**CESAR SCHOOL**

LORENA MARQUES VASCONCELOS SEABRA

# BEYOND CODE: UNDERSTANDING HOW TRADITIONAL PRODUCTIVITY METRICS OVERLOOK WOMEN IN SOFTWARE ENGINEERING

Recife - PE

2025

LORENA MARQUES VASCONCELOS SEABRA

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**LORENA MARQUES VASCONCELOS SEABRA**

**BEYOND CODE: UNDERSTANDING HOW TRADITIONAL PRODUCTIVITY METRICS OVERLOOK WOMEN IN SOFTWARE ENGINEERING**

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**RECIFE**
**2025**

*I dedicate this work to all the women who came before me, in life, in career, and in history. To those who carved paths with courage, even when the world pushed them to the margins. To those who were silenced, underestimated, made invisible. To those who, even without space, planted seeds of change with every line of code, every dismissed idea, every quiet act of resistance.*

*This research is for you, for us, for those yet to come. May it be a definitive crack in the walls of exclusion. May the community of women in technology be seen, respected, and valued, not as an exception, but as a force. May girls and women no longer merely survive in this space, but live fully in it, heard, included, and recognized as equals.*

*If this is the first study focused on women's productivity in software engineering, may it never be the last. May it echo as a collective cry for a more just future. And may it inspire others to keep writing this story — our story.*

## RESUMO

A produtividade em engenharia de software é comumente avaliada por meio de métricas quantitativas, como linhas de código, número de commits e tempo de conclusão de tarefas. No entanto, esses indicadores tradicionais frequentemente não consideram fatores sociais, culturais e fisiológicos que influenciam as contribuições das mulheres no ambiente de trabalho. Este estudo adota uma abordagem de métodos mistos para investigar como engenheiras de software experienciam e percebem a produtividade na indústria. Os dados foram coletados em duas fases: um survey nacional com 85 mulheres atuantes em engenharia de software no Brasil, e entrevistas em profundidade com 20 participantes, incluindo desenvolvedoras, líderes técnicas e gestoras de engenharia. O questionário explorou temas como perfil demográfico, condições de trabalho, expectativas de produtividade, práticas de avaliação e experiências com inclusão e vieses. As entrevistas permitiram uma investigação mais profunda sobre como cultura organizacional, microagressões, normas de gênero e jornada dupla afetam o desempenho e o reconhecimento. Os resultados indicam que as percepções de produtividade são profundamente moldadas por elementos não técnicos, como trabalho emocional, esforços colaborativos e dinâmicas do ambiente, que não são capturados pelas métricas convencionais. As participantes relataram frequentemente uma autopercepção inferior de produtividade, mesmo entregando resultados equivalentes, em grande parte devido à falta de reconhecimento e à presença de vieses implícitos. Este estudo contribui para o discurso emergente sobre métricas inclusivas na engenharia de software, ao evidenciar como os modelos atuais negligenciam experiências marcadas por questões de gênero. Embora nenhuma métrica nova seja proposta aqui, a análise estabelece uma base para pesquisas futuras que visem desenvolver sistemas de avaliação mais justos e melhorar a retenção e a equidade na área.

**Palavras-chave**: engenharia de software; produtividade; viés de gênero; métricas de avaliação; inclusão; mulheres na tecnologia.

## ABSTRACT

Software engineering productivity is commonly evaluated through quantitative metrics such as lines of code, number of commits, and task completion time. However, these traditional indicators often fail to account for the social, cultural, and physiological factors that influence women's contributions in the workplace. This study adopts a mixed-methods approach to investigate how female software engineers experience and perceive productivity within the industry. Data were collected in two phases: a national survey with 85 women in software engineering roles across Brazil, and in-depth interviews with 20 participants, including developers, technical leads, and engineering managers. The survey explored topics such as demographic background, workplace conditions, productivity expectations, evaluation practices, and experiences with inclusion and bias. The interviews enabled deeper investigation into how organizational culture, microaggressions, gender norms, and dual workloads affect performance and recognition. Findings indicate that productivity perceptions are deeply shaped by non-technical elements, including emotional labor, collaboration efforts, and workplace dynamics, that are not captured by conventional metrics. Women frequently reported lower self-perception of productivity despite delivering equivalent results, largely due to lack of recognition and implicit bias. This study contributes to the emerging discourse on inclusive metrics in software engineering by highlighting how existing models overlook gendered experiences. Although no new metrics are proposed here, the analysis lays the groundwork for future research that aims to develop fairer evaluation systems and improve retention and equity in the field.

