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Comparison and Integration of TQA ABET and AUN-QA for Quality Assurance of Engineering Education

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Abstract— **Quality assurance in engineering education is vital to ensure that the expectation of stakeholders including graduates, employers of the engineering graduates, and professors are met and hence enhance their satisfaction level. The diversity of criteria can make it difficult for an institution to choose the appropriate criteria for their institutions. The purpose of this paper are (1) to compare the three international quality assurance criteria of Thailand Quality Award (TQA Criteria), Accreditation Board for Engineering and Technology (ABET Criteria) and ASEAN University Network-Quality Assurance (AUN-QA Criteria) and (2) to integrate these three assessments for program QA framework development at the engineering institution. The study used in-depth literature review on these criteria. The authors compared the criteria scoped at the program level of teaching and learning using a matrix diagram and an affinity diagram. Similarities and differences among the three widely adopted QA criteria in ASEAN are presented. The comparative result shows that TQA Criteria focused on overall QA management system while AUN-QA Criteria focused on the learning and teaching process but ABET Criteria focused on program outcomes. This article contributes to distinguish the TQA, ABET, and AUN-QA and proposes a conceptual framework of the integrated QA System.**

Keywords— **Engineering education, Quality Assurance, TQA, ABET, AUN-QA**

I. INTRODUCTION

The rapid changes in stakeholders' requirements and expectations results in the educational institution to adjust themselves to meet those changing needs. Stakeholders in higher education may include students, faculty, staff of educational parents, society and so on. Therefore, quality assurance of education at the program level is important to ensure that educated graduates have graduated from institutes with those features that met the stakeholder needs [1].

Over 30 years, many countries in the world have significantly reform their education and hence raise the institution's competitions [2]. Society has changed to a long-life learning [3]. Institutions need to improve the quality of education institutions, such as improving programs in education, research and academic services in order to meet the needs of the stakeholders [4].

In Thailand, there are 166 institutions that are under the supervision of the Office of the Higher Education Commission [5]. From the survey of work applying situation of graduated students in manufacturing engineering and process engineering in academic year 2008, the total number of graduated students are 1,468 and the graduated students are classified into three categories as shown in Fig. 1.

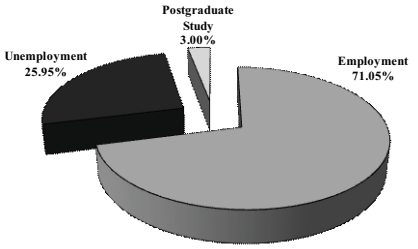

Fig. 1 The percentage of status graduated students in manufacturing engineering and process engineering in academic year 2008. [5]

Fig. 1 demonstrates that the graduated students who are unemployment 25.95% or 381. It is a problem for institutions to be aware of their quality assurance system in teaching and learning program in order to assure that their graduates are complies with the needs of the working society.

In order to compete in today's turbulent competitive educational environment [6], institutions are focusing on the satisfaction of stakeholders' needs by following many quality assurance criteria to evaluate their quality level, e.g., Thailand Quality Award (TQA), Accreditation Board for Engineering and Technology (ABET), ASEAN University Network-Quality Assurance (AUN-QA), Office of the Higher Education Commission (OHEC) and The Office for National Education Standards and Quality Assessment (Public Organization) (ONESQA) and so on. Nevertheless there are many QA assessment criteria which may lead to confusion for QA officers. Each assessment program has its strength and focus. Although TQA Criteria, ABET Criteria and AUN-QA Criteria are used to improve QA in education, but details of the criteria are different. Therefore, the institution must understand and adopt the criteria appropriately [7]. The existing literature only provides description of the assessment criteria but lack of their comparative study. Hence, this research aims to address this issue using an in-depth study of the three criteria includes the background details, similarities and differences of the criteria. Moreover, this comparative result enables QA officer to improve one's QA system at the program level.

II. CHARACTERISATION OF THE APPLICABLE CRITERIA

The following sectors describe the three QA evaluation criteria in summary.

