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Appropriateness of the international accreditation frameworks of engineering education to the academic engineering programs in Saudi Arabia: A comparative study

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ABSTRACT

This paper focuses on the globalization of engineering education which has become a major preoccupation of engineering departments everywhere. There is a lack of literature on the global recognition requirements of Saudi engineering education. Most of the papers published in the field of accreditation of Saudi engineering education focused on reporting the individual experiences of some engineering programs or on identifying the challenges facing these programs when seeking national or international accreditation. This paper examines and explores the main milestones in the path towards the global recognition of engineering education in Saudi Arabia. The only way such recognition can be achieved, however, is through membership in a handful of accreditation frameworks such as the Washington Accord (WA) and the European Accredited Engineer (EUR-ACE). The purpose of this paper is threefold: 1) to take stock of the accreditation status of engineering program in Saudi Arabia, 2) to compare the requirements, rules, and procedures of WA and EUR-ACE to determine which organization best serves the Saudi engineering programs' desire to achieve international recognition, and finally 3) make some recommendations on actions the national accreditation agencies could take to become members of WA. Even though this paper focuses on engineering education in Saudi Arabia, it applies equally to other countries looking to meet the highest quality standards in engineering education and seeking to ensure the international mobility of their graduates.

1. Introduction

One of the five major developments in engineering education that have occurred during the past 100 years is the shift to outcomes-based education and accreditation (Froyd et al., 2012). Accreditation is important for all program constituencies and stakeholders: Students, faculty, parents, employers, alumni, and universities because it guarantees that the programs fulfill the requirements demanded of them by the agency that issues the accreditation. In addition to the recognition that a program is qualified to fulfill its educational mission, accreditation attracts promising students (Al Busaidi, 2020), reinforces parents' confidence in the education of their children, contributes to the professional development of faculty (Uziak et al., 2014), reassures employers that their recruits are qualified, improves the employability of graduates (Al Busaidi, 2020) and increases their chances of being admitted to graduate programs and make it easier for graduates to become professional engineers (Uziak et al., 2014). Therefore, the absence of international recognition of engineering education degrees of any country may deprive engineering students and graduates of advantages offered by globalization such as obtaining scholarships and grants, being admitted to graduate schools, and registering as professional engineers in different countries.

In an era of rapid globalization, engineers may want or have to work in countries other than theirs. International mobility offers them new opportunities to sharpen their skills and acquire new ones. This makes international recognition of engineering programs all the more important. It guarantees that graduates are qualified to perform their functions and are also versatile enough to work in different

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contexts and cultural environments. To gain international recognition, many higher education institutions seek accreditation of their programs from some internationally recognized agencies in other countries either because of the unavailability of equivalent national accreditation systems or because the national accreditor is itself not recognized internationally. To what extent does this attitude ensure a worldwide acceptance of the engineering academic programs? What are the requirements to gain global recognition of the engineering education and profession?

There is a lack of literature on the global recognition requirements of Saudi engineering education. This paper is the first tentative to examine and explore the main milestones in the path towards the global recognition of engineering education in Saudi Arabia. Most of the papers published in the field of engineering education accreditation focused on reporting the individual experiences of some engineering programs or on identifying the challenges facing these programs when seeking an international from the Accreditation Board for Engineering and Technology (ABET) or a national accreditation from the National Center for Academic Accreditation and Assessment (NCAAA).

Ayadat and Asiz (2020) reported on the experience of a Civil Engineering program at a private university in Saudi Arabia, during the process of accreditation from ABET for the first time. Ayadat and Asiz (2020) described the activities undertaken during the preparation for the visit of the ABET Team, focused on the findings raised by the program evaluator during the visit, and also presented the final outcomes of the accreditation visit regarding the compliance of the program to the ABET standards and criteria. Some suggestions were given by Ayadat and Asiz (2020) for improving the readiness of the engineering programs to be accredited by ABET.

Al-Yahya and Abdel-Halim (2012) presented the main procedures of the quality assurance system that was implemented in the Department of Electrical Engineering at one of the Saudi public universities in order to meet the ABET accreditation criteria.

