Analysis of the Participation of Female University Students in STEM/ICT Careers in El Salvador

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Abstract

The low participation of women in careers in the STEM/ICT area due to its acronym (Science, Technology, Engineering, Mathematics, Information and Communication Technologies), has led to the study and analysis of the situation experienced by the female gender in different scopes. of life, one of them is higher education and how the choice of careers is affected by different stereotypes. The objective of the study is to know and compare the statistics of enrollments and graduates of university students from El Salvador in STEM/ ICT, in the periods from 2019 to 2021. The study delves into some fundamental issues that precede the development of the research, such as stereotypes and gender, inclusive sexist education, also known as coeducation, and gender equality policies at the level of El Salvador. In addition, the study presents the different existing and current projects or initiatives that are being developed at the national and international level in favor of gender equality and many are promoted by Higher Education Institutions (HEI), private companies and non-governmental organizations. The research has a quantitative design, and its scope is descriptive. For the collection of information, statistics were requested from the three HEIs participating in the study. Subsequently, six of the careers in the STEM/ICT area were analyzed, obtaining as a result the percentage of participation of the female gender in relation to the total number of women and men in each of the STEM/ICT careers selected for the study. In conclusion, the number of women in some of the careers in the STEM/ICT area is gradually increasing, originating the academic and professional growth of El Salvador.

Keywords

El Salvador, gender, equity, co-education, women

1. Introduction

This research arises from the need to quantify the number of women who study and complete university careers in the STEM/ICT area, by its acronym (Science, Technology, Engineering, Mathematics, Information and Communication Technologies), the main objective is to analyze the participation percentages of female students in the aforementioned careers of Higher Education Institutions (HEI) in El Salvador. There is no platform in the country where this data can be consulted, which allows us to have a broader vision of the schooling situation of women in El Salvador.

During the development of the research, different topics were considered that contribute either positively or negatively to the process of schooling in the female gender, which can be found as follows: Stereotypes and Gender, Female Models, Coeducation, Gender Policy in El Salvador, Initiatives and/or Projects, finally we have the data collected from the participating Universities and their respective graphs.

It is worth mentioning that in the data collection it was necessary to make use of some criteria that served as filters to select which of the Higher Education Institutions would be part of the object of study, these criteria are: If the Higher Education Institution has STEM careers, at the same time if said institution is part of a Latin American University Ranking, for which the QS Latin America University

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Ranking [1] was used. Three HEIs in El Salvador were selected, as well as some of the STEM/ICT careers, taking as criteria the student demand.

In addition, developing the research allowed us to broaden the vision of the study and to propose a technological proposal that facilitates the provision of statistical information on Higher Education Institutions to the public.

2. Background

In the development of the research, several relevant topics are addressed that give rise to the problem of the low participation of women in opting for STEM/ICT careers. The topics described are the following: stereotypes affect important decisions in the choice of a university career, female role models are considered a support to promote the development of women in areas that have been considered a field of men, the aspects of coeducation should be strengthened to ensure equal opportunities for the female gender, in addition, the topic of gender policy is addressed which was developed and implemented in El Salvador [2] since 2016 and the different actions that have been taken since then to ensure the progress of women.

2.1. Stereotypes and gender

Stereotypes are ideas or expectations of roles that are attributed to men and women in society, which provide models of behavior according to gender and if it does not fit these expectations then it does not meet what society expects, ie indicate a representation of being and feeling, currently some entities struggle to break this type of ties which do not allow progress on how to really be, do things that really satisfy regardless of whether society sees it good or bad because it is not attributed to gender

Certain characteristics and roles are associated with the stereotype of femininity: motherhood, domestic work, and care of others, being affectionate, sensitive, weak, sentimental, intuitive, good, dependent, submissive, adaptable. On the other hand, the stereotype of masculinity is associated with the role of provider and being strong, competitive, rational, courageous, not very expressive, dominant, independent, and violent behaviors are naturalized [3].

Stereotypes affect both men and women. However, they often have a glaring effect on the female gender. As Sandra Fredman has explained, "one useful way to examine women's continuing disadvantage is to identify the assumptions and stereotypes that have played a central role in perpetuating and legitimizing women's legal and social subordination. Such assumptions have roots that extend deep into the history of ideas and yet continue to influence the social and legal structure of modern society. Indeed, this continuity is striking, given the degree and fundamental nature of change in the political and economic contexts" [4].

