

## A Holistic Quality Assurance Framework to Acquire National and International Educational Accreditation: The Case of Saudi Arabia

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**Abstract:** Quality assurance and accreditation of academic programs have received considerable attention by the higher education authorities worldwide. Saudi Arabia, for instance, necessitates the computing and engineering programs to fulfill both the local (NCAAA) and international (ABET) accreditation requirements which is often a complex endeavor. In fact, acquiring both accreditations simultaneously is exacerbated by several factors such as the use of different terminologies, redundancy of various tasks and activities and differing philosophies to assess the overall quality of the educational programs. This study details a holistic quality assurance framework that guides the computing and engineering programs in acquiring the local and international accreditation. The framework encompasses all aspects of an educational program including inputs, processes, outputs and outcomes as well as the continuous improvement quality cycle and improvement plan. To this end, the study details 11 shared accreditation tasks and 9 different terminologies used in both accreditations, aligns 11 local accreditation standards with 8 international accreditation criteria which are assigned to dedicated work groups and maps ABET student outcomes to the five NCAAA learning domains. The proposed framework is adopted and implemented by three computing and engineering programs in Saudi Arabia and high satisfaction levels of its implementation are show cased.

**Key words:** Quality assurance in higher education, national and international accreditation, continuous improvement in education, engineering programs, framework, implementation

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### INTRODUCTION

Quality assurance in higher education is the process through which an academic program ensures that best practices and conditions are in place for the achievement of standards established by the institution or by other accreditation awarding bodies (Jaber and Al Batsh, 2016). In order to ensure persistent achievement of standards and goals, a continuous quality improvement has to be implemented and monitored. This will guarantee that all aspects of the programs, e.g., inputs, processes, outputs and outcomes are systematically evaluated and enhanced. The continuous improvement for the academic program is essential to ensure that the program implements the latest strategies in total quality management.

However, accreditation is the process used in higher education to ensure that programs or institutions meet and maintain the minimum standards and criteria of quality (Phillips and Kinser, 2018). Accreditation in academia controls the quality of the outputs such as the graduates of the program, adequate and reputed research activities and indispensable and confident community

contributions. The main objective of academic accreditation is to admit and maintain quality and to apply and monitor continuous improvement process.

Academic programs in Saudi Arabia are required to obtain accreditation from the National Center for Academic Accreditation and evaluation (NCAAA), a government center under the Education Evaluation Commission (EEC) in the Ministry of Education (MoE) which accredits programs and institutions across Saudi Arabia (Anonymous, 2018a-g). Although, NCAAA accreditation is compulsory due its relationship to the Saudi National Qualification Framework and importance in securing future funding from the Ministry of Education in Saudi Arabia, it is considered a new agency and has a limited reputation internationally for the computing and engineering programs. On the other hand, the Accreditation Board for Engineering and Technology, known as ABET is a nonprofit, non-governmental organization and is the internationally renowned and recognized agency that accredits computing and engineering programs (Anonymous, 2018a-g). Therefore, the MoE in Saudi encourages the computing and

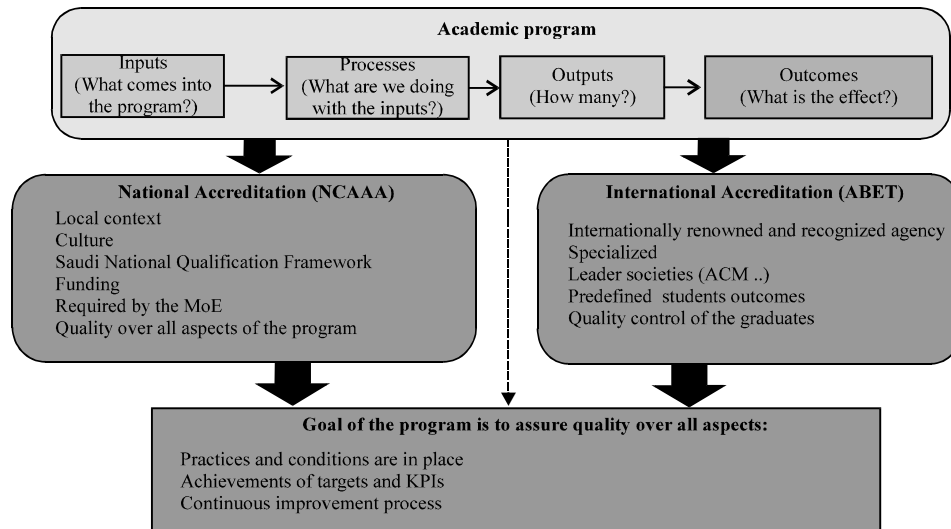


Fig. 1: Local (NCAAA) and international (ABET) accreditations act as a bridge in realizing quality assurance

engineering programs offered by Saudi universities to acquire both the local (NCAAA) and international (ABET) accreditation to confirm that the Saudi graduates can compete at the international level.

Statistically, the total number of bachelor engineering and computing programs in Saudi universities is 476 programs, 116 of which are ABET accredited programs and 19 of which are NCAAA accredited programs (Anonymous, 2018a-g). Although, all bachelor programs must be accredited by the NCAAA, there are 85-90% of the programs are working to stratify the international ABET requirements. There is a constant pressure from decision makers in educational institutions to fulfill the requirements of both local and international accreditation.

The major contribution of this research is therefore, the development of an efficient and holistic quality assurance framework for academic programs in Saudi Arabia to realize NCAAA and ABET accreditations simultaneously. By 'holistic', we mean a generic and comprehensive framework that covers all requirements of NCAAA and ABET, minimizing the efforts and saving time throughout the CQI cycle. Figure 1 summarizes the motivations for using NCAAA and ABET accreditations as a bridge in instilling quality within all aspects of an academic program (e.g. inputs→processes→outputs→outcomes).