Abou-Zeid and Taha (2014) discussed the challenges facing engineering programs for ensuring simultaneously compliance to the ABET criteria as well as to the NCAAA standards. An approach for meeting the requirements of both ABET and NCAAA is presented by Huque (2015).

El-Kady et al. (2014) reported on the results of the efforts made by the higher education authority in Saudi Arabia to formulate a set of learning outcomes for the electrical engineering programs based on various international frameworks. Based on the developed learning outcomes framework, a standardized exit exam is suggested and a trial exam is conducted.

Faiz and Al-Mutairi (2015) used some performance indicators such as the number of ABET associate degree programs, the number of ABET Bachelor's degree programs, and the number of ABET Master's degree programs to discuss the global achievement of some educational institutions in Saudi Arabia comparatively to some international systems for global universities rankings.

This paper explores and reviews the best practices in the field of globalization of engineering education and profession and the efforts made in this regard by investigating the different frameworks underlying the globalization of engineering education and profession. We discuss the appropriateness of these frameworks, illustrate their requirements, and provide guidelines to those looking to meet the highest international quality standards in engineering education and profession.

Even though this paper focuses on engineering education in Saudi Arabia, it applies equally to other countries seeking to ensure global recognition of their engineering education and international mobility of their graduates by advocating the involvement of the national engineering professional body in the academic accreditation as a path towards the global recognition of the engineering academic programs and profession.

2. Methodology

The methodology adopted in this research is based on the investigation and the analysis of the relevant documents particularly those related to the International Engineering Alliance which promotes the development of global standards for the recognition of engineering programs qualifications and professional registration or licensing. The first section of this paper explores briefly two frameworks that are involved in the globalization of engineering education, with particular attention paid to the requirements for joining the Washington Accord. The second section outlines the current situation of the accreditation process of engineering programs in Saudi Arabia. The third section is devoted to a discussion of some agencies that are already members of the Washington Accord to gain helpful insights that may help Saudi Arabia and many other countries to join the Accord as the global recognition of the engineering programs cannot be reached without joining such international accords and agreements.

3. Frameworks for the international recognition of the engineering education

Frameworks for engineering education accreditation vary globally and various accreditation models have been developed. Huge efforts have been made by many countries to standardize criteria for engineering education accreditation, for the establishment of international standards for comparing engineering qualifications and degrees, and to cope with the increasing complexity of the engineering education systems around the world. These efforts have been rewarded by the

establishment of international agreements for multilateral recognition of degrees and accreditation outputs. An excellent example of successful international cooperation in quality assurance of engineering education and cross-border mobility of engineers is the system administered by the International Engineering Alliance (IEA) also called Washington Accord (WA). WA is the largest international system of engineering accreditation. It was established by six founding signatories (Australia, Canada, Ireland, New Zealand, United Kingdom, and the United States). Currently, WA has twenty-one full members and seven provisional signatories (IEA, 2021).

WA is an educational multi-lateral agreement between accreditation agencies (one representative per country) which stipulates that all engineering programs accredited by an accreditation agency having a status of full signatory of the accord are substantially equivalent provided that the accreditation is delivered by the full signatory in its own jurisdiction. Therefore, WA recognizes only programs that the signatories accredit within their jurisdictions. Through WA, signatories recognize that their processes, policies, and procedures used for accrediting engineering programs are comparable. They are also committed to providing the necessary efforts to ensure that any engineering programs accredited by a member of WA are also recognized by the bodies responsible for the professional registration and licensing in their respective countries (IEA, 2021).