Stereotypes degrade women, assign them low roles in society and devalue their attributes and characteristics. Prejudices about women's inferiority and their stereotyped roles generate disrespect for women and their devaluation in all sectors of society. Women may be socially conditioned to internalize negative stereotypes about themselves and to fulfill the subordinate and passive role they consider appropriate to their status. When societies fail to recognize and eliminate prejudices and associated stereotypes, a climate of impunity for violations of women's rights is exacerbated, which allows unfair prejudices and stereotypes about women to become entrenched in society, which in turn causes further devaluation of women [5].

What is the origin of gender stereotypes? There are many that have been imposed by different areas of life, starting with the family, since it is the parents who teach how to behave within society, the latter is a very important entity in terms of assigning gender roles and forms of behavior. This is observed in various ways, from the distinctions in clothing (pink for girls and blue for boys), to the expressions that are heard throughout life. Traditionally, men and women accept these gender stereotypes as a way of fitting in with the rest of the social order [6].

Women perform more routine tasks and less abstract tasks than men in the same occupations [7], for example, it is very common that we hear the following said: ¿Gabriela Reynosa - “And what are you doing in a men’s career?" If the above-mentioned situation is analyzed, professional careers have no gender, in this area we can also encompass the fact that kitchen work is attributed to women only and

when a person of the male sex performs in this field also suffers from the same questioning; continuing with the idea of stereotypes more focused on women, we often hear and even be victims of the following comment: ¿Gabriela Reynosa - “For when the children? You're going to miss the time", with respect to this phrase, it is clearly known that the female sex is the one who has the virtue of giving life, but this does not mean that being a woman is obliged to want to be a mother, many women can find satisfaction in developing professionally and not in being mothers, others on the contrary, prefer to be mothers and put aside their professional career, but others also want to be mothers and develop professionally, each one is free to make the decision.

2.2. Female Models

Few people would disagree with the idea that role models can have a profoundly positive impact on a person's life. Role models may differ in terms of age, race, and/or gender, yet there is one characteristic they share: they are all perceived as competent in their respective areas. For example, female role models in math-related domains might be particularly useful for mathematically talented women because they represent evidence that contradicts stereotypes about women's poor mathematical ability, so that women's performance on math tests is protected after finding or learning about a female role model. Moreover, if a low score on a standardized math test is one of the reasons why women are severely underrepresented in mathematics and engineering, then the benefits of having female role models for female students in those academic domains may be considerable [8].

A study conducted by Microsoft among 11,500 girls across Europe establishes a clear connection between the visibility of female role models in the world of science and technology and girls' interest in STEM subjects [9].

2.3. Coeducation

The dictionary of the Royal Spanish Academy defines the term coeducation as "teaching students of both sexes in the same classroom and with the same educational system" [10]. However, this term is focused on achieving a change of mentality regarding society, taking into account the critical awareness and values that are currently held, since there is much gender inequality and stereotypes, it seeks to promote the acceptance of the gender to which one belongs, as well as using the differences of each as an advantage and not as an obstacle, the purpose is to identify factors of strength that allow incorporating gender equality.

On the part of teachers, it is conceived as "A way of understanding educational practice as something alive, which seeks the existence of two sexes in the same classroom without this meaning inequality, violence or discrimination, but rather an opportunity to enrich and develop to its fullest expression. In other words, coeducation consists of intentionally promoting an education under equal conditions for boys and girls, accepting both sexes as something natural, and without limiting their development based on it" [11].

How can coeducation be put into practice at school? Whenever this question is asked, the debate on transversality arises, that is, whether coeducational practice should be implemented through a specific subject or whether it should permeate all subjects and areas of the curriculum. In coeducational practice, they have opted for developing a dual strategy in which specific and transversal actions are combined in parallel to contribute to advancing the coeducational model. This requires a focus (internal, the educational center itself; or external, technical staff of the bodies responsible for ensuring equality policies) from which to coordinate, promote and supervise the proposals for action in the field of coeducation. The advantages of this dual strategy are that it guarantees the comprehensiveness of the action in all areas, activities, times and spaces and, in turn, allows reinforcing the results through specific and timely actions [12].