By Lim (2018) affirms the need to build a Quality Assurance Framework (QAF) using well-defined criteria and academic standards and practices set by recognized accreditation agencies. However, when the framework aims to fulfill the criteria of several accreditation bodies

the task becomes extremely overwhelming and complicated. As stated earlier, this study contributes a holistic quality assurance framework that supports engineering and computing programs in Saudi Arabia to:

- Understand the common and different tasks and activities between NCAAA and ABET
- Establish a set of working committees to satisfy the requirements of both accreditations efficiently
- Follow a set of practical steps to secure both NCAAA and ABET simultaneously
- Implement a continuous quality improvement cycle to measure and improve the quality of a certain academic program

**Literature review:** In the literature, there are various definitions of quality assurance in higher education (Smidt, 2015, Schindler *et al.*, 2015). However, there is a common agreement about the importance of assuring quality in higher education through the implementation of good educational practices to achieve the desired targets and goals. Moreover, the continuous improvement process including the assessment, analysis and evaluation and the implementation of corrective actions remains the "heart" of any quality assurance framework (Anonymous, 2018a-g). On the other hand, accreditation is a proof that the institution or program meets the minimum standards of quality. The researcher in defined the accreditation as a review of the quality of higher education institutions and programs accreditation agencies have developed standards, good practices and criteria to support institutions and academic programs in

the process of developing their quality assurance framework. In addition, the accreditation agencies provide external peer review of the quality assurance process in the academic institutions and programs. Moreover, the development of sustainable, valid and reliable continuous improvement cycle remains the key success of any quality assurance framework and accreditation agencies. The accredited institution or program must undergo a similar accreditation review process on a regular basis (e.g., 6, 7 years, etc.).

Since, 2000 there is a rapid change in the higher education in Saudi Arabia. Therefore, the focus on assuring quality and monitoring the progress and performance of educational programs and institutions has been increased in the past 15 years (Al-Alawi *et al.*, 2009; Al Ohali *et al.*, 2009). However, the old institutions in Saudi such as King Saudi University, King Fahd University for Mineral and Petroleum and King Abdulaziz University have initiated projects related to academic accreditation and quality assurance for their colleges and programs in late 80's (Al-Eisa and Sahab, 2006; Abulfaraj *et al.*, 2006). In 2004, the National Commission for Academic Accreditation and Assessment (NCAAA) has been established by the Government of Saudi to ensure that all academic entities (institutions and programs) follow a set of well-defined procedures and rules to achieve accreditation and assure quality. In addition, the goals of NCAAA are to establish the accreditation standards and procedures, to assess and evaluate the universities and programs against a set of standards and to improve the quality in higher education (Ibrahim *et al.*, 2016). NCAAA provide eleven broad standards along with their sub-standards that are applied at the program and institution levels. However, the attention of the accreditation at the program level is being given to standard 4 (Teaching and Learning) (Smith and Abouammoh, 2013). Since, 2007 the development and improvement reviews are being commenced in some institutions, like King Saud University (Darandari *et al.*, 2009). In 2007, the NCAAA completed the development of the national quality framework to ensure that the improvement and accountability are integrated within the daily practices of the academic entity (Darandari *et al.*, 2009; Al-Musallam, 2007). Moreover, NCAAA required all institutions and programs to start applying the quality assurance and accreditation accreditations in their practices through the establishment of quality units/centers/deanships, etc. (Al-Yafi, 2008). However, the lack of training and experience in quality assurance and accreditation affect the progress of institutions and programs in this regard (Ibrahim *et al.*, 2016). Moreover, the resistance of staff who are engaged in the quality

assurance activities is considered one of the main obstacles to fulfill the requirements of the accreditation (Al-Yafi, 2008). Student's involvement in the process of quality system needs to be applied and monitored in a more efficient way. The quality of the institutions and programs are assessed and measured using a set of indicators that must be benchmarked internally and externally. However, external benchmarking become one of the biggest challenges in many of Saudi universities (Darandari *et al.*, 2009). Since, 2016 NCAAA has been changed from a commission to a center (National Center for Academic Accreditation and evaluation) under the direct supervision of the Education Evaluation Commission (EEC) in the Kingdom (Anonymous, 2018a-g).

In KSA, there are no professional or specialized accreditation organizations for computing, engineering and technical educational fields of studies. However, there is one professional accreditation organization in the field of health care namely, Saudi Central Board for Accreditation of Healthcare Institutions (CBAHI) (Anonymous, 2008). On the other hand, the USA has several professional accreditation organizations such as the ABET agency. ABET, founded in 1932 is a programmatic or specialized or professional accreditation organization which accredits engineering and technical programs including computing programs at the undergraduate and graduate level. ABET accredits over 3800 programs at more than 775 colleges and universities in 31 countries including Saudi Arabia. ABET evaluates an individual program of study, rather than evaluating an institution as a whole (Anonymous, 2018a-g).

The accreditation process in higher academic institutions, e.g., universities is an opportunity for the university to draw attention to its areas of excellence and to identify areas for improvement. In the United States of America (USA), the accreditation system is classified into four main categories where higher education institutions are accredited by a regional accreditation organizations or agencies. There are six regional accrediting organizations in USA and they do not accredit individual programs (Eaton, 2015). Regionally accredited universities or higher education institutes are mostly non-profit and degree granting. The second type of institutional accreditation called local accreditation organizations focuses on institutions on special areas of study including distance or online education, vocational and technical training, continuing education and training, religious and occupation education. Nationally accredited higher education institutes are mostly for profit and non-degree granting. A third type of academic accreditation is specialized or professional or programmatic accreditation

which focuses on undergraduate and graduate programs in a specific discipline within an institution or university but does not evaluate the entire institution. In USA, there are 47 programmatic accreditation organizations including ACPE for pharmacy education, ACBSP for business program, ABET for engineering and technology and many more. And a fourth type of accreditation is hybrid accrediting organizations review programs and units within vocational or specialized schools and postsecondary institutions including music, theological schools, nutrition and dietetics etc. In USA, all the higher educational institutions must get accredited from regional accreditation agencies and for their programs they must apply to professional accreditation organizations. There is no government accreditation agency in USA but US government monitor and supports all their activities (Anonymous, 2018a-g).

In the literature, there is a substantial number of studies related to ABET accreditation (Hassan and Al-Jabri, 2016; MacKinnon *et al.*, 2016; Khan *et al.*, 2016; Fu *et al.*, 2014). In these studies, the researchers discussed their experience to meet the ABET criteria. They mainly focused on the key criterion of ABET which Criterion 4: Continuous Improvement. They discussed various student outcomes assessment models including direct and indirect, summative and formative assessment methods. The researcher in discusses several key aspects where ABET and NCAAA can share common activities and tasks to reduce workload. However, the researcher in did not show a complete framework to fulfill the requirements of NCAAA and ABET accreditations. By Huque (2015) the researchers discuss the development of a web-based system to assist in the continuous quality improvement processes for both accreditations (ABET and NCAAA). To the best of our knowledge, there is no complete and comprehensive quality assurance framework, presented in the literature, that can support computing and engineering programs to obtain ABET and NCAAA accreditation simultaneously.