Another less global and more regional system was founded in 2006 and is administered by the European Network for Accreditation of Engineering Education (ENAEE) (Polmear et al., 2019). Accreditation agencies authorized by ENAEE, award a common education quality label named the "European Accredited Engineer" (EUR-ACE) in addition to their own accreditations. The authorization by the ENAEE of an agency to award the EUR-ACE label is based on the evaluation of the compliance of the accreditation policies and procedures of this agency to the standards set out by ENAEE (Urquizo, 2019). The EUR-ACE accreditation system refers to the first and second cycles of the Framework for Qualifications of the European Higher Education Area (QF-EHEA). The first cycle corresponds to the bachelor's degree which includes at least 180 European Credit Transfer System (ECTS) and the second cycle relates to the master level which requires a minimum of 90 ECTS or 60 ECTS in some educational systems (Jolly, 2018). Based on the equivalence of one year of study to the total of 60 ECTS, the bachelor's degree in the European framework necessitates at least 3 years of study, while the WA requires a bachelor's degree of at least 4 years of study (Anwar and Richards, 2015). This difference in the number of years of study required for the bachelor's degree caused some difficulties in the equivalence between the two recognition systems (WA and EUR-ACE frameworks). Instead of the European system (EUR-ACE), which is largely limited to the European continent, participation in the WA is not limited to a region or territory. Furthermore, the WA does not impose a common label or set of accreditation criteria as is the case with the EUR-ACE, so each member in the WA has its own accreditation policy, procedures, processes, and criteria. As a result, WA is considered as the first step toward the globalization of engineering education and professionalism. For these reasons, the requirements for joining the WA are developed in this section, because participation in the WA may be considered the most suitable path towards the global recognition of the Saudi engineering programs.

There are two types of members in the WA accord: signatories who have full rights of participation in the accord and members who have provisional status but are acknowledged to have accreditation systems that are potentially suitable for the purposes of the accord and may achieve a signatory status if they develop accreditation systems and processes that conform to those of the accord. Any program accredited by any WA signatory in its own jurisdiction is recognized by the other members as being substantially equivalent to those accredited within their respective jurisdictions. Programs accredited by members holding provisional status are not recognized by the signatories.

IEA (2021) has identified different steps in the process of admission as a WA provisional signatory. In the beginning, the applicant should provide preliminary documentation about the accreditation system to the WA members for evaluation. The purpose of this preliminary phase is to demonstrate the fulfillment of a number of basic requirements on which the full members of the WA will judge the substantial equivalency of the programs accredited by the applicant to the programs accredited by the signatories. One of the basic requirements concerns the accreditation agency, which should be a local non-governmental agency and independent of the higher education providers. Also, it should be autonomous in designing and conducting its accreditation policies, criteria, and procedures without the influence of the stakeholders on the accreditation decisions. In addition, the accreditation agency must be legally incorporated and recognized as being the incontestable agency accrediting academic programs that are offered by recognized higher education institutions and required for the engineering licensure or registration. The status of accreditation agencies differs from one country to another. In some countries, the operations and decisions concerning the accreditation of higher education programs are under the competence of a governmental authority or agency, while in other countries this mission is undertaken by fully independent agencies. Between these two paradigms (government and non-government status), there is a variety of agencies mixing at different levels the features of the two types of statuses. For example, some accreditation agencies are directly or indirectly controlled by the government although they are

officially classified as non-governmental, others are quasi-governmental, yet others are nongovernmental, dominated entirely by professional bodies. According to the Washington Accord, non-governmental status is required for any agency seeking to be admitted as a provisional signatory of the organization.

Another set of important requirements related to the accreditation system. The general requirements that the accreditation system should fulfill are (IEA, 2021):

- Maintain high standards of objectivity, professional conduct, and ethics.
- Accredits individual programs or groups of programs according to well-documented and publicized policies, criteria, procedures, and transparent processes based on self-evaluation and onsite visits that are conducted in confidence.
- Evaluators of programs are active in academia and industry.
- Evaluators of programs are trained according to well-documented mechanism
- Accreditation of programs is maintained by periodic reevaluation.
- Has well-established procedures for preventing conflicts of interest and managing appeals.
- Publish the list of accredited programs.

Also, it is important to note that the accreditation criteria of the applicant should contain at least the standards related to the program outcomes, curriculum, entry and progression standards, human and financial resources committed to the program, program environment, leadership, and faculty.

The documentation-based evaluation is only a preliminary step to be familiar with the accreditation system of the applicant. The detailed evaluation is made via an onsite visit. In this regard, at least two members of the WA have to be designed as nominators. The role of these nominators is to review, observe and evaluate the real implementation of the accreditation systems, criteria and procedures. A positive evaluation of the accreditation system by the nominators is necessary before the consideration of the application to the provisional status. The decision to join the list of provisional signatories of the WA is made during the International Engineering Alliance meetings (IEAM). The admission of the application as a provisional signatory necessitates the approval of at least two-thirds of the members (IEA, 2021).