Although it is not possible to attribute all gender inequalities to education, it has consequences in the configuration of the adult world, and research shows that a sexist education has an impact on the construction of this later reality. [13].

Sexist education is that which maintains the stereotypes and roles that are culturally assigned to one or the other sex. The consequences of a sexist education can be varied, for example, the lack of political

participation of women, difficulties in the generation of leadership or elements of the configuration of sentimental relationships. An education of this type that is configured since exclusion and denial is unequal, since it perpetuates inequalities between men and women. [13].

For the reasons proposed above, it becomes necessary to advance from a mixed school to coeducation but understanding this coeducation as the educational action tending to generate educational spaces where there is equal treatment and opportunities for men and women, which are shared on the basis of respect, tolerance and away from all sexism. We must insist on the fact that it is not enough that men and women are sharing the same school space, since in coeducational education there are no definitions regarding the coexistence of boys and girls. We can compare with society, men and women share spaces, but it is not possible to say that for this reason there is equity in the treatment, access, and opportunities for beings of different sexes [13].

Currently in El Salvador this term has taken a lot of strength, which is why since August 2016 there is a gender policy [2] that seeks and promotes equity from a legal point of view that allows to be more effective in the development of the female sex.

2.4. Gender policy in El Salvador

Education is an important element in the socialization of people, since it is one of the most effective means of transmitting values, including those associated with the social construction of being women or men.

The Ministry of Education (MINED), with support from the Millennium Fund II (FOMILENIO II), formulated its first Gender Equity and Equality Policy (PEIG) and its implementation plan for the period from September 2016 to September 2020.

The policy implementation plan is organized into three major areas of intervention that are closely related and interdependent, grouped for methodological reasons as follows: inclusive non-sexist education, institutional mainstreaming, and prevention of gender-based violence.

Similarly, the internal procedures and guidelines of the governing institution of education, curriculum, teaching methods, supervision, and evaluation systems, among others, are impacted.

Achievements 2017-2018: Design of five training programs on gender and inclusive non-sexist education, aimed at specialist teachers, school management staff, MINED technical staff, students, and families.

Therefore, the development and implementation of the gender policy through MINED has had a direct impact on the existence of greater demand for the female gender in different careers that previously have been considered a male field; based on the analysis of the data obtained in this document in the results section, as well as the development of some initiatives or isolated projects that go hand in hand as support for women.

2.5. Isolated initiatives and projects

Worldwide, less than 35% of professionals in the areas of science, technology, engineering, and mathematics are women. In addition, their careers tend to be shorter and their salaries lower than those of their male peers, according to data from the United Nations Educational, Scientific and Cultural Organization (UNESCO) [14].

As a result of the problem of gender stereotypes in STEM, some organizations, companies, and universities generate different initiatives, projects or isolated programs which aim to get more women interested in STEM careers: Science, Technology, Mathematics and Engineering, where 35% of STEM higher education students are women, and only in Latin America there are 45% of female researchers, surpassing the world average of 28%, according to UNESCO.

2.5.1. National level

Don Bosco University has led the Science Girls Camp, an extracurricular space in which female high school students receive practical training in science, technology, engineering, and mathematics -

STEM areas and interact with students and teachers, exploring career alternatives. Up to 2019, more than 200 young women have participated and completed the Science Girl Camp; 25% of them have become part of the UDB studying a university career, and in addition, in 2019 the first 13 former Science Girls graduated from a career at Don Bosco University.

Distribuidora Eléctrica del Sur (DELSUR) assumed since 2018 the commitment to gender equity as one of its main sustainability commitments. DELSUR has partnered with the organization Plan International to implement the "Educatech" Project, which aims to encourage more girls and young women to study technical careers in the sector and STEM (science, technology, mathematics, and engineering), to increase the number of women who meet the skills required to perform technical work in the electricity sector [15].

Altas Capacidades Foundation promotes a STEM program for girls in El Salvador in which they develop online programming from the early ages of 6 - 16 so that they can decide their future and contribute to the reduction of the gender gap and social inequalities.