## MATERIALS AND METHODS

**Building a quality assurance framework using either ABET or NCAAA:** The first key step towards establishing a Quality Assurance Framework (QAF) using accreditation requirements (NCAAA or ABET) is to develop a clear and correct understanding of the requirements. This study briefly describes the development of a QAF using either NCAAA standards or ABET criteria.

**A quality assurance framework using the NCAAA standards:** The National Center for Academic Accreditation and evaluation (NCAAA) based in Riyadh,

Saudi Arabia is a governmental body performing under the patronage of the Ministry of Education. NCAAA is responsible for defining the required standards to assure quality and accreditation for higher educational programs and institutions. In NCAAA accreditation, there are 11 Standards, each of which compose of sub-standards that are applied for both the institutional and program accreditation requirements. More specifically, the NCAAA 11 Standards and their sub-standards cover all dimensions and aspects of any academic institutions and programs. Although, the standards of NCAAA are similar for both institutions and programs, they are different in how they are implemented and applied to fulfill the requirements of NCAAA at the institutional and program levels (Anonymous, 2018a-g). The NCAAA 11 Standards are Mission and Objectives, Governance and Administration Management of Quality Assurance and Improvement, Learning and Teaching, Student Administration and Support Services, Learning Resources, Facilities and Equipment, Financial Planning and Management, Faculty and Staff Employment Processes, Research and Relationship with the Community (Anonymous, 2018a-g). The following steps support academic programs to form a quality assurance framework according the requirements of NCAAA.

Establish a set of committees and distribute tasks according the NCAAA standards. Develop the mission, goals and objectives of the program and align them with the mission of the institution and the stakeholder's desires.

Develop a curriculum that must be consistent with the Saudi National Qualification Framework (NQF) by Bhatti and Ahmed (2016) terms of the number of credit hours, number of levels and domains of learning.

Establish the Program/Intended Learning Outcomes (PLOs/ILOs) and categorize them in the NQF five domains of learnings as defined in the Saudi NQF (Bhatti and Ahmed, 2016) knowledge, cognitive skills, interpersonal skills and responsibility, communication information technology and numerical skills, psychomotor skills). PLOs/ILOs must be aligned to the mission of the program.

Establish the learning outcomes of the courses and align them with the PLOs/ILOs. Establish a set of procedures, rules, mechanisms, etc., according to, the standards, sub-standards and practices of NCAAA.

Conduct the NCAAA Self Evaluation Scales (SES) which is an instrument for self-evaluating academic programs and institutions and coming up with improvement plans to meet the NCAAA standards. Use the NCAAA standards, substandard and practices to enhance the program. Establish a set of KPIs to measure the quality of all aspects of the program. At least 50% of the pre-defined NCAAA KPIs must be used by the

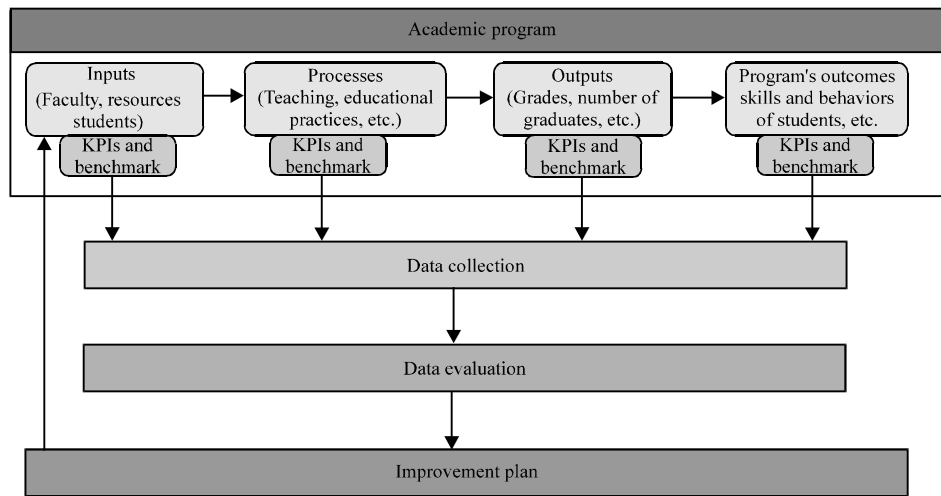


Fig. 2: The Continuous Quality Improvement (CQI) process in NCAAA

program. Use the NCAAA template to prepare the Program Specification (PS), the Annual Program Report (APR), the Course Specification (CS) for all courses and the Course Report (CR) for all courses.

Develop a continuous quality improvement process to measure the quality of the program through the assessment and evaluation of the program's Key Performance Indicators (KPIs) and outcomes. In NCAAA, the development and implementation of the continuous improvement process requires the assessment and evaluation of the program's inputs (e.g., qualification of faculty), processes (e.g., teaching methods), outputs (e.g., ratio of graduates) and outcomes (e.g., knowledge and skills acquired by students).

Complete the NCAAA templates (Self Study Report (SSR), Self-Evaluation Scale (SES), PS, APR, CR, CS) with all supporting evidences and materials required for NCAAA accreditation. Figure 2 illustrates the philosophy of continuous quality improvement process in NCAAA. As can be seen in Fig. 2, for each key element (input, process, output or outcome) in the program, the corresponding data about KPIs should be collected and evaluated to determine the quality of the program. Further, an improvement plan including a set of improvement actions should be triggered and implemented to ensure a systematic continuous improvement process in the program.

