Visibility of Women in the Software Development Life Cycle
Visibilidad de las Mujeres en el Ciclo de Vida del Desarrollo de Software

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Abstract

The visibility of women in the labor context of software production is very weak, due to their low participation and socio-cultural difficulties to grow in the labor context. This article aims to show women's role and contribution in the whole life cycle of software development and thus promote gender equity and equality in this area. Methodologically, we have taken the systematic mapping technique to search in the technical literature as a basis. This allows us to obtain a comprehensive view of the work related to gender gaps women face in their work performance in software manufacturing. To complement this study, a form including closed questions was designed to obtain information about the role women play in software production and their expectations in terms of their professional contribution in this field. The main findings allow us to infer that there are biases when defining leaders and roles in software development. It is hoped that the findings of this study will provide inspiring information for women who wish to lead teams in the field of software development by showing the reduction of gender gaps and the possibility of successfully exercising leadership in this field.

Keywords: Gender Equity, Gender equality, Software development, Women.

Resumen

La visibilidad de las mujeres en el contexto laboral de la producción de software se observa muy débil, debido a su escasa participación y dificultades socioculturales para crecer en el contexto laboral. El propósito de este artículo es, evidenciar el rol y aporte de las mujeres en todo el ciclo de vida del desarrollo de Software y así contribuir a promover la equidad y la igualdad de género en esta área de fabricación de software. Metodológicamente se ha tomado como base la técnica de mapeo sistemático para búsqueda en la literatura técnica. Esto nos permite obtener una visión integral de los trabajos relacionados con las brechas de género que enfrentan las mujeres en su desempeño laboral en la fabricación de software. Para complementar este estudio, se diseñó un formulario que incluye preguntas cerradas para obtener información sobre el rol que desempeñan las mujeres en la producción de software y sus expectativas personales en términos de su contribución profesional en este campo. Los principales hallazgos nos permiten inferir que existe sesgos a la hora de definir líderes y roles en el desarrollo de software. Se espera que los hallazgos de este estudio proporcionen información inspiradora para las mujeres que anhelan liderar equipos de trabajo en el campo del Desarrollo de Software, al evidenciar la reducción de las brechas de género y la posibilidad de ejercer el liderazgo de manera exitosa en este ámbito.

Palabras claves: Desarrollo de software, Equidad de género, igualdad de género, Mujeres.

1. Introduction

The visibility of women in both the professional and business context, specifically in the areas of software production, shows weak labor participation [1], as well as difficulties imposed by sociocultural barriers for the assignment of roles in some stages of the software development life cycle, such as coding, analysis, and leadership [2].

Globally, only 25% of technology jobs are occupied by women, according to the latest report of the National Center for Women Information Technology (NCWIT) [3], and the World Economic Forum also reports a similar figure of 15.6% of women working in the software and technology

sector [4].

In recent years, there have been initiatives by large companies that have become aware of the problem of gender inequality and its adverse effects on teams and are proactively generating activities to reduce the gender gap [5]. To this end, they conduct events and campaigns to encourage women to work in the software industry and create a better workplace free of prejudice and discrimination [6]. As an example, multinational companies such as Google, Amazon, Ford, Nestlé and Accenture have implemented measures to reduce the lack of diversity as companies with a greater diversity of gender and race, among others, generally obtain higher economic profitability than the rest of the companies in the same sector [5]. For example, regarding gender and technology at Google, the first report in 2014 revealed that only 17% of its employees in the technology sector were women. Currently, that gap has been reduced, and there is 37.5% female participation, as can be seen in the results of the 2022 report [7].

In the case of Chile, a study states that by 2019 there was already a deficit of 31% of IT professionals; however, the number of women in this same field currently stands at 35%, according to data from the Ministry of Women and Gender Equity [8]. One of the possible causes of these figures is the construction of social stereotypes based on a false concept or idea of engineering as a masculine profession that makes it difficult for women to identify with this profession [9].