2.5.2. International level

Microsoft celebrated 10 years of promoting the DigiGirlz program in El Salvador, which promotes digital female empowerment, through practical technology workshops, code, and activities for the development of soft skills and inspirational talks, Microsoft has come to sow curiosity and awaken interest in science and technology.

Pontificia Universidad Católica del Perú (PUCP) and Universidad de Ingeniería y Tecnología (UTEC) have developed a virtual inter-university meeting with the aim of making women leaders in the fields of science, technology and engineering in the country and the world more visible, and thus inspiring more women to enter these professional fields.

MasterCard is a project where girls between 6- and 13-years old practice their knowledge in cryptology, coding and data engineering, dynamics where they demonstrate their ability to become professionals in these fields soon.

The NextGen Girls in Technology program of the Shilpa Sayura Foundation, a recipient of the UNESCO Prize for Girls' and Women's Education, the two young women discovered their passion for coding when they were confined to their homes. The classes are designed to empower girls and women by developing their digital skills. They cover everything from the Internet of Things (IoT) to computer programming to Manga art. Since the pandemic began, they have reached a total of 5,000 teachers and 2,500 female students in primary and secondary education. [16]

3. METHODOLOGY

The type of the documentary-field research, in terms of research design, is quantitative and the scope of the study is descriptive.

1. Materials and methods: Some of the techniques for quantitative data collection: request for information, through software that facilitates data collection.

2. Population: HEIs of El Salvador, which are integrated by 24 universities, 11 specialized institutes and 6 technological institutes, but for the study a profile was made that highlights those HEIs that have STEM careers and are in a position in the world ranking, being the study population 3 universities integrated by 2 private universities and 1 public university

3. Sample: The sample for the HEI study population was obtained through non-probabilistic sampling by quotas.

4. Criteria for obtaining the sample of Higher Education Institutions.

- If the university offers STEM careers.
- If this Higher Institution is in the QS Latin America University Ranking [1]

- Selection of the 6 careers with the highest student demand according to MINED's registry.
- Enrollment and graduate's records for the period from 2019 to 2021, considering that the Covid-19 pandemic began in 2020 and its impact on women.

4. Results

4.1. Enrollment Statistics for Women - Universidad Centroamericana José Simeón Cañas (UCA)

Table 1
Registration female gender – UCA

Careers	2019	2020	2021
Architecture	731	487	780
Chemical Engineering	577	609	642
Civil Engineering	296	274	303
Computer Engineering	244	266	310
Electrical Engineering	93	79	71
Mechanical Engineering	83	92	68
Total Sum	2024	1807	2174

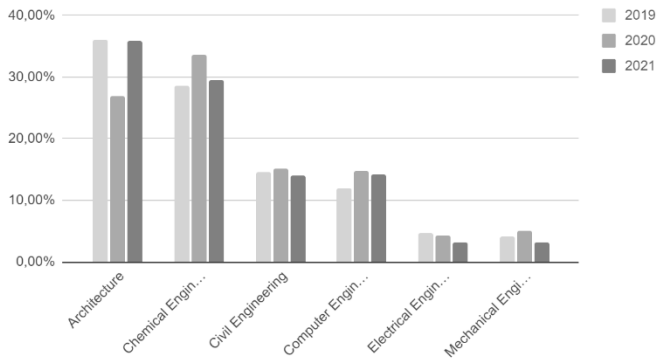

Figure 1: Enrollment Statistics for Women – UCA

Figure 1 shows the statistics corresponding to the Universidad Centroamericana José Simeón Cañas, which reflects the number of female students enrolled per year. In the year 2021, the careers with the highest demand for enrollment by young women are: Architecture 36.12%; Chemical Engineering 29.53%; Computer Engineering 14.26%; Civil Engineering 13.94%; Electrical Engineering 3.27% and Mechanical Engineering 3.13%. In 2020, the career with the highest enrollment demand will be Chemical Engineering 33.70%; Architecture 26.95%; Civil Engineering 15.16%; Computer Engineering 14.72%; Mechanical Engineering 5.09% and Electrical Engineering 4.37%. In 2019, the courses with the highest enrollment demand will be Architecture 36.12%; Chemical Engineering 28.51%; Civil Engineering 14.62%; Computer Engineering 12.06%; Electrical Engineering 4.59% and Mechanical Engineering 4.10%.

