Industry Members' Perceptions about ABET-based Accreditation: An Exploratory Study in a Developing Country

V. Sanchez Padilla, Albert Espinal, Jennifer M. Case, Jose Cordova-Garcia, *Member, IEEE*, Homero Murzi

***Abstract*—*Contribution:* This study explores industry members' perceptions about ABET-based accreditation in a developing country, using the case study of a program in a publicly funded polytechnic university in Ecuador.**

***Background:* Engineering programs often seek international accreditations to enhance education quality, align with global standards, or gain academic reputation. ABET-based accreditation originates in the United States, and thus presents some challenges for institutions in developing countries.**

***Intended Outcomes:* This study aimed to investigate the significance of international academic accreditation, as seen through the perspective of industry members. It focused on identifying fundamental competencies valued by employers and aimed to provide insights for institutions in similar contexts.**

***Application Design:* The research employed an approach informed by a qualitative methodology, involving in-depth interviews with five industry members who had served on the advisory committee board of an engineering program from a higher education institution in Ecuador.**

***Findings:* The findings identified three main areas of competencies that industry members value: communication skills for teamwork, a problem-solving orientation, and an ability for effective task planning. The study also showed that these industry members value international accreditation as a means for enhancing education quality and ensuring graduates develop the necessary skills and competencies, yet the overall awareness with their peers remains relatively low.**

***Index Terms*—ABET, accreditation, advisory boards, industry involvement, professional skills.**

I. Introduction

ACADEMIC programs from higher education institutions (HEIs) may seek to strengthen their credentials through accreditation, which can be seen as an indicator of quality management and assurance [1]. At the local level, countries typically have their own regulatory agencies that establish higher education policies and provide means for checking compliance both at the university and program level [2]. Globally, there are now systems for accreditation of professional programs, notably ABET[1] which accredits post-secondary programs in engineering, computer science, and natural and applied sciences. ABET is aligned with the Washington Accord, a system of mutual recognition of engineering degrees and accreditation, established in 1989 by English-speaking countries such as the United States, the United Kingdom, New Zealand, Canada, and Ireland [3], [4], and now including 20 signatories from across the globe and not limited to Anglophone countries.

ABET's assessment includes a focus on educational objectives, learning outcomes, continuous improvement, and curriculum [5], in which faculty members and industry employers collaborate as stakeholders in advisory committee boards when an HEI pursues ABET accreditation. The assessment of the faculty members involves their workload in teaching and research, academic and professional qualifications, student to faculty ratio, involvement in professional societies, and development in either teaching or non-teaching activities. This evaluation, which also involves the industry employers, identifies the levels of attainments that the industry expects from graduates, including feedback on how the HEI can better satisfy industry needs [6].

Accreditations allow HEIs or academic programs to demonstrate their strength in teaching methodologies [7], assessment processes [8] stakeholders' feedback [9], curricula enhancement [10], and learning resources [11]. However, aligning national and global standards can be challenging for entities seeking accreditation outside the United States [12], [13].

A. Research relevance and contribution

Engineering programs in industrialized countries tend to be aligned with the "school culture" of academia promoted since the end of the 19th century. This culture is opposed to the shop culture where engineering training originated, and which aimed more toward hands-on engineering practice [3], [14]. The school culture focuses on developing a problem-solving orientation based on theoretical mathematics and involving formal assessments [15]. In highly industrialized countries a bachelor's degree can be complemented by graduate professional programs that build further engineering specialization,

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[1] https://www.abet.org/

making the graduate more attractive for industry employment [16].

In developing countries, such as many in Latin America, which are often less developed in technological innovation, such graduate programs are less common and are mainly oriented to fulfilling requisites demanded by HEIs [17]. This region shows later growth in the graduate offerings because of the inequalities in educational background of students and the policies implemented in each country [18]. Additionally, Latin America does not count on a regional accreditation agency to evaluate academic programs [19].

Engineering programs from contexts outside the industrialized countries that are seeking ABET accreditation will thus need to adapt their program educational objectives (PEOs) to meet the accreditor's criteria. This accreditation tends to be sought because of the benefits it can bring to HEIs, including student mobility and agreements between institutions to entail strong collaborations in research [20].