Some authors [10][11][12] point out that diversity often leads to better abilities to perform tasks, greater creativity, and better decisions and results. For example, in software engineering, gender diversity has increased innovation and productivity, reducing turnover and conflict within teams and helping to produce more user-friendly software [11].

This paper's motivating focus is how to encourage women to perform the same type of technical, operational, and managerial work as their male colleagues.

The objective of this article is to find a way to demonstrate the role and contribution of women throughout the software development life cycle, using a search in the technical literature, complemented with a survey of women linked to the software development area, in order to identify which are the tasks in which women would like to enhance their career in the world of software development or which are their best teamwork skills in order to promote gender equity and equality in this area, the software production.

This paper is structured as follows: Section 2 describes the key concepts, and Section 3 describes the steps of the method used. Section 4 presents the results, and Section 5 presents conclusions and future work.

2. Gender equity and software development

Gender equity is fairness in treating women and men according to their individual needs, either with equal treatment or treatment that is differentiated but considered equivalent in terms of rights, benefits, obligations, and possibilities. In the development field, a gender equity objective often requires incorporating measures to compensate for disadvantages [13].

There are currently four primary factors why women choose careers in the computational area: encouragement from their close circle, self-perception of mathematical skills, academic exposure in schools, and perception of the computational career with its various applications [14]. Given the gender biases of computer science careers, women are half as likely to receive encouragement from their circle, which directly influences gender equity in the software development industry [14].

One of the topics mentioned by the UN in its sustainable development goals is Achieve gender equality and empower all women and girls [15]. In the software industry, one of the steps is to analyze how deeply rooted this gap is in the different roles of the software development life cycle.

3. Methods and materials

The objective of this analysis is to know which tasks are preferably assigned to the computer women who participate in the software production process and, at the same time to review the roles in which they would like to perform and if they feel in a scenario of gender inequality in front of their male colleagues to achieve it.
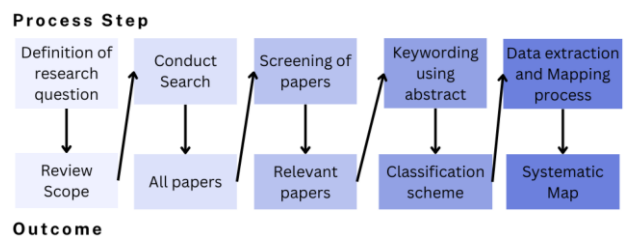

Fig. 1 Systematic literature review steps by Petersen [16].

A literature review of the existing literature was applied, using as a basis Petersen's systematic mapping technique, which serves to identify, categorize and analyze the existing literature that is relevant to a particular research topic [16], thus generating the exploration and search for this analysis of existing literature. The essential steps in the process of our systematic mapping study are: (1) defining the research questions, (2) reviewing the

Scope, (3) conducting the search for relevant articles, (4) selecting relevants articles, (5) defining keywords for the abstracts (see Figure 1).

Through this analysis, we seek to conduct an exhaustive and detailed investigation of the role played by women in software development, with the objective of obtaining a complete and accurate view of their contributions and challenges in this specific field.

Table 1 Research Questions.

ID	Question	Objective
PI-1	What are the most common tasks assigned to a women computer scientist in the field of software development?	To obtain information for a classification, with respect to the assignment of roles or tasks that are assigned to computer women, linked to the software manufacturing process.
PI-2	What are the roles in the software manufacturing process that women engineers prefer?	To obtain information about the role or task that women computer scientists, linked to the software manufacturing process, prefer to perform for their professional growth.

3.1. Definition of Research Questions

Two research questions (RQs) were defined and posed according to the needs presented in this study. The questions are detailed in Table 1 and represent the basis for this analysis.

3.2. Data Extraction

The keywords used for the search were: women, gender equity, gender equality, and software development. The sources where the search was applied were Web of Science (WOS), IEEE Xplore Digital Library, Scopus, and ACM. The search string was: (women OR gender equality OR gender equity) AND software development.