**Keywords**: software engineering; productivity; gender bias; evaluation metrics; inclusion; women in tech.

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# ACRONYMS

| | |
|---|---|
| **CSBC** | Congresso da Sociedade Brasileira de Computação |
| **D&I** | Diversity and Inclusion |
| **ICT** | Information and Communication Technologies |
| **IMF** | International Monetary Fund |
| **LGBTQIA+** | Lesbian, Gay, Bisexual, Transgender, Queer, Intersex, Asexual and others |
| **LOC** | Lines of Code |
| **STEM** | Science, Technology, Engineering, and Mathematics |
| **UNESCO** | United Nations Educational, Scientific and Cultural Organization |

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# 1 INTRODUCTION

This research project aims to investigate how traditional productivity metrics in software engineering impact women, often ignoring their actual performance and reducing their perceived potential. The central objective is to understand how gendered factors influence the way productivity is assessed and experienced, and whether current evaluation models are adequate for equitable comparison. This chapter presents the research context, outlining the motivation, main problem, and justification. The analysis is grounded not only in the literature review but also in empirical data collected through questionnaires and interviews with women working in software engineering. By examining the structural and cultural barriers they face, this research seeks to propose a more inclusive and accurate understanding of productivity, contributing to fairer practices in the evaluation and recognition of professional performance.

## 1.1 MOTIVATION AND CONTEXT

In recent years, despite the increasing visibility of women in science and technology, particularly in software engineering, their representation remains disproportionately low. For instance, in 1997, the proportion of women enrolled in the Bachelor of Computer Science at the Instituto Militar de Engenharia (IME) was 26.4%, but by 2017, this figure had declined to only 13.66%, illustrating the persistence of gender disparity in the field (USP, 2023a). While there has been a 60% growth in women's participation in the technology sector over the past five years, they still occupy only 12.3% of technical roles, while men account for 83.3% (Economia, 2022a). These figures point to a systemic underrepresentation of women, rooted in historical, cultural, and social factors, as well as persistent gender biases that continue to shape workplace dynamics and affect how their contributions are perceived.

The underrepresentation of women is compounded by gender biases in promotion and career progression. According to the MIT Sloan Management Review, women are 14% less likely to be promoted than equally qualified male colleagues, and many report feeling that their contributions are undervalued or overlooked (Sloan, 2022). These experiences contribute to higher attrition rates among young women entering the field and reinforce a perception that their professional advancement is constrained by factors beyond their performance.

Moreover, research shows that gender bias is not exclusive to male-dominated environments. In fact, subtle forms of bias persist even in female-majority or diverse workplaces. A recent Harvard Business Review study demonstrated that women frequently encounter biased assumptions about their competence and leadership ability, which negatively affect their confidence and perceived productivity (Cundiff; Vescio, 2022). These biases often manifest through micro-inequities, subtle, everyday behaviors such as interruptions in meetings or assignment of less impactful tasks, that cumulatively undermine professional growth (Perry et al., 2021).

The impact of these dynamics extends beyond perception. Studies suggest that perceived productivity and actual performance are closely linked, especially in collaborative team settings (Turek et al., 2020). When women's input is undervalued, it can lead to disengagement, lower self-confidence, and reduced motivation, which ultimately affects team performance and innovation. This cycle of invisibility and underestimation contributes to a workplace culture in which women must continually prove their worth while receiving less recognition for their efforts.

Traditional definitions of productivity in software engineering, such as the ability to produce high-quality software efficiently and within deadlines (Vasilescu; Devanbu; Bird, 2019), have typically been measured through quantitative metrics like lines of code (LOC), function points, or hours worked (Pereira; Silva; Costa, 2016). However, these metrics often fail to account for human factors such as collaboration, inclusion, psychological safety, and gender-specific experiences.

