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ABET Accreditation in Colombian Higher Education Institutions: Opportunities and Barriers

Acreditación ABET en Universidades Colombianas: oportunidades y barreras

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Abstract

Accreditation is a contemporary issue in engineering education. There are varying opinions about the opportunities and barriers of this process within the Colombian context. This study compared the advantages and disadvantages of various experiences published in the literature about ABET accreditation. The findings show the ABET accreditation promotes the adoption and implementation of a continuous improvement system and quality culture in engineering education. Additionally, the continuous improvement process aligns the institutional mission, program educational objectives, curricula, and student outcomes. On the contrary, the main concern is the high cost associated with preparing and adapting programs to meet the ABET requirements. Accreditation takes time and effort to be meaningful, which can sometimes lead to increased workloads and time requirements, inadequate training, and lack of faculty commitment. The compilation of experiences with the ABET accreditation process is a significant contribution to engineering programs of public universities in Colombia seeking international accreditation.

Keywords: ABET; engineering accreditation; education accreditation; quality education; engineering education; curriculum; international accreditation; accreditation process; student outcomes; quality accreditation; quality in higher education institutions, accreditation in public higher education institution.

Resumen

La acreditación es un tema contemporáneo en la educación superior, particularmente en ingeniería. Existen diversas opiniones sobre las oportunidades y barreras para emprender este proceso dentro del contexto colombiano. Este estudio comparó las ventajas y desventajas de varias experiencias publicadas en la literatura sobre la acreditación internacional ABET. Dentro de las ventajas se identificaron la formalización de una cultura de mejora continua y calidad en la educación, como también, la integración entre la misión institucional, los objetivos educativos del programa, los planes

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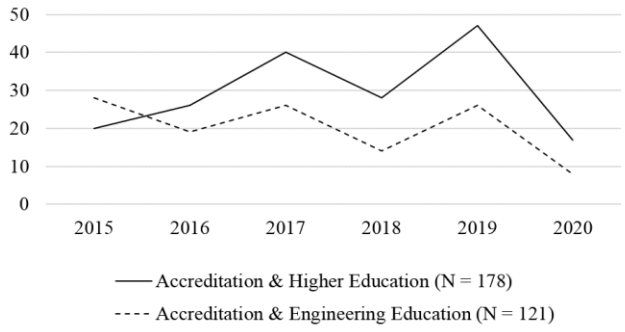
de estudio y los resultados de aprendizaje. Por el contrario, dentro de las barreras se identificaron los altos costos asociados al desarrollo de la acreditación, así como la adaptación de los programas a nivel curricular y reglamentario para cumplir con los requisitos. La recopilación de experiencias sobre el proceso de acreditación ABET es una contribución significativa a los programas de universidades públicas en Colombia que buscan la acreditación internacional.

Palabras clave: ABET; acreditación en ingeniería; acreditación en educación; calidad de la educación; criterios ABET; curriculum; acreditación internacional; proceso de acreditación; competencias de aprendizaje; acreditación de calidad; calidad en la educación superior; acreditación en universidades públicas.

1. Introduction

Accreditation is a contemporary issue in higher education, particularly in engineering education. A preliminary search on the SCOPUS database showed that within the higher education and engineering education domains, near sixty articles related to accreditation were annually published over the last five years (see Figure 1).



Note: Searched on May 3rd, 2020

Figure 1. Number of publications along the last five years. Source: own elaboration

A common idea drawn from this preliminary search is that accreditation implies quality. Accreditation means quality assurance for programs and institutions [1], [2]. Indeed, higher education institutions tend to highlight the quality improvement component as a rule for their accreditation because quality improvement is the most common functional characteristic [3].

To understand accreditation in higher education, a good approach is through the lens of quality standards. The ISO 9000 standard relies on seven quality management principles that guide an organization's performance improvement. Education institutions can address three of these principles: continuous improvement, process approach, and evidence-based decision-making. A successful organization focuses on ongoing improvement to enhance their levels of performance and effectively respond to challenges. Such an organization attains consistent and predictable results effectively by managing their activities as interrelated processes within a system. Furthermore, that organization is more likely to produce desired results when its decisions are based on the analysis and evaluation of data and information [4].

This dynamic of quality has led education institutions to incorporate accountability as a value that increases their legitimacy, enhances their continuous improvement process, and benefits their transparency [5]. Accountability means informing society about the quality delivered by a higher education institution. Two complementary conditions are required: validation and information. Validation legitimizes quality judgments, which can be seen as a way of accountability; while information is a transparency issue that helps people make reasoned choices regarding a program to apply [3].

Some experiences of various universities related to ABET accreditation have been published in different countries. These studies provide learned lessons, best practices, challenges, recommendations, and advice to programs and institutions interested in undertaking the ABET accreditation [6]–[15]. These experiences serve as an excellent reference for those institutions and programs considering international accreditation and for those who believe ABET accreditation brings positive changes for institutions, programs, and their constituents.

Some Colombian Higher Education Institutions have begun to adopt international accreditation to expand their influence borders. Currently, nine higher education institutions in Colombia have ABET-accredited programs. This is a recent process, full filled of challenges and uncertainties, especially for public institutions. Due to its novelty and scarce of experiences shared between Colombian academic institutions, the ABET accreditation process face several obstacles and barriers. The accreditation experiences in Latin America have not been widely shared in literature. Nevertheless, there are available experiences from international higher education institutions.