Based on the framework proposed by Volkwein et al. [21], this study seeks to analyze the impact of pursuing global accreditation such as ABET in a developing country from Latin America. In the region, the interest of the industrial sector to establish a relationship with academia differs based on the size, technological research, or qualified staff that a HEI has [22]. There is an understandable concern that global accreditation could lead to a weakening of nationally established teaching practices and approaches. HEIs from seven countries in the region have pursued ABET accreditation. Table I shows the number of accredited programs by HEIs, 33 private and 12 public institutions, in each of these countries *(updated May 2024)*. The distribution of HEIs with ABET-accredited programs is 27% for public institutions and 73% for private institutions.

The present study investigated an academic program that belongs to a college of electrical and computer engineering from a public polytechnic HEI located on the coast of Ecuador. Sanchez Padilla et al. [23] presented preliminary findings drawing on two interviews. This extended exploratory study includes themes that emerged with additional analysis from those interviews and three more from other participants. Therefore, this extended research presents the responses of five industry members, such as employers and practitioners, who have served on the advisory committee board. Two research questions guided this study:

1) What competencies do industry members from a developing country consider important for recent graduates?
2) What are the views of industry members about the role of the ABET accreditation implemented in an undergraduate program of a developing country?

The present study aims to depict the stakeholders' viewpoints on global accreditation systems. The research team focused on the perceptions that are held by industry members about the ABET-based accreditation process because of its novelty in the context described. It is anticipated that this contribution could be valuable to other HEIs in similar contexts, outlining opportunities, advantages, or shortcomings of following international accreditation guidelines.

Table I
NUMBER OF ABET-ACCREDITED PROGRAMS BY HEI IN LATIN AMERICA

Country	Higher Education Institution	Type	Total
Brazil	Insper	Private	3
	Pontifícia Universidade Católica de Paraná	Private	2
Chile	Universidad Adolfo Ibáñez	Private	3
	Universidad de Concepción	Private	1
	Pontificia Universidad Católica de Chile	Private	8
	Universidad de Talca	Public	2
Colombia	Universidad de los Andes	Private	9
	Universidad Autónoma de Occidente	Private	3
	Universidad de Cartagena	Public	5
	Universidad ICESI	Private	4
	Universidad Industrial de Santander	Public	7
	Universidad Nacional de Colombia	Public	3
	Universidad del Norte	Private	6
	Pontificia Universidad Javeriana, Bogotá	Private	4
	Pontificia Universidad Javeriana, Cali	Private	4
	Universidad de La Sabana	Private	3
	Universidad de La Salle	Private	1
	Universidad de San Buenaventura, Cali	Private	4
Dominican Republic	Instituto Tecnológico de las Américas	Public	3
Ecuador	Universidad de las Américas	Private	3
	Universidad Politécnica Salesiana	Private	1
	Universidad San Francisco de Quito	Private	2
	Escuela Superior Politécnica del Litoral	Public	13
Mexico	Universidad Anáhuac	Private	5
	Universidad Autónoma de Querétaro	Public	2
	Universidad Autónoma de San Luis Potosí	Public	9
	CETYS	Private	3
	Universidad de las Américas, Puebla	Private	6
	Universidad de Guadalajara	Public	1
	Instituto Tecnológico Autónomo de México	Private	3
	Instituto Tecnológico de Aguascalientes	Public	6
	Tecnológico de Monterrey (multiple campuses)	Private	31
	Universidad de Monterrey	Private	6
	Universidad Panamericana	Private	3
Peru	Universidad Católica de Santa María	Private	6
	Universidad Católica San Pablo	Private	1
	ISIL	Private	1
	Universidad de Lima	Private	2
	Universidad Nacional de Ingeniería	Public	27
	Universidad Nacional de San Agustín	Public	5
	Universidad Peruana de Ciencias Aplicadas	Private	6
	Pontificia Universidad Católica de Perú	Private	9
	Universidad Privada del Norte	Private	1
	Universidad Ricardo Palma	Private	5
	Universidad San Martín de Porres	Private	3

II. LITERATURE REVIEW

The research topic of what industry members and employers consider significant competencies for engineering graduates is not new. Yet, the literature is limited on how this plays out in developing countries, especially in relation to studies with a qualitative methodology. This gap in the literature provides an opportunity to advance the understanding of this phenomenon by inquiring about the perceptions of industry members serving on advisory boards.