**A quality assurance framework using ABET criteria:**

The Accreditation Board for Engineering and Technology (ABET) is one of the United States based accreditation bodies in applied science, computing, engineering and technology operating internationally. There are four

different commissions (Applied and Natural Science, Engineering, Computing and Engineering Technology). For instance, the Computing Accreditation Commission (CAC) is responsible for the accreditation of programs in computer science information systems and information technology (Anonymous, 2018a-g). The main requirements for ABET accreditation and quality assurance are its nine criteria (eight general criteria and one program criteria) which are applied to all computing and engineering programs to cover all aspects of any academic entity such as inputs (faculty and students background, etc.), processes (teaching, policies, etc.), outputs (grades, number of publications, etc.) and outcomes (student learning, effectiveness, etc.) of the program. On the other hands, the program-specific criteria (if any) require specific requirements for some of the general criteria such as Criterion 3 student outcomes, Criterion 5 curriculum and Criterion 6 faculty. The eight general criteria are: Students, Program Educational Objectives (PEOs), Student Outcomes (SOs), Continuous Improvement, Curriculum, Faculty, Facilities and Institutional Support (Anonymous, 2008a-g). In addition, the program specific criteria (if any) might require more requirements related to student outcomes, curriculum and faculty general criteria. The key steps to build a quality assurance framework for fulfilling the requirements of ABET accreditation are summarized as follows:

Establish a set of committees and distribute tasks according the ABET criteria. Establish the Program Educational Objectives (PEOs) and align them with the mission of the institution and the needs of the program's key stakeholders (called constituencies in ABET). Adopt ABET Student Outcomes (SOS) (e.g., a-k for computer

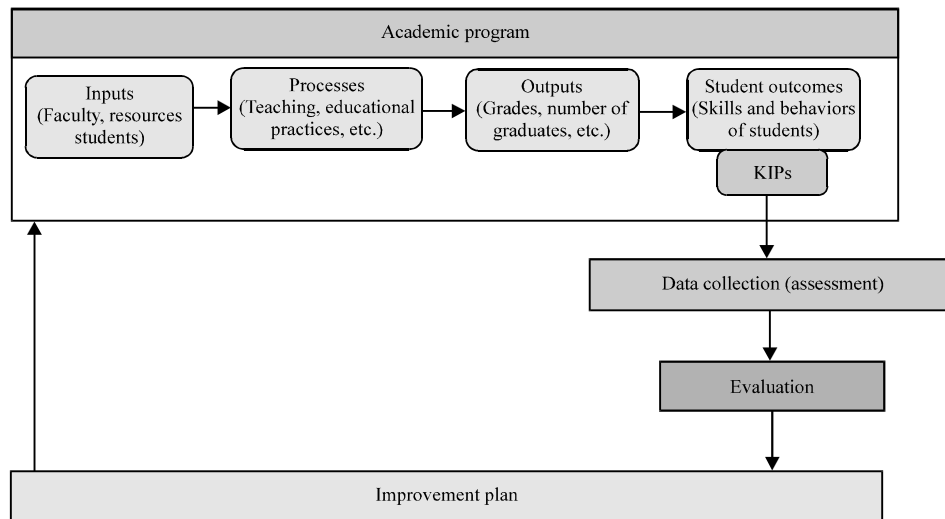


Fig. 3: The Continuous Quality Improvement (CQI) process in ABET

science program, a-k for engineering programs). Update the curriculum to meet the ABET general and specific requirements; Develop the course syllabus including descriptions, Course Learning Outcomes (CLOs), etc. and align CLOs and courses to SOs.

Enhance the program according the requirements of ABET criteria. For example, Criterion 1 requires the programs to provide academic advising and career guidance to their students. Build a continuous quality improvement system to ensure systematic way for the assessment and improvement of student outcomes. The measurement of quality using ABET philosophy focuses on the assessment and evaluation of the program's student outcomes. Complete the ABET template (Self Study Report (SSR)) with all supporting evidences and materials required for ABET accreditation.

Figure 3 depicts the philosophy of Continuous Quality Improvement (CQI) process in ABET. The CQI in ABET assesses and evaluates the extent to which the student outcomes are being attained. The evaluation results of each student outcomes are used to develop an improvement plan that includes a set of actions to improve the quality of the program. The improvement actions can affect any aspects of the programs (e.g., inputs, processes, etc.). We concluded that CQI in ABET focuses only on the measurement of the student outcomes. However, CQI in NCAAA focuses on the measurements of all aspects of the program.

**A Quality Assurance Framework (QAF) using both NCAAA and ABET:** The main goal of our study is to demonstrate the development of a holistic quality assurance framework to obtain both the local (NCAAA)

and international (ABET) accreditations. The first and most crucial step is to create a clear and correct understanding of the common activities of both accreditation (ABET and NCAAA). Table 1 illustrates the mapping of NCAAA standards to ABET criteria along with the names of committees or units that could carry out the tasks. There are a lot of common requirements exist between ABET and NCAAA. The requirements of Standard 1 (Mission and Objective) in NCAAA could be used in the requirements of ABET Criterion 2 (Program Educational Objectives). Similarly, the achievement of NCAAA Standard 5 (Student Administration and Support Services) can be used for the ABET Criterion 1 (Student). Standard 2 (Governance and Administration) is equivalent to part of Criterion 6 (Faculty) and Criterion 8 (Institutional Support) in ABET. Standard 3 (Management of Quality Assurance and Improvement) is equivalent to Criteria 4 (Continuous Improvement) and 8 (Institutional Support). Standard 4 (Teaching and Learning) is equivalent to Criteria 3 (Student Outcomes), 4 (Continuous Improvement) and 5 (Curriculum). Standards 6 (Facilities and Resources) and 7 (Learning Resources) are equivalent to Criterion 7 (Facilities). Standard 8 (Employment Processes) has similarity with Criterion 8 (Institutional Support). Standards 9 (Financial Planning and Management) and 10 (Research) are similar to part of Criterion 6 (Faculty) and Standard 11 (Community Service Unit) is similar to part of Criterion 2 (Program Educational Objectives). It is clear from Table 1 that there are many common activities between ABET and NCAAA which can be combined to reduce the workload to fulfill the requirements of both ABET and NCAAA accreditations.