Understanding that some challenges accompany the benefits of undertaking this process within the Colombian context, an objective for this work was to

identify and describe the opportunities and barriers to ABET accreditation from a Colombian perspective based on the experiences published in the literature and the experience of the ABET readiness in a public university in Colombia.

2. Accreditation in Higher Education

Nowadays, accreditation plays a pivotal role in higher education based on principles of quality, continuous improvement, and interaction with society [16]. Accreditation is the establishment or restatement of the status, legitimacy, appropriateness of an institution or program, through the achievement of a certain threshold of quality [17]. For the Colombian National Accreditation Council (CNA), accreditation is a public recognition of the quality of the educative process of programs and institutions having society as a witness [18].

The aim of the accreditation in higher education rests basically in three objectives: to improve the institutional quality, to assure quality education, and to ensure the educational program being accredited is suitable for preparing students to excel in their chosen professions [19], [20].

For European higher education institutions, quality assurance denotes accreditation and evaluation systems together. In most countries, evaluation includes teaching as well as research and may be carried out at the program as well as at the institutional level. The first implementation of quality assurance in higher education started in Western countries in the middle of the 1980s, and then, they were introduced from 1990 onwards in Central and Eastern Europe, with some differences from the Western countries. The United Kingdom, France, and the Netherlands introduced their first formal quality assurance policies around 1985 [3].

A comparison of the accreditation approaches between Europe and the U.S.A. shows the following: while accreditation is a recent issue of higher education in Europe, the interest in this issue begun started at beginning of the twenty century in the United States; accreditation is a voluntary process in the U.S.A., in contrast to the obligatory character it has in most European countries; the evaluation and accreditation of programs in Europe are a rule that applies across the board to all fields of knowledge, but in U.S.A it is applied only to fields in a strong and organized profession such as engineering; the criteria and standards are strongly influenced by the profession, rather than by an academic interest in the U.S.A. While there is a strong academic influence in most accreditation schemes in Europe; due to the voluntary character of accreditation in the U.S.A. the recognition of accreditation agencies is less straightforward than the foundation in law, which is the main model in Europe; and finally, nowadays both schemes are focused on student learning outcomes (U.S.A.) or graduate competences (Europe) [3].

2.1. Latin American Contex

In Latin America, since the beginning of the 1990s, an increasing interest has been observed regarding assessment and accreditation of the quality of public service in higher education. Compared with the USA's and Europe's structures, there is a similarity in the stages of the models: self-assessment, peer evaluation, and final evaluation by the corresponding body. However, there are differences between the scope of assessment and accreditation. In some cases, there has been more self-assessment than accreditation under the regulatory idea of encouraging self-regulation by institutions; in others, more accreditation than self-assessment to increase government control and oversight [5].

3. International Accreditation

Accreditation has been conceived and applied as an assessment quality tool that focuses on different factors. However, this emphasis has been changing over time in engineering education, focussing more on program objectives and learning outcomes [2]. This new approach seeks to meet employment markets and civil society needs, within a globalized world which requires skilled professionals to properly perform in different contexts.

Besides national accreditation, there are international accreditation bodies that provide a structured mechanism to assess, evaluate, and improve the quality of programs and institutions [21]. The massification of higher education, the pressure on the alignment of the education system within countries, and the diversity as a component of global needs jeopardize the national frameworks of accreditation [3].

In Europe, higher education systems have aimed to evolve towards comparable education systems and ensure the quality of an international accreditation process. An element of validation for quality assurance in higher education is the recognition of study programs abroad for purposes of student mobility or graduate employment abroad. Transnational issues of higher education are addressed in cross-national initiatives such as the "*tunning project*" [3]. A well-known international accreditation agency for engineering, science, and technology programs is ABET, which has received

favorable recognition in the United States, and now more frequently in other countries around the world [22].

International accreditation is an opportunity for worldwide engineers. Educational institutions pursue international accreditation to respond to the current challenges young profession face as work in a knowledge society with highly competitive industries [23]. Nonetheless, in Latin America, public university graduatelack globalized professional skills, which jeopardizes their competitiveness in the international job market [24], [25].

3.1. Latin American Context

Latin American public universities play an important role in improving the standard of living of their students and their families, who usually are a vulnerable population. Due to the social responsibility that public universities have, international accreditation becomes an important opportunity for public institutions to providing better welfare, democracy, and equality from the science, education, and cultural perspective [24].

Accreditation ends up in recommendations that guide institutions or programs regarding the way forward in terms of improvements or institutional consolidation. These results can be used for the allocating public funds. They are also used for making insitutional or program level accreditation decisions that can include insights on improvement, provide a catalyst for healthy inter and intra-institutional competition, comparative analyses, enhanced student and faculty mobility, and a source of institutional differentiation [5].

Due to the growing interest in international accreditation in Latin American higher education institutions, it is important to share experiences regarding international accreditation, especially in public universities [24]. In Latin America, 35% of universities are public institutions; these public universities get around 50% of students who come from 63% of the Latin American region [26].