This review of literature is divided in two parts to align with the research questions: the first part describes what graduate competencies are valued by industry members, and the second part illustrates how industry members collaborate with HEIs.

A. Salient competencies considered by industry members

Educational methods are continually evolving at HEIs, as the industry needs expand in relation to technological advances

[24]–[26] and professional skills [27], [28], which can be influenced based on the characteristics and realities experienced by different societies.

At a regional level, case studies show contextual particularities. Agrawal & Harrington-Hurd [29] and Pyrhonen et al. [30] gathered feedback from graduate students and industry representatives on how to improve learning outcomes according to what employers seek as generic skills with personal attributes. Skills highlighted included good communication, curiosity, self-motivation, awareness of ethical standards, and critical thinking.

Khalid & Qazi [31] showed the value of inter-institutional collaborations and industry inputs in the context of Pakistan, encouraging the mastering of skills using project-based learning pedagogy, hands-on instruction, internship and cooperative training, and participation in workshops. On the other hand, Fathiyah et al. [32] list skills required by engineering accreditation bodies and compare these with skills currently valued by industry, pinpointing the risks that graduates would face when distinct skill sets no longer align with the demands of the labor market.

B. Industry members collaboration with HEIs

Research on stakeholder perspectives in industrialized countries shows how they are used to provide suggestions, feedback, or assessment to enhance academic programs [33]–[35], including an acknowledgement of engineers' societal responsibility [36]. For instance, Hussain et al. [37] describe industry members as external advisors who offer guidance and assistance on program development, outcomes assessment, faculty-industry interaction, and curriculum. According to these authors, by recognizing technical demands, the industry helps to identify needs to foster collaborative research with academia through the interaction between faculty and industry members.

Dotong et al. [38] investigated the significance of local accreditation in achieving transnational recognition from foreign agencies, granting an overview of local and international quality assurance mechanisms. Their research remarks that besides an international accreditation, other components, such as networking, strong relationships with industry, and internship collaborations can improve HEIs' rankings. They also emphasize that partnerships between industry and academia attract enrolments of foreign students because international accreditation aids the attainment of equivalent standards and qualifications recognized abroad. Similarly, Shafi et al. [39] suggest that indirect PEO assessments from industry employers allow programs to realize regional demands asked by industry. They argued that participation and contributions should be planned and agreed upon by all stakeholders before implementing substantial changes.

III. Conceptual Framework

The present study is guided by the conceptual framework proposed by Volkwein et al. [21] (Figure 1), developed to determine if the Engineering Criteria 2000 (EC2000, proposed by the ABET and its stakeholders) impacted student outcomes in engineering programs. Their framework shows how the modified EC2000 accreditation standards should affect curriculum changes, instructional methods, assessment initiatives, institutional procedures and reorganization, faculty activities, and values. It was hypothesized that the EC2000 processes and criteria, and the administrative changes resulting from their use, could influence student learning outcomes and impact employers' perception about the preparation of engineering graduates. In addition, through continuous improvement practices, the information about student learning outcomes and employer satisfaction can provide the foundation for advancements in curriculum and instruction, as well as educational and organizational practices and policy-making.

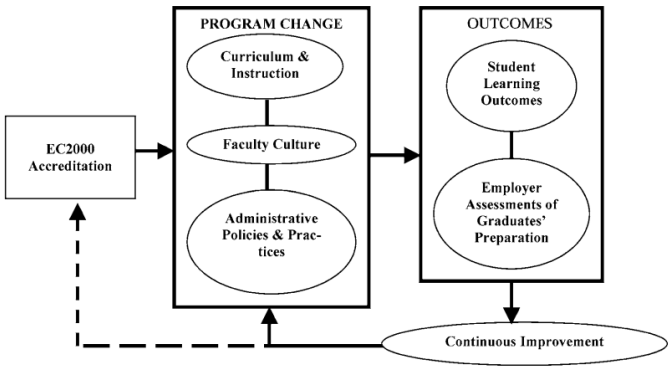

Figure 1. Conceptual Framework proposed by Volkwein et al.