The process for joining the full signatories of the WA contains three important steps (IEA, 2021). The admission to the WA starts with the submission of an application that includes a self-study report and other requested statistics and documents where the applicant demonstrates the fulfillment of all requirements including those related to the Graduate Attribute exemplars of the Washington Accord. The following twelve exemplars and generic Graduate Attributes (WAGA) were adopted in the WA (IEA, 2021):

- WAGA1: Engineering knowledge
- WAGA2: Problem Analysis
- WAGA3: Design and development of solutions
- WAGA4: Investigation
- WAGA5: Modern Tool Usage
- WAGA6: Engineering and Society
- WAGA7: Environment and Sustainability
- WAGA8: Ethics
- WAGA9: Individual and Teamwork
- WAGA10: Communication
- WAGA11: Project Management and Finance
- WAGA12: Lifelong learning

WA's GA embraces the knowledge, skills, and attitudes recommended by the WA as a non-mandatory standard set of program learning outcomes for the engineering program degree that is required as an academic base for engineering professionals. The WA's GA represents the reference for judging the substantial equivalency of the program learning outcomes established by the signatories and those adopted by any accreditation agency seeking to join the WA.

In addition to the WA's GA that should be achieved by the graduates, a set of Knowledge Profile (WK) that each engineering program should encompass is determined by the Washington accord (IEA, 2021) as follows:

- WK1: Natural sciences applicable to the discipline
- WK2: Mathematics, numerical analysis, statistics, and computing applicable to the discipline
- WK3: Engineering fundamentals required in the discipline
- WK4: Engineering specialist knowledge related to the discipline
- WK5: Engineering design
- WK6: Engineering practice
- WK7: Comprehension of the role of engineering in society and ethics
- WK8: Research literature of the discipline

In addition to the basic requirements related to the provisional status, the applicant to the signatory status should fulfill a number of additional requirements concerning the conformity of the accreditation system to the accepted practices (such as evaluators of programs are experts in the accreditation system of the agency; evaluation of programs is carried out consistently and fairly; the recommendations included in the accreditation report are justified in a manner supporting the decision making and the decision-makers have the ability to make difficult decisions that are advantageous to the engineering community), the substantial equivalency between the standard program outcomes of the agency and the Graduate Attribute exemplars of the Washington accord and the appropriateness of the accreditation system management as demonstrated by IEA (2021):

- Accreditation data

- The depth of observations during onsite visits and meetings of decision–making enable appropriate accreditation results.
- Periodic accreditation policies, procedures, and criteria are reviewed based on an appropriate process.
- Appropriate leadership.
- The accreditation decision making is separated from the policymaking.
- The implemented accreditation system ensures making consistent accreditation decisions continuously.

Following the processing of the application, a visiting team consisting of three evaluators is designated to conduct an onsite review covering visits to some higher education providers seeking accreditation of their engineering programs, observation of accreditation visits, and participation as observed in the meeting of the board responsible for the final decision about the accreditation. The aim of the onsite visit is to evaluate the substantial equivalency between the accreditation system and processes of the applicant and those of the signatories, between the program outcomes of the applicant and the graduate attributes exemplar of the WA and the good establishment and management of the accreditation system and its ability to make continually consistent accreditation decisions. Based on the report and the recommendations issued by the reviewers, the signatories will decide during the IEAM whether or not the applicant is qualified to be upgraded as a full member in the WA. The acceptance of upgrading the status of the provisional member to a permanent member requires the unanimous approval of the signatories.

4. Accreditation of academic engineering programs in Saudi Arabia

The Education and Training Evaluation Commission (ETEC) is the agency that is responsible for evaluating public and private education and training institutions in Saudi Arabia. A board of directors, representing the education stakeholders, supervises the ETEC. The national agency responsible for the accreditation of the higher education institutions and programs in Saudi Arabia is the National Center (formerly Commission) for Academic Accreditation and Assessment (NCAAA). NCAAA which was established in 2004 (Aljohani, 2020) is supervised by the ETEC and report to it.