A. Thailand Quality Award (TQA)

Thailand Quality Award is an award given to organizations who achieve world-class standards of performance excellence. TQA initiated from signing the agreement between the Foundation of Thailand Productivity Institute (FTPI) and the National Science and Technology Development Agency (NSTDA) in 1996 [8]. The fundamental of TQA framework and criteria is based on the Malcolm Baldrige National Quality Award (MBNQA) of the United State of America.

The structure of TQA Criteria version year 2009 consists of seven categories as follows:

1) Leadership: examines how the organization's senior leaders make and response appropriately to the publics.

2) Strategic Planning: examines the organization develops and chooses strategic and action plan.

3) Customer and Market Focus: examines how the organization determines the requirements, needs, expectations, and preferences of the stakeholders.

4) Measurement, Analysis and Knowledge Management: examines how the organization selects, analyzes and manages the data, knowledge assets and technology.

5) Workforce Focus: examines how the organization methods utilize your workforce full potential.

6) Process Management: examines how the organization designs, manages and improves its key processes which deliver the stakeholders for the attainable and sustainable organization.

7) Results: examines the organization's performance and improvement in all key areas.

None of the educational institution has yet received TQA but the first institution which received Thailand Quality Class (TQC) is the Continuing Education Center Chulalongkorn University (CEC) in 2003 and 2004 [9]. Therefore, it is challenging for the educational institutions to competing for TQA which represents the internationally and excellence management system.

B. Accreditation Board for Engineering and Technology (ABET)

Accreditation Board for Engineering and Technology (ABET) is an accreditation organization that certified the American institutions at the program level in the subject areas of engineering, applied science, technology, and computing [10]. ABET criteria have been recognized by many countries worldwide. These criteria provide a systematic tool for QA in engineer education and focus on program outcomes which meet the requirements of the program's stakeholders.

ABET Criteria were developed through a collaboration between education and industry. One of the ABET Criteria focuses on continuous improvement of engineering program. Key feature of ABET Criteria is its emphasis on program outcome assessment that based on the improvement of engineering program. The institutions use the data from assessment to guide improvements in the educational processes [11].

The structure of ABET Criteria version year 2009-2010 consists of nine criteria as followings [12]:

1) Students: Program must evaluate and monitor student's progress in achieving program outcomes.

2) Program Educational Objectives: These objectives must have consistent with the mission and ABET Criteria, a process that periodically documents, based on the needs of stakeholders.

3) Program Outcomes: Students must attain at least 11 outcomes.

(3a) an ability to apply knowledge of mathematics, science, and engineering.

(3b) an ability to design and conduct experiments, as well as to analyze and interpret data.

(3c) 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.

(3d) an ability to function on multidisciplinary teams.

(3e) an ability to identify, formulate, and solve engineering problems.

(3f) an understanding of professional and ethical responsibility.

(3g) an ability to communicate effectively.

(3h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.

(3i) a recognition of the need for, and an ability to engage in life-long learning.

(3j) a knowledge of contemporary issues.

(3k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

4) Continuous Improvement: Program must shows evidence of action to improve the program.

5) Curriculum: The program curriculum devotes adequate attention and time, consistent with the outcomes and objectives.

6) Faculty: The faculty must be of sufficient number and cover all of curricular areas in the program.

7) Facilities: The facilities must be appropriate and support for institution activities.

8) Support: Resources must be sufficient to acquire, maintain, and operate facilities and equipment.

9) Program Criteria: Program must satisfy applicable Program Criteria (if any).

These criteria emphasize in program level. Main focus of ABET Criteria are in criteria 2 of program educational objective and criteria 3 of program outcomes. These are the main differences from the others because these criteria vary depending on satisfaction of the stakeholders.

C.ASEAN University Network-Quality Assurance (AUN-QA)

ASEAN University Network-Quality Assurance (AUN-QA) are the ASEAN QA assessment criteria established in 1995 with the cooperation of the ASEAN University Network (AUN) which has agreed to share in 21 member universities in 10 countries of ASEAN, including Thailand, Brunei Darussalam, Cambodia, Singapore, Malaysia, Myanmar, Philippines, Vietnam, Laos and Indonesia [13].

The purposes of AUN-QA are to support the cooperation between AUN member universities on students' exchange, scholarship, academic collaboration, to develop the institutions and to publish the educational information among the other AUN member universities. AUN-QA assessment criteria focused on processes for improving the program QA in the ASEAN universities [14].