In addition to the limitations of traditional productivity metrics in capturing collaborative and non-technical contributions, another critical issue lies in how these metrics are studied and validated. Many empirical studies on software engineering productivity are developed and tested in homogenous environments, often lacking diversity in team composition. For instance, during my 2023 scientific initiation at CESAR School, in partnership with CESAR, we developed the paper The Role of Generative AI in Software Development Productivity: A Pilot Case Study (Seabra; Ferreira; Silva, 2024). As part of that process, we conducted an extensive review of the literature on productivity in software teams, particularly in the context of emerging technologies such as generative AI. However, I observed a recurring and troubling pattern: gender-specific experiences were rarely addressed. Most of the studies failed to report the gender composition of their participants, and many included no women at all. None of them examined female productivity as a distinct analytical lens. This lack of representation highlighted a significant research gap and directly influenced the motivation for the present thesis, which seeks to center women's experiences and contributions in the analysis of productivity in software engineering.

Recognizing this gap, the goal of this work is to investigate and document the various factors that influence women's productivity in software engineering, considering their lived experiences, structural barriers, and specific needs. The aim is not only to identify the limitations of current productivity metrics but also to propose new evaluation parameters that reflect a more equitable, inclusive, and accurate representation of productivity across gender lines. By addressing this gap, the research seeks to contribute to a broader understanding of how productivity can, and should, be measured in a way that values the contributions of all professionals in the field.

## 1.2 RESEARCH PROBLEM

The underrepresentation of women in software engineering is a persistent phenomenon that negatively impacts both diversity and innovation in the field. Despite efforts to promote inclusion and increase female participation, such as initiatives by *AnitaB.org* (ANITAB.ORG, 2024), which connects women in technology and promotes events like the Grace Hopper Celebration; *Mulheres na Tecnologia*, which offers training and support to help women enter the field (Bosch, 2024; Brasil, 2024); and Laboratoria, which trains women in tech across Latin America (Laboratoria, 2024), productivity evaluation tools and metrics often fail to account for the specific realities and needs of these professionals, resulting in inaccurate assessments of their performance.

This issue starts early in life, as pointed out in the study by Davis et al. (Davis et al., 2019), which emphasizes the importance of early interventions to encourage girls' interest in Science, Technology, Engineering, and Mathematics (STEM) and help them develop the confidence and autonomy to feel they belong in such environments. These actions are essential to increasing female participation in the future of technology.

Additionally, current software engineering productivity metrics fail to capture the complexities of female productivity, particularly because they exclude human and social factors that disproportionately affect women (Sarma; Storey; Ford, 2019). Women face unique challenges not typically experienced by men. **Biological factors**, such as the menstrual cycle, significantly affect women's physical and mental health, impacting their ability to concentrate and perform. A study by Ponzo et al. (Ponzo et al., 2022) found that menstrual symptoms can reduce productivity by up to 23% in some women, a result echoed by popular science sources such as (Galileu, 2024).

Social factors such as the double burden, balancing professional responsibilities with domestic and caregiving duties, further aggravate these challenges. Many women are tasked with not only managing their careers but also handling the bulk of household labor and childcare, leading to chronic stress and exhaustion. According to the International Monetary Fund, women represent nearly half of the global workforce yet are responsible for approximately 75% of unpaid domestic labor (Fund, 2018; FMI, 2018).

These realities are rarely reflected in productivity assessments, leading to biased or inaccurate perceptions of women's performance. Moreover, women often face **invisible workplace barriers**, including lack of voice and representation in key decisions. Research published by *The Atlantic* (Atlantic, 2024) reveals that workplace culture frequently fails to accommodate the needs of women, resulting in an undervaluation of their contributions.

Such misrecognition has serious consequences for both individuals and organizations. Feeling undervalued affects women's motivation and overall well-being at work, potentially resulting in emotional exhaustion and loss of interest in their roles. Over time, this scenario can lead to burnout and even decisions to leave the field entirely. In Brazil, for instance, a study by the University of Brasília (Brasília, 2018; UNB, 2018) found that around 79% of women who start engineering and technology programs drop out before graduation, compared to 56% among men. Data from the Higher Education Census (INEP, 2021) also shows that women are 30% more likely to leave such programs than their male peers.

For companies, neglecting women's specific needs not only results in higher attrition but also the loss of opportunity to build diverse and inclusive environments, something that is consistently linked to better performance outcomes. Organizations that embrace gender diversity are generally more productive and innovative, as reported by McKinsey & Company (Company, 2024).

