 2015, after being initiated by DIKTI in November 2013. IABEE is an autonomous institution under the Indonesian Engineers Institution (PII). IABEE is ratified by the Ministry of Research, Technology and Higher Education of the Republic of Indonesia (KEMENRISTEKDIKTI) as the national accreditation body for engineering, technology and computing programmes in Indonesia. National Accreditation by IABEE is compulsory for all education providers, which provide engineering education, in accordance with Indonesian legal regulations. International Accreditation by IABEE is optional, where the feasibility of an engineering programme to undergo an International Accreditation process is determined in part based on its National Accreditation rank.

The importance of international accreditation recognition has led IABEE to join the Washington Accord in 2019. This implies that some important features of the IABEE accreditation process are adopted directly from the WA, such as outcome-based learning, graduate attributes and the accreditation mechanism.

IABEE Accreditation Criteria consist of three parts, namely Common Criteria, Criteria Guide and Discipline Criteria. In undertaking the accreditation of an engineering programme evidence of student mastery of all three IABEE criteria are required. The Common Criteria (with its Criteria Guide) ensures the quality of education and encourages continuous quality improvement that meets the needs of stakeholders in a dynamic and competitive environment. Meanwhile, the Discipline Criteria provide specific requirements in the field of curricular topics for the particular engineering programme.

According to the Common Criteria (IABEE 2018), the engineering programmes must ensure students can demonstrate upon graduation the ability to utilise the knowledge, skills, resources and attitudes described in points (a) to (j).

(a) an ability to apply mathematical, natural and/or material science, information technology and engineering knowledge to obtain a thorough understanding of the engineering principles

(b) an ability to design components, systems and/or processes to meet expected needs within realistic boundaries, such as legal, economic, environmental, social, political, health and safety, sustainability and to recognize and/or utilise potential local and national resources with global insight.

(c) an ability to design and carry-out laboratory and/or field experiments, analyse and interpret data to strengthen technical assessment.

(d) an ability to identify, formulate, analyse and solve engineering problems.

(e) an ability to apply modern methods, skills and techniques needed for engineering practices.

(f) an ability to communicate effectively, both oral and written

(g) an ability to plan, accomplish and evaluate tasks within existing constraints.

(h) an ability to work in multiple disciplines and cultures.

(i) an ability to be responsible to the community and comply with professional ethics in solving engineering problems.

(j) an ability to understand the need for life-long learning, including access to knowledge related to current relevant issues.

While these graduate outcomes were adopted from the WA, we can identify the graduate outcomes related to the EPS (written in *italics*) namely (b), (f), (h), (i) and (j).

The graduate outcomes above (also known as the IABEE Common Criteria) are established as an engineering programme accreditation framework. This criterion is compulsory. Beside this criterion, the engineering programme must establish their own independent professional profiles in order to encourage independence, prosperity, progress and justice for the nation and the global community, based on science, technology, culture and sustainable use of natural resources.

2.5. Summary

The literature review in this research provided an understanding of the gaps in the body of knowledge about engineering professional skills. The first section described the concept of EPS in relation to graduate profiles and existing accreditation systems including consideration of issues of EPS integration in curricula design. The second section addressed the existing methods of EPS assessment including the advantages and disadvantages of each assessment method. The third section reviewed all related publications about the Engineering Professional Skills Assessment (EPSA) method. The fourth section compared international accreditation systems, especially with regard to how EPS are assessed.

The literature review demonstrated that the accreditation standards (e.g. ABET, Washington Accord, Bologna agreement) share many features in common particularly in inclusion of EPS in their graduate attributes (see section 2.4), but there was a gap between the manner in which required graduate attributes are interpreted and the manner in which the societal expectations of local populations are included in the education of engineers.

This gap motivated research question (RQ2) which is how the assessment developed in this research can be extended to include assessment of local/domestic competency.

Chapter 3. Research Methodology

This chapter commences with a brief review of the research design and methodology. Since the research consists of a series of iterative processes or cycles, the action research methodology is adopted. Each cycle sought to investigate and improve the Engineering Professional Skills Assessment (EPSA) method, which was published firstly by Kranov et al. (2008). This chapter discusses each EPSA cycle's process including the scenario development process, the EPSA rubric customisation process (in order to meet both Indonesian and the general engineering programmes' requirements), and the research design for the EPSA class administration. The chapter ends with discussion of the ethics approval required for this research.

3.1. The EPSA Scenarios

The EPSA method uses scenarios as a tool of assessment. Scenarios and case studies have been used widely in teaching/learning (McCormack et al. 2014). According to Boller (2012), there are four advantages of using scenarios in assessment, such as:

- ease of engaging the user in the process;
- ease of context sharing;
- adjustable problem setting; and
- maintaining user focus on the problem

The use of scenarios in the EPSA Administration is similar to the Problem-Based Learning (PBL) model. Problem-Based Learning (PBL) is a pedagogical approach and curriculum design methodology often used in higher education (Barrows 1986; Savery & Duffy 1995). The influence of PBL's practices can be traced from the late 1960s at the medical school at McMaster University in Canada (Barrows 1996; Boud & Feletti 1997). Three other medical schools - the University of Limburg in Maastricht (the Netherlands), Newcastle University (Australia), and the University of New Mexico (United States) then took to using the McMaster problem-based learning model. Various adaptations were made so that this model could be applied in other disciplines such as business, health sciences, law, engineering, and education.

In the PBL model, learning is driven by challenging, open-ended problems with no single “right" answer while problems/cases are context specific. Students work as self-directed, active investigators and problem-solvers in small collaborative groups (typically of about five students). A key problem is identified, and a solution is agreed upon and implemented. Thus, teachers merely play a role as facilitators of learning, guiding the learning process and promoting an environment of inquiry. PBL encourages students to learn how to apply their knowledge to the new situations rather than just merely memorising lessons delivered in a classroom. Students are faced with contextualised, ill-structured problems (often with incomplete information provided) and asked to investigate and find meaningful solutions (David 2014).

The incorporation of scenarios is an integral part of the EPSA class administration. The EPSA scenarios play an important role in assessing the students' ability and understanding in finding effective solutions to local everyday problems that are influenced by local peoples’ practices and principles. It is believed that the use of scenarios will develop critical thinking and creative skills, improve problem solving skills, stimulate motivation and help students to learn how to transfer knowledge to new situations.

Scenarios perform an important role as a trigger for students to learn and understand the situation described in the scenario, while the teacher acts only as a facilitator to enable discussion in small groups and motivate students. An important consideration in the design of scenarios is that scenarios must stimulate active participation from students. Students are faced with a scenario that is intended to function as a trigger for student learning. Usually, scenarios are descriptions of issues that require additional explanations, and students try to explain the issues presented in scenarios in accordance with their assumptions and understanding. For this purpose, they perform discussions in small groups. When discussing this scenario, students soon realise that the knowledge they currently possess is not sufficient to explain the issues in the main problem. As a result, many questions arise that were not answered during the discussion. These questions then motivate students to become independent self-learners. The scenarios require students to search individually for relevant literature that can be used to find the problem solutions (Dolmans et al. 1997).

A good scenario will support the implementation of the expected group discussion process. The ability to analyse everyday cases or problems requires engineering graduates to have the ability to solve problems in their area of expertise, in collaboration with other disciplines.

Ideally, sometimes the data provided to students is incomplete. This prompts creativity and "out of the box" ideas where complex problems can be solved by a simple solution.

Scenarios must also ensure the effectiveness of group discussions. Interaction in groups provides opportunities for students to give and receive opinions, ask questions, and discuss the differences of opinion that lead to a deep understanding of the issues in the scenario (Schmidt & Moust 2000). This group learning environment promises to develop an effective learning environment, although in reality group ineffectiveness also often occurs. One of the problems that often arises is that group performance is operationalised only as a routine where students pretend to be actively involved in group work, even though they are not really involved (Gijselaers & Schmidt 1990).

The use of scenarios is very suitable for measuring students' understanding of dilemmas in an open-ended problem in the study of engineering. Harris et al. (2009) provide a number of good examples. Although the EPSA scenarios might share the same characteristics with the scenarios in Harris et al. (2009), they differ in some ways. The EPSA scenarios are more likely to promote an authentic discussion kernel than just role play because they generate real-time discussion (McCormack et al. 2014).

While it is important for students to learn to identify problems, investigate the scenarios and understand the situation provided by the scenario independently, sometimes these practices become ineffective due to limited classroom time allotted. Students need a guidance to manage the discussion time effectively. In this case, the EPSA scenario is complemented by the use of a set of discussion questions that serve as a prompt to guide the discussion.

Students do not need to punctiliously follow the prompt questions, because these questions are for guidance only so that the discussion will be undertaken effectively. These questions are not standard questions, so they can be further developed and adjusted according to the objective or aspects of assessment that are desired. They were designed to address the assessed professional skills. Each skill might be addressed by one or more questions.

Despite the fact that PBL has been used since the 1960s, some educators still express concern about the effectiveness of scenario-based learning interventions in certain classroom settings (Norman and Schmidt 1992). Some advantages are:

- Development of long-term knowledge retention

  Norman and Schmidt’s research (1992) demonstrated that students who participate in a scenario-based learning intervention can improve their long-term understanding. By sharing facts and ideas through discussion and answering questions, students improve their understanding of subject matter and make it easier to remember.

- Use of diverse instruction types

  Scenario-based learning interventions can effectively meet the diverse needs and learning styles of students. In general, this learning method allows students to find solutions to real problems. This method also helps students who have difficulty learning on their own with the help of various learning methods and resources such as videos, audio recordings, news articles and other materials.

- Continuous engagement

  Vernon and Blake (1993) reported increased student participation and better attitudes towards courses using scenario-based learning interventions. The potential for involvement is demonstrated by the enthusiastic attitude of students in solving real problems that are more attractive to them than just ordinary classroom teaching.

- Development of transferable skills

  Scenario-based learning intervention can help students develop skills that they can transfer to real-world scenarios. The real context and consequences presented in the scenario-based learning intervention allow their learning to be deeper and more durable. What students learn through these real-life scenarios can be applied in the future when they faced similar problems.

- Improvement of teamwork and interpersonal skills

  Successful scenario-based learning intervention relies on interaction and communication, which means students must also build transferable skills based on teamwork and collaboration. Instead of just memorizing them, students get the opportunity to present their ideas to the group, defend and revise them if needed. This can involve developing listening skills and a sense of responsibility when completing one's assignments. Such skills and knowledge are very beneficial for the future of students.

In addition to the various advantages of using a scenario-based learning intervention, there are several detriments as follows:

- Poorer performance on standardised tests

  One of the detriments of using scenario-based learning interventions is when students take standardised tests. While scenario-based learning places more emphasis on developing skills related to collaboration and justifying their reasoning, unfortunately many standard tests take the form of multiple choice and short answer questions. Students may have difficulty achieving high scores because of the unlimited possible answers (open ended questions).

- Student and teacher unpreparedness

  The use of scenario-based learning interventions requires more effort for preparation than traditional teaching. The activity should address a relevant and tangible problem, while students may require new or abstract information to create an effective solution to follow the lessons well. Teachers can help students overcome these difficulties by actively monitoring the classroom and distributing helpful resources, such as guiding questions and articles to read.

- Time-consuming assessment

  Assessing student performance on scenario-based learning interventions requires constant monitoring and note-taking. Ideally, this monitoring is carried out for each student, making it time-consuming to give and justify a grade for every student. Since this research's objective is not to capture each student's EPS achievement, the assessments in both cycles in this research were done in the context of a team-based rating. With the limited number of assessors, this method reduces the number of assessors, simplifies the assessment process, and is less time-consuming.

- Varying degrees of relevancy and applicability

  One of the challenges faced in using scenario-based learning interventions is identifying real problems that students can solve with the content they are studying and the skills they are mastering. It is very important to maintain the level of relevance between the content and the real-world application.

3.1.1. Criteria for an EPSA Scenario

The primary purpose of most of these scenarios is situational awareness and analysis attempting to clarify right and wrong actions irrespective of learner belief/ethics. In order to develop a scenario that can cover all aspects of the assessments, a list of criteria must be established first. McCormack et al. (2014) developed the seven criteria described in Table 8.

Table 8. Criteria for an EPSA Scenario

Criterion	Description
Interdisciplinary Scope	The scenario involves more than one discipline within and beyond engineering. The issue/problem in the scenario should be able to be tackled by an interdisciplinary group at any level in the programme.
Relevant Problem	The scenario has unresolved problem, tension, a disagreement, or competing perspective on how to address the problem. The problem is not emotionally disruptive and will be relevant for five to ten years
Non-technical Complexity	The complex and multifaceted scenario has multiple stakeholders including public, private, global, groups, and individual constituents. The diversity of stakeholders is representative of a problem with ethical, societal/cultural, economic, environmental, and global concerns. Any solution requires all critical stakeholders to be on board with the solution(s).
Technical Complexity	The scenario includes some technical data for students to "hang on to" as they tackle the problem. The problem has a core component of technicality, benefiting from engineers on the solution team.
Elicits Engagement	The scenario draws in the reader and engages the student group in deep discussions because the problem is complex and multifaceted without an obvious, quick fix solution.
References	The scenario has multiple references (3-4) from varied sources such as refereed journal articles, solid news sources, and publications from professional societies. The selection of references is objective and balanced.
Packaging for Classroom Use	The scenario can be read and understood by all engineering undergraduates in 5-7 minutes as a common starting point for a 30-40-minute group discussion. There should be no pictures or tables. Lists are acceptable. The written text must be no more than 1.5 pages, 12-point font, and 1.5 line spacing

Source: McCormack, et.al (2014)

Beside the seven criteria, there are three additional criteria which apply in this research, namely provide dilemma(s), incomplete information and open-ended problems. The scenarios must present the dilemma that occurs, including conflicts of interest between stakeholders. The dilemma is designed to trigger an active participation of discussants with the expectation that will strongly defend their opinions against those of other students.

Although the scenarios might include some technical and non-technical data, the scenarios should not provide complete information. Ideally, they will have some missing information which requires additional assumptions. Students have to explain the issues presented in the scenarios in accordance with their assumptions and understanding. This means that the scenarios are open-ended problems with no single “right" answer. Students work as self-directed, active investigators and problem-solvers in small collaborative groups. Students do not need to suggest specific solutions in detail, they just try to get a consensus from discussion that covers all aspects considered. A key problem is identified, and a solution is agreed amongst them.

3.1.2. EPSA Scenario Development

The method of designing the EPSA scenarios is a key contribution of this research. The process of designing the EPSA scenario could be used by other professional educators to design scenario-based learning interventions for their own students. The method was extended from McCormack et al. (2014) which consisted of three phases, namely scenario scoping, scenario development and scenario assessment and testing. While the scenarios have an important role in inclusion of the local/domestic competency, the improvement encourages more sources of idea for generating relevant topics, especially the local engineering issues faced by the local community.

The scenario scoping began with defining the scenario objective and then selecting the relevant topics. An investigation of the recent local issues was carried out. Some key issues were identified and brought to a brainstorming session (amongst the teaching team) in order to generate some possible scenario topics. The topics must be able to trigger a dilemma among the stakeholders involved and should have unlimited possible answers (open-ended problems). Eventually some promising and relevant topics were selected.

The scenario creation process then moved to the second phase which began with undertaking a literature review. A number of appropriate references were selected. A new scenario is written based on the references. The scenario key issues were extracted from the local news and then crafted hypothetically. The scenario logic was aligned along with the EPSA rubric (soft skills considerations as well as technical skills). After the new scenario has been written, a set of discussion prompt questions is generated. Each skill assessment is addressed by one or more questions. These questions serve as discussion instructions.

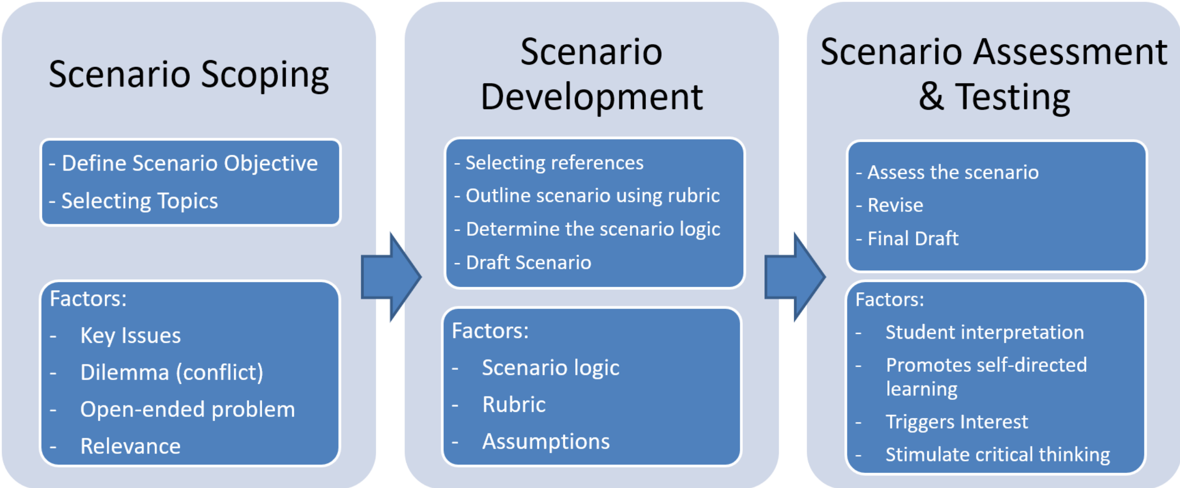

Figure 2. Scenario design method, adapted from McCormack et al. (2014)

The last phase is the scenario assessment and testing. The new scenarios are assessed through brainstorming sessions (amongst the teaching team) using the criteria in Table 8. The assessment and testing must also consider several factors, namely student interpretation, student interest, promoting self-directed learning, and encouraging critical thinking. Before being used in the EPSA class administration, the scenarios should be tried out first. The results are used to revise and adjust the scenario to the final version.

McCormack et al. (2014) also provide a wide range of scenarios that have been developed using the EPSA rubric. Unfortunately, these scenarios did not address the issues of local people's practices and principles. For (Indonesian) students the existing scenarios show little sensitivity to the local situation. They lack the capacity to represent real problems faced by engineers in local (as opposed to country-wide) situations. While engineering is a problem-based practically oriented discipline, graduate engineers are expected to understand and implement good engineering practice. To solve many problems, an inclusive approach that acknowledges and accommodates local people's practices and principles is required. Examples of similar local concerns (in a different country) have been demonstrated by Hikuora et al. (2011); Morgan (2008); Morgan (2011); Morgan et al. (2013); Peacock et al. (2012) and Voyde & Morgan (2012).

For this research, the researcher developed EPSA locally relevant scenarios in two cycles. Four scenarios were developed in the first cycle of research in 2016. Three more scenarios were added in the second cycle in 2017 to make a total of seven scenarios as presented in Table 9.

Table 9. List of New EPSA Scenarios

No.	Scenario Title	Developed in
1	Adam Air	Cycle 1 (2016)
2	Low-Cost Carrier	Cycle 1 (2016)
3	Gojek	Cycle 1 (2016)
4	National Car	Cycle 1 (2016)
5	Bay of Jakarta Reclamation	Cycle 2 (2017)
6	Indonesia Nuclear Power Plant	Cycle 2 (2017)
7	Cigarette Industry	Cycle 2 (2017)

The key difference between the new EPSA scenarios (developed in this research project) and the existing scenarios previously described by McCormack et al. (2014) is the scenarios' setting. The new scenarios are enriched by including many Indonesian local issues. Students are able to easily understand the issues raised in the scenarios because the issues are a part of their everyday life. Although each student may come from a different region of Indonesia with different cultures, these differences will enrich their discussions in combining local people's practices and principles with good engineering practices.

3.2. The EPSA Rubric

The Engineering Professional Skills Assessment (EPSA) rubric is an analytical rubric which is used to evaluate the students' discussion of engineering case studies. The EPSA was firstly published by Kranov et al. (2008). The original version of the EPSA rubric uses five criteria which are related to learning outcomes of ABET. According to McCormack et al. (2014), this assessment method can be applied at course level in order to develop EPS as well as at program level for data collection and inclusion in an accreditation report. A particular advantage of EPSA is a customisation possibility (Schmeckpeper et al. 2014b). There is thus an opportunity for adapting and formalising the EPSA as a tool for accreditation assessment of engineering education in Indonesia.

Differences in local and regional needs have resulted in the development of several different accreditation standards such as ABET, the Washington Accord, and the Bologna agreement. Although these standards share some similar features, there are points of difference including the ways in which the required graduate attributes are interpreted and the ways in which local peoples' expectations are included in engineering education. In the research reported in this thesis, the EPSA rubric is modified to align with the local accreditation requirements (which are distinct from ABET for which the EPSA was developed) and scenarios are developed to be used as case studies when educating engineering students on how to solve local everyday problems that are influenced by local people's practices and principles.

In this research, an Indonesian setting as a case study was used. As a large developing country with a highly dispersed geographic situation, each region in Indonesia has different needs. In consequence, local content has become a mandatory part of the curriculum structure. Indonesia built its accreditation system by interpreting the ABET system and blending it with the eight principles of the ISO 9000 Quality Management System and the local community's needs.

Since IABEE was inaugurated in November 2015, the Indonesian government has decided to change the process by which accreditation of engineering degrees is undertaken. The engineering education accreditation process, which was previously combined with all programmes and carried out by the National Accreditation Body (BAN), has now been separated. Engineering programme accreditation is handled specifically by IABEE which is an autonomous institution under the Indonesian Engineers Institution (PII). ABET, which used to be a reference for the accreditation of engineering programmes, was replaced by the Washington Accord, which is the largest standard recognized globally. This change is not too significant considering that ABET is also one of the signatories of the Washington Accord.

In this research a customised EPSA Rubric was developed by substituting five criteria from ABET with the Competency-Based IE Curriculum 2012 Outcomes of the Department of Industrial Engineering, Universitas Atma Jaya Yogyakarta, Indonesia. Once the criteria related to hard skills were eliminated, we were left with soft skills criteria as outcomes for the new EPSA rubric.

After the criteria are determined, the standard rating for each criterion is formulated and defined. Kranov et al. (2008) used 5-standard ratings, namely 0-Missing, 1-Emerging, 2-Developing, 3-Practicing, 4-Maturing and 5-Mastering. Each standard rating expresses the level of students' achievement of the skills.

3.3. Research Design

This research uses the action research methodology (Riding et al. 1995). The action research methodology is widely used in educational research. This methodology suits practitioners who wish to learn and create knowledge by reflecting upon their own actions and experiences, forming abstract concepts, and testing the implications of these new concepts (Kolb 1984).

Since being introduced in 1944 by Kurt Lewin who viewed this research methodology as cyclical, dynamic, and collaborative in nature, various forms of application of action research have been developed (Carr & Kemmis 1986). Via repeated cycles of planning, acting, observing, and reflecting, the researcher can implement changes required for improvement (Hine 2013). The number of steps involved might vary, but generally they consist of a series of iterative processes or cycles (Riding et al. 1995) as shown in Figure 3.

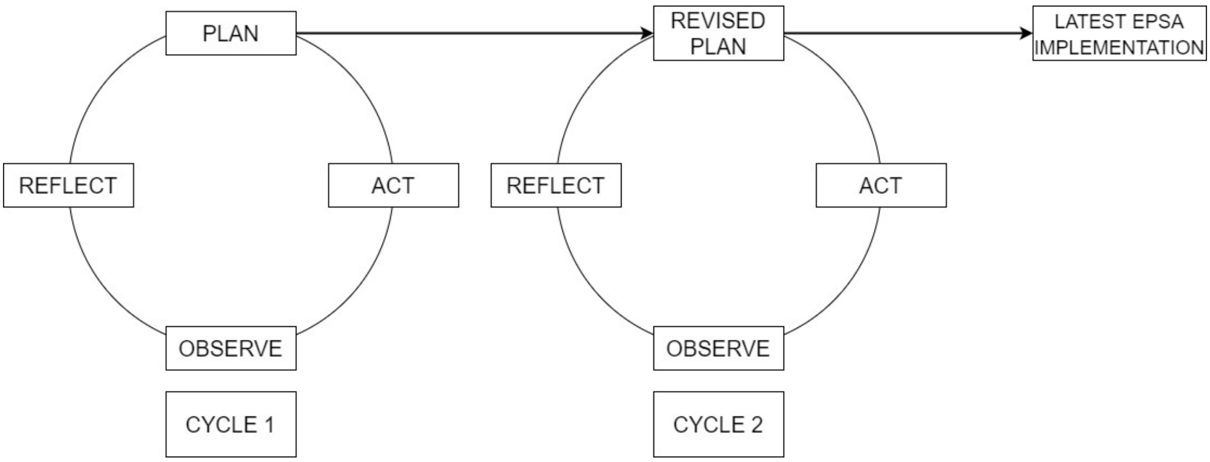

Figure 3. Action Research Model, adapted from Riding et al. (1995)

The first cycle includes planning, action, observation, and reflection. The results obtained from the first cycle are evaluated, and then used to revise the process in the next cycle where the process of planning, action, observation, and reflection is repeated (Kemmis & McTaggart 1988; Riding, et al. 1995; Godfrey & Rowe 2007).

In this research, the EPSA class administration was run in two cycles. The first cycle took place in Semester II Academic Year 2015/2016. The second cycle, which took place in Semester II Academic Year 2016/2017, mirrored that of the first cycle. Some adjustments based on the results of the first cycle's findings were made and then applied. The results of the second cycle were then analysed and following reflection, the second cycle's findings were used to identify matters to be included in any future action cycle.

With such a research methodology, one must always be aware of the potential for research bias. Research bias occurs when researchers might influence the process whilst remaining unaware that they were doing this. Bias is unavoidable (Kirshner et al. 2011). In both cycles of fieldwork, to manage (although not eliminate) bias in data collection and analysis, the potential students were given freedom of consent. They could decide whether to decline or participate in the research at any time freely. The researchers observed the process without being involved in it. In the explanation session, the research procedures were thoroughly described without explaining the scenarios' contents (and thereby lowering the risk of biasing the discussion). The students were required to understand and interpret the scenario using their own knowledge without any researcher input. Finally, the discussion prompt questions were used to trigger the discussions and to allow those discussions to flow freely. These questions need to be used with caution, should be neutral about all aspects of the scenario and avoid implying a preferred set of answers/opinions.

3.3.1. The First Action Cycle

The first action cycle was implemented as the first cycle of fieldwork which took place in Semester II Academic Year 2015/2016 (10 May 2016 – 22 June 2016). It started with developing a customised EPSA rubric based on Curriculum 2012 of the Department of Industrial Engineering at Universitas Atma Jaya Yogyakarta, Indonesia. Via this customised EPSA rubric, four locally relevant scenarios were established through which students could develop their EPS and also gain experience in assessment of such skills. The new EPSA rubric and expanded scenarios were implemented and evaluated via classroom administration.

Participants were undergraduate students of Industrial Engineering (a 4-year program) and were enrolled in the classes of IND3852 Technopreneurship (3rd Year), IND4264 Integrated System Design (3rd Year), or IND5172 Engineering Ethics (4th Year) in the Department of Industrial Engineering, Faculty of Industrial Technology, Universitas Atma Jaya Yogyakarta, Indonesia. These courses were selected because they are integrative courses which are taught in the two final years of the degree. Students already have sufficient engineering knowledge to analyse the engineering issues arising in the scenarios at this stage of their education.