The structure of AUN-QA Criteria version year 2004 consists of six criteria as followings [15]:

1) QA System: AUN member universities aware to the current QA. Therefore, AUN members verified the QA document, which used to implement QA system.

2) Teaching/Learning: AUN member universities must maintenance and enhancement of the quality of teaching and learning. It has five topics under this criterion as following: Course Curriculum, Academic Staff, Student Assessment, Learning Process, Environmental Health and Safety Standards, and Learning Resources.

3) Research: AUN member universities provide appropriate funds and facilities for research, show research output.

4) Services: AUN member universities provide programs that serve to society.

5) Ethics: AUN member universities practice and develop the ethics.

6) Human Resources Development (HRD): AUN member universities develop and support HRD program.

AUN-QA Criteria cover the program QA system. These criteria are appropriate with the QA system in their institutions.

III. Methodology

This paper adopted qualitative research method by conducting in-depth literature study on the three quality assessment criteria including, TQA Criteria, ABET Criteria, and AUN-QA Criteria. Details of the three QA criteria in engineering education were summarized from publication and electronic resources e.g. journal, book, website which related this study. All the resources were reviewed about background, indicator, level, evaluation and assessment of their criteria. The recent updated information of the three criteria is selected for this study which is TQA Criteria version year 2009; ABET Criteria version year 2009-2010; and AUN-QA Criteria version year 2004. All related keywords and acronyms are used for the literature search. Only the educational case studies are selected for this study and not manufacturing or service sector. Table 1 shows type and number of evidence used for analysis. The authors studied the selected resources in details and carried out the content analyses.

TABLE I : Type and number of evidence

Criteria	Book	Journal	Website	Total
TQA	5	5	2	12
ABET	4	7	7	18
AUN-QA	3	2	5	10
Total	12	14	14	40

The total numbers of 40 items of evidence were found; including 12 books, 14 journals and 14 websites. These evidences were selected from the academic databases including Emerald, Science Direct, SpringerLink, ABET (http://www.abet.org/), ASEAN University Network (http:// www.aun-sec.org/), and Office of Thailand Quality Award (http://www.tqa.or.th/).

Then, Similarities and differences among these criteria were presented in a matrix diagram. Criteria related to the program QA were then highlighted for further QA development. Then, an affinity diagram was employed to group those similarities and create key performance indicators of the integrated program QA between ABET Criteria and AUN-QA Criteria. Finally, summary and discussion of the results were presented from the study.

IV. Results

A. Comparison of TQA, ABET and AUN-QA

From the study, the overall of ABET Criteria focus on program outcomes, which describe the students' attribute after they graduates. These ABET criterion is similar to category 3 (Customer and Market Focus) of TQA Criteria but different from AUN-QA criteria which focus on teaching and learning process. In addition, the focus of AUN-QA on teaching and learning process is similar to category 6 (Process Management) of TQA Criteria.

Overall, TQA Criteria focus on the total QA management system but ABET Criteria and AUN-QA Criteria focus on a part of TQA Criteria i.e. category 3 and 6. Therefore, implementing ABET Criteria and AUN-QA Criteria are forming a part to the achievement of the overall TQA Criteria. Fig. 2 demonstrates the focus level of ABET, AUN-QA, and TQA. All three QA criteria similarly assess about student focus and continuous improvement which are the main focus of quality excellence.

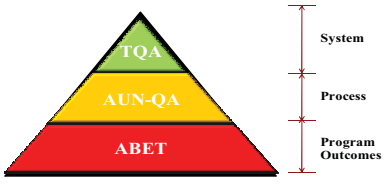

Fig. 2 The focus level of ABET, AUN-QA, and TQA

TQA Criteria are not enforced to use any method or mean in order to attain the achievement. It just provides broad criteria of quality excellence; therefore, it cannot compare with ABET Criteria and AUN-QA Criteria which have specific details about the quality criteria at program level. Comparison and integration of the two criteria enhance the efficiency of the program QA system. Similarities and differences between ABET and AUN-QA are shown in Table 2 and Table 3.