While some strategies, such as agile methodologies, knowledge management, and flexible work environments, aim to optimize developer performance (Meyer; Murphy; Zimmermann, 2022), they rarely consider the distinct barriers and lived experiences of women in software engineering.

In light of this context, the present study seeks to answer the following questions:

1. ***What are the limitations of existing productivity metrics in software engineering concerning female developers?***

2. ***What additional factors, based on female developers' experiences, should be included in productivity measures?***

These questions are essential for understanding the dynamics of work and the barriers faced by women in this field, and for guiding future initiatives toward a more equitable and just work environment.

## 1.3 JUSTIFICATION

The relevance of this research is rooted in the need to address gender inequality in software engineering, a field historically dominated by men (Wand; Reddy; Konda, 2020). Analyzing traditional productivity metrics and their limitations in capturing women's realities is crucial to promoting change in workplace dynamics. To date, studies that include women remain scarce. In *An Exploratory Study of Productivity Perceptions in Software Teams* (Turek et al., 2020), most participants were male, reinforcing the underrepresentation of women in the field. Similarly, in *Do You Really Code? Designing and Evaluating Screening Questions for Online Surveys with Programmers* (Murphy-Hill; Ford; Ponzanelli, 2018), female participation was limited, reflecting the difficulties of recruiting women programmers for research and perpetuating the invisibility of their contributions. This lack of inclusion not only harms women but also limits organizations' ability to fully benefit from diversity and innovation.

By investigating the factors that influence female productivity, this research aims to bring to light issues often neglected by conventional metrics. Understanding how biological, social, cultural, and organizational factors impact women's experiences in software engineering is essential for companies seeking to implement more inclusive policies that are sensitive to the specific needs of all employees. This work's contributions include promoting a fairer work environment that values the contributions of all voices and acknowledges the unique aspects of women's experiences.

Moreover, by highlighting these issues, the study not only contributes to the existing theoretical body but also provides practical insights that can help organizations improve employee retention and satisfaction. Research has shown that more diverse development teams tend to exhibit greater innovation capacity, improved problem-solving, and a significant increase in overall productivity. According to a study by McKinsey & Company (Company, 2024), companies with greater gender diversity in their technical teams are 25% more likely to achieve above-average profitability in their sectors. These organizations also show a greater capacity to meet the diverse needs of end users and to develop more comprehensive solutions. Creating a work environment that takes into account the realities faced by women in software engineering is not just a matter of equity but a proven strategy for driving innovation and organizational success. Companies that actively promote inclusion and the professional development of women in technology are more likely to retain diverse talent and build more resilient and creative teams (Holtzblatt; Marsden, 2018). Therefore, establishing a truly inclusive environment is fundamental not only to ensuring a more equitable future, where all professionals have the same opportunities for growth and development but also to sustaining competitiveness and long-term success in the technology sector.

## 1.4 RESEARCH OBJECTIVES OVERVIEW

This research aims to investigate and comprehend the dynamics affecting women's productivity in software engineering, analyzing the extent to which traditional productivity metrics fail to reflect their realities and contributions. Rather than accepting existing measures as neutral, the study critically examines how social, structural, and cultural factors shape professional performance and hinder equitable evaluation. By identifying these gender-based disparities, the research contributes to a more accurate, inclusive, and context-aware understanding of productivity, while also indicating the changes needed in how performance is assessed in software engineering environments.

### 1.4.1 General Objective

To analyze gender disparities in productivity within software engineering, investigating how social, structural, and cultural factors influence women's professional performance, focusing on identifying patterns, barriers, and perceptions related to productivity.

#### *1.4.1.1 Specific Objectives*

- **SO1:** Study traditional productivity metrics used in software engineering and examine existing research efforts aimed at improving or redefining these metrics to better reflect the complexity of software work.

- **SO2:** Identify and analyze productivity perceptions among female software developers through direct data collection regarding their professional experiences and self-performance assessment.
- **SO3:** Investigate, through qualitative research, the social, structural, and micro-inequities that impact women's satisfaction and productivity in software development, including aspects such as professional recognition, well-being, and workplace pressures.