The EPSA class administration process starts with an introduction session as described in Figure 4. The researcher explains the nature of the research to the students. The students were then given an opportunity to ask anything about the research before they decided to participate and signed the Consent Form (CF). Their participation was voluntary, and they could decline the invitation to participate at any time. The Dean of the Faculty of Industrial Technology at Universitas Atma Jaya Yogyakarta, Indonesia gave an assurance that neither their grades nor academic relationships with course lecturers would be affected by either refusal or agreement to participate.

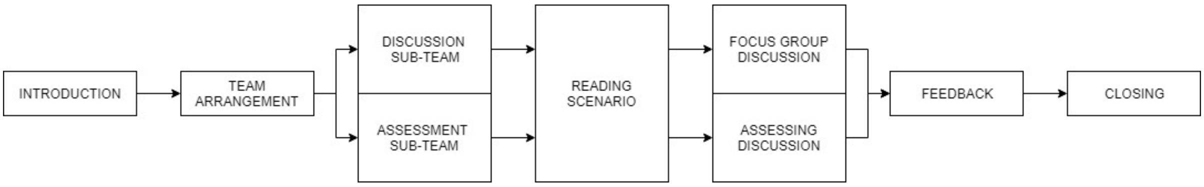

Figure 4. The EPSA Administration Class Process

All participants in the class were divided into teams. Each team then divided again into two sub-teams, namely the discussion sub-team and the assessment sub-team. Each student was asked to be either a discussant or an assessor with the allocation arranged in class. Each team ideally consisted of 7-10 students.

The discussion sub-teams undertook a discussion based on given scenarios (representative of situations encountered in professional engineering). The discussion sub-team (discussants) consisted of 4-7 students. Each student was encouraged to actively participate in group discussion. Each discussion sub-team was allowed to arrange their member's roles in the discussion process as a moderator/facilitator, antagonist, protagonist or timekeeper in order to make the discussion more interesting.

The other sub-team (assessors) used the customised EPSA rubric to undertake the assessment of the discussion process without being involved in the discussion. The assessment sub-team consisted of 3-4 students. Ideally the number of students in the assessment sub-team is less than that in the discussion sub-team because the quality of the discussion is enhanced by having a diversity of views and consequently a larger discussion team is better. The EPS performance is assessed in the context of a team-based rating. By contrast the assessment team can be smaller as assessment is carried out on an individual basis and therefore does not depend on the number of members of the assessment sub-team.

The scenarios were then distributed to all students. Students were given around 15 minutes to read and understand the issues raised in the scenario before the discussion sub-team initiated a 40-minute group discussion. After reading the scenario, the students needed to identify the major problems and secondary problems (if they existed) raised in the scenarios and the related stakeholders. The students then undertook a group discussion in order to find possible solutions. They also needed to consider the potential conflict among stakeholders' interests and the impact of their proposed solution in the context of society and the environment both locally and globally.

To guide the discussion, the students were given a discussion prompt in the form of a series of questions that direct the students during the discussion. The researcher observed the students' discussion while the discussions were recorded.

While the discussion sub-team were reading the scenario, the assessment sub-team (assessors) were exploring how to use the customised EPSA rubric to assess the discussion. The assessment sub-team examined the discussion process without being involved in the discussion. The researcher explained the scoring rules and strategy. To facilitate the assessment process, an EPSA rubric scoring sheet was provided. The assessors gave the appropriate score for each skill and filled in the scoring sheet. When the discussions were over, the assessors summarised the assessment and submitted the results to the researcher. The assessors were offered an opportunity to review and clarify their assessment using the audio recording if needed.

There was an opportunity for students to evaluate the EPSA class administration process and provide feedback before the session ended. These evaluations and feedback were used to inform the next EPSA class administration run. The total time required for an EPSA class administration run was approximately 100 minutes. The rundown and time allocation are shown in Table 10.

Table 10. Rundown of EPSA Class Administration and Time Allocation

EPSA Class Administration Sessions	Time Allocation
1. Introduction	15 min
2. Team arrangement	15 min
a. Discussion Sub-Team	
b. Assessment Sub-Team	
3. Reading a given scenario	15 min
4. Discussion Process	40 min
5. Feedback (Q & A)	10 min
6. Closing	5 min
Total Time Required	100 min

The process took place over three weeks as it was not possible to allocate more than three weeks in the busy class schedule. The first and second week were used for EPSA class administration runs. The third week was used for evaluations and clarifications. While each student was asked to be either a discussant or an assessor with the allocation arranged in class prior to EPSA session, they might have the same or a different role (discussant or assessor) in each EPSA session.

Being an assessor versus a discussant can indicate quite different skills in regard to the Engineering Professional Skills. An observer will become more competent to see the skills in action in others while quite possibly remaining unaware of their own levels of capability. Conversely, those who were in the discussion teams may get feedback on their level of skills, while not necessarily understanding how their actions contributed to their score. While each student might have a different role (discussant or assessor), this arrangement would give them more understanding about how the EPSA works and their level of the skills. Consequently, it would lower the threat to validity regarding to the risk that the assessors may have a flawed understanding of each skill interpretation.

The EPSA class administration was run on a small class size (around 20-50 students). When dealing with a large class size, the EPSA class administrations can be implemented via weekly small tutorial classes (of around 40 students) provided that these tutorials have a 100-minute duration. The only challenge is the logistics of managing multiple small-class tutorials.

Once the EPSA class administration process was over, the results were evaluated. The findings were then used to revise the process for the next cycle where the whole process was repeated.

3.3.2. The Second Action Cycle

The process continued with the second action cycle. The second action cycle was implemented as the second cycle of fieldwork which took place in Semester II Academic Year 2016/2017 (8 May 2017 – 20 June 2017). It started with making a revised plan for EPSA class administration based on the first cycle's findings. Some obstacles which had been experienced in the first cycle were anticipated and corrected in this cycle. Three more locally relevant scenarios were established in this cycle.

Participants were also undergraduate students (4-years programme) and chosen from 3 different subjects as was the case in the first cycle of the fieldwork. Although the participants were students who enrolled in the same subjects as the first cycle of fieldwork, they were (different) students from a different year.

Generally, the second action cycle process mirrored that of the first cycle with some adjustments arising from the results of the first cycle. These adjustments required an amendment of the ethics approval. The ethics amendment approval was granted before undertaking the second action cycle. The process also took place over three weeks with the same weekly arrangement (as in Cycle 1) as well.

The second action cycle results were evaluated. The findings were then used in the next cycle.

3.3.3. Formalising the EPSA Method

The results of both cycles of fieldwork in this research were evaluated and then used to formalise the final EPSA rubric and method. The findings identified the process to be followed to reformulate the customised EPSA rubric to make it more useful in an Indonesian setting. In formalising the rubric, the new accreditation criteria (the IABEE Graduate Outcomes) and the new IE-UAJY 2017 Curriculum Learning Outcomes were merged to form the new learning outcomes. The final rubric also developed by using the SOLO Taxonomy as a new standard rating which was less complicated.

3.4. Ethics Approval

Since this research involved human participants, the University of Auckland has an obligation to ensure that all research conducted by members of the University conforms to established ethical standards. This research required ethics approval from the appropriate review authority, in this case the University of Auckland Human Participants Ethics Committee (UAHPEC).

Full ethics approval for this research was granted by the University of Auckland Human Participant Ethics Committee (UAHPEC) for this research (Ref. No. 016642 – approved 29 April 2016) for a period of three years. The expiry date for this approval was 29 April 2019. An amendment of the ethics approval was granted on 1 May 2017 to include a second cycle of the research project, changes in the Likert scale used, adding rating scales for each measurement aspect, adding new scenarios and modification of the rubric assessment form for ease of use. The approval documents from UAHPEC are included in Appendix A.

3.4.1. Anonymity and Confidentiality

The preservation of confidentiality is paramount, so the information which students share with the researcher will remain confidential. When the group recording was transcribed, no information which could lead to identification of any individual was included in the transcription. Students were able to review the audio recordings and/or transcripts. If the provided information is published, this will be done in a way that does not identify any student as its source. A copy of the research findings will be made available for students if they wish to be informed. Students were able to choose the appropriate option and provide their email address in the Consent Form should they wish to review the transcripts of the recording and receive a copy of the research findings.

3.4.2. Right to Withdraw from Participation

Students had the right to withdraw their participation at any time without giving a reason. Unfortunately, withdrawal of any submitted form or questionnaire is not possible since they were anonymous forms or questionnaires and cannot be identified. This issue also applies to group audio-recording as well (due to the conversational and contextual nature of the discussion). However, students had the opportunity to review but not edit the transcripts of the recording.

3.4.3. Data Storage, Retention, Destruction and Future Use

The researcher collected the data by audio-recording and data collection forms. All hardcopy data forms were destroyed after a digitising process. Only softcopy data was kept. This was stored in a secure university computer network. The data will be stored for a maximum of 6 years. After the storage time has elapsed, the data will be deleted.

Chapter 4. The Customised EPSA Rubric

This chapter discusses the customised EPSA rubric in depth. The development of the new EPSA rubric was inspired by the specific requirements of an Indonesian setting. An ability to include these issues was not considered in the EPSA rubric, which was published by Kranov et al. (2008). The inclusion of local issues is one of the novel contributions of this research, and this chapter discusses the inclusion of these local issues into the rubric including the consequential scenario development.

This chapter treats customisation of the EPSA rubric in order to meet both Indonesian and the general engineering programmes' requirements. The discussion starts with the identification of the unique criteria of local content, then addresses building a customised EPSA rubric and finally extends the new rubric by including locally relevant scenarios. The chapter concludes with a description of the generation of the EPSA Scoring Sheets as a tool for EPSA rubric class administration.

4.1. Unique Criteria of Local Content

Indonesia has the fourth largest population in the world (261 million in 2018). In Indonesia there are currently 4,693 higher education providers in the form of academies, polytechnics, colleges, institutes, and universities. Most higher education providers offer engineering programmes (Higher Education Data Centre 2019).

Any engineering programme is likely to be strongly influenced by both the global and local situations faced by the country in which the engineering program is located. For instance, in a developing country like Indonesia, in addition to global accreditation requirements (such as ABET EC 2000 or the Washington Accord), the curriculum must simultaneously cover both the national (core) curriculum and the local (institutional) curriculum. The requirement to cover both the national and institutional curricula is stipulated by a Decree of the Minister of National Education of the Republic of Indonesia No. 232/U/2000 about Guidelines for Proposing of Higher Education Curriculum and Assessment of Student Learning. This necessitates a requirement for assessment which is able to evaluate students' understanding of global accreditation requirements as well as the national and local curricula.

As local content is a part of the curriculum structure, the existence of local content subjects is a form of education provision that is not centrally defined. The deliberate lack of central control is to ensure the provision of education in each region which is relevant to the circumstances and needs of the region concerned. This is in line with efforts to improve the quality of national education so that the existence of local curriculum supports and complements the national curriculum. The scope of the local content can take the form of the local language, local arts, skills and crafts, customs, and knowledge of the various characteristics of the surrounding natural environment, as well as things that are considered necessary within the relevant location.

In this case, the learning process can include intra-curricular, curricular, and extra-curricular activities. However, there is a limited space available for inclusion of local content as the curriculum must simultaneously cover all necessary aspects. In turn, this limits the amount of curriculum space for development of EPS. One possible solution is to integrate these local issues into all teaching and learning activities (Sofyan, 2006). This solution offers flexibility in the design of local content since it does not need additional curricular space. Thus, the specific local solution can be determined independently by each institution. For this reason, the local contents are also known as institutional contents.

While the development of EPS is not easily taught in a traditional engineering lecturing format (as might also be expected of local content issues), integration of this material into all teaching and learning activities may be a better solution. This solution however has a consequence, which is the need for suitable assessment for this enhanced EPS. The goal of the research described in this thesis is to address the requirement for suitable assessment for the EPS.

4.2. The Competency-Based IE Curriculum 2012

In 2012, the Department of Industrial Engineering, Universitas Atma Jaya Yogyakarta, Indonesia developed a new curriculum, namely the Competency-Based Curriculum 2012, which is derived from ABET EC-2000 (ABET 2017), Decree No. 232/U/2000 and Universitas Atma Jaya Yogyakarta, Indonesia curriculum contents.

In developing this curriculum, learning outcomes were derived from ABET EC-2000 Criterion 3 (Student Outcomes) which consists of eleven outcomes (see section 2.5.1) and the Decree of the Minister of National Education of the Republic of Indonesia No. 232/U/2000. The decree requires any bachelors programme graduate to demonstrate the following competencies:

- mastery of the scientific basics and skills in certain fields of expertise so that they are able to find, understand, explain, and formulate ways of solving problems that exist within their area of expertise (2.3.2.a)
- an ability to apply knowledge and skills in accordance with his/her expertise in the field of productive activities and service to the community with good attitudes and behaviour in society (2.3.2.b)
- an ability to act and behave ethically in working in his/her field of expertise in society (2.3.2.c)
- an ability to engage in life-long learning (thereby remaining up to date in the development of science, technology, and/or art in his/her field of expertise) (2.3.2.d)

In the Competency-Based Curriculum 2012, there are three outcome criteria which are, respectively, identified as Main Criteria (MC), Supporting Criteria (SC) and Additional Criteria (AC). MC refers to the compulsory competencies that must be achieved by all engineering graduates. There are seven MCs as follows:

- MC1: An ability to use analytical and computational tools.
- MC2: An ability to perform data collection and analysis, design an experiment and analyse its results.
- MC3: An ability to design an integrated system which consists of humans, materials, information, equipment, and energy, and measure its performance using a systems approach.
- MC4: An ability to identify and formulate an improvement for a problem in an integrated system using a systems approach.
- MC5: An ability to find solutions of a formulated problem.
- MC6: An ability to make the decision to implement the results of the problem solutions and demonstrate a deep understanding of its impact on the social, environmental, local and global contexts.
- MC7: An ability to communicate effectively.

SC refers to the compulsory competencies that must be achieved by engineering graduates within their specific engineering field. SC consists of three outcomes as follows:

- SC1: An ability to adapt to new techniques and tools of analysis in the Industrial Engineering profession.

- SC2: An ability to work effectively in a team either as a leader or member.
- SC3: An understanding of professional and ethical responsibility.

AC encompasses the competencies that refer to the local conditions and needs. AC is more flexible since it can be defined independently by the institution. The uniqueness of an engineering program in Indonesia is represented by AC. For the Department of Industrial Engineering, Universitas Atma Jaya Yogyakarta, Indonesia, AC consists of five outcomes as shown below:

- AC1: An ability to be a technology-based entrepreneur in order to create new jobs.
- AC2: An ability to master Computer Aided Design/Computer Aided Manufacturing (CAD/CAM) and Computer Numerical Control (CNC) Machinery.
- AC3: An ability to master Enterprise Resource Planning (ERP).
- AC4: An ability to master Industrial Automation.
- AC5: An ability to master a foreign language (English).

If we eliminate the outcomes related to hard skills and then compare the outcomes related to EPS from ABET EC-2000, Decree No. 232/U/2000 and IE UAJY Curriculum, there is considerable similarity among them as demonstrated in following table (Table 11).

Previously, accreditation of engineering programmes in Indonesia were carried out by the National Accreditation Board for Higher Education (BAN-PT). Since 2016, accreditation has been handled by IABEE as the national accreditation body for engineering, technology and computing programmes in Indonesia. The consequence of this change is the shifting of the learning outcome criteria and graduate profiles which previously referred to the ABET EC-2000; this is now changing to the Washington Accord (WA). This shift does not encompass major change, since ABET is also one of the 6 foundation signatory organisations of the WA. Broadly speaking, ABET's and WA's learning outcomes and graduate profiles are similar but are sometimes phrased differently. ABET has been recognised internationally since 1979 when ABET signed its first Mutual Recognition Agreement with the Canadian Engineering Accreditation Board. ABET is a professional engineering body dedicated to the education, accreditation, regulation and professional development of engineering professionals and students in the jurisdiction of the United States. On the other hand, WA is the more widely recognised international standard currently with 20 signatories (IEA 2019).

Table 11. Comparison of ABET EC-2000, Decree No. 232/U/2000 and IE UAJY (2012)

ABET EC-2000	DECREE No. 232/U/2000	IE UAJY Criteria (2012)
3d. Ability to Function on Multi-disciplinary Team		SC2. An ability to work effectively in a team either as a leader or member
3f. Understanding of Professional and Ethical Responsibility	2.3.2.c. Ability to act and behave ethically in working in his/her field of expertise in society;	SC3. An understanding of professional and ethical responsibility
3g. Ability to Communicate Effectively		MC7. An ability to communicate effectively
3h. Understanding of the Impact of Engineering Solutions in Global, Economic, Environmental, and Cultural/Societal Contexts	2.3.2.b. Ability to apply knowledge and skills in accordance with his/her expertise in the field of productive activities and service to the community with good attitudes and behavior in society;	MC6. An ability to make the decision to implement the results of problem solutions and demonstrate a deep understanding of its impact on the social, environmental, local and global context
3i. Recognition of and Ability to Engage in Life-Long Learning	2.3.2.d. Ability to engage in Life-Long Learning (thereby remaining up to date in the development of science, technology, and/or art in his/her field of expertise)	
3j. Knowledge of Contemporary Issues		
		AC1. Ability to be a technology-based entrepreneur in order to create new jobs

4.3. Building a Customised EPSA Rubric

The Engineering Professional Skills Assessment rubric (EPSA rubric) is an analytical rubric which is used to evaluate the students' discussion and through that discussion, the extent of their mastery of EPS. Students are given an engineering case study to discuss and the EPSA rubric is applied for assessing the students' discussion. The original version of the EPSA rubric used five criteria which are related to learning outcomes of ABET-EC2000.

Although the learning outcomes of ABET EC-2000 were adopted by the Indonesian Higher Education Provider, there are other outcomes which are also necessary to provide mastery of local needs. For this reason, the research described in this thesis develops a customised EPSA rubric by substituting five criteria from ABET (2017) with the Competency-Based IE Curriculum 2012 Outcomes of the Department of Industrial Engineering (2012), Universitas Atma Jaya Yogyakarta, Indonesia. Once the criteria related to hard skills are eliminated, what remains are five soft skills criteria as outcomes for the new EPSA rubric. The criteria which contain the local needs are represented by MC6, MC7 and SC3. Each outcome was then expanded into several specific areas considered according to its definition as presented in Table 12.

Table 12. EPS Aligned in the Customised EPSA Rubric

OUTCOME	SPECIFIC AREA CONSIDERED
MC6. An ability to make decisions to implement the results of problem solutions and demonstrate a deep understanding of the solution's impact on the social, environmental, local and global context	MC6.1. Problem solving MC6.2. Impact/Context
MC7. An ability to communicate effectively	MC7.1. Verbally MC7.2. Non-verbally
SC2. An ability to work effectively in a team either as a leader or member	SC2.1. Leadership SC2.2. Participation
SC3. An understanding of professional and ethical responsibility	SC3.1. Stakeholder Perspective SC3.2. Problem Identification SC3.3. Ethical Considerations
AC1. An ability to be a technology-based entrepreneur in order to create new jobs	AC1.1. Creativity AC1.2. Technology Innovation

The next step of building the customised EPSA rubric is formulating the definition of each skill and providing the standard ratings. In this research, six standard ratings for assessing students' EPS were adopted from the EPSA. Specifically, these were: 0-missing, 1-emerging, 2-Developing, 3-Practicing, 4-Maturing, and 5-Mastering. These were redefined to align with the modified EPSA criteria.

The first criterion is *an ability to make decisions to implement the results of problem solutions and demonstrate a deep understanding of the solution's impact on the social, environmental, local and global context* (MC6). For this criterion, students demonstrate their ability in problem solving, starting from generating new ideas of problem solving to choosing the best solution. Students also demonstrate their awareness of the impact of the solution on social, environmental, local and global contexts. Using this definition, the standard rating for each level was developed (see Table 13).

Table 13. Standard Ratings for MC6

MC6. An ability to make decisions to implement the results of problem solutions and demonstrate a deep understanding of the solution's impact on the social, environmental, local and global context						
Specific Area	0 – Missing	1 – Emerging	2 – Developing	3 – Practising	4 - Maturing	5 - Mastering
Problem Solving	Students do not have any idea how to solve the problem	Students are able to come up with ideas of problem solving although these ideas are taken from the solutions that already exist.		Students are able to come up with ideas of problem solving. Although these ideas are taken from the solutions that already exist, they are able to make some adjustment and modification of the ideas.		Students are able to generate new ideas of problem solving and demonstrate how they choose the best solution from some alternative solutions.
Impact/Context	Students do not consider any impacts of potential solutions on social, environmental, local and global context	Students start to consider the impact of their proposed solutions. Contexts considered may not be relevant. Students don't seem to understand the value or point of considering impacts of technical solutions or the contexts within which the solution is proposed.		Students consider how their proposed solutions impact major relevant contexts, and possibly re-think their understanding of the problem(s) themselves; justify possible solutions with reasonable accuracy. Impacts considered may be associated with relevant secondary problems.		Students clearly examine and weigh how their proposed solutions impact major relevant contexts and justify possible solutions with reasonable accuracy. Impacts considered may be associated with relevant secondary problems, and display understanding of how different contexts can affect solution effectiveness.

This criterion consists of many aspects, especially related to impact/context. The assessment may be too complicated if all aspects are simultaneously evaluated. In practice, the assessor can evaluate each aspect separately, distinctly from each other, and then combine them in one overall assessment. For example, the assessor can assign a partial score for each impact/context (social, environmental, local and global) and then combine them into a final score for this criterion. This strategy is equally applicable to other criteria which consist of multiple aspects.

The second criterion is *an ability to communicate effectively* (MC7). For this criterion, students work together to address the problems that arise in the scenario by acknowledging and building upon each other's ideas to come to a consensus. In the EPSA discussion process, students were encouraged to participate actively. Students are expected to be able to communicate both verbally (the ability to speak, listen, question and write with clarity and conciseness) and non-verbally (using body language, gestures and the tone and pitch of voice). The communication outcome may include several forms of communication, such as written and oral presentation. In this research we assessed only how students communicate with each other during the discussion process. The standard ratings for each level are defined as shown in Table 14.

In assessing this criterion, frequency of utterances among discussion members should be considered as well as the level of individual engagement. This can be measured by the length and depth of utterances. Assessing this criterion is expected to be more difficult than other criteria because it is entirely based on observation during the discussion process while the other criteria can be traced back through the audio transcript of the discussion. For practical reasons, an assessor might use "a rule of thumb" for assessing this criterion. For example, to give a score at level 2, fewer than 75% of students demonstrate their abilities in their important ideas. To score at level 3, at least 75% of students in the group demonstrate their abilities in their important ideas, attempting to build on and/or clarify other ideas (verbally). Similarly, for the non-verbal area, to score at level 2, one or two students demonstrate their body language and gestures when they deliver their ideas. To score at level 3, at least 75% of the students should demonstrate their body language and use tone and pitch to emphasise their ideas.

Table 14. Standard Ratings for MC7

MC7. An ability to communicate effectively						
Specific Area	0 – Missing	1 – Emerging	2 – Developing	3 – Practising	4 - Maturing	5 - Mastering
Verbally	Students do not demonstrate their ability in presenting their own ideas.	Students deliver their own ideas without considering other student's ideas.		Students demonstrate their ability to absorb, summarize and clarify other student's ideas. Most of the discussants give valuable input and attempt to clarify other's ideas.		Students invite and encourage participation of all discussion participants, build and clarify ideas together. Students build upon all ideas to come to a consensus.
Non-Verbally	There is no evidence of using body language during discussion progress.	Some students may demonstrate their body language and gestures when they deliver their ideas, but it may not express their understanding of the problems raised in the scenario.		Students use body language, gestures and the tone and pitch of voice to emphasise their ideas. Students attempt to convince their colleagues to reach consensus.		Students demonstrate how to use body language, gestures and the tone and pitch of voice to emphasise their ideas effectively. It can be seen that students clearly work together to reach a consensus in order to clearly frame the problem and develop appropriate ways to solve the problem.

The third criterion is *an ability to work effectively in a team either as a leader or member* (SC2). The assessment is focused on leadership and participation. Student are expected to demonstrate their leadership and active participation during the discussion process. The standard rating for each level was established as shown in Table 15.

When assessing this criterion, the assessor needs to consider the flow of discussion; each discussant should be able to play their own role in a team either as a leader or member. In a similar manner to the second criteria, assessing this criterion is entirely based on observation during the discussion process. The assessor might use a similar way for assessing participation, for example to assess the score at level 2, when fewer than 75% of students participate in the discussion. To score at level 3, at least 75% of the students in the group should participate in the discussion. A greater weighting would be given for smooth and in-control discussion processes.

Table 15. Standard Ratings for SC2

SC2. An ability to work effectively in a team either as a leader or member						
Specific Area	0 – Missing	1 – Emerging	2 – Developing	3 – Practising	4 - Maturing	5 - Mastering
Leadership	Students do not demonstrate their leadership ability in a team	Students begin to demonstrate their leadership ability in a team but have difficulty playing a role as a leader.		Students are generally successful in playing a role as a leader in a team.		Students demonstrate their leadership ability in a team, take control and lead all team members toward the main goals.
Participation	Students do not participate in a team	Students begin to participate a little in a team after getting encouragement from other team members.		Students participate actively in a team.		Students participate actively in a team while they also drive other team member's participation.

The fourth criterion is *an understanding of professional and ethical responsibility* (SC3). Students demonstrate their ability to frame the problems raised in the scenario clearly and begin the process of resolution. They are able to identify the primary and (if relevant) secondary problems. Students are also able to identify related ethical considerations (e.g. health and safety, fair use of funds, risk, and doing "what is right" for all involved). Students recognize relevant stakeholders and their perspectives. From this point, students are able to identify the linkages between ethical considerations and stakeholders' interest. This understanding will help students in finding the "win-win solution' for all stakeholders involved. This criterion is then expanded to define a standard rating for each level of achievement as listed in Table 16.

The last criterion is *an ability to be a technology-based entrepreneur in order to create new jobs* (AC1). This criterion requires students to demonstrate their creativity, entrepreneurial spirit and ability to create a new business idea based on technology innovation ideas. When assessing this criterion, the assessor might consider the student's creativity and technology innovation in generating new business ideas. Unique business ideas are most welcome. This criterion is then expanded to define a standard rating for each level of achievement as shown in Table 17.

Table 16. Standard Ratings for SC3

SC3. An understanding of professional and ethical responsibility						
Specific Area	0 – Missing	1 – Emerging	2 – Developing	3 – Practising	4 - Maturing	5 - Mastering
Stakeholder Perspective	Students do not identify stakeholders	Students identify few and/or most obvious stakeholders, perhaps stating their positions in a limited way and/or misrepresenting their positions		Students explain the perspectives of major stakeholders and convey these with reasonable accuracy		Students thoughtfully consider perspectives of diverse relevant stakeholders and articulate these with great clarity, accuracy and empathy
Problem Identification	Students do not identify the problem(s) in the scenario	Students begin to frame the problem, but have difficulty separating primary and secondary problems. If approaches to address the problem are advocated, they are quite general and may be naïve.		Students are generally successful in distinguishing primary and secondary problems with reasonable accuracy and with justification. There is evidence that they have begun to formulate credible approaches to address the problems.		Students convincingly and accurately frame the problem and parse it into sub-problems, providing justification. They suggest detailed and viable approaches to resolve the problems.
Ethical Consideration	Students do not give any attention to ethical considerations	Students give passing attention to related ethical considerations. They may focus only on obvious health and safety considerations and/or fair use of funds involving primary stakeholders.		Students are sensitive to relevant ethical considerations and discuss them in the context of the problem(s). Students make linkages between ethical considerations and stakeholder interests. Students may identify ethical dilemmas and discuss possible trade-offs.		Students clearly articulate relevant ethical considerations and address these in discussing approaches to resolve the problem(s). Students make linkages between ethical considerations and stakeholder interests and incorporate them into their analysis and resolutions. Students may discuss ways to mediate dilemmas or suggest trade-offs.