3.3. Filtering Criteria

The selection of studies was formulated based on the following inclusion/exclusion criteria:
1) INCLUSION: Research articles from scientific journals and conferences discussing women or gender equity and software development; only articles published since 2015.
2) EXCLUSION: Articles before 2015 and presentations excluded based on relevance and timeliness.

3.4. Search Execution

Data extraction was performed by searching for titles or abstracts containing the keywords in search engines, published since 2015. Initially, 4907 articles were obtained (see Table 2), this table details the number of articles by search engines.

Table 2 Search and filter results.

Search Engines	Results			
	WOS	IEEE	ACM	Scopus
Search Result	664	2978	300	965
Candidates	462	1833	271	807
Selected publications	8	267	57	41
Selected Papers	374			

In the second stage, duplicates were discarded, leaving 4693. Then a filter was made by reading the titles of the articles, from which 3373 were selected. Finally, 374 articles remained in the final selection, whose abstracts emphasized women in the software manufacturing process and not the use of "software applications", a process described in Fig. 2.
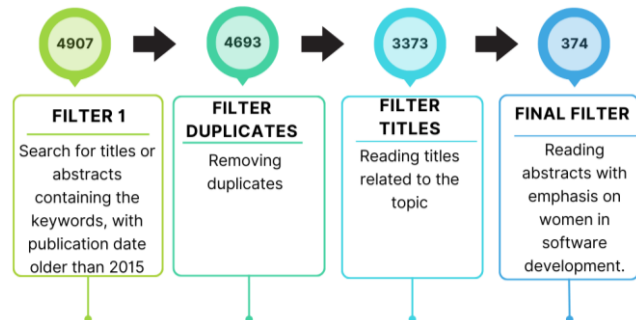

Fig. 2 Steps of the search and selection process implemented.

3.5. Search Results

This section presents the results obtained after the classification and analysis of the selected studies, focusing on the sources of the primary published studies, allowing us to identify the most active databases in the field of women in software development (see Figure 3). The sources selected for this study included Web of Science, ACM Digital Library, Scopus, and IEEE Xplore. It is observed that there is a higher rate of publications in IEEE Xplore, with 71.39% of the selected papers. In second place is ACM Digital Library, with 15.24% of the papers, followed by Scopus, with 10.96%. Finally, eight selected articles were found in Web of Science, representing 2.14% of the total, suggesting that this source may not be considered interesting for researchers in the area.
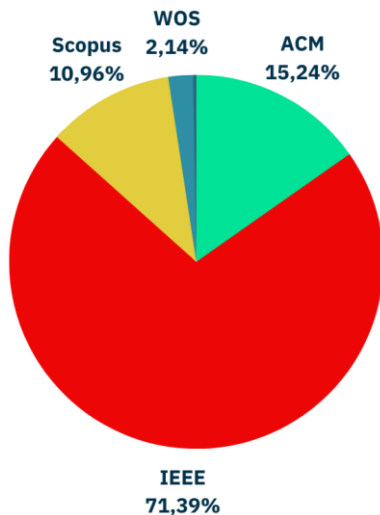
Fig. 3 Publications by scientific database.

3.6. Survey Analysis

The above is complemented with the results obtained from a survey applied to 40 Chilean female engineers with an active role in a work team that is currently executing a software development project.

The participants of this survey are mainly ex-students of the Computer Science careers of the Universidad de la Frontera, Temuco, at the same time it was published on the LinkedIn portal, a social network oriented to entrepreneurial aspects, business and employment. The age range of the participants is between 25 and 45 years old, and they are mainly employed in small and medium-sized companies.

The title of the survey is "Visibility of Women in the Software Development Life Cycle", and its objective is to support research generated with the purpose of making visible the roles and tasks of women in the software production process and whether it affects gender inequality. The questions posed in the questionnaire are the following:

In what roles have you worked?

In which roles did you work for the first time?