4. ABET Accreditation for Engineering

ABET is an international accreditation body for engineering, science, and technology programs. In the USA, ABET is the recognized accreditation authority for college and university programs in the disciplines of applied and natural sciences, computing, engineering, and technology at the associate, bachelor's, and master´s levels. ABET is a nonprofit and non-governmental organization with ISO 9001:2015 certification. This accreditation body was founded in 1932 as the Engineers' Council for Professional Development, and then, in 1980, changed to ABET [27].

ABET affirms that educational programs meet defined quality standards of the profession for which that program prepares graduates [28]. The accreditation is renewed periodically to ensure that the quality of the educational program is maintained [29].

To date, 4.144 programs at 812 colleges and universities in 32 countries have received ABET accreditation. Over 100,000 students graduate from ABET-accredited programs each year, and millions of graduates have received degrees from ABET-accredited programs since 1932 [28].

In Latin American, 48 Higher Education Institutions have ABET-accredited programs, with approximately 185 bachelor programs, of which 15 are Civil Engineering. These institutions are found in Chile, Colombia, Ecuador, Perú, and México, among others.

Currently, in Colombia, there are nine higher education institutions with thirty-five ABET-accreditated programs. The Universidad de Cartagena is the sole public university with an engineering program accredited by ABET. Its first accredited program was chemical engineering in 2017. The remaining eight institutions are private universities with several engineering programs accredited: the Universidad de Los Andes, the Universidad del Norte, the Universidad EAN, The Universidad Icesi, The Pontificia Universidad Javeriana (campuses: Bogotá y Cali), The Universidad de la Sabana, and The Universidad de San Buenaventura (Campus: Cali). Four out of the thirty-five programs are Civil Engineering programs from private universities. These facts show the lack of participation of public universities in the ABET accreditation process, which could be a consequence of the challenges and barriers faced by public universities concerning to pursue an international accreditation [25].

Although some public and private universities are pursuing international accreditation, where ABET accreditation is an option, there are varying opinions about the advantages and disadvantages of undertaking this process within the Colombian context, besides, having the national accreditation process.

There are scarce publications that share experiences upon the accreditation process itself, in the academic literature from Colombia and Latin America. The Spanish databases Redalyc, Scielo, and Dialnet registered 33 publications in Spanish, journal articles and proceedings, from 1996 to 2019.

The search boolean-equation (in Spanish) was "ABET AND acreditación AND ingeniería." The research topic of each published article was categorized into one of the following eight categories: (1) Accreditation process; (2) Quality; (3) Competences; (4) Curriculum; (5) Capstone design; (6) Teaching strategies; (7) Student assessment; and (8) Supportive Infrastructure. The criteria for each category were mainly adapted from a content analysis done with Nvivo™, a qualitative data analysis software. Based on a frequency analysis of topics through the Nvivo, the most frequent topics were ajusted and correlated to the main eight criteria of the ABET accreditation. The ABET criteria will explain in further sections (see Table 1).

Table 1. Publications in Spanish databases related to ABET accreditation

Topic related to ABET	# Articles	Percentage (%)
Accreditation process	4	12
Quality	2	6
Competences	9	28
Curriculum	8	24
Capstone design	2	6
Teaching strategies	5	15
Student assessment	2	6
Supportive Infrastructure	1	3
Total	33	100

Searched by May 17th, 2020

Source: own elaboration.

Only four publications (12%) addressed experiences related to the accreditation process itself at an international level [30], [31] or general level [32] and just one is from a Colombian journal [33] (see Table 1).

5. Methodology

This study conducted a systematic review of the specialized literature to achieve the objectives. Based on relevant primary studies, the reviewing process gathered evidence, summarized the results, and drew further conclusions. Thus, these findings provide insight to inform and improve practice and generalize patterns [34], [35].

The first steps of the systematic review were the searching and selection of relevant studies, published under a blind peer review process through Scopus, Redalyc, Scielo, Dialnet, and Google Scholar databases. The Boolean equations used combinations of keywords with the operators "AND" and "OR." The searching equations were: (1) *abet* AND "*engineering education*"; (2) *abet* AND *accreditation*; and (3) "*abet accreditation*" AND (*advantages OR disadvantages*). The search was limited to the period 1995-2019.

A final set of 48 primary studies was the basis for collecting, analyzing, and summarizing the advantages and disadvantages of the ABET accreditation for engineering programs (see Annex A).

The final sample composition of the primary studies showed the following distribution by year of publication (see Table 2).

Table 2. Sample composition of articles by year of publication

Year of Publication	# Articles	Percentage (%)
[1995 to 2000]	6	13
[2000 to 2005]	11	23
[2005 to 2010]	16	33
[2010 to 2015]	11	23
[2015 to 2019]	4	8
Total	48	100

Searched by March 2nd, 2020

Source: own elaboration.

Out of 48 articles, ten of them (21%) were written in Spanish and the remaining 38 (79%) in English; 25 (52%) articles were drawn from the Scopus database, 17 (35%) from google scholar, and the remaining 6 (13%) from Scielo and Redalyc databases. Fifty percent of the sources were journal-articles (see Table 3). The sample composition by geographical location of the publications showed that 21% (10/48) of experiences analyzed herein came from Latin-American countries sharing general reflexions about the ABET accreditation (see Table 4).