Table 17. Standard Ratings for AC1

AC1. An ability to be a technology-based entrepreneur in order to create new jobs						
Specific Area	0 – Missing	1 – Emerging	2 – Developing	3 – Practising	4 - Maturing	5 - Mastering
Creativity	Students do not demonstrate their creativity.	Students are able to modify an existing business idea into a new business idea.		Students are able to create a new business idea (think out of box).		Students are able to create a new business idea (think out of box) and formalize it into a business plan.
Technology Innovation	Students do not demonstrate their technology innovation ideas.	Students are able to master existing technology and use it to modify an existing business idea into a new business idea.		Students are able to master existing technology and use it to create a new business idea.		Students are able to develop a new technology innovation and use it to create a new business idea.

All criteria (Table 13 to Table 17) are then merged into a complete EPSA rubric as below (Table 18). Using this completed version will be very helpful in EPSA class administration because it is practical and easy to use.

Table 18. The Customised EPSA Rubric

Specific Area	0 – Missing	1 – Emerging	2 – Developing	3 – Practising	4 - Maturing	5 - Mastering
MC6. An ability to make decisions to implement the results of problem solutions and demonstrate a deep understanding of the solution's impact on the social, environmental, local and global context						
Problem Solving	Students do not have any idea how to solve the problem	Students are able to come up with ideas of problem solving although these ideas are taken from the solutions that already exist.		Students are able to come up with ideas of problem solving. Although these ideas are taken from the solutions that already exist, they are able to make some adjustment and modification for the ideas.		Students are able to generate new ideas of problem solving and demonstrate how they choose the best solution from some alternative solutions.
Impact/Context	Students do not consider any impacts of potential solutions on social, environmental, local and global context	Students start to consider the impact of their proposed solutions. Contexts considered may not be relevant. Students don't seem to understand the value or point of considering impacts of technical solutions or the contexts within which the solution is proposed.		Students consider how their proposed solutions impact major relevant contexts, and possibly re-think their understanding of the problem(s) themselves; justify possible solutions with reasonable accuracy. Impacts considered may be associated with relevant secondary problems.		Students clearly examine and weigh how their proposed solutions impact major relevant contexts, and justify possible solutions with reasonable accuracy. Impacts considered may be associated with relevant secondary problems, and display understanding of how different contexts can affect solution effectiveness.
MC7. An ability to communicate effectively						
Verbally	Students do not demonstrate their ability in presenting their own ideas.	Students deliver their own ideas without considering other student's ideas.		Students demonstrate their ability to absorb, summarize and clarify other student's ideas. Most of the discussants give valuable input and attempt to clarify other's ideas.		Students invite and encourage participation of all discussion participants, build and clarify ideas together. Students build upon all ideas to come to a consensus.
Non-Verbally	There is no evidence of using body language during discussion progress.	Some students may demonstrate their body language and gestures when they deliver their ideas, but it may not express their understanding of the problems raised in the scenario.		Students use body language, gestures and the tone and pitch of voice to emphasise their ideas. Students attempt to convince their colleagues to reach consensus.		Students demonstrate how to use body language, gestures and the tone and pitch of voice to emphasise their ideas effectively. It can be seen that students clearly work together to reach a consensus in order to clearly frame the problem and develop appropriate ways to solve the problem.
SC2. An ability to work effectively in a team either as a leader or member						
Leadership	Students do not demonstrate their leadership ability in a team	Students begin to demonstrate their leadership ability in a team but have difficulty playing a role as a leader.		Students are generally successful in playing a role as a leader in a team.		Students demonstrate their leadership ability in a team, take control and lead all team members toward the main goals.
Participation	Students do not participate in a team	Students begin to participate a little in a team after getting encouragement from other team members.		Students participate actively in a team.		Students participate actively in a team while they also drive other team member's participation.
SC3. An understanding of professional and ethical responsibility						
Stakeholder Perspective	Students do not identify stakeholders	Students identify few and/or most obvious stakeholders, perhaps stating their positions in a limited way and/or misrepresenting their positions		Students explain the perspectives of major stakeholders and convey these with reasonable accuracy		Students thoughtfully consider perspectives of diverse relevant stakeholders and articulate these with great clarity, accuracy and empathy
Problem Identification	Students do not identify the problem(s) in the scenario	Students begin to frame the problem, but have difficulty separating primary and secondary problems. If approaches to address the problem are		Students are generally successful in distinguishing primary and secondary problems with reasonable accuracy and with justification. There is		Students convincingly and accurately frame the problem and parse it into sub-problems, providing justification. They suggest detailed and viable

Specific Area	0 – Missing	1 – Emerging	2 – Developing	3 – Practising	4 - Maturing	5 - Mastering
		advocated, they are quite general and may be naïve.		evidence that they have begun to formulate credible approaches to address the problems.		approaches to resolve the problems.
Ethical Consideration	Students do not give any attention to ethical considerations	Students give passing attention to related ethical considerations. They may focus only on obvious health and safety considerations and/or fair use of funds involving primary stakeholders.		Students are sensitive to relevant ethical considerations and discuss them in the context of the problem(s). Students make linkages between ethical considerations and stakeholder interests. Students may identify ethical dilemmas and discuss possible trade-offs.		Students clearly articulate relevant ethical considerations and address these in discussing approaches to resolve the problem(s). Students make linkages between ethical considerations and stakeholder interests and incorporate them into their analysis and resolutions. Students may discuss ways to mediate dilemmas or suggest trade-offs.
AC1. An ability to be a technology-based entrepreneur in order to create new jobs						
Creativity	Students do not demonstrate their creativity.	Students are able to modify an existing business idea into a new business idea.		Students are able to create a new business idea (think out of box).		Students are able to create a new business idea (think out of box) and formalize it into a business plan.
Technology Innovation	Students do not demonstrate their technology innovation ideas.	Students are able to master existing technology and use it to modify an existing business idea into a new business idea.		Students are able to master existing technology and use it to create a new business idea.		Students are able to develop a new technology innovation and use it to create a new business idea.

4.4. Building Locally Relevant Scenarios

This modified rubric is then complemented using a series of locally relevant scenarios for the assessment. The incorporation of scenarios is an integral part of the EPSA administration. The EPSA scenarios play an important role in assessing the students' ability and understanding in finding the effective solutions of local everyday problems that are influenced by local peoples' practices and principles. EPSA scenarios are intended to cover real life experiences, related to the field of engineering that the students are studying, and are used to identify aspects, raise issues or otherwise enhance the understanding and learning experience of the engineering students. Because the scenario provides real-world examples of problems and solutions, challenges and strategies, the scenarios can be prepared based on the local situation faced by the stakeholders.

The scenario development followed the steps described in Chapter 3. Seven locally relevant scenarios were designed for this research according to recent local issues in Indonesia. Four scenarios were established in the first cycle of the research (in 2016) and three more scenarios were added in the second cycle (2017). The details of the scenarios and aspects of their assessment are presented in Table 19.

Table 19. List of Locally Relevant Scenarios

Scenario Number	Title	General aspects of assessment	Locally relevant aspects of assessment
1	Adam Air	• Problem identification • Stakeholder identification and their interest • Potential impact of proposed solution • Ethical issues	• Bribe issue based on political situation • Local procedures for conflict of interest resolution versus international best practice
2	Low Cost Carrier	• Problem identification • Stakeholder identification and their interest • Potential impact of proposed solution • Ethical issues • Problem solving	• Local culture and customs view of the dilemma of safety versus cheap airfares
3	Gojek	• Problem identification • Stakeholder identification and their interest • Potential impact of proposed solution • Problem solving	• Creating business opportunities and ideas based on local situation • Local culture and customs view on transportation problem
4	National Car	• Problem identification • Stakeholder identification and their interest • Potential impact of proposed solution • Problem solving	• Understanding political aspect of problem • Conflict of interest among stakeholders based on business and national pride
5	Bay of Jakarta Reclamation	• Problem identification; • Stakeholder identification and their interest; • Potential impact of proposed solution; • Problem solving	• Bribe issue based on political situation; • Understanding political aspect of problem; • Creating business opportunities
6	Indonesia Nuclear Power Plant	• Problem identification; • Stakeholder identification and their interest; • Potential impact of proposed solution; • Problem solving	• Conflict of interest among stakeholders on safety versus the need for electricity supply
7	Cigarette Industry	• Problem identification; • Stakeholder identification and their interest; • Potential impact of proposed solution; • Problem solving	• Creating business opportunities and ideas based on local situation; • Conflict of interest among stakeholders on health versus national income (taxes)

The scenarios are empowered by the use of a set of discussion questions that serve as a prompt to guide the discussion. The EPSA (prompt) discussion questions can be seen in Table 20.

Table 20. The EPSA Discussion Questions

Instructions for Discussion:

Suppose you are an engineer working together with a team in the scenario. Discuss what your team would need to take into consideration to address the issues in the scenario.

You do not need to suggest specific technical solutions in detail, just try to get a consensus from discussion that covers all aspects considered.

Use the following questions as a discussion guide.

1. Identify the major problems raised in the scenario.
2. Identify secondary problems (problems not directly related to the case in the scenario, but which may influence the situation in the scenario significantly).
3. What are the ethical issues that arise in the scenario?
4. Who are the stakeholders in the scenario and what are their interests in the scenario?
5. What is the solution proposed by your team?
6. What are the potential impacts of your proposed solutions in the context of the social, environmental, local and global context?
7. What business ideas do you get from the scenario?
8. What technology innovation do you use to bring your business idea into a successful business?

These questions were designed to serve as a prompt to guide the discussion. Students do not need to fully answer the questions, because these questions are for guidance only, so that the discussion will be undertaken effectively. These questions are not standard questions, so they can be further developed and adjusted according to the objective or aspects of assessment that are to be achieved. They were designed to address the assessed professional skills. Each skill might be addressed by one or more questions. Table 21 demonstrates the professional skills addressed in the discussion questions (Table 20).

Details for all scenarios used in this research (Scenarios 1-7) are presented in Appendix E.

Table 21. Professional Skills addressed in the EPSA Discussion Questions

DIMENSION	SPECIFIC AREA CONSIDERED	Covered by Question No.
MC6. An ability to make decisions to implement the results of problem solutions and demonstrate a deep understanding of its impact on the social, environmental, local and global context	Problem solving	5
	Impact/Context	6
MC7. An ability to communicate effectively	Verbally	Assessed by observation of discussion process
	Non-verbally	Assessed by observation of discussion process
SC2. An ability to work effectively in a team either as a leader or member	Leadership	Assessed by observation of discussion process
	Participation	Assessed by observation of discussion process
SC3. An understanding of professional and ethical responsibility	Stakeholder Perspective	4
	Problem Identification	1, 2
	Ethical Considerations	3
AC1. An ability to be a technology-based entrepreneur in order to create new jobs	Creativity	7
	Technology Innovation	8

4.5. Generation of the EPSA Scoring Sheet

The last step of customising the EPSA rubric was generating the EPSA scoring sheet. This scoring sheet was used during the EPSA class administration. Each outcome was represented by a scoring table to facilitate the assessment with each level of achievement definition (0-missing, 1-emerging, 2-Developing, 3-Practicing, 4-Maturing, and 5-Mastering). For example, see Table 22 for MC6. The assessor observed the discussion process and then gave the appropriate score directly in the column provided. The assessor might write some comments or keywords to support the score. This scoring sheet was found to be very helpful for the assessor to undertake the assessment process.

Table 22. Scoring table for MC6.

MC6. An ability to make decisions to implement the results of problem solutions and demonstrate a deep understanding of its impact on the social, environmental, local and global context						***TOTAL SCORE:***
Problem solving	0 - Missing	1 - Emerging	2 - Developing	3 - Practicing	4 - Maturing	5 – Mastering
	Students do not have any idea how to solve the problem	Students are able to come up with ideas of problem solving although these ideas are taken from the solutions that already exist.		Students are able to come up with ideas of problem solving. Although these ideas are taken from the solutions that already exist, they are able to make some adjustment and modification for the ideas.		Students are able to generate new ideas of problem solving and demonstrate how they choose the best solution from some alternative solutions.
SCORE: COMMENTS:						
Impact/Context	Students do not consider the impacts of potential solutions	Students start to consider the impact of their proposed solutions. Contexts considered may not be relevant. Students don't seem to understand the value or point of considering impacts of technical solutions or the contexts within which the solution is proposed.		Students consider how their proposed solutions impact major relevant contexts, and possibly re-think their understanding of the problem(s) themselves; justify possible solutions with reasonable accuracy. Impacts considered may be associated with relevant secondary problems.		Students clearly examine and weigh how their proposed solutions impact major relevant contexts and justify possible solutions with reasonable accuracy. Impacts considered may be associated with relevant secondary problems, and display understanding of how different contexts can affect solution effectiveness.
SCORE: COMMENTS:						

In assessing the EPSA discussion, the assessor should apply scoring rules as follows:

1. The assessor must understand each skill definition and assign appropriate scores for each of the performance indicators;
2. When uncertainty occurs on assigning a score, refer back to the skill definition to determine whether a higher or lower score is appropriate;
3. In the comment boxes, provide keywords that support the score;
4. Eventually assign one total score for the skill and use whole numbers (no fractions);
5. When averaging scores for the performance indicators, round them down. For example, 2.6 would be a 2 not a 3. The rationale is that the score represents the level the student attained, not the level that they almost attained.

There were two versions of EPSA scoring sheets established in this research, namely a short version (3-pages) and a long version (6-pages). The difference between them (in addition to the number of pages), was that the long version included the definition and explanation in detail of the strategy for assessing each outcome. The first cycle of fieldwork revealed this long version was very troublesome because students had to flip through the pages during the assessment. This issue greatly disrupted the assessment and discussion process. To overcome this issue, a short version was established by eliminating some definitions and information so that the scoring sheet can be simple and compact.

The short version might pose a risk of losing some information. To compensate this risk, the EPSA scoring sheets (long version) along with other documents (scenarios and EPSA rubric) were distributed a week before each EPSA class administration session in the second cycle of fieldwork. This change to procedure gave the students an opportunity to understand about the missing information (definitions and detail of the strategy for assessing each outcome) in the short version which was used in EPSA class administration session. In addition, in the case of the long version, the required briefing session time before the EPSA class administration was longer in order to explain each of these definitions and the strategy for the assessment to the students. Furthermore, the students (especially the assessment sub-team) were offered the opportunity to review and clarify their assessment later through audio records before submitting their assessment to the researcher.

Chapter 5. The Fieldwork Cycle 1

This chapter describes the experiences, obstacles, results, conclusions and recommendations from the first cycle of fieldwork. The first cycle of fieldwork was undertaken in Semester II Academic Year 2015/2016 (10 May 2016 until 22 June 2016) at the Department of Industrial Engineering, Universitas Atma Jaya Yogyakarta, Indonesia. The fieldwork was the first attempt to evaluate the customised EPSA rubric.

Full ethics approval was granted by the University of Auckland Human Participant Ethics Committee (UAHPEC) for this research before undertaking the fieldwork (Ref. No. 016642 – approved 29 April 2016) for a period of three years. The expiry date for this approval is 29 April 2019.

Some findings of the first cycle of fieldwork have been published in a conference paper at the 27th Australasian Association for Engineering Education Conference, Coffs Harbour, Australia (Hadisantono et al. 2016).

5.1. Preparation

The fieldwork required three weeks. While the available weeks for effective learning activities at the Universitas Atma Jaya Yogyakarta, Indonesia was only 16 weeks, it was not possible to allocate more than three weeks. Each class had its own tight schedule for what should be accomplished in the limited time available. With the limited time, the fieldwork needed to be well planned and organised, so that the available time could be utilised effectively.

The preparation started by determining those activities that could be carried out remotely prior to departure, for example correspondence with the Head of Department (HoD) of Industrial Engineering, Universitas Atma Jaya Yogyakarta, Indonesia. We had informed the HoD earlier about the fieldwork details by sending a Consent Form (CF), Participant Information Sheet (PIS) and Invitation Letter to the HoD. The HoD then advised the fieldwork details to each course coordinator and sent the invitation letter to the potential students on behalf of the researcher.

Participants were undergraduate students (4-year programme) and chosen from three different subjects, namely Technopreneurship (IND3852), Integrated System Design (IND4264) and Engineering Ethics (IND5172). These courses were integrative courses which are taught in the two final years of the degree. By that stage it could reasonably be assumed that students already had sufficient engineering knowledge to analyse engineering issues arising in the EPSA scenarios. The class information obtained from the HoD is presented in Table 23.

Table 23. Class Information

Code	Subject	Credit	Number of Classes	Class	Number of Registered Students
IND3852	Technopreneurship	2	2 of 2	A	70
				B	69
IND4264	Integrated System Design	4	2 of 5	A	10
				B	15
				C	17
				D	23
				E	24
IND5172	Engineering Ethics	2	1 of 1	A	50

Higher education providers in Indonesia are using the Semester Credit Unit (SKS) system based on the Regulation of the Minister of Education and Culture of the Republic of Indonesia Number 49/2014 concerning National Standards of Higher Education. This system enables students to choose their own courses in one semester. The SKS system is used as a measure of:

- the amount of student study load;
- the amount of recognition for the success of student learning efforts; and
- the amount of learning effort required by students to complete a programme for each semester and the whole programme.

By this system, a student can be recognised to have passed their degree if they have completed a certain number of credits. For example, an undergraduate program (or baccalaureate level) requires students to complete 144-160 credits.

One credit is equivalent to the study load each week for one semester, consisting of 50 minutes scheduled classroom teaching, 50 minutes structured academic activities (homework and assignments) and 60 minutes of independent academic activities (e.g. literature reviews). It makes one credit equivalent to a total 160 minutes study load each week each semester. In Indonesia, a semester normally runs for 16 weeks (including mid and final examination weeks).

Using the information in Table 23, we chose classes for EPSA class administration based on the number of registered students in each class. A larger registrant number was preferred. IND3852 consists of two parallel classes with the number of participants being 70 and 69, and both were chosen (A and B). IND4264 consists of five parallel classes, so only two (D and E) were chosen as they had the largest number of participants. IND5272 only consists of one class (A). A total of five classes were chosen for observation. IND3852 and IND5272 had two credits which were equivalent to 100 minutes class session, while IND4264 has four credits. In practice, it is divided into two class sessions of 100 minutes each. The EPSA class administration requires around 100 minutes for each run, so a 100-minute session class was suitable.

5.2. Process Arrangement

The EPSA rubric administrations were then applied in the five chosen classes. Students were divided into teams, with one part of the team conducting a discussion based on given scenarios and the other part of the team using a modified EPSA rubric to assess the discussions. Each student was assigned their own role (assessor, discussant, or moderator). The allocation was arranged in each class prior to the EPSA class administration run. The total student participants involved in this EPSA class administration were 220 students (as recorded by the number of signed CF – Table 24).

Table 24. The EPSA Chosen Classes

Code	Subject	Class	Number of Participants
IND3852	Technopreneurship	A	64
		B	62
IND4264	Integrated System Design	D	22
		E	23
IND5172	Engineering Ethics	A	49
Total			220

From the total of 220 students who were willing to become participants, not all attended all three consecutive weeks. Some students only attended one or two times as shown in Table 25. This erratic participation had only a minor effect on the EPSA class administration process and was anticipated by the researcher because their participation was voluntary. Students had the right to withdraw their participation at any time. For instance, students who were involved in the EPSA class administration in the first week could withdraw their participation for the next sessions. The Dean of the Faculty of Industrial Technology at Universitas Atma Jaya Yogyakarta had given an assurance that neither their grades nor academic relationships with course lecturers would be affected by either refusal or agreement to participate. The number of students involved, group and scenario arrangements in each week are presented in Table 25.

Table 25. Number of Students Involved, Group and Scenario Arrangements

Code	SUBJECT	WEEK 1			WEEK 2			WEEK 3	
		Scenario No.	Number of Participants	Number of Groups	Scenario No.	Number of Participants	Number of Groups	Number of Participants	Number of Groups
IND3852	Technopre-neurship	3	45	6	2	54	6	55	6
		3	62	6	2	42	5	53	6
IND4264	Integrated System Design	4	22	3	1	21	3	22	3
		1	18	3	4	24	3	21	3
IND5172	Engineering Ethics	1	42	6	4	34	5	38	5
			189	24		175	22	189	23

The first and second week were used for the EPSA class administration and the third week was used for process evaluation, clarification, and feedback from the students. In the first week, the timing between activities in EPSA class administration was not in accordance with the timetable because it turned out that students needed a longer time for the explanation session. Even though the invitation letter, CF and PIS all explained the details of the research (and had been handed out the prior week), some students did not fully understand the research details. This issue was caused by language barriers. Surprisingly the English proficiency of most students was below the researcher's expectation (the researcher is an academic staff member of this institution, on leave to pursue a PhD). Students needed further explanation of the research details before they agreed to participate and sign the CF. This issue was not anticipated by the researcher. The invitation letter, CF and PIS were only provided in English, as the mode of instruction is English.

All participants in the class were then divided into teams, with one part of each team conducting a discussion based on given scenarios and the other part of each team using a modified EPSA rubric to observe and assess the discussions without being involved in the discussion. Students were asked to be either a discussant or an assessor with the allocation arranged in class. During the discussion, the researcher observed the process without being involved in the discussion. The discussions were recorded for documentation. These audio records gave the opportunity to the assessors to review and clarify their assessments before submitting them to the researcher. When the recording was transcribed, no information which could lead to identification of any individual was included in the transcription. This preserved the confidentiality of the participants' identity.

The researcher had considered the possibility of a language barrier related to the scenario description. This barrier was anticipated by providing scenarios in Bahasa Indonesia as well as English. However, there were still some difficulties related to the scenario which arose as a consequence of the limited understanding of students on the issues described in the scenario. Some students stated that they did not know and understand the issues. This was surprising for the researcher because the scenarios were designed based on recent issues in the local society (a kind of common knowledge). The students needed more time to study the issue by doing a short investigation via the internet.

In the second week, the EPSA class administration process was smoother because most participants already had experience from the previous week. The researcher also had compensated for the difficulties of students' understanding of the issues in the scenario by distributing the scenario earlier at the end of the EPSA class administration in the previous week. This gave students enough time to do a brief study of the issues discussed in the scenario. This solution proved to be quite effective. Obstacles that arose in the second week were merely caused by the addition of new participants (students who did not come during the first week but attended in the second week and wanted to participate). The researcher needed a longer time to explain the research details again to this group.

The third week was used for evaluation and feedback from the students about their experience in performing the EPSA class administration. There were two types of evaluation and feedback, namely by individuals and by groups. The students were handed an anonymous paper-based questionnaire individually. Via this questionnaire each student rated their experiences of EPSA Class Administration numerically. The questionnaires used a 5-point Likert Scale (with 5 being the ideal score) and consisted of three parts. The first part was used to evaluate the given scenario, the second part was used to evaluate the EPSA rubric and the last part was used to evaluate the assessment process. At the end of each part, a free format feedback field for gaining the students' responses was provided. The free format feedback gave the opportunity for the students to express their experiences without the bounds of the existing standard questions. A dropbox was provided in the department office for returning the questionnaire. Out of 220 questionnaires that were distributed, 193 were returned.

For group evaluation and feedback, students were asked to undertake a 30-minute focus group discussion. Each group was given a list of feedback questions to guide their discussions. The list of questions consisted of two parts. The first part was used to evaluate the discussion process. The second part was used to evaluate the assessment process. Opportunity for free format feedback was provided at the end.

5.3. Findings and Discussions

On the first attempt, we encountered several obstacles regarding the implementation of the EPSA class administration. The major problem was the language barrier. This barrier had been anticipated by the researcher via providing scenarios in Bahasa Indonesia. Unfortunately, the researcher over-estimated the students' English language proficiency and did not prepare other documents (CF, PIS, Invitation Letter, Rubric, and Scoring Sheet) in Bahasa Indonesia as well. This issue meant that the EPSA class administration did not adhere to the planned time schedule, especially for the explanation session. However, the discussion session did run smoothly. The average discussion time was 26 minutes for the first week and 29 minutes for the second week. They ran approximately for the same duration.

Although the scenarios had been provided in Bahasa Indonesia, there was an unexpected issue with the students' understanding of the scenarios. Some students reported that they did not understand the issues presented in the scenarios. This finding is perhaps explained by Miller's research (Miller 2016). Miller observed literate behaviour and literacy in 200 countries and their supporting resources (in five categories such as size and number of libraries and newspaper readership). Miller's research presented the list of the World's Most Literate Nations Ranked. From 200 countries surveyed there were only 61 that made the cut with the majority eliminated due to the lack of relevant statistics. The list demonstrated that the Nordic countries (Finland, Norway, Iceland, Denmark, and Sweden) were the five most literate nations in the world, while Indonesia was ranked 60th and Bostwana 61th. Miller's research is consistent with the observation that some students did not understand recent local issues. Beside the literacy issue, this finding is perhaps also caused by students' lacking maturity and their inexperience with complex issues. The researcher then compensated for this issue by distributing the scenario prior to the second week's EPSA session. This solution enabled students to undertake a short investigation related to the issues in the given scenario.

The second obstacle was inconsistency in some students' attendance, where not all students attended three consecutive weeks of classes. Some of them only attended one or two of the three weeks. This issue was anticipated by the researcher, as while participation was voluntary, the researcher could not refuse students who were willing to participate. Consequently, more time was required for a briefing session prior to the EPSA class administration process. However, this did not affect the time available for discussion.

The last obstacles identified during the first EPSA administration were mainly due to logistical problems in the form of limited space in the classroom conditions. Some students complained about noise disturbance from other discussion groups. This obstacle was mainly experienced by the assessment sub-team. While they had to assess the discussion without being involved in it, they tended to take seat positions apart from the discussion sub-team so that it was easy to observe the discussion. Unfortunately, the background noise disturbance interfered with their observations. This obstacle was compensated to some extent by using audio recording. We offered the assessment sub-team the opportunity to review and clarify their assessment later through audio records before submitting that assessment to the researcher.

To evaluate the EPSA class administration process, 193 students numerically rated their experiences regarding the scenarios, the assessment rubric and the assessment process by using a 5-point Likert Scale (with 5 being the ideal score). The mean of their ratings (Table 26) were 3.42 / 5 for the scenarios, 3.38 / 5 for the assessment rubric and 3.76 / 5 for the assessment process. The assessment rubric has the lowest rating followed by the scenarios and the assessment process. However, all ratings were greater than the middle scale point, 3.0. This implied that, by and large, the students thought the rubric was adequate but could be improved. Some of the feedback from students also indicated that the rubric was perceived as too complicated and that students needed more time to practice both as participants and as an assessor. Extra practice time would affect the desired length of time to be spent on these assessments. Consequently, we recommend the simplification of the assessment rubric, especially on the scoring sheets regarding the implementation.