NCAAA offers two types of accreditation: institutional accreditation and program accreditation. The aim of institutional accreditation is to determine if the administrative, scientific, service, and other components of the institution satisfy the requirements of the NCAAA. This investigation is conducted by a panel of experts after the submission of the institutional self-study report by the institution seeking accreditation. Obtaining an institutional accreditation from NCAAA is one of the eligibility requirements that should be fulfilled before the submission of an official request for the review of a particular program. This step is then followed by the submission of the program self-study report and an on-site review visit by a team of reviewers.

The new institutional accreditation criteria established in 2018 are composed of 8 criteria in lieu of the old 11 criteria. The old second and third criteria which are "Governance and Administration" and "Management of Quality Assurance and Improvement" are combined in the new first criterion "Governance, Leadership and Management," the old fourth criterion "Learning and Teaching" and the old sixth one "Learning Resources" are merged to form the new third criterion "Teaching and Learning" and finally the old seventh and eighth criteria which are "Facilities and Equipment" and "Financial Planning and Management," are combined in the new sixth criterion named "Institutional Resources." The remaining old 1st, 5th, 9th, 10th, and 11th criteria are equivalent, respectively, to the new 1st, 4th, 5th, 7th, and 8th criteria.

Also in 2018, the NCAAA reviewed its program accreditation criteria. The language used in the new set of criteria is more precise, clearer, and more concise. The changes resulting from the review of the criteria of the program accreditation are quite substantial: The old eighth criterion "Financial Planning and Management" is eliminated. The tenth and eleventh criteria related to "research" and "Relationships with the Community," respectively, have been included in the three new criteria: "Program management and quality assurance," "Faculty members" and "Learning resources, facilities, and equipment." The two old criteria "Program Administration" and "Management of Program Quality Assurance" are combined to make the new criterion "Program management and quality assurance." In the same manner, the two criteria "Learning Resources" and "Facilities and Equipment" are merged into the new criterion "Learning resources, facilities, and equipment." The names of the following old criteria: "Mission Goals and Objectives," "Learning and Teaching," Student Administration and Support Services" and "Employment Processes" are changed respectively to the following new ones: "Mission and goals," "Teaching and learning," "Students" and "Faculty members." Another important change to be noticed in the new criteria of the program accreditation is the important emphasis on the outcome-based continuous improvement of education and its process. In the third new criterion named "teaching and learning," it is mentioned that: "The extent of achievement of learning outcomes must be assessed through a variety of means and the results are used for continuous improvement."

It is important to mention that the same accreditation criteria of NCAAA are applicable to all sorts of academic programs; they do not provide any specific requirements, graduate attributes, or

program learning outcomes for any specific discipline or specialization. However, criterion 3, "Teaching and Learning," of the Program Accreditation Standards of the NCAAA, requires that the graduate attributes and the program learning outcomes must satisfy the requirements of the National Qualifications Framework, the applicable academic and professional standards, and also the needed labor market requirements. Also, NCAAA accreditation criteria do not identify any special requirements for the different and various areas of curricular topics of the academic programs, but it is required that the curriculum of any program seeking the NCAAA accreditation must meet the related professional requirements without specifying their source or nature. However, in the criterion "teaching and learning," the following requirement is mentioned, "The curriculum must conform to professional requirements."

Despite the fact that the new developments in the accreditation criteria of NCAAA will more likely improve the effectiveness and the efficiency of the accreditation system and will make the accreditation procedure more precise and easier to follow, it is expected that Saudi engineering programs will continue to seek accreditation or re-accreditation from the Accreditation Board for Engineering and Technology (ABET).

Many international accreditation frameworks and agencies operate around the world, such as Engineers Canada (Canada), Engineering Council (United Kingdom), Commission des Titres d'Ingénieur (France), Engineers Australia (Australia), Engineers Ireland (Ireland), Institution of Professional Engineers NZ (New Zealand), Japan Accreditation Board for Engineering Education (Japan), ASIIN (Germany), AEER (Russia), MÜDEK (Turkey). Because these agencies are less known in Saudi Arabia than their American counterpart (ABET), no Saudi university has asked any of them to carry out an onsite review of its engineering programs. ABET remains the unique international agency from whom accreditation of engineering programs in Saudi universities is being sought and awarded. The relationship between ABET and engineering education in Saudi Arabia is deep-rooted. More than 25 years ago, ABET was requested by the King Fahd University of Petroleum and Minerals (KFUPM) to evaluate the "substantial equivalency" of its engineering programs compared to the ABET-accredited programs in the USA.