**Table 1: Alignment of NCAAA standards and ABET criteria**

NCAAA		ABET		
Standard #	Standard name	Criterion #	Criterion name	Committees/Units
1	Mission and objectives	2	Program educational objectives	Strategic Planning Committee
		3	Student outcomes	
2	Program administration	Part of 6, Part of 8	Faculty Institutional Support	Head of the Department
3	Management of program	Part of 4	Continuous Improvement	Quality Assurance Unit
	Quality assurance	Part of 8	Institutional Support	
Part of 4	Teaching and learning	3	Students Outcomes Continuous improvement	Assessment Committee
		4	Curriculum	Curriculum Committee
Part of 4	Teaching and learning	5	Students	Student Affairs Committee
5	Student administration and support services	1	Facilities	Facilities and Resources Committee
6	Learning resources	7	Facilities	Facilities and Resources Committee
7	Facilities and equipment	7	Facilities	
8	Financial planning and management	8	Institutional Support	Faculty Affairs Committee
9	Employment processes	6	Faculty	
10	Research	6, 8	Faculty Institutional Support	Research Unit
11	Relationships with the community	2	Program Educational Objectives	Community Service Unit

**Table 2: Common key task/activities between NCAAA and ABET**

NCAAA key activities	ABET key activities	Where is the merge?
Establish a set of committees as per the NCAAA standard	Establish a set of committees as per the ABET criterion	Committees can be combined to carry both ABET and NCAAA (e.g., Student Affairs Committee may handle NCAAA Standard 5 and ABET Criterion 1)
Establish the mission, objectives and goals of the programs	Establish the program educational objectives	The requirements of ABET and NCAAA can be done together. Strategic Planning Committee or similarly named committee could lead this activity
Define the roles of the program's stakeholders including faculty, students, alumni, employers, advisory board, etc.	Define the roles of the program's constituencies including faculty, students, alumni, employers, advisory board, etc.	The same roles of the program constituencies/stakeholders can be used for both ABET and NCAAA
Develop intended learning outcomes of the program and classify them in the five domains of learning as per the Saudi National Qualification Framework	Adopt the pre-defined ABET Student Outcomes (e.g. a-k for engineering program)	The ABET SOs can be adopted and re-written in the NCAAA five domains of learning as per the Saudi NQF
Use the NCAAA templates to prepare the PS, APR, CS and CR	Use the ABET template to prepare the course syllabus	The ABET syllabus can be extracted easily from the NCAAA course specification
Develop Key Performance Indicators (KPIs) for the program using the predefined NCAAA KPIs	Prepare Performance Indicators (PIs) for each ABET student outcome	The PIs of each ABET student outcome can be used as KPIs in the NCAAA accreditation
Update the curriculum to meet the minimum and maximum credit hours, according to, the Saudi NQF (National Quality Framework)	Update the curriculum to meet the ABET general and specific requirement in terms of number of credit hours and ABET subject areas	ABET curriculum requirements are very similar to the NCAAA curriculum requirements. Therefore, if updates are required, this can be done once for both ABET and NCAAA
Measure and improve the quality of the program through the assessment and evaluation of the KPIs	Measure and improve the quality of the program through the assessment and evaluation of the student outcomes	The measurement of the student outcomes can be used for both ABET and NCAAA. However, the assessment of other NCAAA KPIs can be used as strengths in the ABET accreditation process
Conduct the NCAAA surveys (course survey, program assessment survey, co-op training survey) to collect feedbacks from students about several issues in the program	Use locally developed survey such as exit survey to measure indirectly the attainment of student outcomes	The NCAAA surveys can be used in the ABET accreditation
All issues, rules, procedures and policies (advising, transfer credit, graduation, admission, etc.) related to students should be implemented, according to, NCAAA Standard 5 requirements	All issues, rules, procedures and policies (advising, transfer credit, graduation, admission, etc.) related to students should be implemented, according to, ABET Criterion 1 requirements	The activities for both ABET and NCAAA requirements are overlapped
Conduct the Self Evaluation Scales (SES)	Prepare the preliminary SSR and apply for readiness review	Both NCAAA SES and ABET readiness review processes are used as initial assessment of the program

Table 2 shows the key activities in each accreditation (NCAAA and ABET) and how these activities could be

merged. Table 3 list the different key terms in NCAAA and ABET that have the same meaning. Therefore, a clear

**Table 3: NCAAA and ABET terminologies that have the same meaning**

NCAAA key terms	ABET key terms
Objectives (broader than the ABET PEOs)	Program Educational Objectives (PEOs)
Intended learning outcomes, program learning outcomes or student learning outcomes	Student outcomes
Key performance indicators (required for all standards)	Performance Indicators (required for the student outcomes only)
Data collection	Assessment
Data interpretation	Evaluation
Standard	Criterion
Self-Study Report for the Program (SSRP)	Self-Study Report (SSR)
Course Specification (CS)	Course syllabus template
Program's stakeholders	Program's constituencies

**Table 4: NCAAA domains of learning and ABET SOs**

NCAAA learning domains	ABET SOs (e.g. a-k for CS program)
<b>Knowledge</b>	<b>Level 1 and 2 of Bloom's taxonomy</b>
An ability to outline knowledge of computing and mathematics appropriate to the program's student outcomes and to the discipline	SO (a)
An ability to explain the knowledge of analyzing problem, identification and definition of the computing requirements appropriate to its solution	SO (b)
An ability to describe a computer-based system, process, component, or program to meet desired needs	SO (c)
An ability to recognize current techniques, skills and tools necessary for computing practice	SO (i)
An ability to explain mathematical foundations, algorithmic principles and computer science theory in the modelling and design of computer-based systems	SO (j)
An ability to state the design and development principles in the construction of software systems of varying complexity	SO (k)
<b>Cognitive skills</b>	<b>Level 3-6 of Bloom's taxonomy</b>
An ability to apply knowledge of computing and mathematics appropriate to the program's student outcomes and to the discipline	SO (a)
An ability to analyze a problem and identify and define the computing requirements appropriate to its solution	SO (b)
An ability to design, implement and evaluate a computer-based system, process, component or program to meet desired needs	SO (c)
An ability to use current techniques, skills and tools necessary for computing practice	SO (i)
An ability to apply mathematical foundations, algorithmic principles and computer science theory in the modeling and design of computer-based systems in a way that demonstrates comprehension of the trade-offs involved in design choices	SO (j)
An ability to apply design and development principles in the construction of software systems of varying complexity	SO (k)
<b>Interpersonal skills and responsibility</b>	<b>Bloom's affective domain</b>
An ability to function effectively on teams to accomplish a common goal	SO (d)
An understanding of professional, ethical, legal, security and social issues and responsibilities	SO (e)
An ability to analyze the local and global impact of computing on individuals, organizations and society	SO (g)
An ability to recognize the need for and to engage in continuing professional development	SO (h)
<b>Communication, information technology, numerical</b>	<b>Bloom's affective domain</b>
An ability to communicate effectively with a range of audiences	SO (f)
<b>Psychomotor</b>	
N/A	

understanding of the common activities and key terms of both accreditations as mentioned in Table 1-4 support the academic programs to eliminate of the redundant activities and workloads.