The researcher made improvements based on the first week's experience, specifically handing the scenarios and rubric scoring sheets out earlier to the students prior to the EPSA class administration session. However, the evaluation was undertaken at the end of the second week. It was thus not possible to determine if there was any difference in student experience between the first week and the second week. We recommended undertaking the evaluation for each week separately in the second cycle of the fieldwork.

Table 26. The Student Individual Evaluation of EPSA Class Administration for Cycle 1 (Out of 5, 5 is the highest (i.e. ideal) rating)

CODE	SUBJECT	Part 1 (Scenario)	Part 2 (Rubric)	Part 3 (Assessment Process)
IND3852	Technopreneurship	3.47	3.32	3.48
		3.40	3.26	3.68
IND4264	Integrated System Design	3.68	3.73	4.07
		3.42	3.43	3.92
IND5172	Engineering Ethics	3.14	3.16	3.66
AVERAGE		3.42	3.38	3.76

Feedback from the Focus Groups (189 students were divided into 23 groups) also demonstrated similar results. The major obstacles encountered during the process of discussion was the lack of time given (as declared by 18 of the 23 groups). Furthermore, 20 of the 23 groups expressed feedback that they easily understood the content of a given scenario but needed extra time to explore the scenario in more depth. Students also fed back that the assessment rubric was too complicated (as expressed by 14 of the 23 groups).

Another finding (which was anticipated) was that students would complain about incomplete information in each scenario. The scenario should provide complete information as suggested by 54 of 193 students. We intended that the scenarios would not provide all the information needed because they dealt with "open-ended problems". The scenarios need to be brief to limit the number of pages so they can be read quickly. It is desirable that students learn how to make decisions with incomplete information. Inevitably, this makes some students feel uncomfortable with the conditions that exist in the scenario. Some students try to avoid making a firm decision. Students tend to expect a situation with all the data complete so that decision-making tends to be “algorithmic”. By contrast, the information provided in the scenarios (including deliberate gaps) is intended to replicate situations which will be encountered by students in the real world following their graduation.

The results from the EPSA class administration demonstrated that the average student ratings for all skills lay between level 2 (developing) and 3 (practicing). The skill of “An ability to be a technology-based entrepreneur in order to create new jobs (AC1)” had the lowest rating while “An ability to work effectively in a team either as a leader or member (SC2)” had the highest rating. The average skill rating of 2 to 3 implies that student assessors felt that their peers had not demonstrated that most of the skills were well developed in the design of the curriculum. The complete results of the EPSA class administrations can be seen in Table 27. Prior to the development of this rubric the course designers had no tool available to collect such feedback in a way that could usefully inform course design. The modified EPSA rubric has provided such a tool.

Table 27. The EPSA Result for the First Cycle of Fieldwork (Out of 5, with 5 highest (i.e. ideal) rating)

Scenario No.	MC6	MC7	SC2	SC3	AC1
1	2.81	2.89	3.38	3.30	1.76
2	2.70	2.62	3.10	2.56	2.25
3	2.81	2.49	2.72	2.65	2.49
4	2.78	2.63	2.80	2.83	2.17

5.4. Recommendations arising from Fieldwork Cycle 1

The customised EPSA rubric developed in this research extends that of the original rubric, beyond ABET EC-2000 requirements, to include specific requirements related to an Indonesian setting. The analysis of the first cycle of fieldwork results indicates the rubric is appropriate in assessing students' EPS regarding the specific requirements of the Indonesian setting. The trial identified some obstacles in the EPSA class administration process including the language barrier, the inconsistency in students' attendance, and logistical problems in the form of limited space in the classroom conditions. The trial also identified issues to be investigated further before a second trial in 2017, with the most significant being shortening the rubric to fit within the limited classroom time available for this assessment.

Chapter 6. The Fieldwork Cycle 2

The first cycle of fieldwork identified some obstacles in the EPSA class administration process including a language barrier, inconsistency in students' attendance, and logistical problems in the form of limited space in the classroom conditions. That fieldwork also identified some issues to be investigated further before undertaking the second cycle of fieldwork. The most significant improvement identified was the desirability of shortening the rubric to fit within the limited classroom time.

The second cycle of fieldwork was undertaken in Semester II Academic Year 2016/2017 (8 May 2017 until 20 June 2017) at the Department of Industrial Engineering, Universitas Atma Jaya Yogyakarta, Indonesia. The fieldwork was intended to evaluate the customised EPSA rubric after some changes (resulting from the previous fieldwork cycle) were made.

An ethics amendment was granted by the University of Auckland Human Participant Ethics Committee (UAHPEC) on 1 May 2017 to include a second cycle of the research project, changes in the Likert scale, adding rating scales for each measurement aspect, adding new scenarios and a modification of the rubric assessment form for ease of use.

This chapter describes the experiences of the second cycle of fieldwork. It also describes how the changes affected the EPSA class administration results. The chapter ends with conclusions and recommendations for further research.

Some findings of the second cycle of fieldwork have been published in a conference paper at the 29th Australasian Association for Engineering Education Conference, Hamilton, New Zealand (Hadisantono et al. 2018).

6.1. Preparation

The second cycle of fieldwork also required three weeks for the same reason that it was not possible for the course coordinators to allocate this research project more than three weeks in the busy class schedule. Generally, the process followed that of the previous cycle of fieldwork although it did include improvements and adjustments in methodology to compensate for the obstacles that were experienced during the first cycle of fieldwork.

Earlier (than in cycle 1) contact was made with the Head of Department (HoD) of Industrial Engineering, Universitas Atma Jaya Yogyakarta, Indonesia. The Consent Form (CF), Participant Information Sheet (PIS) and Invitation Letter were also sent to the HoD. The HoD then advised the fieldwork details to each course coordinator and sent the invitation letter to the potential students on behalf of the researcher. In this cycle of fieldwork, we anticipated the language barrier by providing all documents in Bahasa Indonesia.

Participants were undergraduate students (4-year programme) and chosen from three different subjects, namely Technopreneurship (IND3852), Integrated System Design (IND4264) and Engineering Ethics (IND5172) as was the case in the first cycle of the fieldwork. Although the participants were students who enrolled in the same subjects as the first cycle of fieldwork, they were different students from a different year. The class information is provided in Table 28.

Table 28. Class Information for Cycle 2

Code	Subject	Credit	Number of Classes	Class	Number of Registered Students
IND3852	Technopreneurship	2	1 of 1	A	57
IND4264	Integrated System Design	4	2 of 5	A	25
				B	24
				C	24
				D	27
				E	28
IND5172	Engineering Ethics	2	1 of 2	A	50
				B	11

From the Table 28, some classes were chosen for EPSA class administration. IND3852 consists of only one class with the number of participants being 57. IND4264 consists of five parallel classes, and only two (D and E) were chosen as they had the largest number of participants. IND5272 consists of two parallel classes (A and B), and as class B only had 11 registered students, class A with the largest number of students was chosen. A total of four classes were chosen for this fieldwork cycle.

6.2. Process Arrangement

The EPSA class administrations were applied in the four chosen classes of the three different subjects in the same manner as occurred in the first cycle of fieldwork. The number of students involved in this second cycle of the fieldwork was 159 students, as recorded by the number of signed CF (Table 29).

Table 29. Number of Participants for each Chosen Class based on Signed CF

Code	Subject	Class	Number of Participants
IND3852	Technopreneurship	A	57
IND4264	Integrated System Design	D	26
		E	28
IND5172	Engineering Ethics	A	48
Total			159

As was the case in the first cycle of the fieldwork, not all students attended all three consecutive EPSA class administration weeks. Since their participation was voluntary, we could not do anything regarding this issue. The students had the right to withdraw their participation at any time. The number of students involved, groups and scenario arrangements in each week are presented in Table 30.

Table 30. Number of Students Involved, Group and Scenario Arrangements

Code	Subject	Week 1			Week 2			Week 3	
		Scenario No.	Number of Participants	Number of Groups	Scenario No.	Number of Participants	Number of Groups	Number of Participants	Number of Groups
IND3852	Technopre-neurship	7	40	4	6	42	4*	42	4*
IND4264	Integrated System Design	6	26	3	5	24	2*	24	2*
		6	28	3	5	24	3	24	3
IND5172	Engineering Ethics	5	37	4	7	32	4	32	4
			131	14		122	13	122	13

The second cycle of fieldwork mirrored that of the first cycle, in which the first and second weeks were used for the EPSA class administration and the third week was used for process evaluation, clarification and feedback from the participants. In the first week, the EPSA class administration ran smoothly. The obstacles which had been identified in the first cycle of fieldwork had been adequately attended to. To compensate for the language barrier, all documents had been provided in Bahasa Indonesia. These documents were provided to the students a week before the EPSA class administration in order to give the students enough time to undertake a short investigation related to the issues in the scenarios.

In the second and third week, some students arrived late and asked to be involved in the EPSA class administration session, particularly in the Technopreneurship and Integrated System Design classes (identified with * mark in Table 30). These late arriving students were added into the existing groups.

As in Cycle 1, this cycle of fieldwork involved two types of evaluation of feedback from the students about their experience in the EPSA class administration, by individual and by group. For individual evaluation, all participating students were given an anonymous paper-based questionnaire. The questionnaire consisted of three parts. The first part was used to evaluate the given scenario, the second part was used to evaluate the EPSA rubric and the last part was used to evaluate the assessment process. For the second cycle of fieldwork, in addition to the use of a 5-point Likert scale (with 5 being the ideal score), additional rating scales 1-10 (with 10 being the best) were added for each part to evaluate the overall performance.

Students were asked to respond to each question using a 5-point Likert scale and eventually rate their whole response with a score (1-10) to express the overall performance for each part. At the end of each part, a free format feedback field for recording the students' responses was provided. While the questionnaires were only provided to the students in the third week in the first cycle of fieldwork, in this second cycle of fieldwork, the questionnaires were provided for each week separately.

Group evaluation and feedback were undertaken in the third week in the form of focus group discussion as happened in the first cycle of fieldwork.

6.3. Findings and Discussions

The customised EPSA rubric has been implemented in two cycles of fieldwork (2016 and 2017) in the Department of Industrial Engineering, Universitas Atma Jaya Yogyakarta, Indonesia. The number of students involved were 220 students for the first cycle of fieldwork and 159 for the second cycle of fieldwork. In total 379 students were involved.

Table 31. Comparison of Number of Participants for Both Fieldwork Cycles

Code	Subject	Class	Fieldwork Cycle 1	Fieldwork Cycle 2
			Number of Participants	Number of Participants
IND3852	Technopreneurship	A	64	57
		B	62	-
IND4264	Integrated System Design	D	22	26
		E	23	28
IND5172	Engineering Ethics	A	49	48
Total			220	159

In the first cycle of fieldwork, some obstacles were experienced especially with a language barrier. In this second cycle of fieldwork, this problem was not observed. The language barrier was compensated for by providing all documents in Bahasa Indonesia (Invitation, PIS, CF, Scenarios, EPSA Rubric and Scoring Sheets). Nevertheless, this strategy might not entirely eliminate the problem of the students' understanding of the given scenarios. These scenarios contained some (possibly) unfamiliar issues related to local peoples' practices and principles. This issue was anticipated by distributing all documents a week before each EPSA class administration session. This change to procedure gave the students an opportunity to undertake a short investigation on the issues in the scenarios before attending the scheduled class. Students' feedback was sought via questionnaire and the analysis of their responses demonstrated better understanding of the scenario when pre-reading and investigation was permitted prior to the class. Via pre-reading, students were able to develop more understanding of the issues in the scenarios and were able to participate actively in the discussion session. The students' evaluation (which utilised a 5-point Likert Scale, with 5 being the ideal score) demonstrated that this change to procedure increased the average rating from 3.42 (first cycle) to 3.58 (second cycle) as presented in Table 34.

There was still some inconsistency in students' attendance (where not all students attended three consecutive weeks) in the second cycle of fieldwork. Since student participation was voluntary, nothing could be done except encourage them to attend three consecutive weeks of EPSA class administration sessions. However, this small variability in attendance did not affect the whole EPSA implementation result because each EPSA class administration session was mutually exclusive. The only impact of variable attendance was to require slightly more time for each briefing session. The EPSA process had to be explained again since not all students attended the previous EPSA session.

In the second and third week, a new problem regarding the students' arrival time surfaced. Some students came late, after the groups were already arranged, and the discussion process had begun. There was not enough time to re-arrange the group composition. Since the discussant sub-team did not require as much understanding of the EPSA process as did the assessment sub-team, the late coming students were simply added into the existing discussant sub-teams. By this action, the groups did not always meet their ideal size (which was 7-10 students in a group), but it produced only minimal effect on the EPSA class administration process and was judged a reasonable compromise.

In the first cycle of fieldwork, a logistical problem arose from the limited space in the classroom creating noise disturbance from other discussion groups. This problem was anticipated in cycle

2 as well. While it was not possible to provide a separate room for each discussion group due to limited classroom availability, each group discussion place was arranged to minimise the noise disturbance. Students were also encouraged to bring the Voice Recorder (VR) closer to the student who was speaking. This audio recording helped the assessors to review and clarify their assessment before submitting the assessments to the researcher.

The students' experiences in the EPSA session were rated individually by using a 5-point Likert Scale (with 5 being the ideal score). In the first cycle of fieldwork, these individual evaluations were done in the second week. While the researcher made some improvements in the second week, it was not possible to determine if there was any difference in student experience between the first week and the second week. In the second cycle of fieldwork, these evaluations were done separately. The results presented in Table 32 demonstrate that there were increases in ratings from the first week to the second week. Although there were not process changes from the first week to the second week in this cycle of fieldwork (in contrast with the first cycle of fieldwork), this increase probably was caused by the students having more experience with EPSA process.

Table 32. The Student Individual Evaluation of EPSA Class Administration for Cycle 2 (Out of 5, 5 is the highest (i.e. ideal) rating)

FIRST WEEK				
Code	**Subject**	**Part 1 (Scenario)**	**Part 2 (Rubric)**	**Part 3 (Assessment Process)**
IND3852	Technopreneurship	3.34	3.33	3.36
IND4264	Integrated System Design	3.60	3.37	4.00
		3.71	3.58	3.91
IND5172	Engineering Ethics	3.54	3.66	3.74
AVERAGE		**3.55**	**3.49**	**3.75**
SECOND WEEK				
Code	**Subject**	**Part 1 (Scenario)**	**Part 2 (Rubric)**	**Part 3 (Assessment Process)**
IND3852	Technopreneurship	3.63	3.63	3.80
IND4264	Integrated System Design	3.67	3.92	3.93
		3.53	3.58	3.90
IND5172	Engineering Ethics	3.63	3.49	3.93
AVERAGE		**3.62**	**3.66**	**3.89**

The total ratings for both weeks are shown in Table 33. The mean of their ratings was 3.58 / 5 for the scenarios, 3.57 / 5 for the assessment rubric and 3.82 / 5 for the assessment process. In comparison with the first cycle of fieldwork results (Table 26) in the second cycle of fieldwork

(Table 33), a one-tailed Mann-Whitney U test indicated that the differences between both cycles' results (Table 34) were not statistically significant (z-score = -1.48825, p-value = 0.06811). This implies that the changes made from the first cycle of fieldwork to the second cycle of fieldwork did not improve the EPSA class administration process in a statistically significant manner. However, the rubric requires further improvement, as indicated by the lowest mean score. This finding was also supported by the overall performance ratings of the EPSA class administration (a 10-scale rating, with 10 being the best) where the assessment rubric received the lowest score (7.38) followed by the scenarios (7.46) and the assessment process (7.66) as demonstrated by Table 35.

Table 33. The Student Individual Evaluation of EPSA Class Administration (Out of 5, 5 is the highest (i.e. ideal) rating) for Both Weeks (Cycle 2)

Code	Subject	Part 1 (Scenario)	Part 2 (Rubric)	Part 3 (Assessment Process)
IND3852	Technopreneurship	3.49	3.50	3.58
IND4264	Integrated System Design	3.63	3.62	3.97
		3.63	3.58	3.90
IND5172	Engineering Ethics	3.58	3.58	3.83
AVERAGE		**3.58**	**3.57**	**3.82**

Table 34. Comparison of the Student Individual Evaluation of EPSA Class Administration for Both Fieldwork Cycles (Out of 5, 5 is the highest (i.e. ideal) rating)

Fieldwork	Part 1 (Scenario)	Part 2 (Rubric)	Part 3 (Assessment Process)
Cycle 1	3.42	3.38	3.76
Cycle 2	3.58	3.57	3.82

Table 35. The Overall Performance Ratings of the EPSA Class Administration (out of 10, 10 is the highest (i.e. ideal) rating)

Code	Subject	Part 1 (Scenario)	Part 2 (Rubric)	Part 3 (Assessment Process)
IND3852	Technopreneurship	7.29	7.38	7.26
IND4264	Integrated System Design	7.52	7.27	7.78
		7.51	7.35	7.76
IND5172	Engineering Ethics	7.50	7.53	7.84
	AVERAGE	**7.46**	**7.38**	**7.66**

Feedback from the Focus Groups (122 students in 13 groups) demonstrated that some barriers identified during the first cycle of fieldwork still existed in the second cycle of fieldwork.

Examples are the students' understanding of the given scenarios, logistical problems in the form of limited space in the classroom, the lack of time given, and the incompleteness of the information provided in each scenario. Most students still felt that the rubric was overly complicated and required further improvement, particularly on the six standard ratings (0-missing, 1-emerging, 2-Developing, 3-Practicing, 4-Maturing, and 5-Mastering). A perceived issue was that the existing standard ratings did not have clear cut-offs. For example, students had difficulty in distinguishing between level 1 and 2 or level 3 and 4. Students suggested each standard rating be redefined separately. As a result of this feedback and the experience of two cycles of fieldwork, the rubric has been modified to use the SOLO taxonomy (Biggs & Collis, 1982).

The EPSA class administration during the second cycle of fieldwork demonstrated that the ratings for all skills sit between level 2 (developing) and level 3 (practicing), except for AC1. The AC1 skill (which refers to technology-based entrepreneurship) had the lowest rating as shown in Table 36. Furthermore, if this result is compared with the previous cycle of fieldwork (Table 27), both demonstrate consistent results.

Table 36. The EPSA Result for the Second Cycle of Fieldwork (Out of 5, with 5 highest (i.e. ideal) rating)

Scenario No.	MC6	MC7	SC2	SC3	AC1
5	2.53	2.38	2.82	2.65	1.59
6	2.44	2.64	2.67	2.44	1.79
7	2.38	2.00	2.03	2.90	1.79

A striking aspect of both Table 27 and Table 36 is the difference between AC1 and the other skills. The students' AC1 skills consistently had the lowest rating as assessed by their peers. In some assessments, the students were perceived as even failing to demonstrate the development of this skill (assessed as 0-missing by their peers). Upon reviewing the curriculum structure in the Department of Industrial Engineering UAJY, the researcher found that entrepreneurship skills are only covered in one subject, i.e. Technopreneurship (IND3852). These engineering students have not previously studied any business courses. Even though entrepreneurship skills have been taught and are known to be needed in future engineering careers, this research clearly shows (Table 27 and Table 36, column AC1) that students still struggle in developing this skill. Feedback from the course coordinator and from students also reinforced this finding.

Skills such as awareness of the impact of engineering solutions, communication, teamwork, ethics and professionalism (as assessed in MC6, MC7, SC2 and SC3) have been developed via integration into most engineering subjects (roughly 83% of the curriculum structure). For instance, the skill related to teamwork is developed through working in teams both inside and outside the classroom, through projects, internships, and extracurricular activities. In relation to how to best integrate entrepreneurship education within the field of engineering, it seems likely that coverage via only one subject in the engineering curriculum is insufficient. A recommendation arising from the research reported in this thesis is that the Department of Industrial Engineering UAJY needs to provide a greater portion of entrepreneurship education in their curriculum structure.

The three subjects (Technopreneurship, Integrated System Design and Engineering Ethics) were selected because they were integrative courses which were taught in the two final years of the degree. By that stage (perhaps with the exception of Technopreneurship) students already have sufficient engineering knowledge to analyse the engineering issues at this stage of their education. In addition, students were expected to be able to easily understand the issues raised in the scenarios because these issues were local issues which included local people's practices and principles. As demonstrated in Table 27 and Table 36, the most highly developed skills were SC2 (teamwork) and SC3 (understanding ethics and professionalism).

As a result of this research, the Department of Industrial Engineering UAJY has revised the curriculum (starting in 2017) to include more entrepreneurship education. Quality Assurance Office UAJY data for three consecutive years (2015/2016, 2016/2017, 2017/2018) for Technopreneurship demonstrated an improvement in student rating of active participation, feedback and understanding. While interpretation of this data is confounded by issues such as slight changes in teaching personnel over the period, they are strongly suggestive of improvements arising from the use of the scenarios and the EPSA.

6.4. Recommendations arising from Fieldwork Cycle 2

The EPSA class administration for both cycles of fieldwork demonstrated consistent results. The customised EPSA rubric developed in this research has been shown to be applicable to the Indonesian setting. Through both cycles of fieldwork, it has been possible to identify the strengths and weaknesses of the students in relation to their EPS achievements. This capability will help the course designers to redesign the curriculum in order to improve the teaching and learning outcomes.

The second cycle of fieldwork showed that some barriers identified during the first cycle of fieldwork still existed in the second cycle of fieldwork. Students still considered the customised EPSA rubric to be complicated and requiring further improvement, particularly the standard ratings. This issue was addressed by the development of a modified rubric based on the SOLO taxonomy.

Chapter 7. Formalising the EPSA Method

The EPSA class administration through both cycles of fieldwork identified some issues to investigate further. The findings from both cycles of fieldwork identified the process to be followed to reformulate the customised EPSA rubric to make it more useful in an Indonesian setting.

This chapter commences with the reflection on what was learned from the two cycles performed in this research and a framework on how a future cycle might be designed. In the future cycle, the IABEE accreditation criteria and the IE-UAJY Curriculum Learning Outcomes were merged to form the learning outcomes. The second cycle of fieldwork showed that students still considered the customised EPSA rubric to be complicated and requiring further improvement, particularly the standard ratings. The chapter discusses the development of a new (less complicated) standard rating using the SOLO Taxonomy.

The chapter then continues with the development of a new EPSA rubric and the consequent adjustment of the existing locally relevant scenarios. The chapter ends by describing development of new EPSA Scoring Sheets.

7.1. Reflection on what was learned from both cycles

Although, both cycles of fieldwork demonstrated consistent results, there were some identified issues to investigate further. The logistical problems can be solved relatively easily by providing an ideal class situation for the implementation of the EPSA administration. On both cycles, some students were assigned as assessors. This might be a threat to validity as they might have incorrect understanding of each skill interpretation because the assessment is actually only based on students' perception. While each skill has different characteristics, students with a lack of experience on this kind of assessment will face some difficulties in understanding of each skill interpretation, especially in a time restricted situation. The use of audio recording can only slightly reduce this bias. Future cycles should be designed to minimise this bias by assigning some competent faculty members as the assessment team members. The assessment team members can also be extended to include other stakeholders, for example, practitioners or employers.

From reflection on both cycles, the modified EPSA framework was developed. The EPSA framework provides the standards and offers flexibility for other professional educators to include their graduate attributes into the EPSA for their own students. It comprises:

- Key Dimensions of the EPSA for Indonesia Higher Education with reference to the accreditation system, the national curriculum and the institutional curriculum. This structure could easily be adapted by other jurisdictions using their own accreditation systems and their curriculum structure.

- Indicators provide a description of each level in terms of learning outcomes, using common domains and dimensions of progression. Knowledge, skills and application describe what a graduate at a particular level is expected to know, do and be. The term "application" encompasses responsibility, behaviours, attitudes, attributes and competence. In this research the indicators of EPSA are a blend of the IABEE learning outcomes, the Indonesian Qualification Framework and the UAJY Graduate Profile.

Based on literature reviews of various jurisdictions (WA and non-WA), there is a difference between a qualification framework from developed countries (Australia, New Zealand, etc.) that describes what exists and a framework from developing countries (Indonesia, Malaysia, South Africa, etc.) that prescribes what ought to be. This difference is seen in how the framework defines 'competency standards' (which is linked to job descriptions) and 'academic standards' (that relate to domains of knowledge). The definition of the standard competency in the graduate profile comes from the linked job descriptions, so that the competency is a measurement of a person's ability to carry out a certain job. Because it comes from the point of view of employers, the competency measure, especially EPS, is determined in detail by the graduate users in the form of competency standards whose achievements can be measured accurately. Unfortunately, in all existing jurisdictional frameworks there is no clear process identifying how this EPS can be formally measured.

The EPSA framework offers a general framework for assessment of EPS in graduate attributes that might be developed through scenario-based learning interventions.

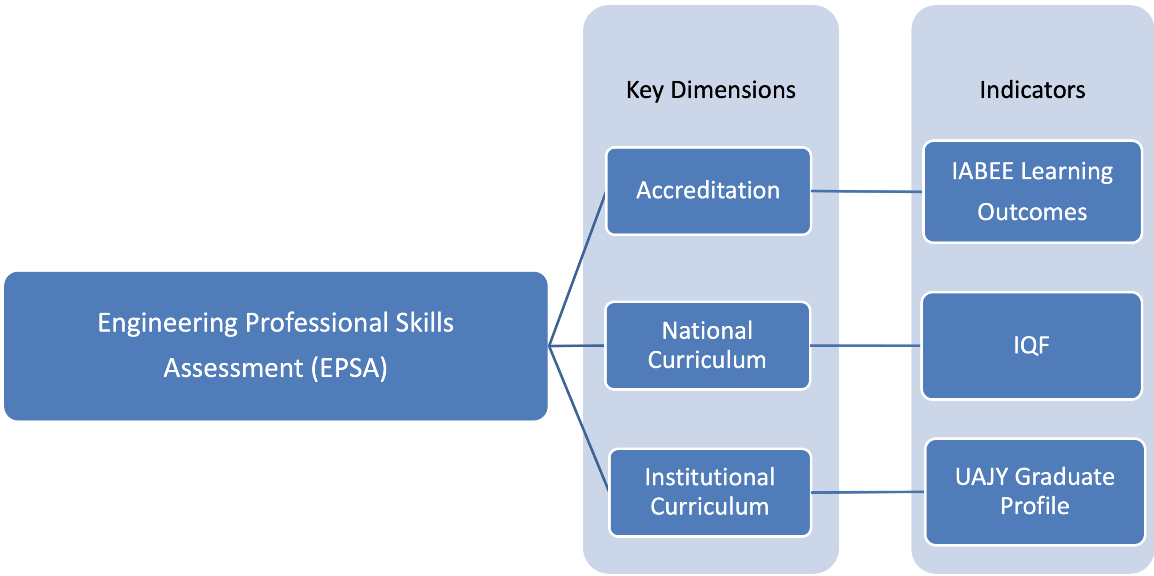

Figure 5. The EPSA framework

7.2. Determining Criteria

Since 2017, the engineering programme accreditation in Indonesia was conducted by IABEE as the national accreditation body for engineering, technology and computing programmes. IABEE accreditation criteria are an outcome-based accreditation model. This model requires that the student can demonstrate upon graduation the ability to utilise their knowledge, skills, resources and attitudes. The IABEE accreditation criteria are derived from the Washington Accord Graduate Attributes. The IABEE was accepted as a Washington Accord (WA) provisional member at the Annual Meeting of the International Engineering Alliance (IEA) in June 2019.