Currently, Saudi Arabia has the biggest number of engineering bachelor programs outside the US accredited by ABET (Marzouk, 2019). Certainly, this demonstrates the remarkable progress made by engineering education in Saudi Arabia. It also reveals the enormous efforts devoted by the Saudi higher education institutions to improve the quality of the engineering programs and exhibits the remarkable support provided by the ministry of education to the development of engineering education.

However, seeking accreditation of engineering programs from international bodies instead of national accreditors does not always guarantee the engineering degrees receive the international recognition they deserve. Having a national accreditation system recognized internationally may guarantee a global recognition of engineering degrees while the accreditation from an international body may ensure a limited international recognition. In the next section, the path toward the global recognition of Saudi engineering education and profession is discussed.

5. Discussion

Undoubtedly, through the close interaction with the ABET which is widely considered as the global leader in the accreditation of engineering education, Saudi institutions have gained a large experience and expertise in using the accreditation for the quality assurance of their engineering programs. As accreditation is not limited to the quality assurance purpose but is also used for benchmarking and supporting international recognition, the engineering community in Saudi Arabia ought to take advantage of this extensive experience with ABET to achieve international recognition of its engineering education. The early introduction of the ABET accreditation model in the Saudi engineering programs has permitted an effective implementation of the outcome-based education elements in Saudi engineering education. The majority of the Saudi engineering institutions have adopted the ABET Students-Outcomes (SOs) as the learning outcomes of their programs. Starting from 2019 the engineering programs transferred to the following revised ABET's SOs:

SO (1): An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
SO (2): An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
SO (3): An ability to communicate effectively with a range of audiences.
SO (4): An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
SO (5): An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
SO (6): An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
SO (7): An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Table 1 illustrates that the ABET's SOs are in line with the WA's GA and Table 2 shows that the different components of the Knowledge Profile (KW) required by the WA in any engineering program are related to the ABET's SOs.

Table 1: Linking ABET SOs to the Washington accord graduate attributes

WA's GAs	ABET's Student-Outcomes						
	SO (1)	SO (2)	SO (3)	SO (4)	SO (5)	SO (6)	SO (7)
WAGA1	√						
WAGA2	√						
WAGA3	√	√					
WAGA4	√					√	
WAGA5	√	√				√	
WAGA6				√			
WAGA7				√			
WAGA8				√			
WAGA9					√		
WAGA10			√				
WAGA11	√	√			√	√	
WAGA12							√

Table 2: Linking ABET SOs to the component of the Knowledge profile of the WA

Knowledge Profile (WK)	ABET's SOs						
	SO (1)	SO (2)	SO (3)	SO (4)	SO (5)	SO (6)	SO (7)
WK1	√						
WK2	√					√	
WK3	√						
WK4	√						
WK5		√					
WK6			√	√	√		
WK7				√			
WK8							√

As the full signatories of WA agree that the attributes of the accredited programs graduates are equivalent and the Saudi engineering programs have adopted the SOs of ABET which is one of the founding signatories, this configuration will permit the Saudi engineering programs to be in line with one of the important requirements to join the WA which concern the Graduate Attributes. In this context, it is important for any agency responsible for the accreditation of the engineering programs in its jurisdiction and aiming to be a member in the WA to use the WA's GA as guides during the development and implementation of the outcome-based accreditation system and particularly during the establishment of the criterion-related to the program learning outcomes.