4.2. Female Enrollment Statistics - Universidad Católica de El Salvador (UNICAES)

Table 2
Registration female gender – UNICAES

Careers	2019	2020	2021

Architecture	247	276	311
Civil Engineering	152	165	157
Computer Systems Engineering	63	63	93
Electrical Engineering			0
Total Sum	462	504	561

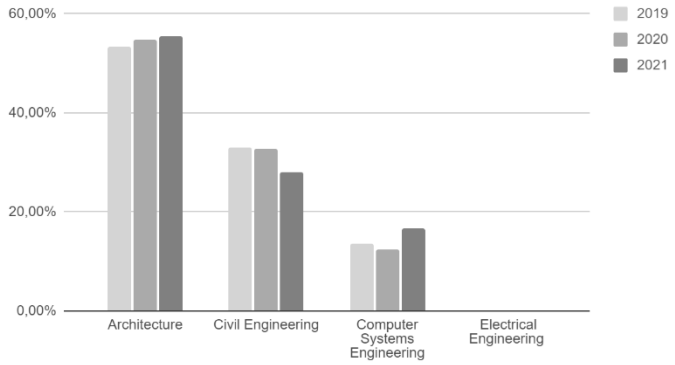

Figure 2: Enrollment Statistics for Women – UNICAES

Figure. 2 shows the statistics corresponding to the Universidad Católica del Salvador, which reflects the number of female students enrolled per year. In the year 2021, the careers with the highest demand for enrollment by young women are: Architecture 55.44%; Civil Engineering 27.99%; Computer Systems Engineering 16.58%; Electrical Engineering 0.0%. In 2020, the career with the highest enrollment demand was Architecture 54.76%; Civil Engineering 32.74% and Computer Systems Engineering 12.50%. In the year 2019 the careers with the highest demand for enrollment were the Architecture career 53.46%; the Civil Engineering career 32.90% and the Computer Systems Engineering career 13.64%. The Electrical Engineering career was opened in 2021, however, there was no enrollment by women.

4.3. Enrollment statistics for women - Universidad de El Salvador - Facultad Multidisciplinaria de Oriente (UES -FMO)

Table 3

Registration female gender – UES – FMO

Careers	2019	2020	2021
Architecture	265	126	168
Civil Engineering	136	129	154
Computer Systems Engineering	90	87	123
Electrical Engineering	4	3	4
Mechanical Engineering	2	1	0
Total Sum	497	346	449

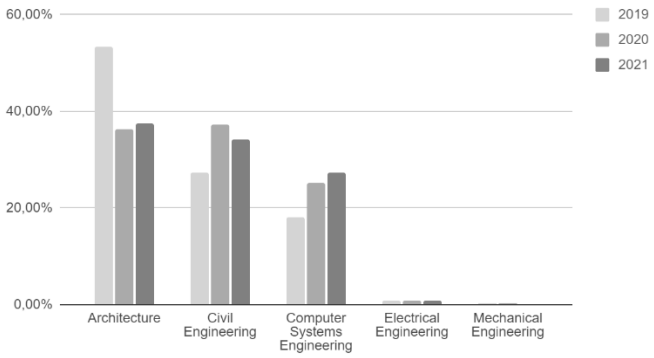

Figure 3: Enrollment Statistics for Women – UES - FMO

Figure 3 shows the statistics corresponding to the Universidad de El Salvador - Facultad Multidisciplinaria de Oriente, which reflects the number of female students enrolled per year. In the year 2021, the careers with the highest demand for enrollment by young women are: Architecture 37.58%; Civil Engineering 34.45%; Computer Systems Engineering 27.52%; Electrical Engineering 0.45% and Mechanical Engineering 0.0%. In 2020, the career with the highest enrollment demand was the Civil Engineering career 37.50%; the Architecture career 36.63%; the Computer Systems Engineering career 25.29%; the Electrical Engineering career 0.44% and the Mechanical Engineering career 0.15%. In 2019, the careers with the highest enrollment demand were Architecture career 53.64%; Civil Engineering career 27.53%; Computer Systems Engineering career 18.22%; Electrical Engineering career 0.40% and Mechanical Engineering career 0.20%.