The IABEE graduate outcomes (also known as the IABEE Common Criteria) consist of ten items. These criteria are compulsory for every engineering programme seeking IABEE accreditation. After eliminating engineering hard skill outcomes, we are left with five outcomes related to the EPS as demonstrated in Table 37.

Table 37. The IABEE Graduate Outcomes related to the EPS

EPS	The IABEE Learning Outcomes
(A1) Awareness of the impact of engineering solutions	(b) An ability to design components, systems and/or processes to meet expected needs within realistic boundaries, such as legal, economic, environmental, social, political, health and safety, sustainability and to recognise and/or utilise potential local and national resources with global insight.

(P2) Oral and written communications	(f) An ability to communicate effectively, both oral and written
(P1) Teamwork	(h) An ability to work in multiple disciplines and cultures
(P3) Understanding ethics and professionalism	(i) An ability to be responsible to the community and comply with professional ethics in solving engineering problems
(A2) Life-long learning	(j) An ability to understand the need for life-long learning, including access to knowledge related to current relevant issues.

Meanwhile, the Department of Industrial Engineering, Universitas Atma Jaya Yogyakarta (IE-UAJY), Indonesia had also launched the new curriculum at the same year (2017). The launching of the new curriculum was an anticipation of the changes of the national accreditation system. National accreditation for engineering programmes was previously conducted by National Accreditation Board for Higher Education (BAN-PT) which was recognised locally (only by Indonesian jurisdiction). Since the national accreditation for engineering programmes is conducted by IABEE, there is an opportunity for high quality engineering programmes to seek international recognition through the International Engineering Alliance (IEA) agreement.

The IE-UAJY Curriculum 2017 was developed based on the Outcome Base Education (OBE) from Indonesian Qualification Framework (IQF) 2012 and IABEE accreditation criteria. The IE-UAJY has accredited provisionally by IABEE in 2018. Beside the curriculum must cover the compulsory criteria, the IQF and the IABEE also required that the engineering programme must establish their own independent professional profiles in order to encourage independence, prosperity, progress and justice for the nation and the global community, based on science, technology, culture and sustainable use of natural resources. These requirements motivate each engineering programme in Indonesia to enrich their curriculum with local curriculum contents (also known as institutional contents) which refer to the local conditions and needs. By adding these local curriculum contents, the engineering programmes give a competitive advantage to their graduates.

Both cycles of fieldwork demonstrated that EPS such as the impact of engineering solutions, communication, teamwork, ethics and professionalism have been developed via integration into most engineering subjects while entrepreneurship education has less coverage in the existing curriculum structure. As one of the learning outcomes and Graduate Profiles, the entrepreneurship education needs a greater portion the curriculum structure. As a result of this research, the new curriculum of the Department of Industrial Engineering UAJY has included a greater portion of entrepreneurship education.

However, there is limited space available in the curriculum structure as the curriculum must simultaneously cover all necessary aspects. Consequently, this limits the amount of curriculum space for explicit inclusion of entrepreneurship education. A compromise was made by integrating the entrepreneurship education into all teaching and learning activities implicitly. This solution offers more flexibility in the design of a new curriculum since it does not need additional curricular space. Thus, the need for a greater portion of entrepreneurship education can be met.

The changes in the Indonesian accreditation system and the IE-UAJY Curriculum 2017 motivated the development of a new EPSA rubric which accommodate the IABEE accreditation criteria and the IE-UAJY Curriculum 2017 learning outcomes.

In the IE-UAJY Curriculum 2017, the Learning Outcomes (CPL) cover four aspects which are Attitude (CPS), General Skill (CPKU), Specific Skill (CPKK) and Knowledge (CPP). The Learning Outcome related to the EPS is shown in Table 38, while the rest related to engineering hard skills.

Table 38. The IE-UAJY Curriculum 2017 Learning Outcomes related to the EPS

EPS	IE-UAJY Learning Outcomes
(P3) Understanding ethics and professionalism	CPS 3. Demonstration of commitment to improving the quality of life in the society and nation based on Pancasila.*
	CPS 7. Understanding of the law and professional ethics
	CPS 8. Understanding academic values, norms and ethics
(A1) Awareness of the impact of engineering solutions	CPS 5. An ability to respect the diversity of cultures, views, religions, and beliefs, as well as intellectual property rights
(P1) Teamwork	CPS 6. An ability to work together and have social sensitivity and concern for society and the environment
(A2) Life-long learning	CPS 9. Demonstration of commitment to continual professional development.
	CPS 10. Demonstration of resilience and an entrepreneurial spirit.

**Pancasila is the philosophical basis of the Indonesian state. Pancasila comprises two Old Javanese words originally derived from Sanskrit: "pañca" ("five") and "sīla" ("principles"). It comprises five inseparable and interrelated principles that are: Belief in the One God, Humanity, Unity, Democracy and Social Justice*

Table 39 demonstrates the comparison of the IABEE and IE-UAJY Curriculum 2017 learning outcomes. Each IABEE criteria is accommodate by one or more of the IE UAJY Curriculum 2017 learning outcomes. The IE UAJY Curriculum 2017 learning outcomes represent more specific values that reflect the local conditions and needs (institutional values).

Table 39. Comparison of the IABEE Graduate Outcomes and IE-UAJY Learning Outcomes

EPS	IABEE Learning Outcomes	IE-UAJY Learning Outcomes
(A1) Awareness of the impact of engineering solutions	(b) An ability to design components, systems and/or processes to meet expected needs within realistic boundaries, such as legal, economic, environmental, social, political, health and safety, sustainability and to recognise and/or utilise potential local and national resources with global insight.	CPS 5. An ability to respect the diversity of cultures, views, religions, and beliefs, as well as intellectual property rights
(P2) Oral and written communications	(f) An ability to communicate effectively, both oral and written	
(P1) Teamwork	(h) An ability to work in multiple disciplines and cultures	CPS 6. An ability to work together and have social sensitivity and concern for society and the environment
(P3) Understanding ethics and professionalism	(i) An ability to be responsible to the community and comply with professional ethics in solving engineering problems	CPS 3. Demonstration of commitment to improving the quality of life in the society and nation based on Pancasila.
		CPS 7. Understanding of the law and professional ethics
		CPS 8. Understanding academic values, norms and ethics
(A2) Life-long learning	(j) An ability to understand the need for life-long learning, including access to knowledge related to current relevant issues.	CPS 9. Demonstration of commitment to continual professional development.
		CPS 10. Demonstration of resilience and an entrepreneurial spirit.

New criteria (Table 40) was formed by merging the IABEE accreditation criteria and the IE-UAJY Curriculum Learning Outcomes. These new criteria are more compatible with the Washington Accord. The specific requirement for assessment of local concerns and practices are addressed by criteria (b), (h) and (j).

Table 40. EPS Aligned in the New Customised EPSA Rubric

EPS	LEARNING OUTCOMES	SPECIFIC AREA CONSIDERED

(A1) Awareness of the impact of engineering solutions	(b) An ability to design components, systems and/or processes to meet expected needs within realistic boundaries, such as legal, economic, environmental, social, political, health and safety, sustainability and to recognise and/or utilise potential local and national resources with global insight.	• Impact/Context on cultures, views, religions, and beliefs, as well as intellectual property rights • Social sensitivity and concern for society and the environment
(P2) Oral and written communications	(f) An ability to communicate effectively, both oral and written	• Oral Communication • Written Communication
(P1) Teamwork	(h) An ability to work in multiple disciplines and cultures	• Leadership • Participation
(P3) Understanding ethics and professionalism	(i) An ability to be responsible to the community and comply with professional ethics in solving engineering problems	• Commitment to Improving the quality of life in the society and nation • The law, professional ethics and academic values
(A2) Life-long learning	(j) An ability to understand the need for life-long learning, including access to knowledge related to current relevant issues.	• Commitment to continual professional development. • Resilience and entrepreneurial spirit

7.3. Developing New Standard Ratings

The second cycle of fieldwork demonstrated that students still considered the customised EPSA rubric to be complicated and requiring further improvement, particularly on the six standard ratings (0-missing, 1-emerging, 2-Developing, 3-Practicing, 4-Maturing, and 5-Mastering). While each standard rating did not have clear cut-offs, students experienced difficulty in distinguishing between level 1 and 2 or level 3 and 4. This issue motivated the development of new standard ratings.

In developing a new standard rating, SOLO (Structure of the Observed Learning Outcome) Taxonomy model seems appropriate to be used. It is a model that describes levels of a learner's understanding of subjects (Biggs & Collis 1982). It helps both trainers and learners in understanding the learning process. The model classifies the order of understanding into five levels in term of their complexity:

- Pre-structural – At this level, the learner doesn't understand the lesson or subject.
- Uni-structural – The learner's response only focuses on single relevant aspect.

- Multi-structural – The learner's response focuses on several relevant independent aspects.
- Relational – The learner is able to integrate all relevant aspects.
- Extended abstract - The learner is able to create new ideas based on their understanding of the lesson or subject.

Biggs & Tang (2007) suggested to use verbs that parallel the SOLO taxonomy in designing the learning outcomes statements. Figure 6 provides a visual representation with some typical verbs for each level. The verbs indicate what the students are required to be able to do to achieve the particular level.

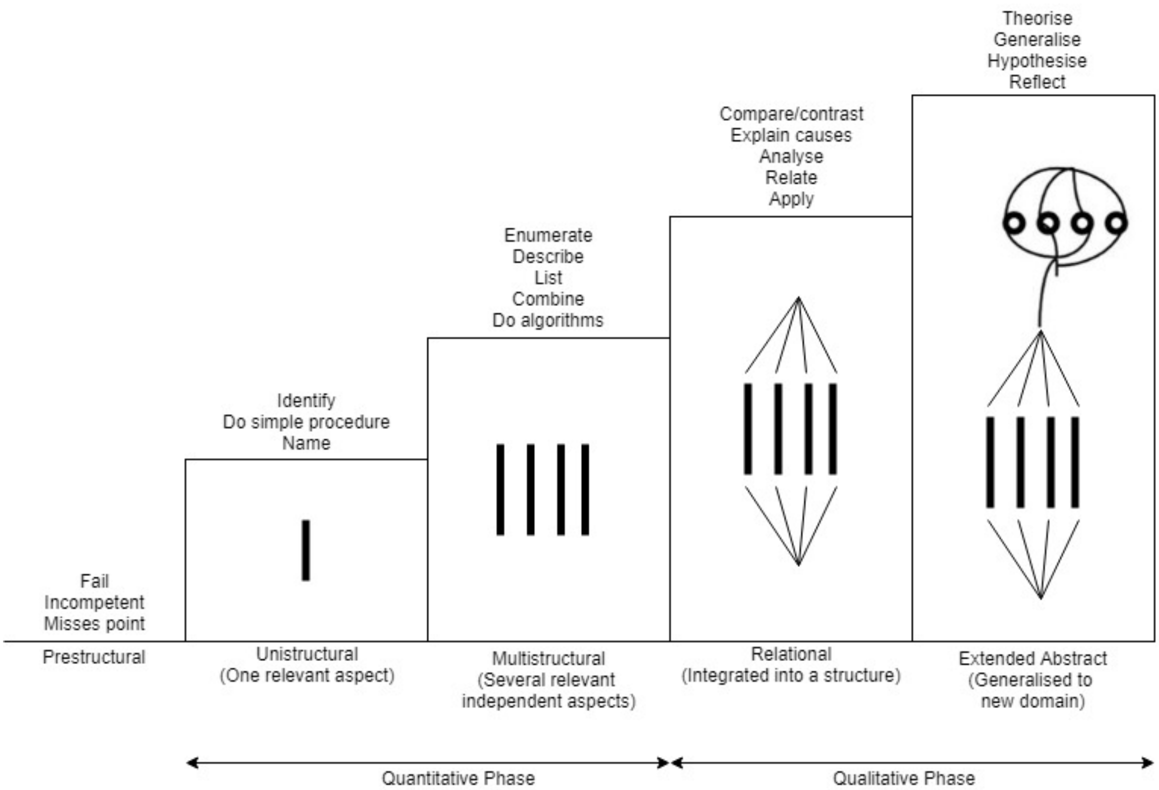

Figure 6. A hierarchy of verbs of SOLO Taxonomy, adapted from Biggs & Tang (2007)

The next step of building the customised EPSA rubric is formulating the definition of each skill and providing the standard ratings. In this research, five standard ratings for assessing students' EPS were developed using the SOLO Taxonomy model. Specifically, these were 1-Pre-structural, 2-Uni-structural, 3-Multi-structural, 4-Relational, and 5-Extended abstract. Each level describes the students' understanding/achievement of the skills. A hierarchy of verbs of SOLO Taxonomy were used to define each level standard rating. Table 41 provides many more useful verbs of the SOLO taxonomy in defining each level of achievement.

Table 41. A hierarchy of verbs of SOLO Taxonomy

Level	Verbs
Prestructural	-
Unistructural	memorise, identify, recognize, count, define, draw, find, label, match, name, quote, recall, recite, order, tell, write, imitate
Multistructural	classify, describe, list, report, discuss, illustrate, select, narrate, compute, sequence, outline, separate
Relational	apply, integrate, analyse, explain, predict, conclude, summarise, review, argue, transform make a plan, characterize, compare, contrast, differentiate, organize, debate, make a case, construct, review and rewrite, examine, translate, paraphrase, solve a problem
Extended Abstract	theorise, hypothesise, generalise, reflect, generate, create, compare, invent, originate, prove from first principles, make an original case, solve from first principles

Source: Biggs & Tang (2007)

The first criterion is *an ability to design components, systems and/or processes to meet expected needs within realistic boundaries, such as legal, economic, environmental, social, political, health and safety, sustainability and to recognise and/or utilise potential local and national resources with global insight (b)*. For this criterion, students demonstrate their ability in designing of components, systems and/or processes. Design is defined as the ability to use a multidimensional mind-set with knowledge of a global perspective to develop components, systems, and/or processes to achieve certain goals. Design is not only limited to engineering drawings, but also refers to the synthesis of various scientific and technological methods to obtain practical solutions to an open-ended problem. Design also involves an optimisation process that is subject to realistic constraints, such as legal, economic, social, political, health and safety, and sustainable use of knowledge about culture, society and the availability of resources. Students also demonstrate their awareness of the impact of the design on cultures, views, religions, beliefs, social, environmental, local and global contexts (CP5, CP6). Using this definition, the standard rating for each level was developed (see Table 42).

The second criterion is *an ability to communicate effectively, both oral and written* (f). This criterion requires students demonstrate their active and effective communication skills while considering socio-cultural perspectives in communication. These oral and written communications should include the use of appropriate engineering terms and the internationally recognised languages (e.g. English). In the EPSA discussion process, students work together to address the problems that arise in the scenario by acknowledging and building upon each other's ideas to come to a consensus. Students are expected to be able to communicate both verbally (the ability to speak with clarity and conciseness) and non-verbally (using body language, gestures, tone and pitch of voice) to emphasise their ideas. The written communication is not relevant to this research, as this research only assessed how students communicate with each other during the discussion process. The standard rating for each level was then defined as Table 43.

Table 42. Standard Ratings for (b)

(b) An ability to design components, systems and/or processes to meet expected needs within realistic boundaries, such as legal, economic, environmental, social, political, health and safety, sustainability and to recognise and/or utilise potential local and national resources with global insight					
Specific Area	1 Pre-structural	2 Uni-structural	3 Multi-structural	4 Relational	5 Extended abstract
Impact/Context on cultures, views, religions, and beliefs, as well as intellectual property rights (CP5)	Students do not understand the impact of the engineering solution.	Students are able to identify a single impact of the engineering solution. Contexts considered may not be relevant.	Students are able to describe some relevant impacts of engineering solution. Students don't seem to understand the relation between each impact.	Students are able to analyse how the impact of the engineering solution affects the major relevant contexts, and possibly construct an integrated engineering solution.	Students are able to generate a new integrated solution while considering how their engineering solution impacts major relevant contexts with reasonable accuracy.
Social sensitivity and concern for society and the environment (CP6)	Students do not demonstrate their understanding of social sensitivity and concern for society and the environment.	Students are able to demonstrate their understanding on a single aspect of social sensitivity and concern for society and the environment.	Students are able to demonstrate their understanding on multiple aspects of social sensitivity and concern for society and the environment.	Students are able to analyse multiple aspects of social sensitivity and concern for society and the environment.	Students are able to compare multiple aspects of social sensitivity and concern for society and the environment. Students also demonstrate an understanding of how different aspects can affect solution effectiveness.

The third criterion is *an ability to work in multiple disciplines and cultures* (h). This criterion refers to the ability to work with people from multiple disciplines, fields and cultural backgrounds. The teamwork success aspects include tolerance, mutual understanding, and appreciation among team members. Multiple disciplines may include both engineering and non-engineering fields. The criterion requires students to demonstrate their ability to work effectively in teamwork either as a leader or a member. The assessment is focused on leadership (CP6) and participation (CP7). Students are expected to participate in accordance with their respective roles in discussion actively. The standard rating for each level was then developed as Table 44.

Table 43. Standard Ratings for (f)

(f) An ability to communicate effectively, both oral and written					
Specific Area	1 Pre-structural	2 Uni-structural	3 Multi-structural	4 Relational	5 Extended abstract
Verbal	Students do not demonstrate their ability in presenting their own ideas.	Students deliver their own ideas without considering other student's ideas.	Students deliver their own ideas and consider the other student's ideas. Students demonstrate their understanding of other student's ideas.	Students demonstrate their ability to summarize and clarify other student's ideas. Most of the discussants give valuable input and attempt to clarify other's ideas.	Students invite and encourage participation of all discussion participants, build and clarify ideas together. Students build upon all ideas to come to a consensus.
Non-Verbal	Students do not demonstrate their ability in presenting their own ideas.	Students are able to deliver their own ideas. They may demonstrate their body language and gesture when they deliver their ideas, but it may not express their understanding of the problems raised in the scenario clearly.	Students use body language, gestures, tone and pitch of voice to emphasise when they deliver their ideas.	Students use body language, gestures, tone and pitch of voice to emphasise when they deliver their ideas. Students attempt to convince their colleagues to reach consensus in discussion.	Students demonstrate how to use body language, gestures, tone and pitch of voice to emphasise their ideas effectively. It can be seen that students clearly work together to reach a consensus in discussion.

Table 44. Standard Ratings for (h)

(h) An ability to work in multiple disciplines and cultures					
Specific Area	1 Pre-structural	2 Uni-structural	3 Multi-structural	4 Relational	5 Extended abstract
Leadership (CP6)	Students do not demonstrate their leadership ability in a team	Students begin to demonstrate their leadership ability in a team but have difficulty playing a role as a leader in a team.	Students are generally successful in playing a role as a leader or member in a team.	Students demonstrate their leadership ability in a team, take control and lead all team members toward the main goals.	Students demonstrate effective leadership, have the ability to communicate well, motivate their team, handle and delegate responsibilities, listen to feedback, and have the flexibility to solve conflict in a team.
Participation (CP6)	Students do not demonstrate their active participation in a team.	Students begin to participate a little in a team after getting encouragement from other team members.	Students demonstrate their active participation in a team.	Students participate actively in a team, while they also motivate other team member's participation.	Students participate actively in a team, motivate other team member's participation, handle and delegate responsibilities, provide positive feedback in a clear and empathic way.

The fourth criterion is *an ability to be responsible to the community and comply with professional ethics in solving engineering problems* (i). This criterion refers to the ability to take action in accordance with the impact of the engineering solution on community welfare, environmental safety, sustainable nation development, professional ethics and academic values. Students demonstrate their commitment to improving the quality of life in the society and the nation (CP3). When solving engineering problem, students are able to identify related legal and ethical considerations and academic values (CP7, CP8). Students recognise relevant stakeholders, their perspectives and conflict of interest. This understanding will help students in finding a "win-win solution' for all stakeholders involved. The standard rating for each level is presented in Table 45.

Table 45. Standard Ratings for (i)

(i) An ability to be responsible to the community and comply with professional ethics in solving engineering problems					
Specific Area	1 Pre-structural	2 Uni-structural	3 Multi-structural	4 Relational	5 Extended abstract
Commitment to improving the quality of life in the society and nation (CP3)	Students do not demonstrate their commitment to improving the quality of life in the society and nation in solving engineering problems.	Students demonstrate their commitment to improving the quality of life in the society and nation in solving engineering problems. They may focus only on one aspect.	Students demonstrate their commitment to improving the quality of life in the society and nation in solving engineering problems. They may consider several relevant independent aspects.	Students demonstrate their commitment to improving the quality of life in the society and nation in solving engineering problems. They may consider several relevant aspects and integrate them into their engineering solution.	Students demonstrate their commitment to improving the quality of life in the society and nation in solving engineering problems. They create new ideas for engineering solutions based on their understanding and commitment.
The law, professional ethics and academic values (CP7, CP8)	Students do not consider related law, professional ethics and academic values in solving engineering problems.	Students consider related law, professional ethics and academic values in solving engineering problems. They may focus only on one aspect.	Students consider relevant law, professional ethics and academic values in solving engineering problems. They discuss them in the context of the problems, but students fail to understand linkages between each aspect.	Students clearly articulate relevant law, professional ethics and academic values in solving engineering problems. Students make linkages between each aspect and incorporate them into their analysis.	Students clearly articulate relevant law, professional ethics and academic values in solving engineering problems. Students may discuss ways to mediate dilemmas or suggest trade-offs. Students are able to generate new solutions.

The last criterion is *an ability to understand the need of life-long learning, including access to knowledge related to current relevant issues* (j). This criterion refers to continuous professional development (life-long learning), the ability to obtain the latest information and knowledge, and awareness of the importance of sharing knowledge (CP9). The criterion also requires students to demonstrate their resilience and entrepreneurial spirit (CP10). This criterion is then expanded to define a standard rating for each level of achievement as shown in Table 46.

7.4. Generating a New Customised EPSA Rubric

All criteria definitions (Table 42 to Table 46) are then merged into a new customised EPSA rubric as below (Table 47).

Table 46. Standard Ratings for (j)

(j) An ability to understand the need for life-long learning, including access to knowledge related to current relevant issues.					
Specific Area	1 Pre-structural	2 Uni-structural	3 Multi-structural	4 Relational	5 Extended abstract
Commitment to continual professional development (CP9)	Students do not demonstrate their commitment to continual professional development.	Students demonstrate their commitment to continual professional development. They may focus only on one aspect.	Students demonstrate their commitment to continual professional development. They may consider several relevant independent aspects to support their commitment.	Students demonstrate their commitment to continual professional development. They may integrate several relevant aspects to support their commitment.	Students demonstrate their commitment to continual professional development. They are able to arrange access to related knowledge of relevant issues.
Resilience and entrepreneurial spirit (CP10)	Students do not demonstrate resilience and an entrepreneurial spirit.	Students demonstrate resilience and an entrepreneurial spirit. They may focus only on one aspect.	Students demonstrate resilience and entrepreneurial spirit. They may consider several relevant independent aspects related to resilience and entrepreneurial spirit.	Students demonstrate resilience and entrepreneurial spirit. They may integrate several relevant aspects to support their resilience and entrepreneurial spirit.	Students demonstrate resilience and entrepreneurial spirit. They are able to generate a new business idea and develop a business plan.

Table 47. The New Customised EPSA Rubric

Specific Area	1 Pre-structural	2 Uni-structural	3 Multi-structural	4 Relational	5 Extended abstract
(b) An ability to design components, systems and/or processes to meet expected needs within realistic boundaries, such as legal, economic, environmental, social, political, health and safety, sustainability and to recognise and/or utilise potential local and national resources with global insight					
Impact/Context on cultures, views, religions, and beliefs, as well as intellectual property rights (CP5)	Students do not understand the impact of the engineering solution.	Students are able to identify a single impact of the engineering solution. Contexts considered may not be relevant.	Students are able to describe some relevant impacts of engineering solution. Students don't seem to understand the relation between each impact.	Students are able to analyse how the impact of the engineering solution affects the major relevant contexts, and possibly construct an integrated engineering solution.	Students are able to generate a new integrated solution while considering how their engineering solution impacts major relevant contexts with reasonable accuracy.
Social sensitivity and concern for society and the environment (CP6)	Students do not demonstrate their understanding of social sensitivity and concern for society and the environment.	Students are able to demonstrate their understanding on a single aspect of social sensitivity and concern for society and the environment.	Students are able to demonstrate their understanding on multiple aspects of social sensitivity and concern for society and the environment.	Students are able to analyse multiple aspects of social sensitivity and concern for society and the environment.	Students are able to compare multiple aspects of social sensitivity and concern for society and the environment. Students also demonstrate an understanding of how different aspects can affect solution effectiveness.
(f) An ability to communicate effectively, both oral and written					
Verbal	Students do not demonstrate their ability in presenting their own ideas.	Students deliver their own ideas without considering other student's ideas.	Students deliver their own ideas and consider the other student's ideas. Students demonstrate their understanding of other student's ideas.	Students demonstrate their ability to summarize and clarify other student's ideas. Most of the discussants give valuable input and attempt to clarify other's ideas.	Students invite and encourage participation of all discussion participants, build and clarify ideas together. Students build upon all ideas to come to a consensus.
Non-Verbal	Students do not demonstrate their ability in presenting their own ideas.	Students are able to deliver their own ideas. They may demonstrate their body language and gesture when they deliver their ideas, but it may not express their understanding of the problems raised in the scenario clearly.	Students use body language, gestures, tone and pitch of voice to emphasise when they deliver their ideas.	Students use body language, gestures, tone and pitch of voice to emphasise when they deliver their ideas. Students attempt to convince their colleagues to reach consensus in discussion.	Students demonstrate how to use body language, gestures, tone and pitch of voice to emphasise their ideas effectively. It can be seen that students clearly work together to reach a consensus in discussion.
(h) An ability to work in multiple disciplines and cultures					
Leadership (CP6)	Students do not demonstrate their leadership ability in a team	Students begin to demonstrate their leadership ability in a team but have difficulty playing a role as a leader in a team.	Students are generally successful in playing a role as a leader or member in a team.	Students demonstrate their leadership ability in a team, take control and lead all team members toward the main goals.	Students demonstrate effective leadership, have the ability to communicate well, motivate their team, handle and delegate responsibilities, listen to feedback, and have the flexibility to solve conflict in a team.
Participation (CP6)	Students do not demonstrate their active participation in a team.	Students begin to participate a little in a team after getting encouragement from other team members.	Students demonstrate their active participation in a team.	Students participate actively in a team, while they also motivate other team member's participation.	Students participate actively in a team, motivate other team member's participation, handle and delegate responsibilities, provide positive feedback in a clear and empathic way.