## 1.5 RESEARCH SIGNIFICANCE

These objectives are fundamental to the research, as they enable an in-depth analysis of gender issues within software engineering productivity. The proposal for developing specific metrics, although not the primary focus of this work, may be considered in future studies based on the findings presented herein. Thus, this study seeks to contribute to the expansion of academic and practical discussions on diversity, inclusion, and recognition in the technological environment, providing relevant subsidies for future investigations and initiatives aimed at fostering equity in the sector.

## 1.6 THESIS STRUCTURE

This thesis is structured into eight chapters, each contributing to the understanding of how productivity is defined, perceived, and measured in the context of women in software engineering.

- **Chapter 1 – Introduction:** Presents the research motivation, context, problem statement, objectives, and significance of the study. It also outlines the research questions and the structure of the thesis.
- **Chapter 2 – Related Work:** Provides a review of existing literature on software productivity metrics, gender and technology, and prior studies that address disparities in the evaluation of professional performance. It identifies research gaps and frames the originality of this study.
- **Chapter 3 – Theoretical Framework:** Introduces the conceptual foundations of the research, including discussions on productivity, gender in computing, invisible labor, and

the social construction of metrics in organizational settings.

- **Chapter 4 – Methodology:** Describes the research design, including the mixed-methods approach adopted. It details the development and distribution of the survey, the structure of the interview scripts, the participant profiles, and the methods used for data analysis.
- **Chapter 5 – Quantitative Analysis:** Presents the results of the survey responses from 85 Brazilian women in software engineering. It analyzes sociodemographic patterns, perceptions of productivity, and the impact of structural factors on performance.
- **Chapter 6 – Qualitative Analysis:** Explores the insights gained from 20 in-depth interviews with developers, technical leads, and engineering managers. It focuses on lived experiences, perceptions of recognition, and the organizational dynamics that affect productivity.
- **Chapter 7 – Cross-Analysis and Discussion:** Integrates the quantitative and qualitative findings, identifying recurring patterns, contradictions, and systemic tensions. It discusses how traditional productivity metrics fail to capture the complexity of women's contributions and proposes interpretative reflections.
- **Chapter 8 – Conclusion:** Summarizes the main findings, discusses the study's contributions and limitations, and offers suggestions for future research and for the development of more inclusive and context-aware productivity evaluation models.

## 2 RELATED WORK

This section analyzes five key studies that investigate the relationship between gender and productivity within the context of software engineering, providing a detailed view of the challenges women face in this male-dominated environment. Each article presents significant data and findings that reinforce the need for strategies aimed at creating a more equitable and inclusive workplace.

The first study, *An Exploratory Study of Productivity Perceptions in Software Teams*, conducted by Meyer, Murphy, and Zimmermann (Meyer; Murphy; Zimmermann, 2022), aimed to examine how developers perceive their own productivity and how this perception affects team performance. Using interviews and surveys with professionals in the field, the authors found that individual productivity perception directly influences collective team perception. For women, who often work in predominantly male environments, this perception can be significantly shaped by the lack of recognition and appreciation of their contributions. According to the authors, "individual productivity perception can shape team morale, especially in settings where not all contributions are equally acknowledged." This insight suggests that in more inclusive workplaces, women's productivity could be significantly enhanced as their efforts become more visible and recognized.

The second study, *Mind the Gap: Gender, Micro-Inequities and Barriers in Software Development*, by Damian, Blincoe, and Church (Damian; Blincoe; Church, 2023b), focuses on micro-inequities, small yet frequent forms of discrimination experienced by women in their daily work. These include constant interruptions, being assigned less meaningful tasks, and exclusion from important discussions. Although often unintentional, such behaviors undermine women's perceived value and negatively affect their productivity. The authors highlight that "micro-inequities, however subtle, accumulate over time, reducing women's motivation and limiting their performance at work." Eliminating these barriers is therefore essential to creating a fair and productive environment for all team members.

The third study, *The Underrepresentation of Women in Computing Fields: A Synthesis of Literature Using a Life Course Perspective*, conducted by Sax, Hirshfield, and Ferris (Sax; Hirshfield; Ferris, 2017), provides a broad view of the barriers women face from early childhood to entering the workforce. The study sought to identify the factors contributing to the underrepresentation of women in computing fields. The results revealed that women encounter obstacles at various stages of life, from the lack of encouragement in STEM during early education to professional limitations in the workplace. The authors state that "the absence of female role models and structural bias throughout education and career development leads to the continuous exclusion of women from computing." The study emphasizes the need for interventions at multiple life stages, including educational programs and supportive workplace environments, to increase female participation in software engineering.