Table 3. Sample composition by source

Source	# Articles	Percentage (%)
Article	24	50
Conference	19	40
Other	5	10
Total	48	100

Searched by March 2nd, 2020

Source: own elaboration.

Table 1. Sample composition by geographical location.

Geographical Location	# Articles	Percentage (%)
Asia	3	6
Europe	10	21
North America	25	52
Latin America	10	21
Total	48	100

Searched by March 2nd, 2020

Source: own elaboration.

6. Opportunities and Barriers of ABET Accreditation in Colombian Higher Education Institutions

Any engineering program that seeks accreditation from ABET must demonstrate that all of the following criteria are met: Criterion 1- Student performance; Criterion 2 - Program Educational Objectives; Criterion 3 - Student Outcomes; Criterion 4 - Continuous Improvement; Criterion 5 – Curriculum; Criterion 6 – Faculty; Criterion 7 – Facilities; and Criterion 8 - Institutional Support [29]. The experiences were analyzed under three main topics:

- The accreditation process, taking into account continuous improvement and quality evaluation.
- Students' abilities, taking into account the student outcomes and performance assessment.
- ABET criteria, stressing the impact on program curriculum and faculty.

6.1. Accreditation Process

The ABET accreditation process relies mainly on continuous improvement and quality principles. These principles must guide the processes for assessing and evaluating the extent to which the outcomes are being attained by the students [6].

Literature shows several advantages regarding the ABET accreditation process and its positive impact on the educational institutions and their engineering programs. Firstly, the ABET accreditation promotes the adoption and implementation of a continuous improvement process and a 'culture of quality' [7], [15], [36], [37]. This quality process leads programs to self-initiated steps to track, document, analyze, report, and develop strategies for improvement [38].

The ABET accreditation process consists of three stages: self-study, a campus visit, and final decision. One of the advantages of this ABET process is that if a program finds deficiencies during the self-study, the program may stop after this introspective process and not continue in the accreditation process while addressing the deficiencies found. Another advantage observed is that during the self-study stage the programs become more aware of their institutional mission and key stakeholders: students, faculty, alumni, employers of program graduates, and funding sources [6].

On the contrary, some publications have documented the barriers and hardships experienced by programs during the ABET accreditation process. The main concern is about the high-cost associate with the preparations and adaption of programs to meet the requirements in the short and long-time [39], [40]. Accreditation involves making difficult decisions for engineering programs in emerging countries like Colombia. Assessment and evaluation processes typically create an additional need for administrative work in institutions and programs, often costly [5].

Other barriers identified that may hinder the accreditation process are the lack of understanding of the importance of the accreditation to the institution and the program; the documents and requirements needed; the characteristics and conditions of the evidence; and the corrective actions and continuous improvement plans [6].

6.1.1. Continuous Improvement

Among the main advantages of being an ABET-accredited engineering program is the adoption of a structured continuous improvement system that reflects the program's ability to learn, correct, and improve its daily processes [5], [7]. To fully take advantage of this benefit, data, information, and results should be evaluated annually in a structured and standardized format. This means that the decisions should be made based on sound documented evidence to make the appropriate modifications and/or additions.

However, one barrier found in the Colombian context is the lacking of a structured, systematized, functional improvement process, that is accepted by the engineering program's faculty members. Moreover, at the institutional level, some times there are no formal and established policies, for improvement process; many times these activities are considered additional or supplementary activities without a specific weight in the academic processes.

6.1.2. Quality Evaluation

The advantage of the accreditation of an engineering program is that it provides a public assurance of the quality of such a program, and thus of its graduates [41].

Furthermore, accreditation might boost the visibility, prestige, and recognition of programs and institutions [2]. However, persist a lack of understanding of the benefits of accreditation as a stamp of quality and how the quality culture might improve the educational process [6].

In Colombia, the adoption of an additional accreditation standard, in addition to the current national accreditation process, sometimes becomes trouble, because demands more resources, institutional support, and an open mind, to promote the quality assurance of engineering education. Additional difficulties have been observed in the Colombian context, the absence of civil society in discussing education policies of the program, regarding quality assessment and accreditation; moreover, the lack of adequate information systems for the program's stakeholders to have the minimum information needed for decision-making.

Best practices call for a program to seek input from their constituents. While it is important to consider this feedback, the program decides on the actual program changes [41]. Nonetheless, in our Colombian context, sometimes the relationships between industry and higher education institutions are feeble, and there is a worrisome disconnection between what industry needs and what institutions are teaching to future professionals.

6.2. Students Abilities

Criteria related to students are the most important requirements for the ABET accreditation process. The student outcomes must be documented as evidence of attaining the program's educational objectives. The student performance must be both evaluated and monitored to verify the attaining both the student outcomes and the program's educational objectives [6].

6.2.1. Student Outcomes

The advantage of ABET accreditation is that the proposed student-outcomes allow programs to focus efforts towards what students learn and what they actually can do at the time of graduation [7]. For instance, thought competencies deemed important for professional work like teamwork, communication, problem-solving, self-learning, experimentation, and critical thinking [6], [42].

On the contrary, adopting the student outcomes criterion into a process sometimes leads to challenges in the Colombia case. Outcome-based assessment is a relatively new concept in the Latin American region. This can lead to faculty misunderstanding and resistance, both barriers to faculty buy-in. Inadequate institutional support and faculty training only exacerbates the situation [24], [40].