Specific Area	1 Pre-structural	2 Uni-structural	3 Multi-structural	4 Relational	5 Extended abstract
(i) An ability to be responsible to the community and comply with professional ethics in solving engineering problems					
Commitment to improving the quality of life in the society and nation (CP3)	Students do not demonstrate their commitment to improving the quality of life in the society and nation in solving engineering problems.	Students demonstrate their commitment to improving the quality of life in the society and nation in solving engineering problems. They may focus only on one aspect.	Students demonstrate their commitment to improving the quality of life in the society and nation in solving engineering problems. They may consider several relevant independent aspects.	Students demonstrate their commitment to improving the quality of life in the society and nation in solving engineering problems. They may consider several relevant aspects and integrate them into their engineering solution.	Students demonstrate their commitment to improving the quality of life in the society and nation in solving engineering problems. They create new ideas for engineering solutions based on their understanding and commitment.
The law, professional ethics and academic values (CP7, CP8)	Students do not consider related law, professional ethics and academic values in solving engineering problems.	Students consider related law, professional ethics and academic values in solving engineering problems. They may focus only on one aspect.	Students consider relevant law, professional ethics and academic values in solving engineering problems. They discuss them in the context of the problems, but students fail to understand linkages between each aspect.	Students clearly articulate relevant law, professional ethics and academic values in solving engineering problems. Students make linkages between each aspect and incorporate them into their analysis.	Students clearly articulate relevant law, professional ethics and academic values in solving engineering problems. Students may discuss ways to mediate dilemmas or suggest trade-offs. Students are able to generate new solutions.
(j) An ability to understand the need for life-long learning, including access to knowledge related to current relevant issues.					
Commitment to continual professional development (CP9)	Students do not demonstrate their commitment to continual professional development.	Students demonstrate their commitment to continual professional development. They may focus only on one aspect.	Students demonstrate their commitment to continual professional development. They may consider several relevant independent aspects to support their commitment.	Students demonstrate their commitment to continual professional development. They may integrate several relevant aspects to support their commitment.	Students demonstrate their commitment to continual professional development. They are able to arrange access to related knowledge of relevant issues.
Resilience and entrepreneurial spirit (CP10)	Students do not demonstrate resilience and an entrepreneurial spirit.	Students demonstrate resilience and an entrepreneurial spirit. They may focus only on one aspect.	Students demonstrate resilience and entrepreneurial spirit. They may consider several relevant independent aspects related to resilience and entrepreneurial spirit.	Students demonstrate resilience and entrepreneurial spirit. They may integrate several relevant aspects to support their resilience and entrepreneurial spirit.	Students demonstrate resilience and entrepreneurial spirit. They are able to generate a new business idea and develop a business plan.

7.5. Adjusting Existing Locally Relevant Scenarios

The existing scenarios can be used with the new customised EPSA rubric. However, some adjustments are desirable. While both cycles of fieldwork demonstrated that the EPSA method can be strengthened by inclusion of the assessment of local cultural competency, the locally relevant scenarios were improved by expanding the treatment of local issues.

An example of such an “enriched” scenario is the issue of female drivers of Gojek or motorcycle taxis (a two-wheeled version of Uber) considered in Scenario 3. In early 2019, the percentage of female drivers was about 10% out of a total of 2 million Gojek drivers. Although there are no differences in the recruitment process between male and female drivers, including Gojek driver’s training and safety riding tests, unfortunately, female drivers experience discrimination. Gojek's internal data reported that user cancellation rates for female drivers tend to be higher than male drivers.

To understand this issue, we need to refer to Indonesian culture, where women are not perceived as appropriate drivers of public transportation. The gender issue is also likely strongly related to religious beliefs. Indonesia has the largest Muslim population in the world. Islam is a patriarchal society where men are the primary authority figures and women are subordinate. Although the women's emancipation movement is also quite significant in

Indonesia, the issue of gender equality is still creating tension in Indonesian society because of cultural and religious influences.

Engineering educators have an opportunity to enrich EPSA discussion by suitable selection of group demographics. For instance, inclusion of students from West Sumatera, which is a matriarchal Muslim society where women are the primary authority figures and men are subordinate would potentially lead to diverse views. Similarly, ensuring groups include a mix of students who are Christians, Buddhists and Hindus (in addition to Muslim students) would further enrich discussion. Via such EPSA discussions, students have the opportunity to learn how to facilitate different spiritual and cultural perspectives through the combination of engineering and local knowledge.

As a further example consider the Bay of Jakarta reclamation treated in Scenario 5. In this scenario rejection of the reclamation projects arose not only from affected parties (on financial grounds), but also from the local people. The local people believe that reclamation followed by the rearrangement of the Bay of Jakarta area will potentially damage their cultural heritage (sacred places) such as mosques and ancient tombs. In addition, people in coastal areas depend on marine products. They are accustomed to living by maintaining the balance of nature and traditional marine conservation. The reclamation project will potentially destroy all aspects of their traditional life.

By contrast, the reclamation project also brings some benefits to local people. As part of economic development, the reclamation project will create new jobs and open greater investment opportunities that will ultimately improve the lives of local people. This scenario has been re-drafted to challenge students to find ways to facilitate the different spiritual and cultural perspectives of all stakeholders.

The other desirable adjustment is alteration of the discussion prompt questions, which need to be adjusted to fit the new criteria. The new EPSA discussion questions are presented in Table 48. Each criterion may be addressed by one or more questions. Table 49 demonstrates the linkages between each criterion and the discussion questions.

Table 48. The New EPSA Discussion Questions

Instructions for Discussion:

Suppose you are an engineer working together with a team in the scenario. Discuss what your team would need to take into consideration to address the issues in the scenario.

You do not need to suggest specific technical solutions in detail, just try to get a consensus from discussion that covers all aspects considered.

Use the following questions as a discussion guide.

1. Identify the problems raised in the scenario.
2. How do you get access to knowledge related to current relevant issues?
3. What are the ethical issues that arise in the scenario?
4. Who are the stakeholders in the scenario and what are their interests in the scenario?
5. What are the potential impacts of your proposed solutions in the context of the social, environmental, local and global context?
6. What business ideas do you get from the scenario?

7.6. Developing New EPSA Scoring Sheets

The experiences from the first and second cycles of fieldwork demonstrated that the EPSA scoring sheets play an important role in the success of the EPSA class administration process. In the first cycle of fieldwork students considered the EPSA scoring sheets (long version, 6-pages) to be impractical because students had to flip through the pages during the assessment. An improvement was made before the second cycle of fieldwork including shortening the EPSA scoring sheets (short version, 3-pages) by eliminating some definitions and information so that the scoring sheet can be simple and compact. A concern may be that this improvement might introduce a risk of losing some important information in the EPSA class administration process.

This risk was anticipated in the second cycle of fieldwork by distributing the EPSA scoring sheets (long version) a week before each EPSA class administration session so that the students had an opportunity to learn about the EPSA class administration process in advance. A longer briefing session time was also allocated in order to explain each of these definitions and the strategy for the assessment to the students. Furthermore, the students (especially the assessment sub-team) were offered the opportunity to review and clarify their assessment later through audio records before submitting their assessment to the researcher.

Table 49. Professional Skills addressed in the new EPSA Discussion Questions

Professional Skills	Specific Area Considered	Addressed by Question No.
(b) An ability to design components, systems and/or processes to meet expected needs within realistic boundaries, such as legal, economic, environmental, social, political, health and safety, sustainability and to recognise and/or utilise potential local and national resources with global insight	Impact/Context on cultures, views, religions, and beliefs, as well as intellectual property rights (CP5)	4, 5
	Social sensitivity and concern for society and the environment (CP6)	4, 5
(f) An ability to communicate effectively, both oral and written	Verbally	Assessed by observation of discussion process
	Non-verbally	Assessed by observation of discussion process
(h) An ability to work in multiple disciplines and cultures	Leadership (CP6)	Assessed by observation of discussion process
	Participation (CP6)	Assessed by observation of discussion process
(i) An ability to be responsible to the community and comply with professional ethics in solving engineering problems	Commitment to improving the quality of life in the society and nation (CP3)	1
	The law, professional ethics and academic values (CP7, CP8)	3
(j) An ability to understand the need for life-long learning, including access to knowledge related to current relevant issues.	Commitment to continual professional development (CP9)	2
	Resilience and entrepreneurial spirit (CP10)	6

Unfortunately, these improvements do not seem to be fully effective. In the feedback at the end of the second cycle of fieldwork, students considered the short version of EPSA scoring sheets to be still impractical and requiring further improvement to fit within the limited classroom time available for this assessment.

The use of the SOLO taxonomy model in developing new standard ratings simplifies the EPSA scoring sheet. The SOLO Taxonomy's five standard ratings which describe the students' understanding/achievement of the EPS and a hierarchy of verbs of the SOLO taxonomy (Table 42) have been used to develop a new EPSA scoring sheet. These new EPSA scoring sheets are simpler and are more concise as presented in Appendix F.

Chapter 8. Conclusion and Future Work

This last chapter summarises the research findings and highlights the major contributions of the research. Some ideas for future work are also identified and discussed.

8.1. Summary

The term "soft skills" (which is referred to as Engineering Professional Skills (EPS) by the American Society for Engineering Education (ASEE)) relates to six skills: teamwork, oral and written communication, understanding ethics and professionalism (which are labelled as process skills), awareness of the impact of engineering solutions, life-long learning, and knowledge of contemporary issues (which are labelled as awareness skills). Since their introduction as Accreditation Board for Engineering and Technology (ABET) criteria for engineering programmes, their assessment has been found to be much more subjective and significantly harder to measure than quantitative disciplinary skills (hard skills).

The differing graduate mobilities required for global, regional and local engineering has led to development of several accreditation standards (e.g. ABET, Washington Accord, Bologna agreement, and the (Indonesian) IABEE). Although these standards share most of their EPS features, a significant difference exists in the extent to which development of cultural competency in relation to local populations is required in the education of engineers. The assessment of cultural competency further complicates the (already) complex assessment of EPS. This is the issue that is specifically addressed in this thesis.

In this thesis, we establish a method for formal assessment and evaluation of EPS in an Indonesian setting. The research completed in this work proposed an extension of the EPSA method (which was introduced by Kranov et al. in 2008) to include local cultural competency, especially in the customised rubric and in the locally relevant scenarios. The method has been evaluated through two cycles of fieldwork involving the undergraduate students of Industrial Engineering (a four-year programme) who are enrolled in the classes of IND3852 Technopreneurship (3rd Year), IND4264 Integrated System Design (3rd Year), or IND5172 Engineering Ethics (4th Year), Department of Industrial Engineering, Faculty of Industrial Technology, Universitas Atma Jaya Yogyakarta, Indonesia. By selecting third- and fourth-year courses, it was observed that students have sufficient maturity to cope with scenarios that exposed them to contentious local issues for application of the EPSA.

The EPSA class administration for both cycles of fieldwork demonstrated consistent results. The customised EPSA rubric developed in this research has been shown to be amenable to introduction of region specific (e.g. Indonesia) local issues. Through both cycles of fieldwork, it has been possible to identify the strengths and weaknesses of the students in relation to their EPS achievements. This capability has been used to provide advice to the course designers to help them redesign the curriculum in order to improve the teaching and learning outcomes.

Both cycles of fieldwork also demonstrated that students still considered the customised EPSA rubric to be complicated and requiring further improvement, particularly on the six standard ratings (0-missing, 1-emerging, 2-Developing, 3-Practicing, 4-Maturing, and 5-Mastering). While each standard rating did not have clear cut-offs, students experienced difficulty in distinguishing between level 1 and 2 or level 3 and 4. This issue was addressed by the development of a new modified rubric based on the SOLO taxonomy (Biggs & Collis 1982).

The findings of this research demonstrated that students who participate in the EPSA class administration can improve their understanding of the subject matter and increase active participation. This finding is consistent with that of Norman and Schmidt (1992); Vernon and Blake (1993) and Battista (2017). The findings suggest that students learned through these real-life scenarios which can be applied in the future when they are faced with similar problems. The findings provide insight into how students harnessed the benefits of scenario-based learning intervention through the local cultural issues they learn, the social interactions they engage in, the structured interventions they perform, and the roles they are assigned.

In general, the EPSA class administration provides a number of important benefits that can be leveraged to complement real-world based experiences and provide students with an adaptability to anticipate the ambiguity and uncertainty found across all professions in their future. Errington (2010) outlined the characteristics of specific kinds of scenario approaches and the graduate attributes they might embed within the curriculum and subsequent professional practice.

8.2. Contributions

This research results in two major contributions.

8.2.1. Inclusion of local competency into the EPSA

One of the major contributions is the inclusion of local cultural competency in the EPSA. In the latest EPSA rubric, the specific requirement for assessment of local concerns and practices are addressed by criteria (b), (h) and (j).

To support the assessment of local cultural competency in the EPSA, seven locally relevant scenarios have been developed in this research. The key difference between the new EPSA scenarios and the existing scenarios previously described by McCormack et al. (2014) is the scenarios' background setting. The new scenarios are enriched by including many Indonesian local issues. In the EPSA discussion, these local issues will help to trigger discussion of engineering solutions which combine local people's practices and principles with good engineering practices.

This research also provided a more systematic method of designing scenarios whereby other professional educators could design scenario-based learning interventions for their own students.

8.2.2. The EPSA framework and new standard rating using SOLO taxonomy

The second major contribution is the EPSA framework and development of a new standard rating for the EPSA rubric using the SOLO taxonomy. The EPSA framework provides the general implications and standards for other jurisdictions whereby their graduate attributes might be developed through the EPSA rubric.

Both cycles of fieldwork also demonstrated that students still considered the customised EPSA rubric to be complicated and requiring further improvement, particularly in relation to the six standard ratings previously devised by Schmeckpeper et al. (2014a). Because each standard rating did not have a clear cut-off, in the EPSA class administration process, students experienced difficulty in distinguishing between level 1 and 2 or level 3 and 4. Furthermore, each level of each criterion has a different definition. An assessor needs to memorise each definition before they can undertake the EPSA class administration. Consequently, the EPSA process consumed more time.

This research proposes a new standard rating based on the SOLO taxonomy for the latest EPSA rubric. The model classifies the order of understanding into five levels in term of their complexity: Pre-structural, Uni-structural, Multi-structural, Relational, and Extended abstract.

Each level has a simple and clear definition. Using this model, an assessor does not need to memorise the definition of each level of skill achievement. One definition for each level applies to all criteria. Furthermore, the SOLO taxonomy also provides some typical verbs for each level. The verbs indicate what the students are required to be able to do to achieve the particular level. The assessor can use these verbs in capturing students' level of achievement when assessing the EPSA discussion.

8.3. Future Work

In this thesis, several potential areas for further investigation were identified from the discussion of the research and findings. Most of the future works concern how to manage (but not eliminate) the threat to validity regarding confounders of the EPSA results.

8.3.1. Extending the Voice Recording to become Video Recording

In this research, a threat to validity was identified as the assessors potentially incorrect understanding of each skill interpretation. The assessment is actually only based on students' perception. While each skill has different characteristics, students with a lack of experience on this kind of assessment will face some difficulties in understanding of each skill interpretation, especially in a time restricted situation. In this research, each discussion was recorded (voice recording). These audio recordings gave the opportunity to the assessors to review and clarify their assessments later before submitting them to the researcher.

Future work may include extending these voice recordings to video recordings. One of the logistic problems of the EPSA implementation is the number of assessors required. In this research, the issue was addressed by peer assessment. In an EPSA class administration, the participants were divided into teams. Each team then divided again into two sub-teams, namely the discussion sub-team and the assessment sub-team. Ideally the number of students in the assessment sub-team is less than that in the discussion sub-team because the quality of the discussion is enhanced by having a diversity of views and consequently a larger discussion team is better.

The use of video recording will reduce dependence on resources, especially related to the number of assessors. The whole team then can be assigned to conduct discussions. While the discussion is undertaking, the process is recorded. The EPS assessment is done later by reviewing the video recordings.

To minimise bias, faculty/department could assign a team of competent faculty member as an assessor team. The team then undertakes the EPS assessment by observing the video recording.

8.3.2. Individual-based Rating

While in this research, the EPS performance ratings were assessed in the context of a team-based rating, the future work may consider detailing the assessment of student capability on each EPS as an individually based rating.

Team-based rating do not reflect the individual capability on EPS. A student who was in the discussion team may get feedback on their level of skills, while not necessarily understanding how their actions contributed to their overall score. Individually based rating enables engineering educators to map students' EPS level in more detail by combining other data, such as demographic data. Capturing student's EPS competency level individually would be a useful contribution in redesigning the engineering curriculum.

8.3.3. Inclusion of Another Stakeholder's Perspective

Overall, the EPSA process in this research was developed from a single (researcher's) perspective. The future work may consider the other stakeholder's (e.g. practitioner, workplace, or employer) perspective about the implications for the students' capacity to apply the identified Engineering Professional Skills (EPS) criteria in real time. In this case the outcomes of the process would also indicate the extent to which the students have been able to demonstrate their EPS in action.

8.3.4. Transferability and Flexibility

Lastly, the potential future improvements for the customised EPSA rubric involve enhancing its transferability (to other countries with similar characteristics) and its flexibility.

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Appendix A. Ethics Approval

Full ethics approval has been granted by the University of Auckland Human Participant Ethics Committee (UAHPEC) for this research (Ref. No. 016642 – approved 29 April 2016) for a period of three years. The expiry date for this approval is 29 April 2019. An amendment of the ethics approval was granted on 1 May 2017 to include a second cycle of the research project, changes in the Likert scale, adding rating scales for each measurement aspect, adding new scenarios and modification of the rubric assessment form for ease of use.

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UNIVERSITY OF AUCKLAND HUMAN PARTICIPANTS ETHICS COMMITTEE (UAHPEC)

29-Apr-2016

MEMORANDUM TO:

Dr Gerard Rowe
Electrical & Computer Engineer

Re: Application for Ethics Approval (Our Ref. 016642): Approved

The Committee considered your application for ethics approval for your project entitled **Formalising and evaluating the assessment for engineering professional skills.**

We are pleased to inform you that ethics approval is granted for a period of three years.

The expiry date for this approval is 29-Apr-2019.

If the project changes significantly, you are required to submit a new application to UAHPEC for further consideration.

If you have obtained funding other than from UniServices, send a copy of this approval letter to the Research Office, at ro-awards@auckland.ac.nz. For UniServices contracts, send a copy of the approval letter to the Contract Manager, UniServices.

In order that an up-to-date record can be maintained, you are requested to notify UAHPEC once your project is completed.

The Chair and the members of UAHPEC would be happy to discuss general matters relating to ethics approvals. If you wish to do so, please contact the UAHPEC Ethics Administrators at ro-ethics@auckland.ac.nz in the first instance.

Please quote reference number: **016642** on all communication with the UAHPEC regarding this application.

(This is a computer generated letter. No signature required.)

UAHPEC Administrators

University of Auckland Human Participants Ethics Committee

c.c. Head of Department / School, Electrical & Computer Engineer
Dr Nasser Giacaman
Mr Hadisantono Hadisantono

Additional information:

1. Do not forget to fill in the 'approval wording' on the Participant Information Sheets and Consent Forms, giving the dates of approval and the reference number, before you send them out to your participants.

2. Should you need to make any changes to the project,please complete the online proposed changes and include any revised documentation.

3. At the end of three years, or if the project is completed before the expiry, please advise UAHPEC of its completion.

4. Should you require an extension, please complete the online Amendment Request form associated with this approval number giving full details along with revised documentation. An extension can be granted for up to three years, after which a new application must be submitted.

5. Please note that UAHPEC may from time to time conduct audits of approved projects to ensure that the research has been carried out according to the approval that was given.

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UNIVERSITY OF AUCKLAND HUMAN PARTICIPANTS ETHICS COMMITTEE (UAHPEC)

01-May-2017

MEMORANDUM TO:

Dr Gerard Rowe
Electrical and Computer Eng

Re: Request for change of Ethics Approval Ethics Approval (Our Ref. 016642): Amendments Approved

The Committee considered your request for change for your project entitled **Formalising and evaluating the assessment for engineering professional skills** and approval was granted for the following amendments on 01-May-2017.

The Committee approved the following amendments:

1. To include a second phase of the research project
2. To change the Likert scale from 1 for strongly agree to 5 for strongly agree.
3. To add rating sales (1-10) for each measurement aspect
4. To add three new scenario's to the focus group discussion topics.
5. To modifications to the rubric assessment form for ease of use.

The expiry date for this approval is 29-Apr-2019.

If the project changes significantly you are required to resubmit a new application to the Committee for further consideration.

In order that an up-to-date record can be maintained, it would be appreciated if you could notify the Committee once your project is completed.

The Chair and the members of the Committee would be happy to discuss general matters relating to ethics approvals. If you wish to do so, please contact the UAHPEC Ethics Administrators at ro-ethics@auckland.ac.nz in the first instance.

Please quote reference number: **016642** on all communication with the UAHPEC regarding this application.

(This is a computer generated letter. No signature required.)

UAHPEC Administrators
University of Auckland Human Participants Ethics Committee

c.c. Head of Department / School, Electrical and Computer Eng
Dr Gerard Rowe
Dr Nasser Giacaman
Mr Hadisantono Hadisantono

Appendix B. Participant Information Sheet

The Participant Information Sheet (PIS) is an information sheet that provides brief and clear information on the essential elements of the research: what the research is about, the research procedures, the voluntary nature of involvement, what will happen during and after the research has taken place, and ethical considerations (anonymity and confidentiality). The purpose is to ensure that participants are fully informed before they decide to participate or not.

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PARTICIPANT INFORMATION SHEET
"FORMALISING AND EVALUATING THE ASSESSMENT OF ENGINEERING PROFESSIONAL SKILLS"

Name and contact email address of researcher:

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Names and contact email address of supervisors:

Dr. Gerard Rowe ***gb.rowe@auckland.ac.nz***

Dr. Nasser Giacaman ***n.giacaman@auckland.ac.nz***

Introduction

I am Hadisantono and I am a Ph.D. student in the Department of Electrical, Computer and Software Engineering at the University of Auckland, New Zealand. I am also currently a lecturer in the Department of Industrial Engineering, Universitas Atma Jaya Yogyakarta, Indonesia (on leave to pursue Ph.D. research). My supervisors for my Ph.D. study are Dr. Gerard Rowe and Dr. Nasser Giacaman.

Research Description

This research forms part of the research I am undertaking for a Ph.D study. The reason that I am doing this research is that there are only a few researchers in Indonesia with expertise in assessment of engineering education, especially in assessing Engineering Professional Skills (EPS). The manner in which EPS are assessed is a frequently asked question by the National Accreditation Board in the accreditation process. The method that I am studying, the Engineering Professional Skill Assessment (EPSA) rubric, was very recently published (in 2014) and still needs considerable improvement.

The research goal is to establish a formal assessment and evaluation for EPS based on terms and conditions in engineering education in the Department of Industrial Engineering, Faculty of Industrial Technology, Universitas Atma Jaya Yogyakarta, Indonesia.

This research will continue for 3 years according to the length of my Ph.D. study.

I expect that the results from this research will help the Department of Industrial Engineering, Faculty of Industrial Technology, Universitas Atma Jaya Yogyakarta to develop a better curriculum. Furthermore, the study I am proposing potentially has considerable significance to Indonesia in improving the quality of engineering education and is generally applicable to engineering internationally.

The funding for this research has been obtained through a Ph.D. scholarship from the Indonesian Government through DIKTI (Directorate General of Higher Education of Republic of Indonesia). Other funding for this research includes an additional scholarship from Universitas Atma Jaya Yogyakarta.

Invitation to Participate

Participants are the students who are enrolled in the classes of IND3852 Technopreneurship, IND4264 Integrated System Design, and IND5172 Engineering Ethics, Department of Industrial Engineering, Faculty of Industrial Technology, Universitas Atma Jaya Yogyakarta in Semester II Academic Year 2015/2016 and 2016/2017 (2 cycles). Your participation is voluntary, and you may decline this invitation to participate. Neither your grades nor academic relationships with course lecturers will be affected by either refusal or agreement to participate. The Dean of the Faculty of Industrial Technology at Universitas Atma Jaya Yogyakarta, Indonesia has given an assurance that this is the case.

Research Procedures

All participants in the class will be divided into teams, with one part of each team conducting a discussion based on given scenarios and the other part of each team using a modified EPSA rubric to observe and assess the discussions without being involved in the discussion. Identifying information will not be required on the completed rubric sheets. Specifically, no student IDs or names will be recorded. These sheets cannot be withdrawn once returned to the researcher. During the discussion, the researcher will observe the process without being involved in the discussion. You will be asked to be either a discussant or an assessor with the allocation to be arranged in class. The process will take 3 weeks; the first and second week will be used for the assessment; and the third week will be used for focus group feedback and clarifications. During the process, you can choose to withdraw from participation at any time. The researcher will also use a paper based anonymous questionnaire in order to get your feedback. The questionnaire will be handed to you in class during the third week. The researcher will arrange a dropbox in the department office. When you have completed the questionnaire, you can submit it into the dropbox. Once you have returned your feedback via the questionnaire, you will not able to withdraw it as it cannot be identified.

Data Storage, Retention, Destruction and Future Use

The researcher will collect the data by audio-recording and a data collection form. All hardcopy data will be destroyed after a digitizing process. Only softcopy data will be kept. This will be stored in a secure university computer network. The data will be stored for a maximum of 6 years. After the storage time has elapsed, the data will be deleted.

Right to Withdraw from Participation

You have the right to withdraw from the focus group at any time without giving a reason. Withdrawal of data is not possible for the focus group as group audio-recording is to be conducted along with the use of anonymous questionnaires. You will have the opportunity to review but not edit the transcripts of the recording, due to the conversational and contextual nature of the discussion.

Anonymity and Confidentiality

The preservation of confidentiality is paramount. The information you share with the researcher will remain confidential. When the group recording is transcribed, no information which could lead to identification of any individual will be included. You are able to review tapes and/or transcripts. If the information you provide is published, this will be done in a way that does not identify you as its source. A copy of the research findings will be made available to you if you wish. Please choose the appropriate option and provide your email address in *the Consent Form* if you wish to review the transcripts of the recording and receive a copy of the research findings.

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For any queries regarding ethical concerns you may contact the Chair, The University of Auckland Human Participants Ethics Committee, The University of Auckland, Research Office, Private Bag 92019, Auckland 1142. Telephone 09 373-7599 ext. 83711. Email: ro-ethics@auckland.ac.nz

Approved by the University of Auckland Human Participants Ethics Committee on 29 April 2016 for three years. Reference number 016642.

Appendix C. Invitation Letter

The invitation letter invites potential students to participate in this research. The invitation letter provides brief information about the research and why they were invited and encouraged to participate.

The invitation letter was sent to the Head of Department (HoD) of Industrial Engineering, Universitas Atma Jaya Yogyakarta, Indonesia along with the Participant Information Sheet (PIS). The HoD then advised the research details to each course coordinator and sent the invitation letter to the potential students on behalf of the researcher.

This research was run in two cycles. The first cycle took place in Semester II Academic Year 2015/2016 and the second cycle took place in Semester II Academic Year 2016/2017. Both cycles used the same invitation letter.

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INVITATION TO PARTICIPATE IN RESEARCH
"FORMALISING AND EVALUATING THE ASSESSMENT OF ENGINEERING PROFESSIONAL SKILLS"

WHAT DO YOU STUDY IN INDUSTRIAL ENGINEERING? Every year, the National Association of Colleges and Employers (NACE) conducts a survey to assess the top qualities and skills sought by leading companies in their new college hires. In addition to the major-specific knowledge you gain in academic classes, these skills are necessary to help you be competitive when you begin to apply for internships, jobs, or graduate school. These skills are called Engineering Professional Skills (EPS).