4.4. Statistics on Female Graduates - Universidad Centroamericana José Simeón Cañas (UCA)

Table 4

Graduates female gender – UCA

Careers	2019	2020	2021
Architecture	21	37	29
Chemical Engineering	18	24	20
Civil Engineering	1	11	9
Computer Engineering	4	2	7
Electrical Engineering	3	4	6
Mechanical Engineering	6	0	6
Total Sum	53	78	77

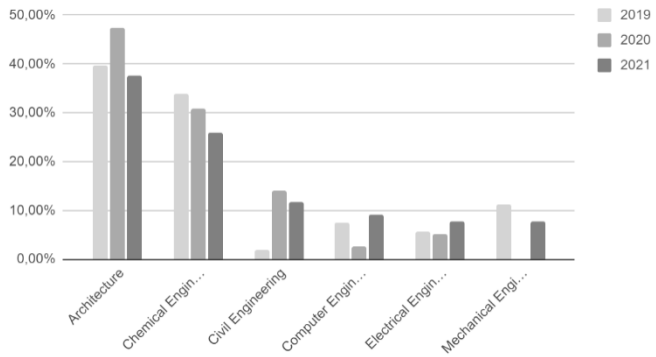

Figure 4: Graduates Statistics for Women – UCA

Figure. 4 shows the statistics corresponding to the Universidad Centroamericana José Simeón Cañas, which reflects the number of female students graduating per year and per career. The careers with the highest number of women completing their undergraduate studies in the STEM area in 2021 are: Architecture 37.66%, Chemical Engineering 25.97%, while the careers with the lowest number of female graduates are Electrical Engineering and Mechanical Engineering both careers 7.79%, Computer Engineering 9.09% and Civil Engineering 11.69%. In the year 2020 in first place Architecture 47.44%, Chemical Engineering 30.77%; Civil Engineering 14.10%, Electrical Engineering 5.13%, Computer Engineering 2.56% and Mechanical Engineering 0.0%. In 2019 Architecture registered 39.62%, Chemical Engineering 33.96%, Mechanical Engineering 11.32%, Computer Engineering 7.55%, Electrical Engineering 5.66% and Civil Engineering 1.89%. It is necessary to mention that the highest number of graduates was registered in 2020 by the Architecture career with 37 young women graduates.

4.5. Statistics of Female Graduates - Universidad Católica de El Salvador - (UNICAES)

Table 5

Graduates female gender – UNICAES

Careers	2019	2020	2021
Architecture	19	13	18
Civil Engineering	8	6	14
Computer Systems Engineering	6	5	5
Electrical Engineering			0
Total Sum	33	24	37

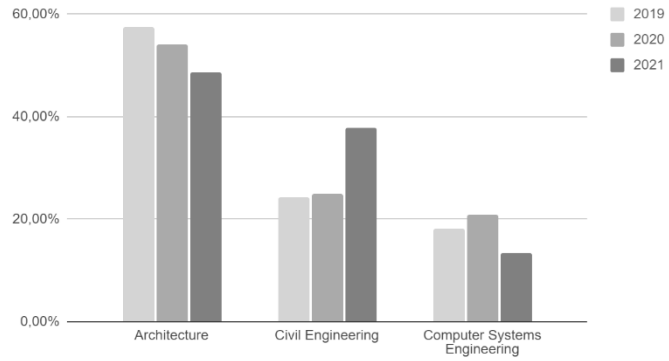

Figure 5: Graduates Statistics for Women – UNICAES

Figure. 5 shows the statistics corresponding to the Universidad Católica de El Salvador, which reflects the number of female students graduating per year and per career. The careers with the highest number of women completing their undergraduate studies in the STEM area in 2021 are: Architecture 48.65%, Civil Engineering 37.84%, while the career with the lowest number of female professionals is Computer Systems Engineering 13.51%. In 2020, Architecture 54.17%, Civil Engineering 25.0% and Computer Systems Engineering 20.83% will be in first place. In the year 2019 Architecture registered 57.58%, Civil Engineering 24.24% and Computer Systems Engineering 18.18%. It is necessary to mention that the highest number of graduates was registered in 2019 by the Architecture career with 19 young women graduates.