TABLE II : THE OVERVIEW OF SIMILARITIES BETWEEN ABET AND AUN-QA

Description	ABET	AUN-QA
1. Evidence	All data must be evidence, i.e., record of data and so on.	Evaluators review the evidences, i.e., evidence of research activities and so on.
2. Level of Criteria	International	International (ASEAN)
3. Review of Program	Must be continuous improvement	Must be continuous improvement
4. Documentation	Several documentation requirements, e.g., assessment data, objective and so on.	Review documentation, e.g., record of student assessment, review
5. Assessment	Self and group assessment	Self and group assessment
6. Frequency of revisits	Maximum 6 years depending on accreditation status	Approximate 2 – 3 years

Table 2 shows that both criteria require documents based evidence for assessment in each criterion. Moreover, documents must demonstrate how the institution improves and develops of the program. Examples of the documents are student survey, alumni survey, employee survey, student portfolios and so on. However, assessors of the two criteria are interested in on-site evidence more than document and they provide feedback to educational processes at the engineering institutions [16]. Both AUN-QA and ABET assessors are responsible for inspecting self-study report, interviews stakeholders; prove validity of the documents and to monitor continuous improvement activities.

TABLE III THE OVERVIEW OF DIFFERENCES BETWEEN ABET AND AUN-QA

Description	ABET	AUN-QA
1. Scope	Specific Program	All Program
2. Number of Criteria	9	6
3. Criteria Focus	Program Outcomes	Process
4. Program Outcomes	Identify clearly (outcome 3a-3k)	Not identify
5. Indicator	Defines statements	Identify clearly
6. Self-Study	Self-Study format	Indicator
7. Other	Criteria 9 Program Criteria	Criteria 1 QA System Criteria 5 Ethics Criteria 6 HRD

Table 3 shows the differences of ABET and AUN-QA. The number of ABET Criteria have more than AUN-QA Criteria. Fig. 3 illustrates the relationship between ABET Criteria and AUN-QA Criteria. One AUN-QA Criterion can be related to many ABET Criteria such as AUN-QA's Criteria 2 about learning and teaching relates to ABET's Criteria 1 to Criteria 6. ABET Criteria focus on program outcomes that the student attains the course which based on the needs of the stakeholders. Program outcomes include outcomes 3a-3k as described in section 2. The Program accredited by ABET must comply to the program outcomes. AUN-QA Criteria focus on teaching and learning process. Their criteria recommended teaching methods, for example, problem-based learning (PBL), and cooperative learning. Nevertheless, ABET Criteria are not defined Key Performance Indicators but it identified statement about program criteria. The institution sent self-study report to the nominated ABET evaluators' team. Then, the evaluators' team visits to the campus; and send feedback to the institution. AUN-QA Criteria define KPIs. Institutions can be evaluated using self-study report. It was prepared before an assessment.