The fourth study, *What Predicts Software Developers' Productivity?*, by Vasilescu, Devanbu, and Bird (Vasilescu; Devanbu; Bird, 2019), explores factors influencing developer productivity, with a focus on non-technical elements such as motivation, job enthusiasm, and peer support. The authors found that positive team interactions and emotional support are key drivers of productivity, especially for women, who may feel more comfortable and motivated in collaborative and inclusive environments. As the authors note, "women significantly benefit from environments that promote collaboration and value everyone's contributions, boosting their motivation and performance." The study concludes that companies implementing policies that support well-being and inclusion can not only enhance women's productivity but also foster a more effective and harmonious work environment.

Finally, the study *Implicit Gender Biases in Professional Software Development: An Empirical Study*, by Sarma, Storey, and Ford (Sarma; Storey; Ford, 2019), addresses the implicit gender biases present in software development. The authors conducted an empirical study to identify how such biases affect the perception and treatment of women in the workplace. The results showed that many professionals, often unconsciously, underestimate women's contributions, leading to fewer opportunities for recognition and career advancement. Sarma et al. state that "implicit bias not only hinders women's progress but also perpetuates a culture of inequality within development teams." Recognizing and addressing these biases is essential to ensure that women have the same professional advancement opportunities as their male colleagues.

The analysis of these five studies reveals that women in software engineering face specific challenges that directly affect their productivity. Meyer et al. (Meyer; Murphy; Zimmermann, 2022) highlight that the lack of recognition impacts team morale and performance. Damian et al. (Damian; Blincoe; Church, 2023b) emphasize that micro-inequities reduce women's motivation and output. Sax et al. (Sax; Hirshfield; Ferris, 2017) demonstrate that barriers arise from early life stages, while Vasilescu et al. (Vasilescu; Devanbu; Bird, 2019) stress the importance of peer support. Sarma et al. (Sarma; Storey; Ford, 2019) provide evidence that implicit bias limits professional growth. Collectively, these studies confirm that social and structural factors are key determinants of female productivity in software engineering.

# 3 THEORETICAL FRAMEWORK

## 3.1 PRODUCTIVITY IN SOFTWARE ENGINEERING

Productivity in software development is defined as the ability to produce high-quality software effectively and efficiently, meeting user needs within set deadlines and budgets, while maintaining high levels of job satisfaction and well-being (Vasilescu; Devanbu; Bird, 2019). This concept is multifaceted, encompassing technical, human, and organizational aspects, making it essential to the success of software projects.

Traditionally, productivity is measured as the ratio between output (software produced) and input (effort, such as work hours). However, this simplistic view fails to capture the complexity of software work, especially when considering variables such as motivation, communication, autonomy, and team support. Productivity is not limited to the amount of code written but also includes code quality, developer satisfaction, and the influence of the organizational environment on performance (Meyer; Murphy; Zimmermann, 2022).

Studies like the one by Hoda et al. (Hoda; Salleh; Grundy, 2021) point out that human factors play a central role in productivity. Motivated developers who work in collaborative environments and have autonomy tend to be more productive and satisfied. Organizational support, effective knowledge management, and a positive team culture are essential to achieving good results. In contrast, the absence of these elements can hinder performance, leading to dissatisfaction and reduced software quality (Pereira; Silva; Costa, 2016).

In the case of women in software engineering, additional challenges must be considered, such as cultural factors, gender bias, and micro-inequities, which affect productivity perception and limit opportunities for advancement (Damian; Blincoe; Church, 2023b). Elements such as organizational support, collaboration, autonomy, and time management are crucial for fostering motivation and engagement. Moreover, team cohesion and social support play a significant role in building an environment that enables productive performance for women (Vasilescu; Devanbu; Bird, 2019).

Thus, productivity in software development must be seen as a multidimensional concept that includes work quality, developer satisfaction, and workplace dynamics. Adopting an inclusive approach that takes into account the different realities and challenges faced by women, such as micro-inequities, double work shifts, gender bias, and cultural expectations, is essential to reflect the diversity of experiences within teams.