6.2.2. Student Outcomes

An advantage of the ABET approach of outcomes-based assessment is that this approach focuses on identifying what students learn during their academic experience in a programs, and the students' skils, knowledge, and behavior at the time of graduation [7]. Adoption of the 'formative assessment culture' promoted by ABET contributes directly to enhancing student education, the program's quality through self-assessment, and ensuring that students achieve program outcomes before graduation [43], [44].

The formative assessment culture facilities an effective interaction and exchange of knowledge and philosophies among faculty members. It is an opportunity for junior faculty to receive advice, and for senior faculty to be coaches. Also, opens the door to discuss assessment issues among colleagues, leading faculty to be closer, establishing a common understanding of current students strengths and weaknesses; enabling faculty to quickly see how their efforts contribute to the overall process, allowing them to become familiar with other parts of the program curriculum [10], [43]. Sharing regularly the assessment issues leads program updates and develops confidence and awareness about what is done and what needs to be done.

Additionally, a benefit observed is that students become confident the education received by the program and being aware such education is current, competitive, and recognized by potential employers.ABET accreditation takes into account the overall satisfaction of the students, monitoring their performance, and taking care about the current trend in teaching and profession [9], [37], [45], [46].

By contrast, some barriers and difficulties from both administrative and academic points of view are observed as well. For example, the assessment of soft outcomes using direct methods and the trend of assessing individual students rather than programs itself. In most engineering programs in Colombia, the student assessment approaches are summative rather than formative assessments. The custom of assessing by rubrics that ensure consistency in a formative assessment is not very common. Some authors argue the development of rubrics requires and adequate investment of time, training, and support to counter faculty change resistance, and create confidence in a feedback-based continuous improvement process [14], [47], [48].

Finally, although the advice is the use of a comprehensive and formative assessment that use multi-source approaches, to maximize validity and reduce the bias of individual approaches [41], this approach would be an inconvenience in our Colombian context due to the large size of classrooms in public institutions that may affect the process. However, some templates of formative assessment are available in the literature and provide guide to be adapted to our context.

6.3. ABET Criteria

While ABET has 8 criteria, as mentioned previously, this section shall only focus on curriculum, faculty, and instutional support because these are the ones that normally present the largest challenges in the Colombian context. The curriculum must specify subject areas appropriate to engineering but do not prescribe specific courses. The faculty members must be of sufficient number and must have the competencies to cover all of the curricular areas of the program. The facilities and institutional support must be adequate to support the attainment of the student outcomes and to provide an atmosphere conducive to learning, as well as, to ensure the quality and continuity of the program [6].

6.3.1. Curriculum

The adoption of the ABET accreditation model creates opportunities for reviewing periodically and updating the curriculum, encouraging the implementation of innovations in the curriculum and teaching methods [2], [13], [20]. These opportunities allow programs to identify which prerequisites are incorrect, redundancies between classes, courses that are no longer on-demand, course syllabus outdated, and to reevaluate the lab sessions and complementary courses, among other issues [6], [8]. The changes can take place in the educational plans, curricular contents, facilities, activities, and assessment practices [7], [37], [46].

Another advantage of ABET accreditation is the implementation of feedback processes from both internal and external stakeholders regarding the suitability of the program curriculum. An assessment process must determine whether a program is meeting the needs of the discipline, or whether curriculum modifications need to be made [11]. ABET develops quality standards based on the needs of each profession and through professional and technical societies. With the curriculum harmonized with international needs, students can find worldwide employment options or academic opportunities to continue education.

However, within our Colombian education system, some inconveniences occur with any substantial change in curriculum that must be done, because these changes must follow a long and tedious process for official approval. Often, this curriculum modification process runs slower than the continuous update the profession faces. Furthermore, the accreditation process reveals an obstacle present in many public universities: the resistance to modification of the curriculum, because there is a lack of culture to involve professional bodies in the reviewing process. The curriculum has been always analyzed only from the academic point of view.

6.3.2. Faculty

Accreditation provides a great opportunity for a comprehensive review of development plans for faculty members, recruitment strategies, and well-qualified staff that support the program delivery. Programs and institutions must review if programs faculty are enough and well-qualified to ensure the proper guidance of the program.

Furthermore, the process is a good opportunity to promote faculty development in teaching, assessment, and research that help students to achieve the expected student outcomes [13], [45], [49]. Proper training in assessment brings faculty members opportunities to improve teaching and learning strategies [50], [51].

Accreditation also represents a great chance to evaluate and improve the institutional support, training, and investment in the faculty welfare to allow them to work in optimal conditions, having adequate facilities, reducing high workload, and respecting the academic freedom of teaching.

On the contrary, one of the barriers identified is that accreditation involves time and efforts by faculty, which can lead to additional workload for them and turn into lack of commitment. Sometimes accreditation process is not supported by part of the faculty members because there are misconceptions about the process and the belief assessing student's outcomes is time-consuming and complex [6], [40]. These misconceptions mostly come from the lack of support of the administration providing adequate guidance and tools for faculty and staff. Although assessment demands time for preparing documents and evidence, filling documents and forms, gathering and analyzing proper evidence, if the administration provides enough resources and guidance for the process this barrier turns into an opportunity [6], [52].

