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Industrial engineering in higher education processes in zone 4: Ecuador

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Abstract

In zone 4, Manabí Santo Domingo de los Tsáchilas there are 4 public and 4 private higher technological institutes, which offer higher education at a technical and technological level. The purpose of this research is to determine the contribution of industrial engineers to the processes of higher education teaching and research within the public institutes of zone 4. As a methodology, a mixed investigation was applied to determine the contribution of the professional of the industrial engineer within of the institutes, as well as and the revision of statistics. As a result, it was obtained that industrial engineers reach 5.74% of the total of linked teachers, contribute 26.48% of the substantive axis of teaching with the teaching of subjects in various technical and technological training careers, and 30, 69% of the axis of the investigation with its scientific productions. It is concluded that industrial engineering professionals have excellent professional skills and contribute significantly to higher education processes, but their role remains relegated to teaching without being able to perform other managerial-administrative functions, although, in accordance with the reform to the Higher Education Law and its Regulations, and to the policies issued by the Higher Education Council, in the public contest of merits and opposition for Rectors and Vice-Rectors of the institutes, the professional profile of Industrial Engineering is one of the most suitable for effectively exercise these positions.

Keywords*: Higher education, technological training, industrial engineering, professional competences, processes.*

1. Introduction

In a globalized world, in which it is believed that competitiveness is synonymous with competition against each other, using growing technology, full of constant changes, training in the various disciplines is transformed, making a narrow line of division between the one and the other. Taking this consideration into account, one of the disciplines that has always been forged as multidisciplinary is industrial engineering, thus, "industrial engineering today shares knowledge and techniques with all other disciplines and areas of knowledge that deal with the resources that it coordinates to achieve a purpose" Archibold (nd).

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The industrial engineering professional has knowledge of all the operations that make up an organization, can create and direct their own company for the production of goods and / or services, be a consultant or advisor to companies, carrying out diagnoses and designing methods and strategies that increase the organizational effectiveness (UTN, 2019).
For an Industrial Engineer, knowing the guidelines and contents of accounting is perhaps the most important element for the performance of any company or business, as it allows knowing the economic and financial reality of the company, its evolution, its trends and what can be expected of her (Mendoza, 2018).
Within the historical context of industrial engineering, during the industrial revolution characters such as Adan Smith, Emerson, Henry Ford appear, who lay the foundations of industrial administration. Taylor is the pioneer of work engineering (human resources, machinery and equipment, work organization, times and movements), he is the one who supports industrial engineering. Fayol establishes the 14 principles of administration in companies, inherent to structure, process, person and change. Gantt, for its part, designed the technological method for the control of management and operations in the company, used to date (Acevedo & Linares, 2012).
The American Institute of Industrial Engineers defines Industrial Engineering as one that:
Deals with the design, improvement, and installation of integrated systems of men, materials, equipment, and energy. It draws on specialized knowledge and skill in the mathematical, physical, and social sciences, along with the principles and methods of engineering analysis and design to specify, predict, and evaluate the results to be obtained from these systems (Hodson, 1996).

Industrial engineering tends to the rational use of resources and effective administration and control, as follows: Industrial Engineering is located in the application of techniques, methods and procedures in all the factors involved in the management, production and distribution of products and services in any Company or Organization where it operates. As for the term "Industrial" its connotation is broad; They not only have to do with the manufacture of products, but with the transformation of resources into goods and / or services with high added value (Camacho, 2006).
For Valencia (1999) cited by Mendoza (2006): "Engineering today is understood as the set of principles, rules, norms, theoretical and practical knowledge that are professionally applied to have the bases, resources and objects, materials and man-made systems to project, design, evaluate, plan, organize, operate equipment and offer goods and services, in order to respond to the needs that society requires. As a consequence, it cannot be isolated from changes in processes generated by globalization and internationalization, characterized by the change of standards that somehow affect the realities of the country and therefore local realities ".
According to the publication of (Uziel, nd) there are several precursors of industrial engineering, so Henry Ford, Taylor, Frank and Lilian Gilbrett, Emerson, Harold Maynard, are some of those who promoted the engineering revolution with the principles of industrial engineering, emphasizing the concept and importance of productivity throughout the business field.
The Industrial Engineer has a generalist training that enables him to practice professionally in practically all the technical areas of all types of companies, both in solving the technical problems raised, as well as in the design and implementation of new technologies in the production process. Therefore, the Industrial Engineer is trained to adapt to any business sector and to know where to find the solution and how to apply it to any problem that arises. The general training of the Industrial Engineer allows them to cover very varied areas, such as: business management, energy, environment, approval and industrial property, construction, materials, manufacturing, mechanics, transport and logistics, electricity, acoustics, electricity, business organization, etc. COIICO (2015).
Other engineering firms have limited competencies to their specialty; however, industrial engineering has the particularity of the diversification and breadth of the field of professional practice, which is why mentioning the countless functions that an industrial engineer can perform is difficult, among the main Research, Design and Development, Administration, Management, Teaching, Testing, Manufacturing, Construction, Commercial Technician are counted. The industrial engineer has the ability to conceive a project from its phase of idea, drafting, development, execution, direction and evaluation or control, carry