Although, there are various similarities in respect to the tasks and practices in NCAAA and ABET (as shown in Table 1-3), there are some requirements that are not explicitly required by both accreditations (ABET and NCAAA). For example, there are no explicit requirements for financial planning and management, research and relationship with the community in ABET. On the other hand, there are no explicit requirements for readiness review report in NCAAA. However, the works done for the specific requirements of each accreditation may be presented as key strengths of the program. For example, the work achieved in the NCAAA research standard can be presented in ABET as a key strength of the program.

**NCAAA intended learning outcomes vs. ABET student outcomes:** The definition of the intended learning outcomes in NCAAA is equivalent to the definition of the student outcomes in ABET (i.e. what students are expected to know and be able to do by the time of graduation). However, ABET has a predefined set of student outcomes that must be covered by any program seeking ABET accreditation. The program may adopt or adapt the ABET SOs. However, most of the academic programs adopt ABET pre-defined SOs, otherwise, they must show the ABET SOs to their own SOs. On the other hands, the ILOs in NCAAA should be developed by the program and classified in the Saudi NQF five domains of learning. The first two domains of learning in NCAAA Knowledge and cognitive are equivalent to the six levels of the Bloom's cognitive domain. More specifically, the NCAAA Knowledge covers the Knowledge and



Comprehension levels of Bloom's taxonomy cognitive domain whereas the NCAAA cognitive domain covers the remaining four levels of Bloom's cognitive domain (application, analysis, synthesis and evaluation). In ABET, the SOs that are related to the knowledge of the students belong to Level 3 (Application) or above in the bloom's taxonomy cognitive domain. There are some SOs in ABET belong to the bloom's affective domain and can be easily categorized under the third (Interpersonal Skills and Responsibility) and fourth (Communication Information Technology and Numerical) domains of learning in NCAAA. For the engineering and computing programs, no psychomotor skills are required for both accreditations ABET and NCAAA.

The ABET SOs can be easily categorized in the NCAAA domains of learning. For example, the ABET SOs (a-k) for the computer science program (Anonymous, 2018a-g) can be re-written in the NCAAA domains of learning as mentioned in Table 4. The SOs (d, e, g, h) and SO (f) clearly cover the third and fourth domains of learning in NCAAA. The ABET SOs (a, b, c, i, j, k) cover the second domain of learning (Cognitive) in NCAAA. However, for the first domain of learning in NCAAA (Knowledge), the action verbs of the ABET SOs (a, b, c, i, j, k) could be changed according the Bloom's taxonomy level 1 and 2 (knowledge and comprehension). For instance, the action verb (apply) in the ABET SO (a) is changed to the action verb outline and the action verbs (design, implement and evaluate) in SO (c) is changed to the action verb describe.

With respect to the learning outcomes at the course level, the Course Learning Outcomes (CLOs) for each course should be developed in the NCAAA first four domains of learning and re-written directly in the ABET course syllabus. For example, the CLOs that belong to the Knowledge domain of the Saudi NQF covers the first two levels of Bloom's cognitive domain (knowledge and comprehension) and so on.

## RESULTS AND DISCUSSION

This study presents the consolidated quality assurance framework and reports on the acceptance testing of implementing the framework in three computing programs.

**A holistic quality assurance framework:** The proposed quality assurance framework for obtaining both NCAAA and ABET accreditations simultaneously was developed by following the below steps.

**Understand the requirements of both accreditations:** The first step was to create a clear understanding of the

latest requirements of both accreditations (ABET and NCAAA). This was achieved by attending the necessary NCAAA and ABET workshops, training and seminars.

**Establish a set of committees and distribute the tasks:** A number of committees were established to perform all tasks related to the accreditations. Several factors should be considered such as the organizational chart of the faculty and the common activities (Table 1-3) as well as the facul's and program's contexts (e.g., resources, ..., etc.). A steering committee with a good background in accreditation led and guided the works of other committees. Other key committees that were established include the Strategic Planning Committee (Standard 1 and Criterion 2) Assessment Committee (Standard 4 and Criterion 4), Curriculum Committee (Standard 4 and Criteria 3 and 5), Student Affairs Committee (Standard 5 and Criterion 1), Facilities and Resources Committee (Standard 6 and 7 and Criterion 7) and Faculty Affairs Committee (Standard 8 and 9, Criterion 6 and 8).

**Identify similar and different requirements for NCAAA and ABET:** Next the similarities and differences between NCAAA and ABET were identified in order to eliminate redundancies and reduce the workload of faculty. Table 1 maps NCAAA standards and ABET criteria and whilst Table 2 specifies the common activities between NCAAA and ABET. Moreover, Table 3 shows the terminologies in NCAAA and ABET with the same meaning. Finally, Table 4 discusses how to use the ABET pre-defined SOs in NCAAA.

Define the key stakeholders/constituencies (e.g., advisory board, alumni, employers, faculty, students, etc.) and their roles in the development and improvement of the program. Define the mission, goals, objectives and program educational objectives of the program based on the needs of the program's stakeholders, the university mission and NCAAA and ABET requirements.

**Adopt ABET student outcomes:** ABET Sos should be re-written in the five domains of learning in NCAAA and documented in the program specification (Table 4).

**Define or update the curriculum:** ABET criterion 5 has the general requirements related to the number of credit hours and program-specific requirement related to the subject areas. On the other hands, the Saudi NQF specifies the general number of credit hours for the program. At this stage, the program must ensure that the curriculum meets both ABET and NCAAA requirements.

**Define the course syllabus and specification and align them to SOs:** The course specification and syllabus of all courses including the learning outcomes at the course level were prepared. The curriculum mapping including the alignment of learning outcomes at the course level to the learning outcomes at the program level is required to ensure valid and reliable assessment of the student outcomes. The ABET course syllabus template and NCAAA course specification could be used to simplify this step.