6.3.3. Infrastructure and Institutional Support

Deciding to undertake international accreditation brings the opportunity to evaluate how well coordinated are the efforts carried out by programs and the institutional administration in preparing professionals. Programs require adequate infrastructure, facilities, institutional services, renewing laboratory equipment, financial support, staff (administrative and technical), and proper training for faculty to meet program needs.

On the other side, meeting the ABET requirements also encourages the strengthening of the relationship between programs and the institution, through collaboration towards a common goal [2], [46]. This coordinated work allows programs and institutions to review the consistency between institutional mission, program educational objectives, and student outcomes following the constituents' needs [50]. A well-established interaction between the educational systems and its constituents will allow the institution and engineering programs a better understanding of students, society, and the industry needs [37], [43].

Because ABET accreditation requires a standing commitment of resources from both the institution and the program, this requirement becomes a critical issue due to the limited availability of resources [9], [46], especially in Colombian public universities. Indeed, the lack of funding to cover the expenses for submitting a readiness review for several engineering programs is evident due to the high costs and, therefore, there are reluctant faculty members about undertaking the process. Nonetheless, some Colombian private universities present a different condition, therefore, there are more private than public ABET-accredited programs.

7. Conclusions

Accreditation is a contemporary issue in higher education, particularly in engineering education. Indeed, some public and private universities are seeking international accreditation in Colombia, where ABET accreditation is an option.

Several opportunities and advantages were noticed in this study. For instance, ABET accreditation promotes the adoption and implementation of a continuous improvement system and quality culture in engineering education. The continuous improvement process aligns the institutional mission, program educational objectives, curricula, assessment methods, and student outcomes. Thus, programs become more aware of their institutional mission and their key stakeholders: students, faculty, alumni, employers of program graduates, and funding sources.

Another benefit identified is that the preservation of an assessment culture with a formative approach rather than summative one is the most remarkable habit learned through the accreditation process. Results of assessment culture feed a continuous improvement philosophy, making it possible to take appropriate decisions based on sound documented evidence.

On the contrary, the study found some barriers and disadvantages. The main concern is the high cost associated with preparing and adapting programs to meet the ABET accreditation requirements. Accreditation takes time and effort to be meaningful, which can sometimes lead to increased workloads and time requirements, inadequate training, and lack of faculty commitment.

Another barrier identified was the lack of a structured, systematized, functional improvement process, that is accepted by the engineering program's faculty members. Sometimes there are no formal and established policies, for improvement process, thereby these activities are considered additional or supplementary activities without a specific weight in the academic processes.

In Colombia, the adoption of an additional accreditation standard, in addition to the current national accreditation process, sometimes becomes trouble, because demands more resources, institutional support, and an open mind, to promote the quality assurance of engineering education.

Finally, this endeavor of identifying what barriers and opportunities are brought by an international accreditation process allows institutions, programs, and civil society be aware of the importance to link the program's constituents, its current needs, and which professional skills are required to allow students to successfully perform in a worldwide context.

8. Recommendations

Over the last decade, public and private universities have made efforts to adopt the ABET accreditation criteria for their programs. International accreditation has brought significant advantages to graduates, faculty, and the program itself increasing visibility in the academic and social field. Any type of experience regarding the international accreditation process it deserves to be shared and known for other Colombian institutions, programs, and society. Each accreditated and non-accreditated program have their own story, and those

stories can make a great contribution to those programs who are barely starting the process.

Continuous improvement not only involves faculty members and school director, but administrative and technical staff, who have an important role in supporting each process' step. This is the reason why institutional support and training about the accreditation process also must include the active participation of deans and program staff.

References

[1] J. D. Sobrinho, "La educación superior en el mundo 2007: Acreditación de la educación superior en América Latina y el Caribe," *UPCommons. Portal del Coneix. obert la UPC*, pp. 282-295, 2007.

[2] J. Uziak, M. T. Oladiran, M. Walczak, M. Gizejowski, "Is accreditation an opportunity for positive change or a mirage?," *J. Prof. Issues Eng. Educ. Pract.*, vol. 140, no. 1, pp. 1-6, 2014, doi: 10.1061/(ASCE)EI.1943-5541.0000172

[3] S. Schwarz and D. F. Westerheijden, *Accreditation and Evaluation in the European Higher Education Area*. Dordrecht, Netherlands: Springer, 2007.

[4] *Quality management systems - Fundamentals and vocabulary*, ISO 9000: 2015.

[5] L. E. Orozco-Silva, R. Cardoso-Rodriguez, "La evaluación como estrategia de autorregulación y cambio institucional," *Perfiles Educ.*, vol. 25, no. 102, pp. 73-82, 2003.

[6] A. Abou-Zeid, M. A. Taha, "Accreditation process for engineering programs in Saudi Arabia: Challenges and lessons learned," in *IEEE Global Engineering Education Conference, EDUCON*, 2014, pp. 1118-1125, doi: 10.1109/EDUCON.2014.6826250

[7] S. A. Al-Yahya, M. A. Abdel-Halim, "A successful experience of ABET accreditation of an electrical engineering program," *IEEE Trans. Educ.*, vol. 56, no. 2, pp. 165-173, 2013. doi: 10.1109/TE.2012.2206112

[8] E. Carey, "A quest for ABET accreditation: in retrospect," *J. Comput. Sci. Coll.*, vol. 19, no. 1, pp. 139-146, 2003.