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out the respective procedures for permits and licenses required by sectional governments. In such virtue due to "Its great technical base, its logistical vision, and its adaptability make it possible to find Industrial Engineers in practically any position of responsibility in any company in any sector, not only in the industry" (Baca, et al., 2014).
A competence is a set of attributes that a person possesses and allows him to develop an effective action in a certain area; it is the harmonious interaction of the skills, knowledge, values, motivations, personality traits and aptitudes of each person that determine the behavior that leads to the achievement of the objectives to be achieved in the organization (Tunning (2007).
Professional competence is only definable in action; that is, it is not reducible to knowledge, nor to know-how and therefore, it is not assimilable to what was acquired in training. Having ability does not mean being competent; since professional competence does not reside in resources (capabilities), but in the mobilization of these itself. To be professionally competent, it is necessary to put into play the entire repertoire of resources; knowing is not having, but using (Tejada, 1999).

2. Materials and methods

The research was developed in Ecuador, in zone number 4 that includes 2 coastal provinces, Manabí and Santo Domingo de los Tsáchilas, within which there are 4 public ISTs, 2 in each of them.
Figure 1 details the location of the study area.

Figure 1. Study area

The research considered a mixed, qualitative-quantitative approach, through the revision of statistics, an analytical-synthetic methodology was applied for the interpretation of the results and the discussion.
We worked with a population of 331 teachers hired from the 4 ISTs in the area, namely, Tsáchila and Calazacón from the province of Santo Domingo de los Tsáchilas, and Paulo Emilio Macías and Luis Arboleda Martínez from the province of Manabí.
The 19 industrial engineering teachers linked to the 4 ISTs in the area were taken as a sample.

3. Results and Discussion

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Training by competencies. Currently and especially from the point of view of the European Higher Education Area (EHEA), the professional profile has acquired a strong role in the training of professionals; This becomes a key point in a context where change and need have become the priority reasons for analysis and evaluation, when thinking about a training that has relevant validity to guarantee regional development and economic progress and technology of a country (Escamilla, et al., 2014). Figure 2 shows the competencies of industrial engineering.