**Define (a new program) or enhance (an existing program) all aspects of the program (inputs→processes→outputs→outcomes):** The development of a Quality Assurance Framework (QAF) to secure ABET and NCAAA requires full revision of all aspects, procedures, rules and policies of a specific program. The NCAAA Self Evaluation Scale (SES) with the consideration of ABET criteria is conducted at this step to discover the weaknesses and strengths of the program. The end result of conducting the SES is a set of priorities for improvements to ensure that the program meets the needs of NCAAA and ABET. For example, the enhancement of the program's inputs may include the policies and procedures related to faculty members (e.g., hiring), admission of students and facilities and resources. The processes such as the implementation of procedures and rules (e.g., teaching and learning practices), implementation of

student's activities (e.g., advising practices) should be updated according the best practices of NCAAA and ABET.

**Establish a set of Key Performance Indicators (KPIs) to measure the quality of the program:** In NCAAA, at least 50% of the NCAAA pre-defined KPIs must be adopted by the program whereas in ABET, each SO should be defined as a set of Performance Indicators (PIs) to assess the learning outcomes at the program level reliably. The same set of PIs is also used in NCAAA. Create and implement a Continuous Quality Improvement (CQI) cycle: the development and implementation of the CQI cycle is the key factors in the success of any Quality Assurance Framework (QAF). The CQI cycle consists of four main phases including CQI planning, data collection or assessment, data interpretation or evaluation and design and implement of improvement actions. The CQI cycle in ABET uses the assessment and evaluation results regularly as an input for the continuous improvement of the program. Conversely, the CQI cycle in NCAAA uses the evaluation results of KPIs over all aspects of the program including the program learning outcomes, to measure and improve the quality of the program. Therefore, the same CQI process based on the program learning outcomes is used for both NCAAA and ABET.

Figure 4 shows the proposed Quality Assurance Framework (QAF) using the NCAAA and ABET models.

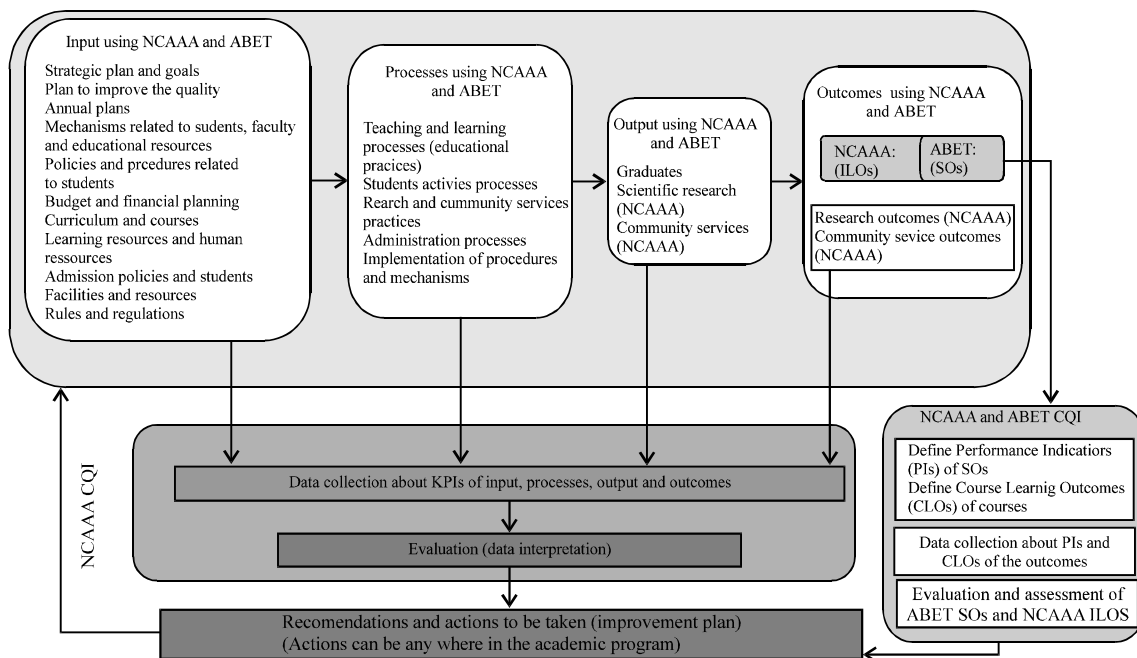


Fig. 4: A holistic quality assurance framework for NCAAA and ABET

Table 5: Survey questions to evaluate the usefulness of the proposed quality assurance framework

Key questions to evaluate the proposed quality assurance framework	Strongly agree or agree	Neutral	Disagree or strongly disagree
I fully participate in quality assurance activities	63(94%)	4(6%)	0(0%)
Mistakes and weaknesses in the program are acknowledged and dealt constructively (Closing the loop of CQI)	59(88%)	8(12%)	0(0%)
Improvements in quality are appropriately acknowledged	59(88%)	8(12%)	0(0%)
All aspects of the program (e.g. students learning outcomes, facilities and services, etc.) are evaluated and reported to improve the quality of the program (ABET and NCAAA continuous improvement)	61(91%)	6(9%)	0(0%)
Program evaluation reports are carried out in a consistent way in both male and female sections	56(84%)	10(15%)	1(1%)
Quality assurance processes are fully integrated into program planning and delivery. Different aspects of the program (Inputs, processes, outputs and outcomes) are enhanced using the local and international requirements	58(87%)	9(13%)	0(0%)
The program's quality assurance processes are based on evidence and use predetermined performance indicators	60(90%)	7(10%)	0
Faculty members are involved in planning and carrying out the quality assurance processes	54(81%)	10(15%)	3(4%)
All activities related to quality assurance are regularly evaluated and improved (NCAAA continuous improvement)	62(93%)	4(6%)	(1%)
Processes of evaluation of quality are transparent	51(76%)	12(18%)	4(6%)
The program uses performance indicators and benchmarks for program evaluation and improvements (NCAAA continuous improvement)	57(85%)	10(15%)	0(0%)
Meetings, seminars, workshops, training programs and presentations about ABET and NCAAA are provided in a regular and constructive manner	60(90%)	7(10%)	0
Reports on surveys/questionnaires related to quality as per ABET and NCAAA requirements are conducted and provided accordingly	59(88%)	7(10%)	1(1%)
The requirements of accreditations (NCAAA and ABET) including common tasks and different templates are considered and distributed to the appropriate committees	56(84%)	9(13%)	2(3%)
Guidelines based on the latest requirements of both ABET and NCAAA accreditations are provided in a regular basis to the working committees	58(87%)	7(10%)	2(3%)
The quality assurance framework is practical, doable and easy to implement	53(79%)	11(16%)	3(5%)

All aspects of the educational program (i.e., inputs, processes, outputs and outcomes) are enhanced and updated according the best practices in both accreditations. The CQI process based on the learning outcomes is performed only once for both the purpose of NCAAA and ABET. However, the assessment and evaluation of the KPIs for the inputs, processes and outputs are explicitly required in NCAAA only.