### 3.1.1 Traditional Productivity Metrics

Traditional productivity metrics in software engineering, such as lines of code (Lines of Code (LOC)), function points, and work hours, aim to standardize and quantify completed work in a comparable manner (Pereira; Silva; Costa, 2016). However, these metrics present important limitations. For instance, LOC does not assess code quality or the value delivered to the client, and it may even encourage writing unnecessary code to inflate the count.

Function points offer a more refined measure by evaluating the functionality delivered to the user. Nonetheless, they also face challenges, such as failing to capture the subjective effort involved in developing more complex or innovative features (Vasilescu; Devanbu; Bird, 2019). The II model, which estimates project cost based on factors such as software size and complexity, also exhibits shortcomings, as it disregards human and collaborative elements that have a significant impact on productivity (Hoda; Salleh; Grundy, 2021).

Beyond these quantitative metrics, organizational factors, such as well-defined processes and the use of appropriate tools and technical factors such as code reuse and tooling quality are essential for a more comprehensive understanding of productivity. However, these metrics particularly fail to reflect the reality of women in software engineering. Research shows that micro-inequities and the frequent lack of recognition experienced by women are not captured by metrics like LOC or function points (Damian; Blincoe; Church, 2023b). This highlights the need to complement traditional metrics with qualitative approaches that consider contextual and subjective factors, promoting a fairer and more inclusive evaluation of productivity that recognizes the diverse contributions of all team members.

## 3.2 DIVERSITY AND WOMEN'S PARTICIPATION IN SOFTWARE ENGINEERING

Diversity in software engineering is an increasingly relevant topic, particularly concerning the participation of women. Despite progress in recent decades, women's representation in the field remains significantly lower than that of men. Gender inequality results not only in a lack of equity but also in the loss of innovative and productive potential for organizations (Williams; Multhaup; Trotta, 2020). Studies indicate that more diverse teams are 21% more likely to be innovative and achieve superior results (Company, 2024).

### 3.2.1 Historical Context of Women in Technology

Historically, women have made significant contributions to the field of technology. Pioneers such as Ada Lovelace and Grace Hopper played fundamental roles in the development of computing. However, since the 1980s, women's participation in tech careers has declined, influenced by factors such as gender stereotypes, the lack of female role models, and the perception of computing as a male-dominated field. This decline is evident in Computer Science programs in Brazil, where the proportion of enrolled women dropped from 26% in 1997 to just 13.66% in 2017 (USP, 2023b).

According to the 2022 Higher Education Census, only 18% of students enrolled in computing and Information and Communication Technologies (ICT) programs in Brazil are women, while in engineering and production-related programs, they represent 32% of students (Bosch, 2024). This underrepresentation is also reflected in dropout rates. A survey by the University of Brasília (UnB) revealed that 79% of women who enroll in engineering and technology programs drop out before graduation, compared to 56% of men (Brasília, 2018). The absence of support networks, the prevalence of gender bias, and the lack of representation in leadership positions are contributing factors to this high attrition rate.

In the labor market, gender inequality is equally concerning. The global software developer population reached 28.7 million in 2024, but most positions are held by men (STATISTA, 2024). In Brazil, data from the Revelo platform shows that in areas like full-stack, infrastructure, and back-end, the ratio is ten men for every woman (Brasil, 2024). Furthermore, while women represent about 30% of entry-level positions, this share drops to only 10% in leadership roles. In software engineering specifically, 12.3% of professionals are women, whereas men hold 83.3% of such roles (Economia, 2022b). According to Girls Who Code (2022), half of the women who enter tech careers leave the field within ten years, compared to only 20% of men. This disparity highlights the difficulties women face in entering, staying, and advancing in the tech workforce.

Challenges extend beyond workforce entry. Microaggressions, invisible barriers, and impostor syndrome affect women's confidence and perceived competence. Often, they are excluded from strategic projects and leadership opportunities, which perpetuates inequality and limits professional advancement (Brasil, 2024). The lack of female role models in leadership positions also discourages newcomers from aspiring to such roles.