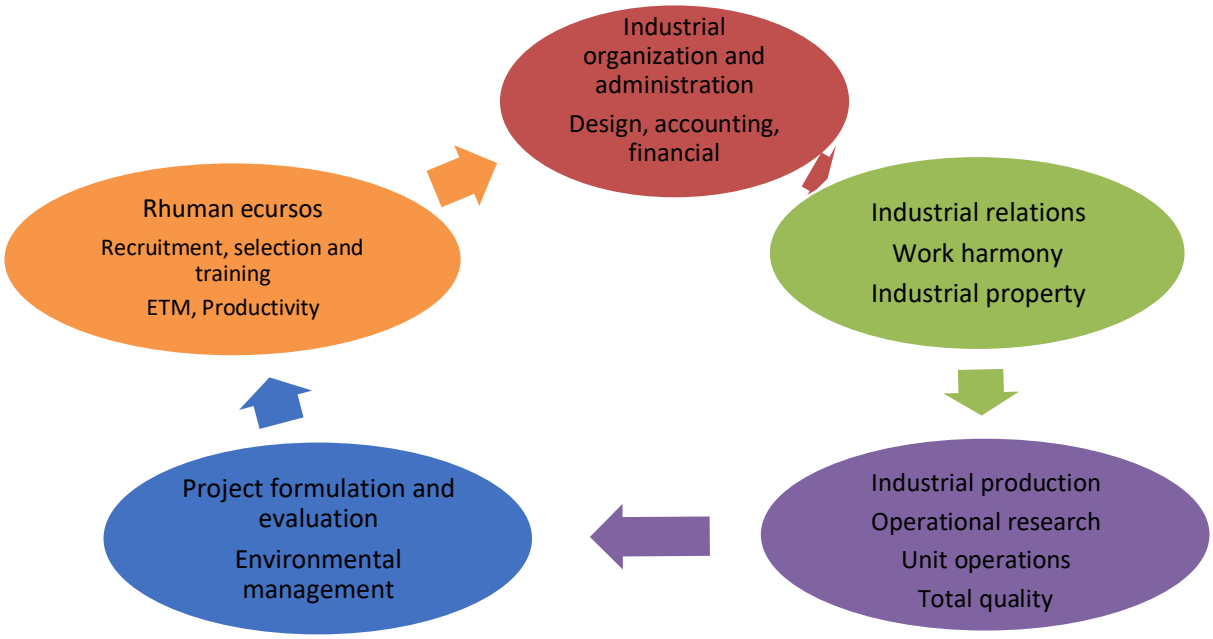

Figure 1. Various competences of industrial engineering

In Ecuador, the Organic Law of Higher Education (LOES) in force, promulgated by the (National Assembly, 2018) and the Academic Regime Regulation decreed by the (CES, 2017) in article 14 determines two levels of training in higher education in the country, within which third level training is contemplated: technical-technological and undergraduate, of which the technical-technological training is given by the higher technical and technological Institutes, and conservatories at the national level, these higher education institutions (IES), according to the (Ministry of Higher Education, Science, Technology and Innovation [SENESCYT])in the regulation for the operation of Higher Education Institutions of technical and technological training (IST) established by the (Higher Education Council [CES], 2019)are distributed according to the need or demand for higher education in the areas or regions.

Likewise, article 4 of the Academic Regime Regulation, issued by the (CES, 2017) stipulates the substantive functions of higher education, in accordance with article 117 of the LOES, promulgated by the (National Assembly, 2018) which are teaching, research and bonding, functions that tend to achieve the purposes of higher education, within which it stands out that "teaching integrates the disciplines, knowledge and theoretical frameworks for the development of research and link with society; it receives feedback from these to design, update and strengthen the curriculum " (CES, 2017).

According to what has been stated, the exercise of teaching practice is vital as a substantive function, which requires the need to incorporate professionals with mastery of know-how, with knowledge of the facts, with professional experience, with self-determination and motivational capacity that can effectively contribute to the academic training of hundreds of new third-level professionals who, in turn, will contribute positively with their work to local and regional productive development.

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Within the public and private ISTs, teachers can also act as academic and administrative authorities, thus they can act as career coordinators or of similar hierarchy, being able to also participate in merit and opposition competitions to perform other academic functions at the level of academic authority , when the competent bodies require it, complying for this matter, due process.

In his research,refers Burneo (2018) that the purpose of the IES of Ecuador is to develop in students competencies that respond to the strengthening of the labor market to which they will be linked when they are professionals, whether public or private. In the industrial engineering career, the competence acquired during third-level training and that required by labor demand stands out particularly, since its field of action includes several areas of the organization or institution, linking the integral management work as an organizing entity, not only in the production of goods, but also in the production of the multiple services provided by a public or private company, which includes higher education.

In North American industrial and organizational psychology, especially, there has been a real movement toward competencies since the late 1960s and early 1970s (Pereira, et al., 2008).

Professional competencies are related to the level of performance of a professional, from a successful one to the minimum level in a trade, integrating being, knowing and doing. The competence is "an identifiable and assessable set of knowledge, skills, values and attitudes related to each other that allow satisfactory performances in real work situations, according to standards used in the occupational area" (Tirado, et al., 2007).