This research (part of my PhD study) aims to establish a formal assessment and evaluation rubric for Engineering Professional Skills (EPS) based on terms and conditions in engineering education in the Department of Industrial Engineering, Faculty of Industrial Technology, Universitas Atma Jaya Yogyakarta, Indonesia. I expect that the results from this research will not only help the Department of Industrial Engineering, Faculty of Industrial Technology, Universitas Atma Jaya Yogyakarta to develop a better curriculum but will also be generally applicable to engineering programs internationally. Furthermore, the study I am undertaking is potentially of considerable significance to Indonesia in improving the quality of engineering education.

If you are an Industrial Engineering student of Universitas Atma Jaya Yogyakarta who is enrolled in the classes of IND3852 Technopreneurship, IND4264 Integrated System Design, and IND5172 Engineering Ethics in Semester II Academic Year 2015/2016 then I would like to invite you to take part in this research. Your participation is voluntary, and you may decline this invitation to participate. Neither your grades nor academic relationships with course lecturers will be affected by either refusal or agreement to participate.

You may not benefit from participation in the study directly. However, in general this research will help Universitas Atma Jaya Yogyakarta to assess the Engineering Professional Skills of their students. There may be an indirect benefit to you in that this research may help Universitas Atma Jaya Yogyakarta keep accreditation. Your professional careers will be likely benefit if you have graduated from accredited institutions.

To participate in this research, please see attachment to view the Participant Information Sheet and Consent Form.

For more information, please contact Hadisantono, by email hsan991@aucklanduni.ac.nz

Approved by the University of Auckland Human Participants Ethics Committee on 29 April 2016 for three years. Reference number 016642.

Appendix D. Consent Form

The Consent Form (CF) is a form signed by a participant prior to an EPSA Class Administration to confirm that he or she agrees to the research procedure and is aware of any issues that might be involved. The primary purpose of the CF is to provide evidence that the participant gave consent to participate in the research.

This research involves participation of the Head of Department, the course lecturers and the students.

This research was run in two cycles. The first cycle took place in Semester II Academic Year 2015/2016 and the second cycle took place in Semester II Academic Year 2016/2017. Both cycles used the same CF.

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CONSENT FORM – PARTICIPANT
THIS FORM WILL BE HELD FOR A PERIOD OF 6 YEARS

Project Title:

FORMALISING AND EVALUATING THE ASSESSMENT FOR ENGINEERING PROFESSIONAL SKILLS

Names and contact email address of researchers:

Hadisantono ***hsan991@aucklanduni.ac.nz***

Dr. Gerard Rowe ***gb.rowe@auckland.ac.nz***

Dr. Nasser Giacaman ***n.giacaman@auckland.ac.nz***

I have read the Participant Information Sheet, and I have understood the nature of the research and why I have been selected. I have had the opportunity to ask questions and have them answered to my satisfaction.

- I agree to take part in this research.
- My participation is voluntary. I understand that the Dean of the Faculty of Industrial Technology at Universitas Atma Jaya Yogyakarta has given an assurance that neither my grades nor academic relationships with course lecturers will be affected by either refusal or agreement to participate.
- I understand that all participants in class will be divided into teams, with one part of the team conducting the discussion based on given scenarios and the other part of the team using a modified Engineering Professional Skills Assessment (EPSA) rubric to assess the discussions.
- I understand that the discussion will be recorded and transcribed.
- I understand that I will have the opportunity to review but not edit the transcripts of the recording, due to the conversational and contextual nature of the discussion.
- I understand that I am free to withdraw participation at any time without giving a reason.
- I agree to not disclose anything discussed in the focus group.

- I understand that data will be kept for 6 years, after which any data will be destroyed.

Name: ________________________

Signature _____________________ Date _____________________

Please provide your email address, if you wish to review the transcripts of the recording and receive a summary of findings.

Email address: ________________@______________________

Approved by the University of Auckland Human Participants Ethics Committee on 29 April 2016 for three years. Reference number 016642

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CONSENT FORM – COURSE LECTURER
THIS FORM WILL BE HELD FOR A PERIOD OF 6 YEARS

Project Title:

FORMALISING AND EVALUATING THE ASSESSMENT FOR ENGINEERING PROFESSIONAL SKILLS

Names and contact email address of researchers:

Hadisantono ***hsan991@aucklanduni.ac.nz***

Dr. Gerard Rowe ***gb.rowe@auckland.ac.nz***

Dr. Nasser Giacaman ***n.giacaman@auckland.ac.nz***

I have read the Participant Information Sheet, and I have understood the nature of the research. I have had the opportunity to ask questions and have them answered to my satisfaction.

- I agree to facilitate this research.
- I understand that the students who are enrolled in the classes of IND3852 Technopreneurship, IND4264 Integrated System Design, and IND5172 Engineering Ethics, Department of Industrial Engineering, Faculty of Industrial Technology, Universitas Atma Jaya Yogyakarta in Semester II Academic Year 2015/2016 will be invited to participate in this research.
- I understand that student's participation is voluntary, and they may decline this invitation to participate. The Dean of the Faculty of Industrial Technology at Universitas Atma Jaya Yogyakarta, Indonesia has given an assurance that neither their grades nor academic relationships with course lecturers will be affected by either refusal or agreement to participate.
- I understand that this research will take 3 weeks; the first week will be used for a trial run, the second week will be the actual assessment, and the third week will be used for process

evaluation, clarification, focus group feedback, and class wide report on EPSA Performances.

- I understand that all participants in class will be divided into teams, with one part of the team conducting the discussion based on given scenarios and the other part of the team using a modified Engineering Professional Skills Assessment (EPSA) rubric to assess the discussions.
- I understand that the discussion will be recorded.
- I understand that data will be kept for 6 years, after which any data will be destroyed.

Name: ______________________

Position: Course Lecturer

Course Name: IND3852 TECHNOPRENEURSHIP / IND4264 INTEGRATED SYSTEM DESIGN / IND5172 ENGINEERING ETHICS

Department/Institution: Industrial Engineering / Universitas Atma Jaya Yogyakarta, Indonesia

Signature ____________________ Date ____________________

Please provide your email address, if you wish to review the transcripts of the recording and receive a summary of findings.

Email address: _______________@_____________________

Approved by the University of Auckland Human Participants Ethics Committee on 29 April 2016 for three years. Reference number 016642

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CONSENT FORM – HEAD OF DEPARTMENT (UAJY)
THIS FORM WILL BE HELD FOR A PERIOD OF 6 YEARS

Project Title:

FORMALISING AND EVALUATING THE ASSESSMENT FOR ENGINEERING PROFESSIONAL SKILLS

Names and contact email address of researchers:

Hadisantono ***hsan991@aucklanduni.ac.nz***

Dr. Gerard Rowe ***gb.rowe@auckland.ac.nz***

Dr. Nasser Giacaman ***n.giacaman@auckland.ac.nz***

I have read the Participant Information Sheet, and I have understood the nature of the research. I have had the opportunity to ask questions and have them answered to my satisfaction.

- I agree to facilitate this research.
- I understand that the students who are enrolled in the classes of IND3852 Technopreneurship, IND4264 Integrated System Design, and IND5172 Engineering Ethics, Department of Industrial Engineering, Faculty of Industrial Technology, Universitas Atma Jaya Yogyakarta in Semester II Academic Year 2015/2016 will be invited to participate in this research.
- I understand that student's participation is voluntary, and they may decline this invitation to participate. The Dean of the Faculty of Industrial Technology at Universitas Atma Jaya Yogyakarta has given an assurance that neither their grades nor academic relationships with course lecturers will be affected by either refusal or agreement to participate.
- I understand that this research will take 3 weeks; the first week will be used for a trial run, the second week will be the actual assessment, and the third week will be used for process evaluation, clarification, focus group feedback, and class wide report on EPSA Performances.

- I understand that all participants in class will be divided into teams, with one part of the team conducting the discussion based on given scenarios and the other part of the team using a modified Engineering Professional Skills Assessment (EPSA) rubric to assess the discussions.
- I understand that the discussion will be recorded.
- I understand that data will be kept for 6 years, after which any data will be destroyed.

Name: ____

Position: Head of Department of Industrial Engineering

Institution: Universitas Atma Jaya Yogyakarta, Indonesia

Signature ______________________ Date ______________________

Please provide your email address, if you wish to review the transcripts of the recording and receive a summary of findings.

Email address: ________________@_______________________

Approved by the University of Auckland Human Participants Ethics Committee on 29 April 2016 for three years. Reference number 016642

Appendix E. The EPSA Scenarios

Seven locally relevant scenarios were designed for this research according to recent local issues in Indonesia. Four scenarios were established in the first cycle of the research (in 2016) and three more scenarios were added in the second cycle (2017).

The scenarios were:

1. Adam Air (developed in Cycle 1)
2. Low Cost Carrier (developed in Cycle 1)
3. Gojek (developed in Cycle 1)
4. National Car (developed in Cycle 1)
5. Bay of Jakarta Reclamation (developed in Cycle 2)
6. Indonesia Nuclear Power Plant (developed in Cycle 2)
7. Cigarette Industry (developed in Cycle 2)

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SCENARIO #1
ADAM AIR

On 1 January 2007, Air Traffic Control (ATC) lost contact with Adam Air KI 574 flying from Surabaya (SUB) to Manado (MDC). The aircraft, a Boeing 737-400 with registration number PK-KKW (c / n 24 070), had 96 passengers (85 adults, 7 children and 4 infants) and six crew on board. On 10 January 2007, parts of the aircraft's tail stabilizer were found 300m offshore.

The flight recorders and suspected debris were located but were not initially recovered due to a dispute between Adam Air and the Indonesian Government over who should pay recovery costs. Both recorders were retrieved after Adam Air agreed to pay for 7 days' worth of searching.

About Adam Air

Adam Air (incorporated as **PT Adam SkyConnection Airlines**) was a privately-owned airline based in West Jakarta, Jakarta, Indonesia. It operated scheduled domestic services to over 20 cities and international services to Penang and Singapore. Its main base was Soekarno-Hatta International Airport, Jakarta.

Adam Air was founded by Agung Laksono, an Indonesian businessman and Chairman of the House of Representatives, together with Sandra Ang. The son of Sandra Ang, Adam Adhitya Suherman, was the Chief Executive Officer (CEO) of the airline. The airline was established in 2002 and commenced operations on 19 December 2003 with two Boeing 737 aircraft leased from GE Commercial Aviation Services.

Although referred to as a low-cost carrier, Adam Air promoted itself as an airline straddled between low-cost and traditional carriers, offering both on-board meal service and low fares, similar to the model adopted by Singapore-based Valuair. Prior to the crash of Flight KI574, it was the fastest growing low-cost carrier in Indonesia. On 9 November 2006, Adam Air received the Award of Merit in the Category Low Cost Airline of the Year 2006 in the 3rd Annual Asia Pacific and Middle East Aviation Outlook Summit in Singapore.

Adam Air had been involved in talks with multiple private investors, including a planned sale of 20% stake to Qantas, a takeover bid from a private equity fund Texas Pacific Group, and a planned initial public offering in Singapore. However, foreign investment interest evaporated following the KI574 Flight accident. Indonesian investment company, PT Bhakti Investama Tbk. was interested in acquiring Adam Air. The company already owned a stake in PT Indonesia Air Transport Tbk., a subsidiary of PT Media Nusantara Citra Tbk., the largest and most integrated media group in Southeast Asia. Adam Air ultimately sold a 50% stake to PT Bhakti Investama Tbk.

Following the subsequent crash of Adam Air Flight KI292 in Batam, PT Bhakti Investama Tbk. and a business consortium, Bright Star Perkasa, which together owned a 50 percent share in Adam Air, planned to recover their investments by selling their shares back to the airline's founder. The reasons were that they saw a lack of transparency and no significant improvement by the airline in its handling of safety issues during the past year. The operational activities of Adam Air stopped on 17 March 2008 and will be continued only if there is a new investor willing to bail out 50 percent of the shares drawn by PT Bhakti Investama Tbk.

On March 18, 2008, the Operation Specification of Adam Air was repealed by the Department of Transportation via Decree No. AU/1724/DSKU/0862/2008. Adam Air was no longer allowed to fly its aircraft starting from 00:00 on 19 March 2008. Then the AOC (Aircraft Operator Certificate) was also revoked on 19 June 2008, which put an end to all Adam Air flight operations.

Safety Record

The safety record of Adam Air has been heavily criticized. Adam Air has reportedly bribed pilots to fly aircraft they knew were unsafe. Pilots have reported repeated and deliberate breaches of international safety regulations, and aircraft being flown in non-airworthy states for months at a time. They claim that there have been such incidents as requests to sign documents to allow an aircraft to fly, while not having the authority to, and while knowing the plane to be unairworthy; flying a plane for several months with a damaged door handle; swapping parts between aircraft to avoid mandatory replacement deadlines; being ordered to fly aircraft after exceeding the take-off limit of five times per pilot per day; flying an aircraft with a damaged window; using spare parts from other aircraft to keep planes in the air and ignoring pilot's requests not to take off due to unsafe aircraft. They also claim that if pilots confronted their seniors in the airline, they were grounded or had their pay docked. The CEO of Adam Air, Adhitya Suherman denied the accusations, stating that maintenance costs up to 40 percent of the total operating costs of Adam Air.

Adam Air's original advertising campaign contained statements considered by many to be direct lies, telling passengers to take to the skies with its "new Boeing 737-400s", despite the fact that its two Boeings, leased from GE Capital Aviation Services, were used and over 15 years old. At the time Adam Air was founded, the 737 aircraft family making up Adam Air's fleet had been out-of-production for several years, replaced by the 737 Next Generation series.

After an incident in which an aircraft with 145 people on board was lost for hours, eventually making an emergency landing in West Sumba, East Nusa Tenggara, 525 kilometres away from its intended destination, the pilot blamed a malfunctioning navigation system. Adam Air claimed that the equipment was working properly and had the pilot arrested on charges of endangering passenger safety. Immediately after the incident, the Directorate General of Civil Aviation (DGCA) sent instructions to Adam Air to repair the faulty system. Adam Air was then required to conduct a total of 13 test flights with DGAC inspectors aboard before the aircraft could return to commercial service. Adam Air instead left behind a team from the National Transportation Safety Committee (NTSC), who they were supposed to transport to the site, and sent only their own engineers. According to Adam Air, they repaired the fault, and the aircraft was immediately returned to service without any inspection. Critics say that Adam Air used its political connections to sidestep aviation authorities. The Asia Times reported that due to corruption the real cause of the Adam Air crash may never be known.

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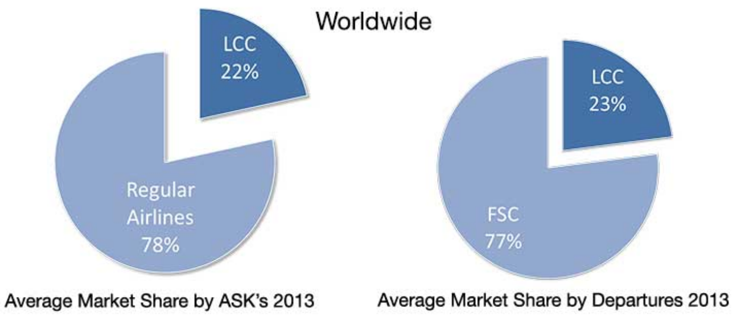
SCENARIO #2
LOW COST CARRIER

A Low-Cost-Carrier (LCC) or low-cost airline (also known as a budget airline) is an airline which generally has lower fares with fewer comforts. To replace the lost revenue arising from cheap airfares, airlines may charge extra for on-board meals, priority boarding, seat allocation, baggage, etc. The term is derived from the airline industry and refers to airlines with lower operating cost structures than their competitors. However the term is often also applied to any airlines with low ticket prices and limited services, regardless of their operating models. An LCC is not the same as regional airlines that operate short flights without service or with Full-Service Carrier (FSC) which offer discount fares.

In the early 1980s, low-cost carriers (LCC) were seen as a business phenomenon that was ridiculous, especially by major airlines with global networks. Almost no one believed that the LCC would be a successful business model in the future. Airline Profiler in its report mentioned that no airlines felt an LCC would be a threat or a serious alternative for their business model. But the reality proved different over the past 30 years. In 2013, LCCs took 23% market share by departures in the global aviation industry, according to Airline Profiler sites. LCC businesses became a very successful concept, with increasing frequency of flights, number of passengers and capacity. Many airlines began to compete with the various start-up airlines, to apply the very profitable LCC concept.

A series of plane crash tragedies that occurred in Indonesia triggered an instant policy change by the Indonesian Transportation Minister, Ignatius Jonan, with regard to LCC. Cheap flights were considered to compromise safety. Does the success of LCC generate profits at the expense of safety? Both experts and aviation safety statistics show that the answer is no. Based on incidence data collected by Airline Profiler, there were 818 serious incidents involving the FSC in 2003-2013, while LCC only suffered 112 serious incidents in the same period.



Comparison of market share FSC vs. LCC in 2013
(Source: Airline Profiler)

FSC Airlines 2003-2013 Region	Serious Incidents	Accidents Hull Losses	Fatalities
Africa	61	23	49
Asia	169	32	18
Central America	5	5	0
CIS Region	61	28	333
Europe	239	31	0
Middle East	50	11	28
North America	198	23	53
Oceania	17	4	28
South America	18	3	0
in Total	**818**	**160**	**509**

AirlinePROFILER

LCC - Airlines 2003-2013 Region	Serious Incidents	Accidents Hull Losses	Fatalities
Africa	3	4	175
Asia	28	8	1
CIS Region	3		
Europe	60	1	
Middle East	4		
North America	6		
South America	8	1	154
in Total	**112**	**14**	**330**

AirlinePROFILER

Table Comparison of FSC vs. LCC Accidents Year 2003-2013
Source: Jet Airliner Crash Data Evaluation Centre, Airline Profiler

"LCC benefit from the efficiency and reduction of costs spent on customer service rather than by neglect on safety issues," said Max Leitschuh, a transportation analyst for the International iJET. "In places such as North America and Europe, where the aviation industry is well organized, they would not let any airlines get away with sub-standard safety practices. The major LCC have very good safety records. In fact, many of them have never had a serious accident ".

Data proves that Ryanair and EasyJet, the two largest LCC airlines in Europe, have never experienced a fatal accident. This is also true for JetBlue and Spirit in the US. The latest annual safety index of the world's 60 largest airlines issued by the Jet Airliner Crash Data Evaluation Centre (JACDEC) in Germany, shows that four budget airlines (JetBlue, WestJet, Southwest and Ryanair) were considered safer than American Airlines, the largest airline in the world, which ranked 39 out of 60. JetBlue ranked inside the top 10, in ninth position.

Even for the 10 worst aviation accidents in Europe, there was no LCC airline involved, while for the 10 worst aviation accidents in North America there was only one in the list, namely Pacific Southwest Airlines in 1978.

In Asia, where standards vary and regulations are poor, LCC are booming. AirAsia, for example, suffered a major accident in January 2015 but had a clean safety record until then. But in Indonesia, Lion Air (with eight incidents of accidents since 2002) has a terrible safety rating and is already banned by the European Union. "Asia is very varied, both in terms of flight and regulatory authorities," said Leitschuh. Certain authorities such as Singapore are very good. The regulatory body is mediocre in Malaysia, while Indonesia has a big problem, he said. "But just because there is poor regulation, it does not mean the airline is unsafe; it depends on how the airline regulates itself".

LCC airlines make savings by putting more passengers into the cabin space, limiting customer service and running the operation efficiently. "When you pay less at a LCC airline, you get what you pay for - it's just lacking in terms of comfort and customer service, but in terms of safety it is not diminished," said Leitschuh. "Every airline in the world knows that an accident or a bad reputation for safety is bad for business. A bad reputation will cause the loss of more revenue earned rather than cut the cost of safety".

How about Indonesia? Indonesian people's behaviour may be regarded as an anomaly. Lion Air, although it has a poor record of safety, is still very popular. Each flight of Lion Air is always crowded. For Indonesian people, comfort and safety may not be the main consideration which is instead the cheap fares.

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SCENARIO #3
GOJEK

Gojek was founded by Nadiem Makarim in 2010 as a transportation network and logistic startup company. By 2019, the firm was worth up to US$ 10 billion, which made Gojek one of Indonesia's giant tech startup companies. Gojek was first established as a call centre, offering the delivery of goods and ride-hailing services by motorcycle. Now, Gojek has been transformed into a super app, providing more than 20 services, ranging from transportation, food delivery, daily necessities, massages, house cleaning, and logistics to a digital payment platform known as Gopay.

Ojek or motorbike taxi is a transportation service by motorcycle. Ojek is a very popular mode of transportation in Jakarta, because several traditional modes of public transportation in Jakarta are not connected properly so that the people of Jakarta experience difficulty in reaching their destination if they only rely on public transport (bus, minibus and train), especially during peak hours. People often use ojek from their office to the train station or bus terminal and vice versa. Another reason is the traffic in Jakarta is very difficult to predict. Some say that Jakarta has the worst traffic congestion in the world. Ojek is a solution to avoid traffic congestion so that the destination can be reached quickly and inexpensively.

The main weaknesses of traditional ojek (a.k.a. ojek pangkalan) are limited service area and the majority of an ojek pangkalan driver's time is spent on waiting for passengers. Such weaknesses are mitigated by mobile applications that are used as the basic operation of Gojek. This application helps Gojek drivers get passengers and passengers who require an ojek service can also be facilitated. The business model of Gojek is a social business model, involving 80% sharing of revenue for Gojek drivers from the total amount of the transaction obtained from passengers. Gojek only equips Gojek drivers with jackets, helmets and an Android Smartphone.

The Gojek presence is like an oasis in the middle of the poor public transportation system in Jakarta. This condition is a reality in many big cities in Indonesia. The government has failed to provide a safe, comfortable and adequate public transportation system. For this reason, Gojek provides a service with ease, clarity, and hospitality. Most of the Gojek users even attribute the label 'security and comfort' to Gojek.

With the tagline 'an ojek for every need', Gojek services operate with Android and iOS based applications as its basic technical infrastructure. Via smartphones, Gojek services can be accessed and booked at the pick-up and delivery point, and there is a summary of the amount of fares that must be paid for this service.

Although Gojek provides a modern transportation service based on information technology applications, its existence leads to two controversies. First, the controversy of rejection of the presence of Gojek by ojek pangkalan. The rejection of the Gojek basically arises from the fears of the loss of income from the ojek pangkalan with the presence of Gojek as a competitor. In some cases Gojek drivers have faced physical attacks by blocking when entering a particular area. In addition, billboards began to emerge advocating the rejection of the Gojek. This opposition could potentially lead to greater conflict if not prevented and addressed. The government should be able to act as a mediator and act fairly between the different parties with the aim of finding a balanced solution.

Second, the controversy around the legality of the operation of Gojek. Many critics cite the legality of ojek (motorcycles) which are used as a means of public transport. Act No. 22 Year 2009 on Road Traffic does not regulate the provisions of the law where motorcycles are used as public transportation. An ojek is categorised as a two-wheeled motor vehicle for the purpose of individuals in accordance with Article 47 paragraph (2) and (3). The article that is allegedly violated by the activity of Gojek is Article 137 paragraph (1) and (2) which stipulates that two-wheeled vehicles or motorcycles can only be used for the transport of people and goods privately, and so they cannot be used for public transport.

Having regard to these controversies, there is a dilemma between the need to comply with the Act No. 22 Year 2009 on Road Traffic and the public desire for an improved transportation system based on Android devices and iOS. Gojek has opened up employment in the transportation sector as well the provision of alternative transportation of goods and people which is difficult when the public transport sector is not adequate. The prohibition of the operation of the Gojek will potentially create mass layoffs in this emerging sector, while the provision of cheap and mass transport in urban areas, such as Jakarta and surrounding areas will not be resolved.

Gender Issue

The percentage of female drivers is about 10% of 2 million Gojek drivers (2019). Although there are no differences in the recruitment process between male and female drivers, including safety riding tests and Gojek driver's training, unfortunately, there is a gender issue experienced by female drivers. According to local Indonesian culture, women are not appropriate as drivers of public transportation. The gender issue is also likely more strongly related to religion. Indonesia has the largest Muslim population in the world of approximately 225 million Muslims or 12.7% of the world's Muslim population. Muslim is a patriarchal society where men are the primary authority figures and women are subordinate. Although the women's emancipation movement is also quite significant in Indonesia, the issue of gender equality is still difficult to be accepted by society in general because of cultural and religious influences.

Gojek's internal data reported that user cancellation rates for female drivers tend to be higher at 2.7%. These cancellations were reportedly mainly caused by the reasons that some Gojek users feel unsafe or uncomfortable when having a ride with a female driver. These cancellations will affect the female drivers' performance ratings and eventually will lower their incomes, even though they have the same abilities and skills as male drivers in riding motorcycles safely and maintaining passenger safety.

Meanwhile, potential risk of sexual harassment against the female drivers is also high because of physical contact between the driver and the motorcycle passenger is inevitable. This risk was anticipated by Gojek management by improving the security system for both passengers and drivers through the panic button feature. If the passenger or driver feels threatened by a harasser, they can press the Panic Button which is connected to the police and the Gojek emergency service unit.

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SCENARIO #4
NATIONAL CAR

The idea of developing a national (Indonesia) car first emerged in 1975. This initiative started with the "Toyota Kijang" which was the first car entirely manufactured in Indonesia. The nationalisation of the Mazda 323 became the "MR 30" in 1994. Then in 1996, B.J. Habibie created the "Maleo" in cooperation with Australia. A 500cc car from "Kalla Motor" and the MPV "Beta 97" from the Bakrie Group have been developed up to the prototype phase. Car "Timor" which was fully supported by President Soeharto had to be terminated along with "Bimantara" after the monetary crisis hit in 1998.

After being crippled as a result of the financial crisis, the national car program began to surface again. Developments include the "Texmaco Macan" minibus and "Esemka", "Gang Car" mini car, "Arina" and "Nuri", "Texmaco Perkasa" trucks, "Fin Komodo" off-road, and most recently the electric car "Marlip" and "Tucuxi" as well as other national cars such as the "Kancil", "Tawon" and "Wakaba". Given the number of national cars that have been created previously, it is no wonder that the plan of creating a national car in cooperation with Proton was not considered viable, especially given that Proton's market share has continued to decline. The national car issue is politically charged.

Having a national branded car without the frills of foreign brands is the dream of the people of Indonesia. But it is not just a matter of making the car itself, but also ensuring the industry produces a profit. To build a national car industry, at least four stages need to be completed within a period of 10-15 years. The four stages are Licensing, Manufacturing, Co-Design & Development, and Innovation. These are necessary so that Indonesia really owns the copyright in the car industry.

A national car is a car for which the whole activity of its manufacturing, ranging from concept design, ownership of the company, manufacturing, assembling, and components to be made are completed in Indonesia and by the Indonesian people. The ambition to produce a national car is still strong. Various strategies have been proposed so that it could compete with neighbouring countries such as Malaysia and Thailand.

Esemka Car

PT Solo Manufaktur Kreasi (Esemka) is an Indonesian automotive company based in Solo, Indonesia. Initially local media used to refer to it as a national car, however the company denied this. The company prefer to refer to Esemka as a vehicle which is totally made in Indonesia since they are a private company without any special support or privilege from the government to develop the Esemka car.

Development of Esemka was started in 2007. The Esemka car was a project to improve the skills of vocational high school students in Surakarta to create a local car. This project was supported by some local automotive companies. The project was then continued to form a private company in 2010. The Esemka got wide publicity when Joko Widodo started to use it as an official vehicle of the Mayor of Surakarta in 2012.