[9] M. Gourley, G. Qian, H. Sung, T. Turner, "Seeking ABET accreditation of a computer science program at a public regional university," *J. Comput. Sci. Coll.*, vol. 23, no. 6, pp. 140-147, 2008.

[10] K. L. Huggins, L. A. Shay, J. M. D. Hill, B. S. Goda, E. K. Ressler, "Experiences in preparing multiple programs for a joint ABET accreditation general review," *Proceedings-Frontiers Educ. Conf.*, vol. 1, pp. 16-21, 2002, doi: 10.1109/FIE.2002.1157926

[11] A. Jackson, D. Horton, M. Johnson, "First-time accreditation: Lessons learned from the ABET accreditation process," in *ASEE Annual Conference and Exposition, Conference Proceedings*, 2006.

[12] F. G. Kohun, D. F. Wood, D. Colton, "The ABET CAC Accreditation Experience – Intent and Reality — The Information Systems Perspective," *Information System Education Journal*, vol. 1, no. 43, pp. 1-10, 2003.

[13] Y. A. Shatilla, A. H. Zahed, Y. A. Hegazy, "Engineering education excellence at King Abdul Aziz University: ABET accreditation and beyond," *ASEE Annu. Conf. Expo. Conf. Proc.*, vol. 2, no. March, pp. 5343-5356, 2005.

[14] K. Shryock, H. Reed, "Preparing effectively for ABET accreditation: What does it all mean?," *ASEE Annu. Conf. Expo. Conf. Proc.*, vol. 13, pp. 1-11, 2008.

[15] T. Thomas, M. Alam, "Strategy for ABET self-study and re-accreditation," *ASEE Annu. Conf. Expo. Conf. Proc.*, vol. 10, pp. 13131-13140, 2005.

[16] H. Chowdhury, F. Alam, S. K. Biswas, M. T. Islam, A. K. M. S. Islam, "Quality assurance and accreditation of engineering education in Bangladesh," *Procedia Engineering*, vol. 56, pp. 864-869, 2013, doi: 10.1016/j.proeng.2013.03.208

[17] L. Harvey, "The power of accreditation: Views of academics," *J. High. Educ. Policy Manag.*, vol. 26, no. 2, pp. 207-223, 2004, doi: 10.1080/1360080042000218267

[18] Consejo Nacional de Acreditación,"Acreditación de programas de pregrado," [Online]. Available: https://www.cna.gov.co/1741/channel.html

[19] B. Brittingham, "Accreditation in the United States: How did we get to where we are?," *New Dir. High. Educ.*, vol. 2009, no. 145, pp. 7-27, 2009, doi: 10.1002/he.331

[20] J. W. Prados, G. D. Peterson, L. R. Lattuca, "Quality Assurance of Engineering Education through Accreditation: The Impact of Engineering Criteria 2000 and Its Global Influence," *J. Eng. Educ.*, vol. 94, no. 1, pp. 165-184, 2005, doi: 10.1002/j.2168-9830.2005.tb00836.x

[21] H. L. Reif and R. G. Mathieu, "Global Trends in Computing Accreditation," *Computer (Long. Beach. Calif).*, vol. 42, pp. 102-104, 2009, doi: 10.1109/MC.2009.356

[22] H. A. Al-Twaijry, M. C. Mekhallalati, H. R. Abachi, G. Muhammad, "A rubrics based quality improvement methodology for ABET accreditation," *Int. J. Eng. Educ.*, vol. 28, no. 6, pp. 1266-1273, 2012.

[23] C. Rama, "El nacimiento de la acreditación internacional," *Avaliação Rev. da Avaliação da Educ. Super.*, vol. 14, no. 2, pp. 291-311, 2009, doi: 10.1590/s1414-40772009000200004

[24] K. Chiluiza, M. Wong-Villacrés, J. Duque, "En búsqueda de la acreditación ABET : Estrategias exitosas en una institución de educación superior pública de Sudamérica," in *12th Lat. Am. Caribb. Conf. Eng. Technol. Lat. Am. Caribb. Conf. Eng. Technol.*, 2014, pp. 1-10.

[25] M. Larrondo, V. Medina, G. Méndez, "Modelo de Registro y Acreditación de Instituciones de Educación Superior basado en el Modelo CMMI," in *Seventh LACCEI Lat. Am. Caribb. Conf. Eng. Technol*, 2009, pp. 1-8.

[26] A. L. Gazzola, A. Didriksson, *Tendencias de la educación superior en el mundo y en América Latina y el Caribe*. Caracas, Venezuela: IESALC, 2008.

[27] ABET, "ABET History," 2020 [Online]. Available: https://www.abet.org/about-abet/history/

[28] ABET, "ABET accreditation," 2020 [Online]. Available: https://www.abet.org/accreditation/

[29] ABET, "What is accreditation," 2020 [Online]. Available: https://www.abet.org/accreditation/what-is-accreditation/

[30] P. G. Altbach, J. Knight, "The internationalization of higher education: Motivations and realities," *J. Stud. Int. Educ.*, vol. 11, no. 3-4, pp. 290-305, 2007, doi: 10.1177/1028315307303542

[31] D. E. Marín-Méndez, "La acreditación de carreras universitarias. Una tendencia actual en la formación de profesionales universitarios," *Perfiles Educ.*, no. 71, pp. 1-16, 1996.