In the reality of Ecuadorian education, particularly within higher education with regard to technical-technological education, as stipulated by the MMMM, the participation of industrial engineering professionals is not so evident, although the processes require it. of training in the various technical-technological training careers and their professional and labor competencies stand out from among other professionals in the engineering branches and in other disciplines in general.

This deficiency is even so latent that within the directive and administrative levels there is a lack of industrial engineering professionals, at the head of these institutions as Rectors and Vice Rectors, etc., which becomes a substantial weakness for these institutions , which for various reasons, does not contemplate the linking of industrial engineering professionals to their IST, taking into consideration the strength in which their incorporation into the area of higher education is constituted and all the processes that this involves.

This ignorance becomes a problem, which undoubtedly affects the accreditation processes of HEIs such as IST, according to the Council for the assurance of the quality of higher education (CACES, 2019), in which the parameters or quality indicators must show that the substantive axes of teaching, linking and research have been effectively developed, that the institutional strategic plans truly contribute to the achievement of the goals, that the quality of technical-technological education can be demonstrated not only in the documents of the project of career, but also in the level of satisfaction and receptivity of the student public.

This study is an analysis of the participation-contribution of industrial engineering professionals in the higher education processes inherent to the substantive axes of teaching and research, with an emphasis on the technical-technological training of the public ISTs in zone 4 , Manabí-Santo Domingo de los Tsáchilas of Ecuador.
Figure 2 shows the contribution of industrial engineering to the teaching component in ISTs in zone 4.

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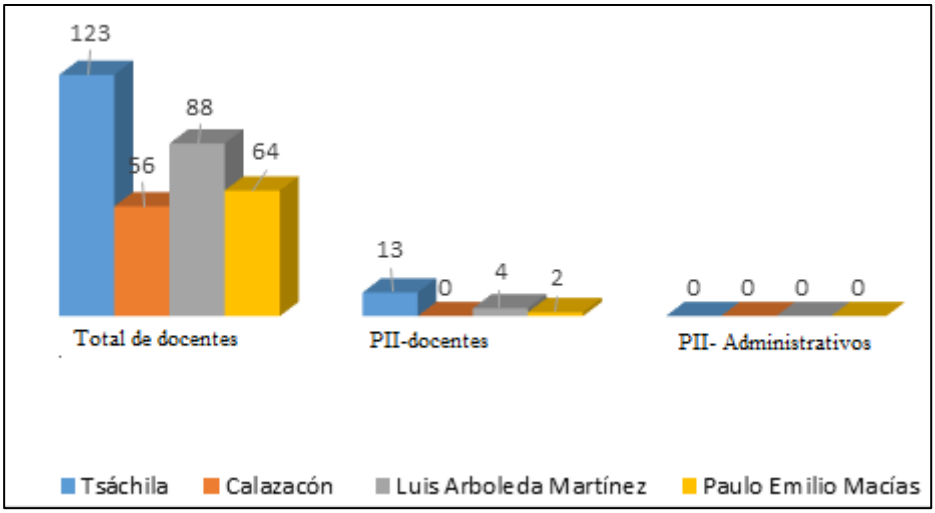

Figure 2. Presence of industrial engineering in ISTs in zone 4.

Of the total of 123 teachers linked to IST Tsáchila, 13 (5.65%) are industrial engineering professionals dedicated to teaching, none to the administrative area. At the IST Calazacón there are a total of 56 teachers, of which none (0%) is an industrial engineer. The IST Luis Arboleda Martínez has 88 teachers and 4 (4.55%) are industrial engineers who teach, none is administrative. In the IST Paulo Emilio Macías there are 64 teachers, of which 2 (3.13%) are industrial engineers linked to teaching, none of whom perform administrative functions. According to the graph, the presence of industrial engineers in the ISTs is scarce, representing an average of 5.74% in the 4 public ISTs studied.

For an industrial engineer, decision-making and the formulation and execution of projects are part of his job. For (Stincer, 2012) industrial engineers in addition to "project leaders, system creators, conductors and site guides", are also the engineers of work, of times and movements, of sustainable development, of the well-being of workers , of the organization. "That is why the systematization of each of the processes that it will carry out, through decision-making, is necessary."