Since 2013 an average of 10 units of SUV and mini trucks have been manufactured per month by the company. The company started commercial production of various models of cars and minivans in its manufacturing plant at Demangan village, Boyolali Regency in Central Java in 2016. In 2019 the Esemka manufacturing plant was officially inaugurated by Indonesian President Joko Widodo. At the time of inauguration, the manufacturing plant had production capacity of 12,000 vehicles per year. Esemka uses locally made components.

Some political opponents of Joko Widodo complained that the Esemka car was Joko Widodo's political vehicle. This occurred despite the fact that Joko Widodo claimed to only support the project so that the development of the Esemka car could be expanded. In fact through the car brand, the name Widodo soared into the national political scene. Since then Joko Widodo's political career has grown rapidly, from the mayor of Surakarta to the Governor of Jakarta and later elected President of the Republic of Indonesia.

Local Design

To compete with existing automotive manufacturers, local automotive companies can use the unique design as one of their competitive advantages. Even though everyone has their own preferences, the region and culture also play an important role in influencing the consumers' preference for choosing the type of car. This is also a concern for international automotive manufacturers. Some of their product types are only sold in Indonesia because of the local preferences.

In Europe, the local culture tends to be individualistic and they do not have big families, so the cars chosen are mostly a city car with a seating capacity of no more than four and prioritising comfort. It is different for the culture of Indonesian people who tend to enjoy socialising and have close kinship so that they need a car that has a lot of capacity. This is the reason why a type of family car or MPV (Multi-Purpose Vehicle) with more than 4 seats is preferred in Indonesia than the type of sedan or city car.

National car design is expected to meet the local people's preferences while providing opportunities to generalise the local design for international market. Issues regarding the national car program are very complicated, ranging from environmental issues related to the use of fossil energy, development costs to the commercialisation stage, design models that suit local conditions and tastes to political issues.

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SCENARIO #5
BAY OF JAKARTA RECLAMATION

Land reclamation, usually called reclamation, is the process of making new land out of that previously covered by sea or river. Reclaimed land is usually known as land reclamation or landfill. Land reclamation is generally carried out for the purpose of repair and restoration of a watery region that has been damaged or rendered useless to make it better and more useful. This area can then be used for residential land, attractions and as a commercial district.

Reclamation is not new to Jakarta. Activities to enhance the benefits of land resources and land drainage backfill has been done since the 1980s. PT Harapan Indah reclaimed Pluit Coast neighbourhood with a width of 400 meters of hoarding. The newly formed area is used for the luxury residential Mutiara Beach. PT Pembangunan Jaya Ancol reclaimed the northern side into an industrial area and recreation area around 1981. Ten years later, Kapuk mangrove forests was reclaimed for a luxury residential area that is now known as Pantai Indah Kapuk. In 1995, following the reclamation it is used for industry, namely Marunda Bonded Zone. At that time, reclamation activities at four locations already stirred debate. Some parties claimed that the Pluit Coast reclamation interfered with the Pluit Muara Karang power plant working system. Allegedly, this occurred due to changes in ocean current patterns in the Mutiara Beach reclamation area impacting the power plant cooling flow mechanism. In addition, the sinking of a number of islands in the Thousand Islands group was allegedly caused by the removal of sand from the sea to create the Ancol reclamation area.

Covering an area of 2,700 hectare, the reclamation plan was first presented in the presence of President Suharto in March 1995. In addition to addressing the scarcity of land in Jakarta, it served to establish a reclamation project in North Jakarta which was lagging behind compared to development of the four other regions. To support the plan, a Presidential Decree (No. 52 Year 1995) was approved for the North Coast Jakarta Reclamation and Regulation No. 8 Year 1995. However, due to the monetary crisis which hit Indonesia in 1997 the construction process was postponed.

In 1999, Parliament and the Jakarta administration under the leadership of Governor Sutiyoso issued Local Regulation of City Layout Plan 2010 where the reclamation was included into the plan thus substantially changing the plan of 1995. The purpose of the reclamation was described as international trade and services, housing and establishment of a tourist harbour. A Local Regulation (RTRW) described the reclamation area as approximately 2,700 hectares and indicated it was earmarked for housing.

In 2003, the Ministry of Environment, when it was headed by Minister Nabiel Makarim, issued Decree No. 14 stating that the reclamation and revitalization projects in North Jakarta were not feasible. The Ministry said that the reclamation would increase the risk of flooding, especially in the northern region, damaging marine ecosystems, and causing a decrease in fishermen's incomes. The Ministry indicate the project also would require about 330 million cubic meters of sand (for reclaiming an area of 2,700 hectares) and would disturb the Muara Karang power plant in North Jakarta. In 2003, six contractors appealed this decision to the administrative court. The six companies were PT Bakti Era Mulia, PT Taman Harapan Indah, PT Mangala Krida Yudha, Pelindo II, PT Pembangunan Jaya Ancol and PT Jakarta Propertindo.

In spite of ongoing litigation, in 2007 Governor Sutiyoso issued (on 19 July) approval in principle permits for the 2A island (which later was renamed island D) to PT Kapuk Naga Indah, a subsidiary of the General Sedayu Group via the Governor's letter No. 1571/-1711. The Ministry of the Environment subsequently won a Supreme Court decision in the case of the six contractors' lawsuit against the minister's decision. The Ministry had previously lost decisions in this case in two lower courts. However, in 2011 in the Supreme Court reconsideration of the case the Ministry of Environment won the decision.

Until now the legality of the northern coastal reclamation of Jakarta is still disputed. Director General of Marine, Coastal and Small Islands, Mr. Sudirman Saad said that issuing reclamation permits is not the responsibility of the governor, but the Ministry of Marine Affairs. Reclamation on 17 islands had never obtained any permission from the Ministry. On Thursday (03/31/2016), the Corruption Eradication Commission (KPK) arrested a member of the Regional Representatives Council (DPRD) of DKI Jakarta, M. Sanusi after receiving money with a total value of Rp 1.14 billion. Bribes were allegedly linked to the discussion of the draft law and the Zoning Plan for Coastal Zone North Beach and the revision of Regulation No. 8, 1995 on the Implementation of Reclamation and Layout Planning of North Jakarta. As a result of this arrest, on 18 April 2016 Maritime Coordinating Minister Rizal Ramli, the Minister of Maritime Affairs and Fisheries Susi Pudjiastuti, the Minister of Environment and Forestry Siti Nurbaya and the Governor of Jakarta Basuki Tjahaja Purnama decided suspension or moratorium of North Coast Jakarta reclamation. All parties agreed that the reclamation is not wrong, but there are overlapping rules that need to be remedied.

Rejection of the reclamation projects generally does not come only from affected parties who feel reclamation is less useful for themselves financially, but also from the local people. The local people believe that reclamation followed by the rearrangement of the bay of Jakarta area will potentially damage their cultural heritage (sacred places) such as mosques and ancient tombs. In addition, people in coastal areas depend on marine products. They are accustomed to living by maintaining the balance of nature and traditional marine conservation. The reclamation project will potentially destroy all aspects of their traditional life.

In fact, when viewed in the long term, reclamation contains some positive benefits that can be felt by people around the project. In the economic field, for example, the reclamation is almost certain to create new jobs and open up greater investment opportunities. The opening of a new business area in various fields, particularly tourism, will also increase the income per capita and purchasing power to boost the impact on the rate of expansion of the nation's economy. Other experts have also suggested that such large-scale reclamation in Jakarta will assist to keep the nation's sovereignty and avoid conflicts of maritime boundaries with neighbouring countries such as Singapore.

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SCENARIO #6
INDONESIA NUCLEAR POWER PLANT

Indonesia does not have a nuclear reactor as an electricity resource yet. Nevertheless, the research and study of nuclear power options has taken place since 1954. At that time the main goal was to investigate the possibility of radioactive fallout from nuclear weapons testing in the Pacific. The nuclear reactors that Indonesia owns have so far been limited to research usage and other applications that are not intended for large-scale electric power generation. The first reactor owned by Indonesia was the Training Research Isotope Production reactor produced by General Atomic (TRIGA) in Bandung, which was inaugurated by President Soekarno in December 1965. This reactor is not used as a supplier of electric power. As the name implies the TRIGA reactor is used for researching and developing isotope technology mastery of useful radioisotopes in the medical field. In addition, there was a reactor in Yogyakarta (named the Kartini Reactor) in 1979 and a Multipurpose Reactor (named the G.A. Siwabessy Reactor) in Serpong in 1987.

Plans to use nuclear reactors to generate electricity continue to be explored to date. This exploration is being conducted as a potential solution to the deficit of electric energy in Indonesia. Growth of electricity usage in Indonesia has increased by around 8.5% per year, whereas the supply has increased by only 6.5% per year. The government argues that nuclear power plants should be constructed as alternative power plants to meet energy needs. This approach was taken by the government since PT PLN (Persero), as the official agency appointed by the government, had failed to manage the problem of electricity supply. The government resumed the Muria Nuclear Power Plant Project after it had been postponed eleven years. Planned in 2008, the National Atomic Energy Agency (BATAN) started the auction process for a megaproject worth Rp 76.5 trillion. Japan, Korea, France, the US and Russia mentioned interest in the project. BATAN plans to build four units of the Muria nuclear power plant. Each reactor would generate about 1,000 megawatts of electric power. The first unit was planned to be operated in 2016. The second unit was to start running in 2017, and would be followed by a number of processes such as evaluation and transfer of technology. Furthermore in 2018 and 2019, the other two reactor units would be operational.

Unfortunately, all plans are still not operating today due to rejection of the project by local people.

The local people believed that the nuclear power plant project damaged their sacred place. For example, the Muria nuclear power plant project contradicted with the local values of the Muria people. The problem was that the Muria people were not involved in the planning and construction of the Muria nuclear power plant. They learnt of the project after the project had already started. The project did not use an appropriate approach that respected the local values of the Muria people. The Muria people considered the project area as their sacred place that must be preserved, including its flora and fauna. The project had trespassed and destroyed some of the flora and fauna that are guarded by the Muria people. The project creates conflict with traditional conservation that had been carried out for hundreds of years by the Muria people.

Moreover, the geographical layout of Indonesia, which consists of thousands of islands, has led to the unequal distribution of electricity load centres. Similarly, the low levels of demand for electricity in some areas and the high marginal cost of electric energy supply system construction, is also a constraint. Gas, as the main alternative fuel replacement, could not be expected to meet demand. There are already many foreign sales contracts that must be met by the government. Suitable means of distribution of raw materials such as coal and distribution of gas to power plants are not available and their provision will be very costly. In addition, use of coal can also contribute to the greenhouse effect. These were the reasons that prompted the government to build nuclear power plants. By using nuclear energy to produce electricity, oil subsidies can be suppressed by the government.

Nuclear energy has become a controversial issue because many countries that were previously utilizing electricity-producing nuclear power are thinking of switching to other alternative energy sources. Three major nuclear accidents have heightened concern about the safety of nuclear plants: Three Mile Island in 1979 in the USA, Chernobyl in the Soviet Union in 1985, and most recently, in 2011, Japan's Fukushima. The long-term impact of the radiation emitted in such accidents is the reason behind concerns of countries that develop and use nuclear power.

In Indonesia, meeting the national electricity supply targets is the reason behind the use of nuclear power. Some commentators argue that because of the nature of the geography of Indonesia, specifically its many islands, centralised power plants in Java, a gas pipeline, or a nuclear initiative as an energy source will not resolve the problems facing Indonesia. However, there are a lot of problems associated with nuclear energy. First, nuclear technology is really expensive. Second, Indonesia has not yet mastered the technology. Third, Indonesia is a disaster-prone country of earthquakes, floods, and tsunamis. Further the Indonesian Forum for Environment (WALHI) stated that nuclear energy is not an alternative solution to supply energy and avoid environmental issues. On their website, they said that nuclear energy is not a cheap energy resource. Reactor technology and uranium supplies are scarce, and sources of uranium near the earth's surface will likely shrink quickly due to the increasing number of nuclear power plants thus leading to increased costs. Moreover, nuclear energy is not a renewable energy source.

Indonesia needs decentralised, clean, and renewable energy as a source of power. It was impossible to build a centralised power plant to cover the total need of electricity in the scattered island nation. Decentralisation means the building of small-capacity power reactors distributed evenly throughout the region. A small capacity reactor can be filled with micro-hydro and biogas energy. In addition, Indonesia also has the largest geothermal energy potential in the world because it lies in the Pacific Ring of Fire region.

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SCENARIO #7
CIGARETTE INDUSTRY

The market share of the current tobacco industry began to change because it is influenced by the changing of smokers' lifestyles. They pay more attention to their health by choosing cigarettes containing lower tar and nicotine. Currently the community of smokers are switching to machine made cigarettes (namely Sigaret Kretek Mesin/SKM). In 2016, market share for SKM amounted to 72.07%, while hand-made cigarettes (namely Sigaret Kretek Tangan/SKT) amounted to 20.23%, and the machine-made white cigarettes (namely Sigaret Putih Mesin/SPM) market share was 5.43%. The rest, including shelf-hand-rolled cigarettes and incense rheum officinale accounted for 2.27% of market share.

Work termination that threatens workers in the tobacco industry is not due to a decline in sales as a result of an anti-smoking campaign which is encouraged by some elements of society. Instead this was due to the switching of production from SKT to SKM. Mechanisation options have been taken because of their higher productivity and they do not require a large number of workers. Such a reduction in costs is the key to cigarette industry player's survival in the face of global competition.

According to the research conducted by the Southeast Asia Tobacco Control Alliance (SEATCA), the amount of shift in people's choice from SKT to SKM is as follows; the SKM proportion has risen from 57% to 66% while the SKT proportion has decreased from 35 % to 26%. During 2013 an expansion and large-scale mechanisation of the tobacco industry (by adding new machinery production capacity) resulted in 1.5 billion cigarettes per-year or an enhanced production capacity of 15 cigarettes/minute with a 24-hour shift system. As a result, during 2013 there were 17,288 cigarette workers laid off. Tobacco industry workers fell by half during 2010-2012 from 689,000 to 339,000 or from 0.6% to 0.3% of the total workers. These are all consequences of the big tobacco company's decision to make a large profit via the use of mechanisation. This is not a result of the excise policy. It also shows the indifference of large tobacco companies to the impact of their strategies on their workers. Ironically, impact on employees has often been used as a pretext for rejecting a tax increase that is already a necessity if cigarette consumption in Indonesia is to be lowered, for the future of Indonesia which is more healthy, productive, and fair.

Research by the Institute of Demography, University of Indonesia also gives the same result. Problems of employment termination of the tobacco industry is not entirely due to the increase in excise rates, but rather is more likely due to business competition, i.e. big company versus small cigarette company. Small cigarette factories have been defended by the government by being subjected to the lowest taxes. Handmade cigarettes also have cheaper tax rates than do machine made cigarettes. In addition, changes in consumer preferences (for instance increased preference for machine-made cigarettes with a filter) have contributed to the termination of employment in hand-making cigarettes. This shifting preference is desirable to the tobacco industry since the machine-made cigarette is more profitable than are hand-made cigarettes.

Despite the problems, the tobacco industry still contributes significantly to the national economy. This sector's contribution covers employment, and domestic income, as well as being an important commodity for Indonesian farmers. The Ministry of Industry noted that revenues from the tobacco industry that are derived from customs and taxes each year have increased. The contribution of the tobacco industry in 2016 in the form of excise tax payments was Rp 138.69 trillion, or 96.65% of the total national customs. In addition the absorption of labour in the manufacturing and distribution sector reached 4.28 million people as well as the plantation sector, which involved as many as 1.7 million people. Manufacture of tobacco products have also become part of the nation's history and culture of our society, especially SKT is a commodity-based tobacco and cloves are very typical of Indonesia and is the ancestral heritage of the nation and has been rooted for generations.

The phenomenon of declining of tobacco industry business units in recent years is not accompanied by a decrease in production quantities. Total production has increased. In 2014 the number of producers in the industry reached 700 companies with production capacity of as much as 346.3 billion cigarettes. While there was a reduced number of 600 companies in 2015, cigarette production rose to 348.1 billion cigarettes, and in 2016 amounted to 350.03 billion cigarettes. However, there has been a decline in the last five years of the number of workers in the tobacco manufacturing and plantation sector, which respectively fell by 3.5% and 4.7%.

Drafting rules and policies about tobacco should be undertaken very carefully because it affects the lives of many people. The application of import quotas should be realistic given the needs of the domestic cigarette industry. Imports of tobacco cannot be stopped immediately if the supply of raw materials for industry is not assured. Data reported by the Central Bureau of Statistics and the Ministry of Finance indicates that the production of cigarettes increased by 47 percent from 235.5 billion cigarettes in 2005 to 346 billion cigarettes in 2013. Meanwhile, the number of industrial workers in the tobacco industry has continued to decline since 2006.

Female Workers

The Indonesian employment system tends to hamper women's participation in the workforce. Indonesia is a patriarchal society where men are the primary authority figures and women are subordinate, and women mostly take care of the home and the children as a housewife. The main objectives of their day are that their home is clean and tidy, their children are well cared for and a home cooked meal is on the table for their families come dinner time. The role of a career women is still difficult to be accepted by society in general because of cultural and religious influences. Other rigid aspects relate to the problem of working hours and the number of days-off. Indonesia has not yet adopted flexible working hours to the same extent that other countries have. Similarly there is no provision for maternity leave. Many employers cannot accept female employees who want to divide their time between work and household duties as a housewife. As a result, women's participation in workforce rates are still low. Based on World Bank data in 2018, there were only 50.7% of Indonesian women aged 15 years and over participating in the workforce (either working or looking for work).

Many women happily pursue the careers of their choice. Then there are other women who take on a career due to financial constraints. They continue to work because their family needs their salary to survive. They go to work each day to put food on the table. Then they go home and still perform all the household duties that the traditional housewife would do. They cook, they clean, they do laundry and they tend to their children.

In contrast, the cigarette industry absorbs a lot of workers and most of them are women. Women become a very productive workforce. The reason the cigarette industry employs more women than men, is because male workers are more involved in labour unions and often carry out strikes so that it can hamper the production process. Although this work is fairly monotonous with relatively long working hours, women workers continue to hold on to this work. Many of them have worked for more than 10 years.

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Appendix F. The EPSA Scoring Sheets

This scoring sheet was used during the EPSA class administration. Each outcome was represented by a scoring table to facilitate the assessment with each level of achievement definition. The assessor (assessment sub-team) observed the discussion process and then gave the appropriate score directly in the column provided. The assessor might write some comments or keywords to support their assessment.

There are three versions of EPSA scoring sheets established in this research, namely May 2016 version (6-pages), May 2017 version (3-pages) and August 2019 version (2-pages). The difference between them (in addition to the number of pages), was that the May 2016 version included the definition and explanation in detail of the strategy for assessing each outcome. The first cycle of fieldwork revealed this version was very troublesome because students had to flip through the pages during the assessment. This issue greatly disrupted the assessment and discussion process. To overcome this issue, a short version (May 2017 version) was established by eliminating some definitions and information so that the scoring sheet can be simple and compact.

Unfortunately, these improvements do not seem to be fully effective. In the feedback at the end of the second cycle of fieldwork, students considered the short version of EPSA scoring sheets to still be impractical and requiring further improvement to fit within the limited classroom time available for this assessment. The third version (August 2019 version) which uses the SOLO taxonomy model to define standard ratings is presented here. This version is simpler, more concise, and easier to use.

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EPSA SCORING SHEETS
(Version August 2019)

Rater's Name	:	Scenario No.	:
Subject	:	Scenario Title	:
Date	:	Group	:

Scoring Rules

1. Understand each skill definition. Assign scores for each of the specific areas based on the SOLO Taxonomy levels. Provide keywords that support your score (refer to the hierarchy of verbs of the SOLO Taxonomy).
2. Ultimately assign one total score for the skill. Use whole numbers; round down, no fractions. For example, 2.6 would be a 2 not a 3. The rationale is to report the level the student achieved, not the level that they almost achieved.

The hierarchy of verbs of the SOLO Taxonomy

Levels	Descriptions	Verbs
1 – Pre-structural	At this level, the student doesn't understand the lesson or subject.	-
2 – Uni-structural	The learner's response only focuses on single relevant aspect.	memorise, identify, recognize, count, define, draw, find, label, match, name, quote, recall, recite, order, tell, write, imitate
3 – Multi-structural	The learner's response focuses on several relevant independent aspects.	classify, describe, list, report, discuss, illustrate, select, narrate, compute, sequence, outline, separate
4 - Relational	The learner is able to integrate all relevant aspects.	apply, integrate, analyse, explain, predict, conclude, summarise, review, argue, transform make a plan, characterize, compare, contrast, differentiate, organize, debate, make a case, construct, review and rewrite, examine, translate, paraphrase, solve a problem
5 - Extended Abstract	The learner is able to create new ideas based on their understanding of the lesson or subject.	theorise, hypothesise, generalise, reflect, generate, create, compare, invent, originate, prove from first principles, make an original case, solve from first principles

Source: Biggs & Tang (2007)

EPSA Scoring Sheet

(b) An ability to design components, systems and/or processes to meet expected needs within realistic boundaries, such as legal, economic, environmental, social, political, health and safety, sustainability and to recognise and/or utilise potential local and national resources with global insight					Score:
Specific Area	1 Pre-structural	2 Uni-structural	3 Multi-structural	4 Relational	5 Extended abstract
Impact/Context on cultures, views, religions, and beliefs, as well as intellectual property rights (CP5)					
Social sensitivity and concern for society and the environment (CP6)					
KEYWORDS					

(f) An ability to communicate effectively, both oral and written					Score:
Specific Area	1 Pre-structural	2 Uni-structural	3 Multi-structural	4 Relational	5 Extended abstract
Verbal					
Non-Verbal					
KEYWORDS					

(h) An ability to work in multiple disciplines and cultures					Score:
Leadership (CP6)					
Participation (CP6)					
KEYWORDS					

(i) An ability to be responsible to the community and comply with professional ethics in solving engineering problems					Score:
Specific Area	1 Pre-structural	2 Uni-structural	3 Multi-structural	4 Relational	5 Extended abstract
Commitment to improving the quality of life in the society and nation (CP3)					
The law, professional ethics and academic values (CP7, CP8)					
KEYWORDS					

(j) An ability to understand the need for life-long learning, including access to knowledge related to current relevant issues.					Score:
Specific Area	1 Pre-structural	2 Uni-structural	3 Multi-structural	4 Relational	5 Extended abstract
Commitment to continual professional development (CP9)					
Resilience and entrepreneurial spirit (CP10)					
KEYWORDS					

Appendix G. Questionnaire

This questionnaire was used to evaluate the students' experience in performing the EPSA class administration. Each student rated their experiences by using a 5-point Likert Scale (with 5 being the ideal score) and a 1-10 rating scale (with 10 being the ideal score). The questionnaire consisted of three parts. The first part was used to evaluate the given scenario, the second part was used to evaluate the EPSA rubric and the last part was used to evaluate the assessment process. At the end of each part, a free format feedback field for gaining the students' responses was provided. The free format feedback gave the opportunity for the students to express their experiences without the bounds of the existing standard questions.

This in an anonymous questionnaire. A dropbox was provided in the department office for returning the questionnaire.

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QUESTIONNAIRE
THIS FORM WILL BE HELD FOR A PERIOD OF 6 YEARS

Project Title:
FORMALISING AND EVALUATING THE ASSESSMENT FOR ENGINEERING PROFESSIONAL SKILLS

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Date	:		Scenario No.	:
Subject	a. IND3852 Technopreneurship b. IND4264 Integrated System Design c. IND5172 Engineering Ethics		Scenario Title	:
Group	:			

1. Items Used to Measure the Scenario
For each of the following statements about the given scenario, please indicate whether you: Strongly Disagree (1); Somewhat Disagree (2); Neither Agree nor Disagree (3); Somewhat Agree (4); Strongly Agree (5).

No.	Statements	1	2	3	4	5
1.	The given scenario is easily understood.					
2.	The given scenario represents engineering problems in everyday life.					
3.	The given scenario already includes an assessment of all Engineering Professional Skills.					
4.	The given scenario contains complete information.					
5.	The given scenario does not contain biased information.					

On a scale from 1-10, with 1 being *very poor* and 10 being *very good*, how do you rate the given scenario based on the above measurement items?

1	2	3	4	5	6	7	8	9	10

Comments/Recommendations:

2. Items Used to Measure the Modified EPSA Rubric
For each of the following statements about the modified EPSA rubric, please indicate whether you: Strongly Disagree (1); Somewhat Disagree (2); Neither Agree nor Disagree (3); Somewhat Agree (4); Strongly Agree (5).

No.	Statements	1	2	3	4	5
1.	The modified EPSA rubric is easily understood.					
2.	The modified EPSA rubric is easy to use.					
3.	The modified EPSA rubric already includes an assessment of all Engineering Professional Skills.					
4.	The modified EPSA rubric uses a good assessment scale.					
5.	The modified EPSA rubric does not contain biased assessment aspects.					

On a scale from 1-10, with 1 being *very poor* and 10 being *very good*, how do you rate the modified EPSA rubric based on the above measurement items?

1	2	3	4	5	6	7	8	9	10

Comments/Recommendations:

3. Items Used to Measure the Assessment Process
For each of the following statements about the assessment process, please indicate whether you: Strongly Disagree (1); Somewhat Disagree (2); Neither Agree nor Disagree (3); Somewhat Agree (4); Strongly Agree (5).

No.	Statements	1	2	3	4	5
1.	All participants understand their own role in the assessment process					
2.	The explanation given before the assessment process was well understood.					
3.	The time allocation for the assessment process is sufficient.					
4.	The assessment process went well.					
5.	The discussion prompt questions are very helpful in guiding discussion.					

On a scale from 1-10, with 1 being *very poor* and 10 being *very good*, how do you rate the assessment process based on the above measurement items?

1	2	3	4	5	6	7	8	9	10

Comments/Recommendations:

Approved by the University of Auckland Human Participants Ethics Committee on 29 April 2016 for three years. Reference number 016642.

Appendix H. Focus Group Feedback Questions

For group evaluation and feedback, students were asked to perform a 30-minute focus group discussion in the third week. Each group was given this list of questions to guide their discussions. The list of questions consisted of two parts. The first part was used to evaluate the discussion process. The second part was used to evaluate the assessment process. The opportunity to include free format feedback was provided at the end of the list.

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FOCUS GROUP FEEDBACK QUESTIONS
THIS FORM WILL BE HELD FOR A PERIOD OF 6 YEARS

Project Title:
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Date	:		Scenario No.	:
Subject	a. IND3852 Technopreneurship b. IND4264 Integrated System Design c. IND5172 Engineering Ethics		Scenario Title	:
Group	:			

A. Questions for the Discussion Process

1. What was your role in the discussion process?

Answer:

2. What obstacles did you experience during the discussion process?

Answer:

3. Do you understand the scenario provided for discussion?

Answer:

4. What benefits did you get from the discussion process?

Answer:

5. How could the discussion process be improved?

Answer:

B. Questions for the Assessment Process

1. What obstacles did you experience during the assessment process?

Answer:

2. What benefits did you get from the assessment process?

Answer:

3. How could the assessment process be improved?

Answer:

C. Recommendation

Approved by the University of Auckland Human Participants Ethics Committee on 29 April 2016 for three years. Reference number 016642.