The framework is consistent with this study as it includes constructs that involve different stakeholders. These activities should support the revision, modifications, and appraisal of the curriculum and teaching methods implemented. The model proposes that faculty members will lead assessment processes, employ innovative instructional strategies, and boost their awareness of current topics. This research is focused on employers, represented by industry members, in different roles at their organizations, such as hiring, supervising, or practicing the profession with the engineer graduates. They were considered relevant because they are implicated in the skill assessment of interns and recent graduates, providing firsthand information on how they perceive their capabilities based on the instruction attained by student learning outcomes. They convey feedback to the academic program through the advisory committee boards about the strength the students and graduates require for proper career development outside the educational setting.

This framework informed the present thinking about the role of industry participants in the accreditation process, and of the value of investigating their perceptions. From the framework, employer assessments of graduates' preparations are hypothesized to work in conjunction with the student learning outcomes, feeding into a process of continuous improvement generated from the interaction of these components. Therefore, the first research question of this study analyzes employer ratings on the knowledge and professional skills that recent graduates are required to demonstrate in their professional performance. The second research question focuses more on

industry members' perceptions of the role that accreditation can play in influencing the academic quality of engineering programs.

IV. Methods

The case study presented is located in Ecuador, classified as a developing country according to the World Economic Situation and Prospects (WEPS) [40]. The context concerns to an engineering program that is part of a polytechnic university. The industry members that comprise the advisory board have active collaboration with the technological sector of this country. The purpose of addressing the research questions through a case study is to obtain an in-depth examination of the scenario described. Case studies do not aim at generalizability but rather offer transferability of relevant insights to similar related contexts [41]. The study aimed to determine the participants' perceptions about the ABET accreditation process through a qualitative methodology based on semi-structured interviews, where Figure 2 depicts the overall process involved. The following subsections indicate the selection criteria used to recruit participants for the study, the instrument used, the data collection process, and the approach to analysis.

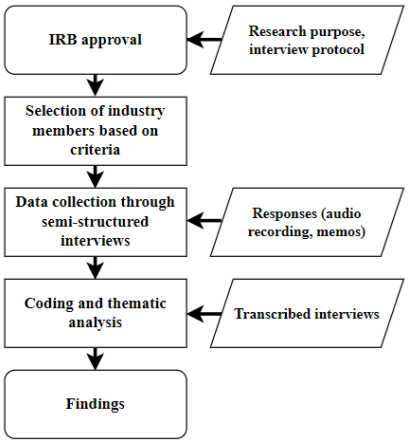

Figure 2. Steps involved to conduct the research

A. Context and participants

The participants of this exploratory study were industry members that are part of the advisory committee board of an undergraduate engineering program which had previously gone through an ABET accreditation. This program is part of the college of electrical and computer engineering from a public polytechnic HEI located on the coast of the Republic of Ecuador, which operates with funding from the central government. Besides complying with national accreditation requirements, the university holds thirteen engineering programs accredited under the ABET accreditation commissions, most of them awarded since 2019, including the approached engineering program. In addition, based on suggestions from the quality assurance department of the institution, the advisory committee board members are required to meet at least once a year.

Table II
Profile of the participants

Participant label	Education level	Gender	Industry field	Years of experience
Doaldo	Bachelor's	Male	R&D software	6+
Jamal	Master's	Male	Data networks	15+
Luar	Master's	Male	IP solutions	15+
Jena	Master's	Female	Cybersecurity	20+
Ana	Master's	Female	Cybersecurity	10+

Based on purposive sampling [42], this research drew the selection of the participants according to two criteria, which were that the members had attended the two last board meetings, held in October 2021 and December 2022, and had six or more years of engineering practice pertinent to the field of the academic program. The first criterion draws on the continuity in collaboration and attendance at the meeting, and the second because the accreditation process started in 2017. The advisory committee board of 2021 included fourteen representatives, while in 2022 the meeting was attended by nine. According to the criteria, five industry members met the requirements.

The second author contacted the selected industry members to ask about their availability to collaborate with the research. After they agreed, the first and second authors explained to them the study objective and research purpose. These authors indicated to the participants that their identities would remain anonymous, passing through a labeling procedure. As the primary language of the participants is Spanish, the interviews and coding process were conducted in that language to keep the authenticity of the data. In addition, no reward was provided for the participants' cooperation to avoid unnecessary bias in their responses. Table II depicts the participants' profiles, labeling their identities with pseudonyms.