The foregoing means the multiple facets for which the industrial engineer is prepared to assume, thus in the exposed results the capacities of these professionals in the directive, administrative and teaching areas of these higher education institutions are not being used, they represent a minuscule percentage (5.74%) in relation to the total number of professionals from other disciplines who work as teachers in said ISTs in zone 4.

Figure 3 shows the contribution to teaching made by industrial engineering professionals to the IST of zone 4.

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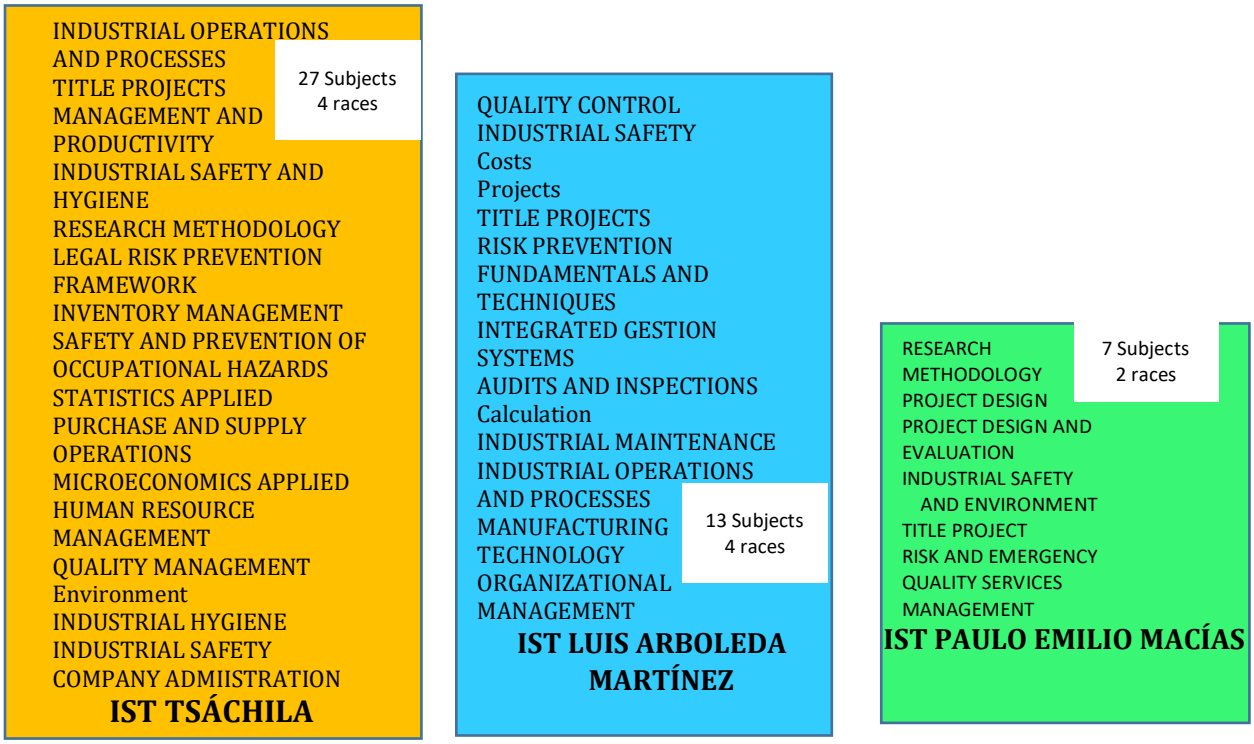

Figure 3. Industrial engineering: Contribution to the substantive axis of teaching.

Regarding the contribution that industrial engineers make to teaching, in the IST Tsáchila the 13 professionals of industrial engineering teach 27 subjects in 4 higher technological training careers. At the IST Luis Arboleda Martínez, the 4 industrial engineers teach 13 subjects in 4 technological careers. At the IST Paulo Emilio Macías, industrial engineering professionals provide knowledge in 7 subjects for 2 higher technological education careers.