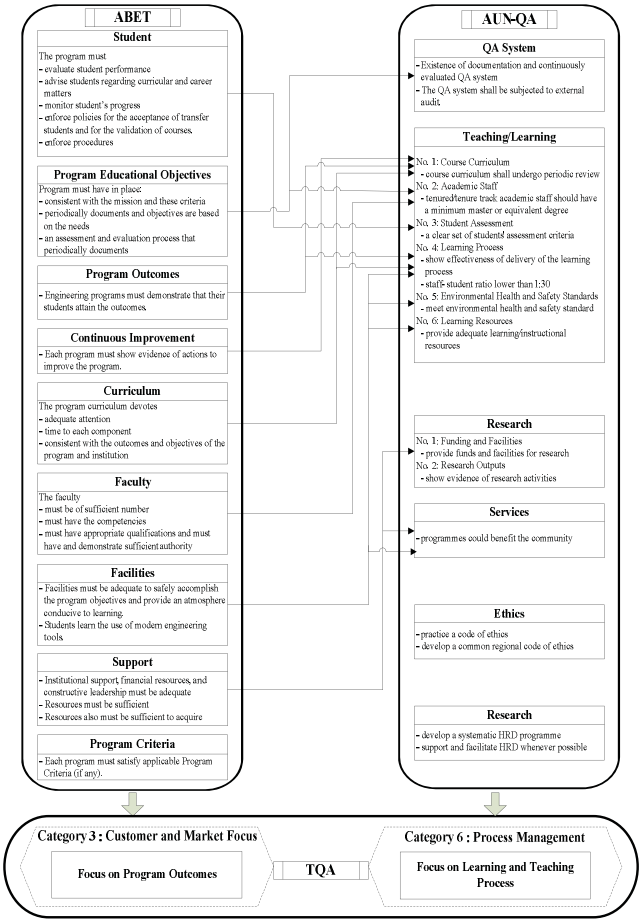

Fig. 3 The relationship between ABET Criteria and AUN-QA Criteria

In addition, ABET Criteria are not related to AUN-QA criteria on Ethics and HRD because ABET Criteria only focus on programs level, not degrees, departments, colleges, or institutions. On the contrary, AUN-QA Criteria emphasis on QA system but do not address professional associations as mentioned in ABET Criteria.

B. Integration of TQA, ABET and AUN-QA

The relationships among TQA Criteria, ABET Criteria, and AUN-QA Criteria and their integrations to represent overall QA system are summarized in Fig. 4. Moreover, this integrated QA system must not be static but shows its continual improvement. Vision and mission

of the institution guides the institution's future direction which inputs should be acquired from the stakeholders. The left part represents the educational program design including vision and mission which determine program educational objectives that affect to Curriculum and Program Outcomes. Program Educational Objective, Program Outcomes, Curriculum, Program Criteria, Faculty, Facilities, Support, HRD and Ethics determine program education. The other part related to the educational service and support including Faculty, Facilities and Support. Both of parts were delivered to students by teaching and learning process.

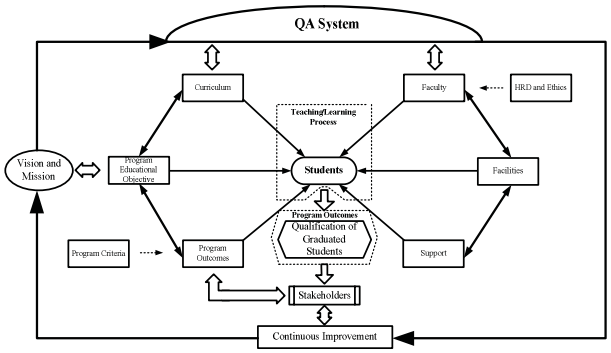

Fig. 4 The integrating QA system model

The integrating QA system model assures that the graduated student from the program will obtain attributes according to the stakeholders' requirements [17]. In addition, the institution will be recognized and be accepted by the society of its accreditation to produce engineering graduates with the stakeholders' expectation.

V. Conclusions

In this paper we have presented (1) Comparison of TQA Criteria ABET Criteria and AUN-QA Criteria which are the international criteria and (2) Integration of these three assessments for program QA framework development at the engineering institution. The authors studied these criteria by in-depth literature review and summarized their relationship in a matrix diagram and an affinity diagram. The results showed that TQA Criteria focused on the overall QA system. ABET Criteria focused on Program Outcomes but AUN-QA Criteria focused on Learning and Teaching Process; these are focused on a part of TQA. Moreover, TQA Criteria cannot compare with ABET Criteria and AUN-QA Criteria because TQA Criteria does not have a specific detail about the program criteria level. The comparative results showed that the three QA criteria similarly assess the topic of student focus and continuous improvement.

The key strengths and major QA concepts from all the assessment criteria were integrated into the proposed QA model for engineering education. Each criterion in the proposed model are linked with criteria of ABET and AUN-QA. Overview of the model including, (1) program education (Program Educational Objective, Curriculum and Program Outcomes), and (2) service and support education (Faculty, Facilities and Support). Both parts of the criteria are essential in supporting the teaching and learning process of students. The students, who attain the program, obtain the knowledge and qualification as expected by the stakeholders through the learning outcome process, student survey, alumni survey and employee survey. Moreover, the program curriculum, objectives, and all elements in the proposed QA system must continuously improve to ensure the changing in stakeholders' expectations. Effective teaching in engineering education will meet the needs of the stakeholders when appropriately integrating all the three criteria.

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