B. Data collection and instrument

Before selecting the participants, the study secured Institutional Review Board (IRB) approval [43] to perform the oral interviews. The interviews were the instrument for data collection for bringing in in-depth and insightful responses from the participants [44]. They were conducted in person (first option) or virtually (alternatively, but not encouraged). The interview protocol was informed by the conceptual framework. Open-ended responses were invited based on the semi-structured interview format. The interview protocol was developed and included follow-up questions when considering something that required further exploration.

The interview protocol had three sections defined by topics such as introduction, competencies, and accreditation. It had the flexibility of being modified according to the fluency and depth of the responses throughout the conversations (Table III). This study covered the first research question based on the responses collected from the competency queries, whereas the second research question was addressed through the information collected from the queries relevant to accreditation.

Besides the interviewees yielding in-depth responses, they also provided insightful first-hand experience thoughts based on their condition of either hiring recent graduates or dealing with them in junior (entry-level) positions.

Table III
INTERVIEW PROTOCOL

Topics	Questions
Introduction	1) Describe a normal day at work and the challenges you presently face in your industry.
Competencies	2) What competencies do you think that engineering graduates should have directly after their graduation? 3) How do you evaluate the participation of the engineering graduates in the application of engineering principles in their work activities? 4) If it is applicable to their responsibilities, how do you assess the participation of the engineering graduates in multidisciplinary teams or in activities that demand leadership? 5) Do you think engineering graduates from an accredited program are more competent? Could you expand on your response?
Accreditation	6) At the moment you or your teamwork hire an engineering graduate, do you take into consideration if the graduate comes from an accredited program? 7) What are your views on the ABET accreditation of engineering programs in Ecuador? 8) What has been your experience of participating on this Board?

The interviews were conducted in the first quarter of 2023, lasting between 25 to 50 minutes in after-hour schedules, including an explanation of the accreditation details to strengthen or confirm what they already know. One interview was conducted in the workplace of the industry member, two at the second author's office, and the last two through video conference. Emergent themes from the transcription and coding process of the interview contents were translated from Spanish to English, while the thematic analysis focused on the development of candidate themes that resulted from an exhaustive review [45].

C. Data analysis and trustworthiness

Creswell and Poth [46] suggest that interviews used for the data analysis strategy be audio recorded, transcribed, and reviewed to attain accuracy. The first and second authors did the interviews and recorded them with the authorization of the interviewees using pseudonyms to guarantee anonymity. When starting off the interviews, participants were asked about their regular workday and the challenges they cope with. This first question was not intended to affect the purpose of the study, but the research team considered it necessary to better grasp the participants' background. While conducting the interviews, the authors used memos to highlight relevant statements from the semi-structured interviews [47].

Participants' responses were in Spanish. Two authors transcribed all the interview data and employed cross-check between them to satisfy trustworthiness to provide other stakeholders information for the transferability of the findings [44]. A web-based software platform for qualitative data analysis was used in the coding process, using the content from the interviews, memos, and annotations. The responses from the participants were cataloged and summarized through a suitable interpretation process. The patterns were coded for data condensation to approach thematic inductive qualitative analysis [44].

V. FINDINGS

This section provides participants' responses regarding the research questions according to themes. For the first research question, a theme emerged from the responses that referred to several competencies that industry members perceive as paramount for recent graduates, and which were determined to be aligned with the ones suggested by ABET throughout an accreditation process. For the second research question, the responses generated two themes with views representing perceptions of the education quality that students received through the following of international standards, and also the lack of awareness by industry members about the process.