The IST Tsáchila has 9 degrees, of which 4 (44%) of them are academically contributed by industrial engineers. The IST Calazacón has 3 degrees and no related industrial engineering professionals. The IST Luis Arboleda Martínez has 12 careers, of which industrial engineers provide technical technical training in 4 of them (33.33%). The IST Paulo Emilio Macías has 7 degrees, of which industrial engineers contribute knowledge in 2 degrees (28.57%). On average, industrial engineering participates with 26.48% in higher technical technological training.

According to (Camacho, 2006) "the Industrial Engineer is involved in different areas of knowledge, which allows him to develop his performance ...". The aforementioned means the multiple capacities of industrial engineers to be able to impart knowledge in the different careers offered by the public ISTs of zone 4, but it is precisely the lack of knowledge of the professional profiles that has generated their scarce linkage in the first instance to these institutions , and in the second instance, pigeonholeing them to specific activities, leaving aside all the potential that these professionals can contribute in the technological education of ISTs.

Figure 4 shows the contribution to scientific research of industrial engineering professionals linked to the public IST in zone 4.

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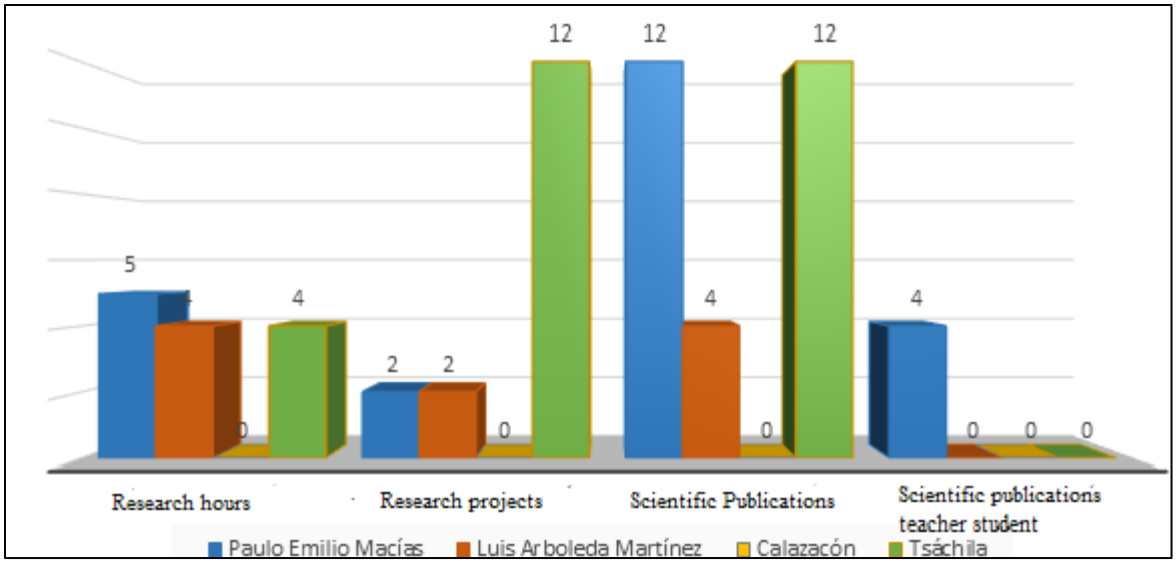

Figure 4. Industrial engineering: contribution to the substantive axis of research.

Regarding the contribution to scientific research of the industrial engineers linked to the ISTs of zone 4, the IST Tsáchila allocates 4 hours for research, has 12 research projects, 12 scientific publications, and has no teacher-student scientific publications in those involving professionals in industrial engineering. The IST Luis Arboleda Martínez assigns them 4 hours of research, they have developed 2 research projects and generated 4 scientific publications, they do not have scientific publications in which the industrial engineering teachers participate with the students. The IST Paulo Emilio Macías provides them with 5 hours of research that have conceived 2 research projects, 12 scientific publications by industrial engineering professionals and 4 scientific publications involving industrial engineering teachers with students.