The length of the period between the provisional membership and the full membership depends on the applicant's ability to achieve equivalency between its criteria and procedures for accreditation and those of the full members of WA. In the case where the provisional member has an accreditation system that is different from those of the signatories, it will take a longer time and huge efforts to attain the required degree of equivalency between its accreditation criteria and procedures and those of the signatories. On the other hand, the time between joining the WA as a provisional member and attaining full membership in this accord will be considerably reduced if the provisional member has an accreditation system that is already consistent with the systems of the signatories. The ABET accreditation of the Saudi engineering programs proves that the outcome-based education accreditation is well implemented across engineering programs in the Saudi higher education institutions. This will act in favor of Saudi Arabia if it applies to join WA as a provisional member. Furthermore, since, outcome-based education is well implemented in Saudi engineering education, as demonstrated by the important number of ABET-accredited programs in the country, it is expected that the period separating the provisional membership and the full membership will be reduced if Saudi Arabia decides to apply to join the Accord.

Table 3 shows the period between the provisional membership and the full membership of the different members of the WA. Table 3 shows that the period between the provisional membership and the full membership differs from one body to another. For instance, it took six years from getting the WA provisional status to being approved as signatory members for ECSA (South Africa) and BEM (Malaysia) and seven years for NBA (India), IESL (Sri Lanka), and PEC (Pakistan). On the other hand, this period was much shorter for MUDEK (Turkey), HKIE (Hong-Kong China), ABEEK (Korea), and IEET (Chinese Taipei).

The long experience of NCAAA in academic accreditation can help to establish an accreditation system that is appropriate to engineering education. The compliance to this requirement may be assured by the collaboration of the NCAAA with the Saudi Council of Engineers (SCE) whose Board of Directors (leadership members) are elected by the General Assembly. SCE is the body responsible for setting and applying the criteria and procedures necessary for obtaining the engineering professional title and also for practicing the profession in Saudi Arabia. As

SCE is responsible for organizing the engineering profession in Saudi Arabia, engineers are required to register with the SCE in order to practice (El Badawi et al., 2017).

Table 3: Signatories of the Washington accord (IEA, 2021)

Country and its representative	Provisional status	Signatory status
Australia: Engineers Australia (EA)		1989
Canada: Engineers Canada (EC)		1989
Ireland: Engineers Ireland (EI)		1989
New Zealand: Engineering New Zealand (EngNZ)		1989
United Kingdom: Engineering Council United Kingdom (ECUK)		1989
United States: Accreditation Board for Engineering and Technology (ABET)		1989
Hong-Kong China: Institution of Engineers (HKIE)	1993	1995
South Africa: Engineering Council of South Africa (ECSA)	1993	1999
Japan: The Japan Accreditation Board for Engineering Education (JABEE)	2001	2005
Singapore: The Institution of Engineers Singapore (IES)	2003	2006
Malaysia: The Board of Engineers Malaysia (BEM)	2003	2009
Korea: Accreditation Board for Engineering Education of Korea (ABEEK)	2005	2007
Chinese Taipei: Institute of Engineering Education Taiwan (IEET)	2005	2007
Russia: Association for Engineering Education of Russia (AEER)	2007	2012
India: National Board of Accreditation (NBA)	2007	2014
Sri Lanka: Institution of Engineers Sri Lanka (IESL) -	2007	2014
Turkey: Association for Evaluation and Accreditation of Engineering Programs (MUDEK)	2010	2011
Pakistan: Pakistan Engineering Council (PEC)	2010	2017
China: The China Association for Science and Technology (CAST)	2013	2016
Peru: Institute of Quality and Accreditation of Programmes in Computing, Engineering and Technology Education (ICACIT)	2014	2018
Costa Rica: Colegio Federado de Ingenieros y Arquitectos de Costa Rica (CFIA)	2016	2020