In what roles would you like to work?

In what roles do you think you would best contribute to the development of the Software?

Through this survey, data was collected on the roles and tasks performed by the participants throughout their professional careers, as well as their experience regarding possible situations of discrimination due to their gender as women engineers. With the latter, we seek to obtain information on equity and inclusion initiatives in the organizations where they work. Other relevant aspects are the skills that have helped them to grow professionally in the software industry.

The performance roles are diverse, with product or project development as the most popular roles.

Fig. 4 Roles assigned to Women in Software Production

3.7. Results

With the information obtained from the surveys and selected articles, the following categorization is generated.

1) Roles or tasks assigned to a computer scientist in a software company.
2) Preferences of roles in the Software manufacturing process of women engineers.

In relation to the first categorisation, the results of the survey aimed exclusively at female engineers are presented in Figures 4 and 5. Figure 5 shows that a significant majority of female engineers start their professional careers as developers and continue to play roles in this field throughout their professional careers. This finding is complemented by more detailed information provided in Figure 4, which shows a visual representation in the form of a word cloud, highlighting the roles that women engineers play in the field of software development at the time of participating in the survey. Notably, the words describing the most frequent roles are presented in a larger size, while the less frequent ones are presented in a smaller size.

It is essential to note that this survey focused exclusively on female engineers, which limits the possibility of making comparisons with their male counterparts. However, it is suggested that future research explore the possibility of generating such a comparison, which could provide a more comprehensive perspective on career trends in the field of software development and gender equity in engineering.
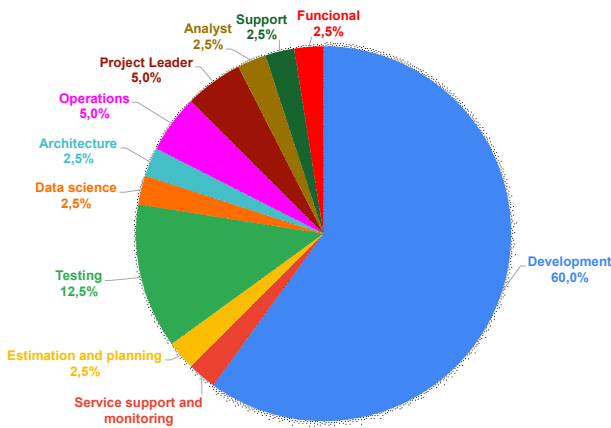
Fig. 5 First role assigned in their careers.

This is not strange, considering that according to the World Economic Forum, "Women are seen as better programmers than men, but only if they hide their gender" [17]. However, the second category is very striking in contrast with this first categorization.

Regarding the second category, although women's field of work is so strongly linked to software development (see Figure 4), when asked which area they would like to work in, 19 answered that they prefer to be a Project Leader (see Figure 6). This is also complemented by their belief that in this role, they would contribute better to software production (see Figure 7) since their best tools are their soft skills.
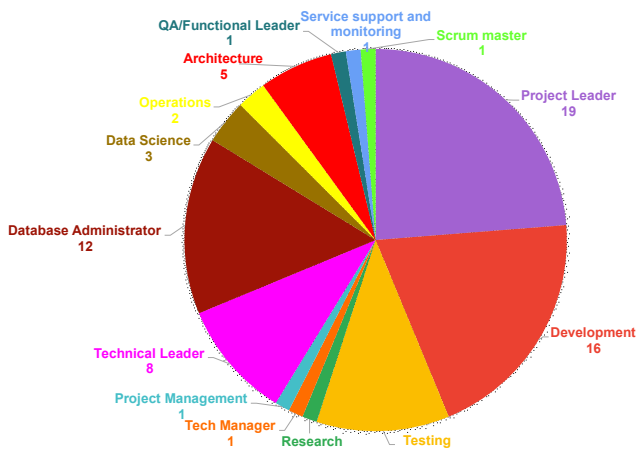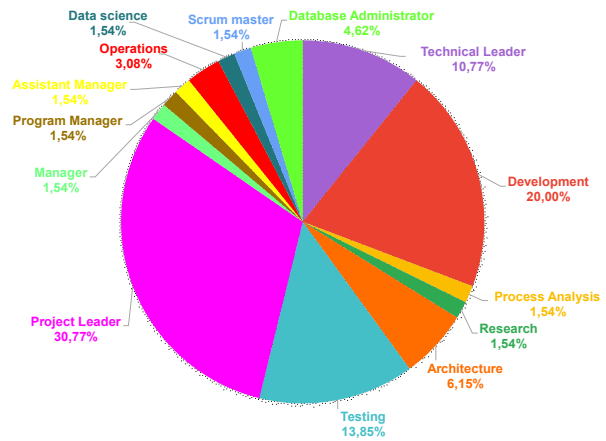