According to Stincer (2012), "Industrial engineering is one of the branches of knowledge that involves creativity and the implementation of the principles of science. It is essentially pragmatic and constantly refines itself ". This definition is related to the results that demonstrate the contribution to science of industrial engineers linked to the ISTs of zone 4, where they are not only dedicated to teaching the chair, but are also entering the world of scientific research, which is also another of the substantive axes of higher education in Ecuador.

Figure 5 presents the total contribution of industrial engineering to the substantive axis of research in higher education.

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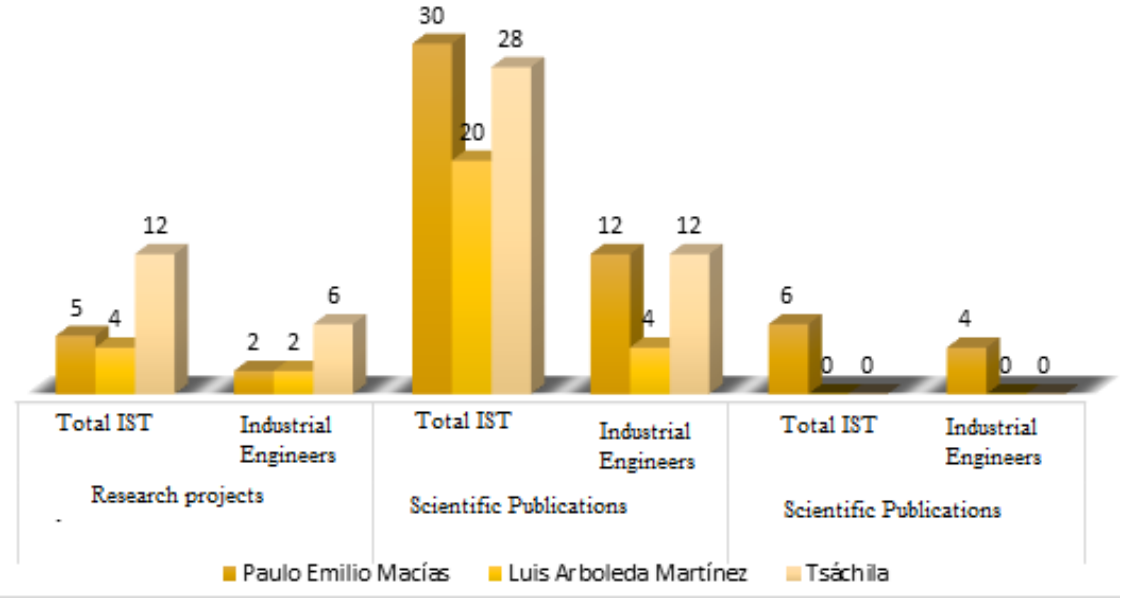

Figure 5. Industrial engineering: total contribution to the substantive axis of research.

Of the total number of research projects generated by the IST Paulo Emilio, industrial engineering professionals have participated in 2 (40%), of the total scientific publications they have participated in 12 (40%) and of the total teacher-student publications , 4 (66.67%) have been promoted by industrial engineers. The IST Luis Arboleda Martínez, of the total of its research axis, in research projects have participated 2 industrial engineers (50%), 4 (20%) in scientific publications. At IST Tsáchila, of all its research projects, industrial engineers (16.67%) and 12 scientific publications (42.86%) have participated in 2 projects.
The average participation of industrial engineers in the substantive axis of research is very important and represents 30.69% of the scientific production of the ISTs in zone 4.

Figure 6 shows the professional competencies and experience in the field of teaching of industrial engineering professionals linked to the ISTs in zone 4.