Another characteristic that works in favor of the collaboration between the NCAAA and the SCE is related to the registration and licensing systems. WA does not enclose the requirements for the substantial equivalency of the engineering professional registration and licensing systems. However, the WA covers the substantial equivalency of the accreditation systems of engineering programs that are required as an academic base by engineering professionalism. The substantial equivalency of the registration and licensing systems in engineering is the purpose of the International Professional Engineers Agreement (IPEA) which belongs to the International Engineering Alliance (IEA). A similar regional agreement, also under the IEA, was signed by a number of countries of the Asia-Pacific Economic Cooperation. It is called the APEC Agreement. The WA was the base on which IPEA and APEC were established. Even though it is not obligatory according to the WA, IPEA, or APEC guidelines to have the accreditation and licensure systems or bodies under the same umbrella (IEA, 2021), it is difficult to join the IPEA when the licensure or registering body is dissociated from the WA. In this context, it is worth mentioning that except for China, Costa Rica, and Turkey, all countries represented in the Washington Accord were also represented at least in one of the other international agreements for professional engineering IPEA, and APEC. Ten countries are represented in the three international agreements WA, IPEA and APEC (IEA, 2021): Australia, Canada, Chinese Taipei, Hong Kong China, Japan, Korea Malaysia, New Zealand, Singapore, and the United States. Five out of the six founding members of the WA belong to this list: Australia, Canada, Ireland, New Zealand, the United Kingdom, and the United States. The requirements and the processes of applying for licensure as a professional engineer in the United States are under the responsibility of the licensing board of the state or territory in which the engineer applying for licensure intends to practice (Anwar and Richards, 2015).

Among the 21 countries represented in the WA, 10 countries are also represented by the same agency in the IPEA. AEER which is responsible for the accreditation of engineering programs in Russia has signed the Washington Accord and the APEC agreement as a full member and the IPEA agreement as a provisional member. All countries represented in the international agreements IPEA are also represented in the Washington Accord. Ten countries among sixteen signatories of the IPEA agreement are represented in the WA by the same agencies which have simultaneously in their respective jurisdictions the responsibility for the professional Engineering registration or licensing and for accrediting engineering programs. The countries represented in IPEA with bodies combining engineering registration and accreditation are Australia, Canada, Hong Kong China, Ireland, New Zealand, Pakistan, Singapore, South Africa, Sri Lanka, and the United Kingdom. In the APEC agreement, the following countries: Australia, Canada, Hong Kong China, New Zealand, Russia, and Singapore are represented in the WA by the same agencies. The Philippines and Thailand are represented in the APEC agreement by two agencies that are provisional members in the WA. Eight countries represented in APEC among fifteen are represented by registering or licensing agencies that are at the same time charged with the mission of accrediting the engineering academic programs in their jurisdictions.

Because SCE is in charge of the engineering professional registration and licensing in Saudi Arabia, it follows that the collaboration between NCAAA and SCE in order to attain a status of full

member in the WA is highly recommended as a first step to join the IPEA, which will enhance the image of the engineering education and profession internationally.

6. Conclusion

The Washington Accord (WA) is undoubtedly the most widespread international standard for the global recognition of engineering education degrees. This is demonstrated by the increasing number of agencies that seek to join the Accord. The importance of joining WA is tied to the needs of countries to ensure international recognition of their educational degrees and mobility for their graduates as a response to the increasing globalization of higher education.

Non-signatory countries of the WA, do not beneficiate from the global recognition of their engineering programs even they are accredited by an international accreditor that is a member of the WA, because these engineering programs are not recognized by the full members of this Accord. In return, signatory members of the WA ensure the global recognition of their nationally-accredited engineering programs without any recourse to any international accreditation agency.

Universities in Saudi Arabia continue to deploy huge efforts to obtain the accreditation of their engineering programs and to improve the quality of their graduates. However, as global recognition of engineering education has become vital, joining international systems of engineering education agreements is crucial. This global recognition is granted through WA membership.

The important number of engineering programs in Saudi Arabia that are accredited by ABET proves that the outcome-based education model, which constitutes the core element of the WA, is well implemented. This situation will contribute substantially to the fulfillment of the requirements for joining WA.

Taking advantage of the long experience of NCAAA in academic accreditation and from the international collaboration with ABET during the process of applying to the WA provisional membership will serve in favor of improving the likelihood of making the candidature to the status of the provisional signatory of the WA successful.

The WA is not an end in itself, but it is an educational base for globalization in engineering professionalism. Specifically, the WA is the platform on which the IPEA is based.

In this paper, it is suggested that the best path to achieve the global recognition of the engineering education and profession is to have the accreditation system of the engineering programs and the registration or licensure system of the professional engineers under the same umbrella. In the case of Saudi Arabia, the collaboration between the NCAAA and the SCE can play a major role in meeting the requirements for joining the WA and the IPEA.

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Compliance with ethical standards

Conflict of interest

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