**Implementation of the proposed framework:** The proposed framework (Fig. 4) has been adopted and implemented by several computing and engineering programs in Saudi universities and received positive recommendations from NCAAA and ABET experts as summarized as:

- Reduction in the workloads because the common and redundant requirements between ABET and NCAAA are combined or eliminated
- Fulfillment of the local accreditation (NCAAA) standards
- Fulfillment of the international accreditation criteria (ABET)
- Development of a very sustainable continuous quality improvement process to ensure quality over all aspects of the program including the assessment

and evaluation of KPIs and learning outcomes

- Enhancement of the academic programs by adopting NCAAA and ABET well-defined practices
- Promotion of a culture of quality assurance and accreditation in the academic program
- Assurance of validity and reliability of the continuous quality improvement process
- High satisfaction of faculty in the quality assurance and accreditation related works
- Increase of student satisfaction about the quality of the program from 65% in 2015-2016 to 87% in 2017-2018

A survey was designed based on the key features of the proposed framework and distributed to faculty members for feedback. A total of 67 faculty members (42 male and 25 female) who were fully involved in the implementation of the framework from three different departments in Saudi Arabia universities answered the survey's questions. Table 5 shows the questions of the surveys along with the number of respondents and their responses in percentage, to the main options (strongly agree or agree, neutral, disagree or strongly disagree). In total, the survey contained 16 closed-ended questions and one open-ended question requesting written comments. The questions captured the overall

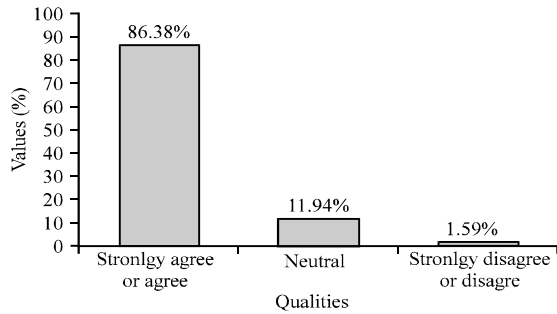


Fig. 5: Aggregated satisfaction scores of faculty members with the proposed holistic quality assurance framework

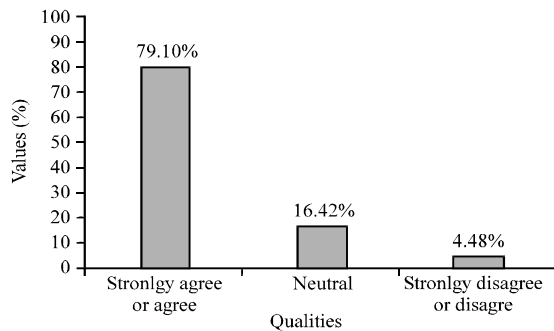


Fig. 6: The quality assurance framework is practical, doable and easy to implement

satisfaction of the faculty members with respect to the quality assurance framework designed to obtain NCAAA and ABET accreditation. Figure 5 shows the overall satisfaction scores of faculty with respect to the proposed quality assurance framework. 86.36% of the faculty strongly agree or agree that the proposed framework is beneficial, 11.94% were neutral and only 1.59% strongly disagree or disagree. In addition, Fig. 6 shows that 79% of the faculty believe that the proposed framework is practical and can be easily implemented and adopted by similar academic programs.

The qualitative feedback about the framework from five faculty were generally positive with some recommendations and revolved around the following points. “We have the best quality system but the weakest point in our process is the quality of students admitted in the program which makes our task difficult. In addition, we lack administrative staff who can help us in certain tasks that are purely administrative in nature” (Staff 1) “Overall performance of the internal quality assurance system is good with some room of improvement” (Staff 2). “The best thing in the quality system is the involvement of all faculty members in planning and carrying out all quality

assurance processes” (Staff 3). “In my opinion, the internal assurance system in our college should do the following:

- Make sure that improvement plan actions are implemented
- Ensure that students must be involved in the quality work
- Make sure that improvement plans are prepared based on evidence and if possible with external benchmarks” (Staff 4)

“Skillful and effective interaction of progress is required to carry out the program evaluation in a consistent way in both male and female campuses. The processes of evaluation of quality are not transparent in the female campus according to many NCAAA or ABET standards/criterion such as management, planning, facility and resource, etc.” (Staff 5).

In summary, the overall satisfaction of faculty members along with their comments demonstrate that the usefulness of our proposed framework and that it can be adopted by computing and engineering programs in Saudi Arabia to achieve NCAAA and ABET accreditations.

## CONCLUSION

This study contributes a comprehensive quality assurance framework for obtaining the Saudi local accreditation (NCAAA) and international accreditation (ABET) for computing and engineering programs. The proposed framework may be adopted by similar computing and engineering programs in the Saudi universities or worldwide to assure quality based on the standards and criteria defined by NCAAA and ABET. Moreover, this framework supports the identification of common tasks and activities, elimination of redundant works, organization of work within dedicated teams and development of a sustainable continuous quality improvement cycle. Finally, the implementation of the proposed framework and the opinions received from the faculty in three different computing programs showed promising results with high levels of satisfaction in regard to realizing a total quality system in computing and engineering programs.

## RECOMMENDATIONS

Nevertheless, future works are required to evaluate and validate the efficiency of the framework in reducing workload of faculty and organizing the accreditation tasks. We plan to launch a large-scale evaluation of the

framework by conducting user studies with faculty and consultation meetings with quality experts in a bid to confirm the findings and improve the framework. There is also potential to translate the framework into a computer system that automates the key elements of the frame and produce reports and evidences as required by NCAAA and ABET.

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