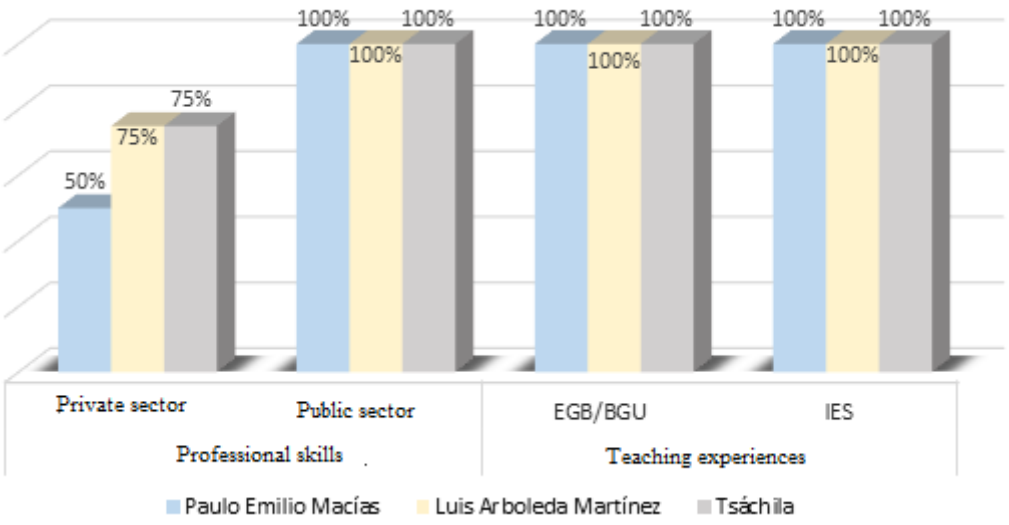

Figure 6. Competences exercised by industrial engineers in the ISTs.

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The graph shows the professional skills that industrial engineers have performed in both the public and private sectors; On average, 66.67% of these professionals have contributed their professional skills to the private sector and 100% to the public sector. Likewise, the teaching experience is remarkable, 100% of the industrial engineers who work as teachers in the public ISTs have teaching experience acquired in basic general education and high school as well as in Ecuadorian HEIs. This is very relevant information that shows the relevance of the professional competencies of industrial engineers as teachers and professionals linked to higher education institutions in 2 Ecuadorian provinces, which undoubtedly constitutes a strength for the public higher institutes in the area 4, since they not only have aptitudes to carry out teaching and research, but they can also perfectly function as administrative and managerial personnel within these institutions, where their contribution to the institutional strategic plans, both in the planning stage, and in the execution, evaluation and follow-up are substantial so that these institutions can achieve the quality indicators established by CACES and be accredited.

Based on the results presented (Burneo, 2018) in his study, he analyzed the professional profiles and competencies developed by 13 universities in the country that offer the Industrial Engineering career, achieving evidence that industrial engineers have the necessary skills to contribute to the growth of the Ecuadorian public sector, supporting the achievement of its objectives of quality, efficiency and effectiveness in the provision of services. The improvement initiatives proposed by the Ecuadorian government are linked to the knowledge acquired by the Industrial Engineers; Management by Processes, the Ecuadorian Model of excellence, Government by results are strategies that have their origin in the private sector, where the industrial engineer commonly works and that allow to demonstrate the contribution that this profession can give to the public sector. With the comparison of competencies carried out, it was possible to observe that many of the competencies requested to hold public office are developed by industrial engineers during their university studies.
Although the industrial engineering professional has excellent professional skills and contributes significantly to academic training processes and research in higher education, their role remains relegated to teaching without being able to perform other managerial-administrative functions in ISTs, despite that, in accordance with the reform of the Higher Education Law and its Regulations, and the policies issued by the Higher Education Council, for the public competition of merits and opposition for Rectors and Vice-Rectors of the IST, the professional profile of Engineering Industrial is one of the most suitable to effectively exercise these positions

Conclusions

Although one of the governing bodies of higher education in Ecuador, determines the policies in matters of higher education and technical-technological training, it is the management level of the IST who issues the need for a professional to meet the demand for higher education Or within the institution, this hinders the possibility of incorporating industrial engineering professionals to its higher education institutions, due to the lack of knowledge of the professional profile of industrial engineers, emphasizing above all in their role as professional in the organization and work.

The proactive role of industrial engineers is fundamental in higher education processes, it is an ally for the correct decision-making and the development of ideas, to guarantee productivity in the institution-company of educational goods or services such as higher technological institutes , to offer or offer a valuable final product of quality (technical and technological careers, university technologies, technological masters), based on good labor relations and a harmonious organizational climate (good work environment), which are pillars for competitiveness in a world globalized by information and communication technologies.

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