A. Competencies that industry requires from graduates

Industry members and employers agreed on three core competencies required for entry-level engineers:

1) Effective communication needed for teamwork: Industry members highlighted the need for effective communication throughout several interview passages, most focusing on how this is essential for teamwork performance. For example, Doaldo highlighted that, based on his experience, he has noticed how recent graduates still struggle to express ideas or even interact with professionals from other fields, often complicating what they wish to communicate by addressing topics using complicated terminology. He recommends engineers convey ideas using charts or graphics and pointed out that engineers should communicate their ideas in an uncomplicated way. Jena confirmed this, referencing situations that forced engineering students to communicate remotely, mentioning: *"They communicate through Teams to follow hints so they can advance with their tasks, so they perform well as a team, they are very competent."*

Other industry members also agreed effective communication leads to better teamwork performance. Jamal specified that during meetings, recently graduated engineers often do not know how to communicate ideas to other areas different than engineering, despite all their experience and technical capability. He stressed that it creates setbacks in multidisciplinary teams, as they do not know how to face discussions with the end customers either. On the other hand, Ana agreed that when expressing their ideas, engineers should be empathetic. She provided an example of how an area in charge of network vulnerabilities must get along with staff in charge of development, infrastructure, and information technology audits. She emphasized that recent engineering graduates should not

speak only for themselves but also convey a language that allows other peers to understand better. Hence, they would avert redundancy and time wasting, knowing how to address specific issues to different audiences, determining the communication to carry out between technical staff to administrative or executive officers. She reinforced this point, asserting that knowing how to communicate complements activities related to project management.

2) Learning strategies for problem solving: The study participants gave responses that reflected the importance of analytical skills for engineers. Luar inferred that engineers should aim to comply with technology certifications, especially if they have had solid training to combine theory with pragmatism to address problem-solving. He commented that when applying different tools, including math equations, must allow engineers to set calculations to speed up the solutions asked. Moreover, Jamal mentioned that customers usually request that project engineers have brand certifications to perceive that staff assigned to their accounts are familiar with corporate solutions with vendor support. However, he considers these strategies should be developed before graduating so students can opt for certifications that qualify them for the labor market to cope with the technical support challenges that customers demand, including algorithm applications.

Furthermore, Doaldo said that academia should encourage students to face challenges that involve complex solutions, primarily if academic programs have international recognition due to accreditation. Although he mentioned that for the hiring process of engineers, employers do not consider whether or not they come from an internationally accredited program, he prefers their profiles to denote necessary technical knowledge but also the learning desire and the interest to investigate information by themselves, without getting stuck. A similar response was offered by Jena, implying she expects a creative and flexible mentality from engineers, which makes them able to solve complex problems, stating:

> *"I think that the first competence that engineers, regardless their specialization, should have is being able to solve problems or, better said, to offer creative solutions to complex problems, that is, being able to think outside the box. Thus, I hope that an engineering student who has learned* a *and* b*, will be able to solve* c *(...), showing what (he/she) learned."*

3) Task planning: In their responses, participants emphasized the importance of task planning. For example, Jena referred to a specific case in which an engineer, due to her proactivity, lays schedules with administrative areas, which she highlighted as positive for integrating with other fields. In addition, Luar commented on an example based on task planning in which engineering staff involved in a project met to propose viable solutions for evaluation and subsequent validation for decision-making with outstanding outcomes.

Jamal expressed that task planning and establishing deadlines according to the scheduled activities in teamwork should be paramount to prevent engineering staff from undergoing stress that leads them to performance decline. According to Doaldo, because of the pandemic, engineering students are more familiar with collaboration, task organization, and scope definition tools, all of them for the enhancement of planning activities, mentioning that: *"I realized that a necessary competence is time management, knowing how long a project takes (...) After designing a product that goes to the production stage, engineers have to deal with something new that can show up"*.

These competencies addressed by the industry members align with some of the key student outcomes suggested by ABET. These outcomes include to learn how to communicate effectively in workplaces to perform well in teamwork, to be able to solve complex problems, to apply the knowledge acquired correctly and, as an additional point, to set goals to optimize timelines for task planning, especially in situations that involve different fields.

B. Education quality through international alignment

Regarding the role of an engineering program seeking non-mandatory foreign accreditation, participants agreed that an accreditation process, such as ABET, should lead to education quality through the alignment with international standards, which can be seen as a plus for graduate readiness and program reputation. They argued that education could be improved with a combination of theoretical and practical factors aligned with the demands of the labor market. Luar indicated that enhancing the teaching methodologies for engineering courses strengthens the knowledge received by engineering students to face challenges the current society demands. Similarly, Jamal felt that education quality improves competitiveness in both local and international settings. He thinks this exposure can help students to be competitive in the selection process for a job position.