Fig. 6 Preferred area of performance.

Fig. 7 Area of contribution to software development.

This is a scenario that many women would like to opt for. Although women have been proven to be influential leaders in many situations [18], is still far away as the gap to equal opportunities and growth towards management and leadership is generated by social factors related to gender, the linkage of roles in this field [19][20] and gendered organizational cultures that are not advantageous for women.

Relational aspects of the workplace are now highly valued. Because of these, traditionally, female leadership practices have begun to gain popularity, with women finally gaining an advantage.

Traditionally the leadership style has always been masculine, and this has caused women to feel disregarded by these discourses of masculinity and feel insecure and pressured to validate themselves as leaders [21]. The important thing is that this culture is on the way out due to the new leadership paradigms, and the new era of the feminine leadership style is beginning, which has become more accepted and is undoubtedly an opportunity for women since this style is better suited to women's soft skills.

4. Conclusions

In this paper, we first present some steps of reviewing the existing literature using the Petersen Method and analyzing a survey of women engineers to analyze women's roles in the software production process.

Supported mainly by bibliographic data, we can affirm the under-representation of women in the software field. Furthermore, it has been shown that gender-balanced teams perform better in innovation thanks to an inclusive culture that reduces biases and interpersonal conflicts, generating greater satisfaction and cohesion. These findings highlight the importance of promoting gender diversity in all areas,

not only in the pursuit of equity, but also to drive success and innovation in projects and teams. However, It is critical to note that despite advances in the understanding of gender equity and its influence on innovation, our research sources also reveal a significant limitation. This limitation relates to our research questions (RQs) focusing on the specific roles and tasks that female software engineers perform or prefer in their day-to-day work. Despite comprehensively addressing the issue of gender equality, we have not found references that provide a solid understanding of the typical roles women assume in this field or their career preferences.

Efforts have been made to address this gender gap issue by generating new opportunities at the corporate level by establishing policies and codes of behavior at the professional level. However, this study may have limitations because it was based on a specific sample of female engineers, which may limit the generalizability of the results to other populations and environments. In addition, the study focused on a review of existing literature and a survey, which may limit the depth of the findings and may not provide a complete picture of the complex interplay between the software gender gap and broader social, cultural, and economic factors.

In relation to the case study, based on the survey results, it can be concluded that the predominant task in software production is software development, a task in which women have been involved since its inception, and many of them continue to play this role. However, a strong preference for leadership roles was also identified, as it is in this context that they can make the most of their individual potential to add greater value to their projects. The findings on this topic in the literature show us that there is a difficult but hopeful path to generate female leaders, given that this is a historically masculinized field, but that there is research that has worked hard to promote the participation of women in software development.

There is undoubtedly pending work associated with the promotion of gender equality in all roles of software production, from childhood education, undergraduate education, and sociocultural education, to achieve not only that more women enter the field of computing but also that women can choose to perform in the role they want and compete with the same tools, skills and sociocultural beliefs as men.

In future work, we intend to implement strategies to help empower women's leadership.

Competing interests

The authors have declared that no competing interests exist.

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