[32] M. Quirós Villalobos, R. Arce Durán, "Acreditación internacional: El caso de la Agencia de Acreditación Canadiense CCPE-CEAB en las universidades costarricenses," *Actual. Investig. en Educ.*, vol. 5, pp. 1-19, 2011, doi: 10.15517/aie.v5i4.9188

[33] L. E. Peláez Valencia, H. Trefftz, I. A. Delgado González, "Vista de Acreditación Internacional de Carreras de Ingeniería," *Educ. en Ing.*, vol. 15, no. 29, pp. 28-33, 2020.

[34] M. Borrego, M. J. Foster, J. E. Froyd, "Systematic literature reviews in engineering education and other developing interdisciplinary fields," *J. Eng. Educ.*, vol. 103, no. 1, pp. 45-76, 2014, doi: 10.1002/jee.20038

[35] H. Cooper, L. V. Hedges, J. C. Valentine, *The handbook of research synthesis and meta-analysis 2nd edition*. New York, USA: Russel Sage Foundation, 2009.

[36] M. Iqbal Khan, S. M. Mourad, W. M. Zahid, "Developing and qualifying Civil Engineering Programs for ABET accreditation," *J. King Saud Univ. - Eng. Sci.*, vol. 28, no. 1, pp. 1-11, 2016, doi: 10.1016/j.jksues.2014.09.001

[37] F. Aqlan, O. Al-Araidah, T. Al-Hawari, "Quality assurance and accreditation of engineering education in Jordan," *Eur. J. Eng. Educ.*, vol. 35, no. 3, pp. 311-323, 2010, doi: 10.1080/03043797.2010.483608

[38] R. T. Shankar, J. P. Dickson, C. A. Mazoleny, "A tool for abet accreditation," in *ASEE Annu. Conf. Expo. Conf. Proc.*, 2013, pp. 1-11.

[39] W. Ceccucci, B. White, "IS faculty perceptions of ABET accreditation," *Proc. Inf. Syst. Educ. Conf. ISECON*, vol. 6, no. 54, pp. 1-8, 2006.

[40] J. Estela, "Un modelo robusto y sostenible para la acreditación de ABET de programas de ingeniería," in *Encuentro Internacional de Educación en Ingeniería ACOFI 2016*, pp. 1-10.

[41] J. M. Fraser, A. Teran, H. T. Pham, "Paths to accreditation," in *ASEE Annual Conference and Exposition, Conference Proceedings*, 2014.

[42] J. Passow, "Which ABET competencies do engineering graduates find most important in their work," *J. Eng. Educ.*, vol. 101, no. 1, pp. 95-118, 2012, doi: 10.1002/j.2168-9830.2012.tb00043.x

[43] N. N. Bengiamin, "Development and implementation of an ABET EC2000 assessment program: Pros and cons," in *1999 Annual conference ASEE Annu. Conf. Proc.*, pp. 1743–1749.

[44] J. Enderle *et al.*, "The ABCs of preparing for ABET," *EIEEE Eng. Med. Biol. Mag.*, vol. 22, no. 4, pp. 122–132, 2003, doi: 10.1109/MEMB.2003.1237513

[45] N. H. Phung, P. T. Vu, T. Nam, "ABET Accreditation: Benefits and Challenges," 2014 [Online]. Available: http://www.hcmut.edu.vn/en/newsletter/view/tin-tuc/2337-abet-accreditation-benefits-and-challenges

[46] K. D. Abel, A. A. Fernandez, "Abet accreditation

of undergraduate engineering management programs: Established versus new programs—the similarities and differences," *EMJ - Eng. Manag. J.*, vol. 17, no. 1, pp. 3-8, 2005, doi: 10.1080/10429247.2005.11415271

[47] J. W. Prados, "Can ABET really make a difference?," *Int. J. Eng. Educ.*, vol. 20, no. 3, pp. 315-317, 2004.

[48] G. K. Patterson, "Preparing for the first ABET accreditation visit under criteria 2000," in *ASEE Annu. Conf. Proc.*, 1999, pp. 4037-4041.

[49] L. Wear, O. R. Baiocchi, M. Alden, R. Gutmann, and J. Sheng, "Getting ABET accreditation right the first time," in *ASEE Annu. Conf. Expo. Conf. Proc.*, 2012.

[50] T. S. Mayes, and J. K. Bennett, "ABET best practices: Results from interviews with 27 peer institutions," in *ASEE Annu. Conf. Expo. Conf. Proc.*, 2005, pp. 53-75.

[51] L. R. Lattuca, P. T. Terenzini, J. F. Volkwein, "A Study of the Impact of EC2000," *Engineering*, vol. 20, no. 3, pp. 318-328, 2004.

[52] A. Estes, S. Ressler, "Surviving ABET accreditation: Satisfying the demands of criterion 3," in *ASEE Annu. Conf. Expo. Conf. Proc.*, 2007, pp. 1-15.