Jena provided a response that ranked the prestige of a university due to the education quality it can offer. She indicated that she does not consider whether the program is internationally accredited. Instead, she has a professional bias toward engineering professionals who graduate from prestigious universities because of the academic quality offered. Her opinion was:

> *"These international accreditations (...) guarantee that, regardless of which university it is (...) that (academic) program has the quality standards and (...) (fundamental) contents, and that students develop their skills and competencies that a professional should have in the field (...), with engineering students who will develop the same skills (...) as the ones from a university from the United States. That is what international accreditations, such as ABET, guarantee to me."*

Ana, similarly, pinpointed that international accreditations are significant to demonstrate how an academic program can grow and point towards international standards and not comply only with the local ones, mentioning:

> *"I would think (it is necessary to have an international accreditation). I honestly think so, because (...) we are trying to equate ourselves (...) to the world standard guidelines and not only the standards asked by the Ecuadorian education law but already looking beyond. And although many people think that certain accreditations or certifications are simply for compliance (...), there are controls*

and things that must be fulfilled to achieve that role. Those controls, those guidelines make us raise the bar for our (undergraduate) programs. It means, if the program has a certification, I believe that they have quite good global guidelines, and that makes the productive sector improve."

Doaldo's criteria focused on indicating that through an accreditation process, education quality assurance is achieved based on standards through rigorous processes, which can reflect how an engineering student or professional from a developing country may have acquired the same knowledge from the highly industrialized world. He considers this would help in many processes related to employment or study abroad based on the suggestions made by ABET towards academic programs seeking to be accredited:

"Processes are something extremely useful, interesting in the sense that the education that I am receiving (...), the series of entities involved in the learning process as such, are the same as in other countries, which is a meaningful fact. (...) as a student and professional, (...) the mindset (. . .) plays an important role, (knowing that) the education received here is the same as abroad."

He complemented his thoughts by signaling the meaning of interacting with others in the workplace, considering this as a plus and a positive influence on the students' and future professionals' attitudes, knowing they were part of a program with international guidelines.

C. Lack of awareness towards the accreditation from employers and industry members

Throughout the semi-structured interview, the participants stated that the experience of being part of the advisory board has been gratifying, mostly when the engineering program acknowledged their comments and recommendations for topics to include in the courses or the curriculum modifications to improve the educational process. Nonetheless, there were additional opinions from them in relation to their awareness of the international accreditation of the academic program. The responses implied that, if they were not members of the advisory board, they would be unaware of this type of process because they have not seen this mentioned in job advertisements yet. For instance, Luar compared the accreditation of an academic program with the importance of obtaining a technology certification from a specific vendor. The response given by Jamal was similar, mentioning he has never seen anything about the process or the earned accreditation, either in the press or social networks. Similarly, Doaldo stated the industry is unaware of the accreditation process and its benefits, even though he was aware that this information was relevant for applications for graduate studies.

Further, Ana and Jena, because of their previous collaboration as faculty members of the institution selected as case study, are aware of the accreditation process. However, when shifting from academia to industry, similar to the other participants' responses, they said they had not heard about the process or the accreditation earned. Ana argued that when evaluating candidates for a post, she pays more attention to the institution the prospective engineers come from rather than seeing in their resume a bullet point underscoring they come from an internationally accredited program. She implied that if a vitae emphasizes this, industry members and employers might be interested in learning more about the accreditation, expecting a diffusion would concern both the academic community and the productive sector. Also, Jena's response assumes the marketing of the process is perhaps targeted to an audience that she is not a part of, mentioning:

"I would think that perhaps a little more marketing is needed. For example, I know about ABET because I have been a lecturer (...) for many years. I even participated when the first meetings were just taking place (...) to start changing the accreditation programs (...). On the one hand, I am an entrepreneur, but on the other hand, I am a lecturer in a permanent relationship with academia. Then I found out about the certifications, accreditations, etc. But the common businessmen or entrepreneurs, that do not have that link with academia, do not find out that these accreditation processes exist unless someone mentions them, and I have not seen much propaganda about it (. . .). Maybe they are doing it as direct marketing and that's why I don't hear about it (because) I'm not the target, because I already know, I'm not in that customer database. I would think (...) incurring costs of, for example, advertising could be (...) very expensive."