4.6. Statistics of Female Graduates - Universidad de El Salvador - Facultad Multidisciplinaria de Oriente - (UES - FMO)

Table 6
Graduates female gender – UES – FMO

Careers	2019	2020	2021
Architecture	35	21	11
Civil Engineering	5	2	7
Computer Systems Engineering	4	3	14
Electrical Engineering	0	0	0
Mechanical Engineering	0	0	0
Suma total	44	26	32

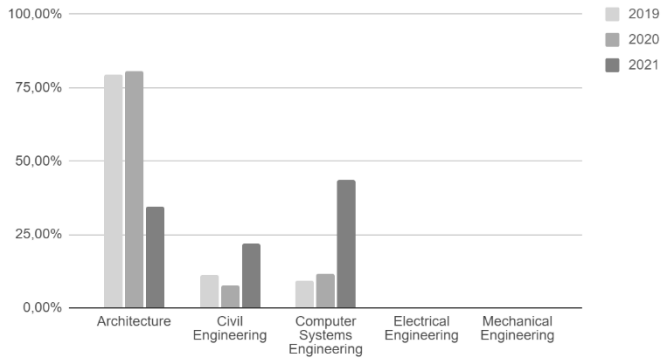

Figure 6: Graduates Statistics for Women – UES – FMO

Figure. 6 shows the statistics corresponding to the Universidad de El Salvador - Facultad Multidisciplinaria Oriental, which reflects the number of female students graduating per year and per career. The careers with the highest number of women completing their undergraduate studies in the STEM area in 2021 are: Computer Systems Engineering 43.75%, Architecture 34.38% and Civil Engineering 21.88%. In 2020 in first place Architecture 80.77%, Computer Systems Engineering 11.54%, and Civil Engineering 7.69%. In the year 2019 Architecture registered 79.55%, Civil Engineering 11.36% and Computer Systems Engineering 9.09%. It is necessary to mention that the highest number of graduates was recorded by the Architecture career in 2019 with 35 young women graduates

5. Conclusions

Figures 1 to 3, obtained from the data collection, which correspond to the enrollment of the different universities participating in the study, reflect a low and a high demand in the different careers. The career with the highest demand is Architecture in all participating universities; Second place the careers of Civil Engineering and Chemical Engineering; Third place the careers with the lowest demand are Electrical Engineering and Mechanical Engineering in all participating universities; in STEM/ICT careers referring to Computer Engineering and Computer Systems Engineering, a considerable increase is reflected compared to the enrollment of the 2019 period in all participating universities, so it can be concluded that women are opting for different STEM areas, an area which has always been dominated by men. However, for future studies it is proposed why the Architecture career has the highest enrollment figures; why the Electrical Engineering and Mechanical Engineering careers are the least selected by young women and finally to know what actions are being taken by the universities that has allowed the increase year by year in Computer Engineering and Computer Systems Engineering.

The enrollment statistics show that women are highly selected for Architecture, Civil Engineering and Chemical Engineering, and the least selected careers for women are Computer Engineering or Computer Systems Engineering, Mechanical Engineering and Electrical Engineering, and the numbers

of graduates from each of the universities participating in the study, as shown in figures 4 to 6, show that these data are consistent with the enrollment figures.

The study reflects high enrollment and graduate enrollment figures; however, it is not known whether isolated initiatives and projects at the national and international levels are responsible for the gradual increase observed in some of the careers selected for the study. Therefore, it is important to continue the analysis, extending the period covered by the sample, considering the year of origin of some of the initiatives and isolated projects implemented in El Salvador.

6. Proposal

The problem of the low participation of women in STEM/ICT careers continues to be a part of everyday life in all countries. Different projects and initiatives are gradually increasing the number of women. Following the study "Analysis of the activity and participation of women in STEM/ICT careers", the development of a digital observatory is proposed to centralize information on enrollment records, graduates, and graduates, allowing the visualization of statistics by different filters, including gender and career, among others. By having centralized information, HEIs can take common actions to support the continued increase in the number of STEM/ICT women. At the same time, the observatory can generate new research proposals based on education and its statistics. The Digital Education observatory would be very useful to analyze and better understand the statistics that are reflected in the HEIs of El Salvador.

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