Her opinions also focused on how social network postings can support low-budget marketing. She also mentioned more professional networks, such as *LinkedIn*, to create awareness among people from the industry about the importance of the added value of engineering programs accredited by international boards. She thinks engineering programs should communicate to society the benefits these processes bring and the advantages of hiring a professional that was part of these accredited programs.

VI. Discussion

The results of this study confirm that industry professionals in a developing country setting require engineering competencies that are aligned with international systems of accreditation. The works presented in [48]–[50] highlight the necessity that, before graduates enter the labor market, education must reinforce the development of skills aiming at innovation with the support of infrastructure improvements, laboratories, software acquisition, and teamwork culture. Thus, aligning with a student outcome model may be convenient for engineers to address more general and interdisciplinary issues in different contexts, which generates a plus for their academic degree. Through the interviews, it was seen how the industry seeks specific skills for engineers pursuing entry-level positions. The participants agreed that engineering program curricula should emphasize technical and non-technical skills. This aspect matches the thoughts highlighted in previous literature [51], [52] about the importance of essential competencies asked by the industry.

Based on the responses, a lack of communication was noted between academia and industry about the engineering programs that align with international accreditations and the

benefits they can bring to the labor market by having more competent professionals aligned with international curriculums. Works carried out in industrialized countries suggest the necessity to establish liaisons between local, regional, or international organizations, both academic and productive sectors, by the active participation of stakeholders [52], [53]. When accreditation badges are not adequately disseminated, it can result in highly qualified engineers being overlooked for positions and graduates from rigorous programs being unable to keep up with industry demands. These findings suggest that academia in developing countries needs to improve the promotion of their international accreditations.

Other findings highlighted the need for a universal system of recognition of competencies such as in ABET accreditation. The findings further extend the thoughts of the participants on their perceptions that an accreditation change education alignments and may even emulate higher education models from industrialized countries, going beyond of the improvement of educational competencies of the academic programs offered by the HEIs. Tacitly, they stressed that industry needs that engineering students develop skills through learning outcomes suggested by international accreditation bodies.

Finally, the responses also implied that earning a well-recognized international accreditation can boost an HEI's prestige, suggesting that program achievements should translate into a positive impact on society. This becomes relevant in such a way that interaction with academia raises standards and make the labor market more competitive with engineering professionals that correspond to the Sustainable Development Goals determined by the United Nations to approach industry 4.0 [54], which can lead to improving economic indicators as well as global academic rankings.

VII. Conclusions

This paper presents an exploratory study examining industry members' perceptions of ABET-based accreditation through a case scenario of a public polytechnic university from Ecuador. Engineering programs from this country do not have the tradition of pursuing accreditation from foreign organizations. Only three other Ecuadorian HEIs have pursued the ABET accreditation so far. The particularity is that those other three institutions are private universities that run with different funding, enrollment conditions, and tuition policies. Findings indicate that industry participants recognize the value of international accreditation processes for enhancing education quality and aligning engineering programs with global standards for the improvement of the professional skills and competitiveness of graduates. This study also highlights the need for better dissemination and understanding of accreditation benefits among employers and industry stakeholders in the context described, suggesting that such efforts can significantly contribute to the prestige and effectiveness of HEIs.

Although in-depth responses from participants with vast industry experience were collected, the criteria for participant selection allowed to gather only five industry members. Another aspect that shows up as a limitation is that this research focused on an engineering program from a college of electrical and computer engineering that has a curriculum related to data communication, cybersecurity, telemetry, and programming. Its structure differs from other engineering programs focused on earth sciences (e.g., civil engineering), marine sciences (e.g., naval engineering), or production sciences (e.g., systems and industrial engineering) that follow different educational objectives, curricula, or management in infrastructure and resources.

Even though this work focused on a case study to know more about industry members' thoughts about accreditation aspects through deep responses, the authors look forward to contributing insights into the current perception of the industry about the outcomes they notice and perceive from the accreditation process itself. This would enhance research and collaboration with academia or realize tangible/intangible aspects from the recent graduates (or interns) in the industry and to encourage further analysis regardless of the economic standards of the country in which the engineering program develops.

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