Despite these challenges, recent initiatives are working to reverse this scenario. Programs promoting women's inclusion in STEM offer mentorships, workshops, and development opportunities. These actions aim not only to attract more women to the field but also to create support networks essential for retention and growth (Davis; Smith; Taylor, 2019). Promoting inclusive and equitable environments and increasing the visibility of women in leadership positions are key to inspiring new generations and reducing attrition in both education and industry.

### 3.2.2 The Impact of Diversity on Software Teams

Diversity in software teams significantly contributes to increased creativity and the ability to solve complex problems. Studies indicate that diverse teams are 33% more likely to outperform competitors in innovation and performance (Company, 2024). The presence of different perspectives helps identify more comprehensive solutions and prevents bias in software development.

Another McKinsey & Company study (Company, 2024) showed that companies with effective diversity policies are 25% more likely to promote women than those without such practices. These findings reinforce the importance of concrete actions to support women's long-term presence in the tech sector. Moreover, gender-diverse teams have shown up to a 15% increase in efficiency and innovation, demonstrating the value of inclusion for overall team performance. This is because diverse perspectives fuel creativity, enabling complex problems to be approached from multiple angles and resulting in broader solutions (Williams; Multhaup; Trotta, 2020). In software engineering, this translates into more inclusive products, greater user satisfaction, and enhanced competitiveness.

These statistics underscore the importance of implementing support and retention policies for women in software engineering. Mentorship programs, flexible work arrangements, and recognition practices are effective strategies to promote equity and improve performance. Thus, analyzing the factors that impact retention and performance should be integral to any effort aimed at making software engineering more inclusive and fair for all.

However, diversity also presents challenges that must be managed. Studies show that highly diverse teams may initially struggle with communication and cohesion, especially in environments where prejudice and stereotypes are more prevalent (Vasilescu; Devanbu; Bird, 2019). Therefore, it is essential for organizations to provide training and foster an inclusive culture to fully realize the benefits of diversity.

### 3.2.3 Challenges and Barriers to Women's Retention in Software Engineering

Women in software engineering face unique challenges that affect their participation and productivity. Micro-inequities, such as frequent interruptions in meetings and the assignment of less meaningful tasks, are examples of invisible barriers that negatively affect professional experiences (Damian; Blincoe; Church, 2023b). These dynamics diminish self-esteem and limit opportunities for growth, making career progression more difficult. The lack of recognition and promotion opportunities are recurring issues that impact women's retention. Studies show that women are 14% less likely to be promoted than equally qualified men, which contributes to their underrepresentation in leadership roles and higher dropout rates (Sloan, 2022).

Another critical factor is the work-life balance. Women often bear the burden of the "double shift," taking on responsibilities both at work and at home. According to the International Monetary Fund (IMF) (Fund, 2018), while women represent nearly 50% of the global workforce, they are responsible for approximately 75% of unpaid domestic labor, increasing stress and exhaustion. This imbalance contributes to higher burnout rates and drives women out of the tech sector, especially in companies that lack flexible work policies or family care support.

Workplace culture also plays a crucial role. Teams that do not foster diversity or maintain exclusionary cultures negatively impact women's retention. Micro-inequities, coupled with the absence of support networks and mentoring programs, make it harder for women to advance. Studies show that women with mentors are 2.5 times more likely to advance in their careers than those without such support (Sloan, 2022). These findings highlight the importance of structured mentoring programs, support networks, and inclusive policies that value women's contributions and promote equity.

Moreover, the gender pay gap remains a persistent issue in software engineering. IMF data (FMI, 2018) show that women earn, on average, 18% less than men in equivalent positions globally, with the gap reaching 22% in Brazil (Economia, 2022a). Even with equivalent qualifications and experience, women often face implicit biases, lack of salary transparency, and fewer promotion opportunities. This wage disparity not only demotivates but also contributes to attrition, making women 30% more likely to leave their careers due to unfavorable workplace conditions (Company, 2024).

Although efforts to increase gender diversity in technology are growing, structural and cultural barriers still limit women's opportunities for advancement in software engineering. Companies that adopt inclusive policies are 25% more likely to promote women, demonstrating the positive impact of such initiatives (Company, 2024). However, the absence of female role models in leadership and the lack of transparency in promotion criteria continue to perpetuate inequality, affecting women's confidence and motivation. Therefore, implementing inclusive policies and providing formal support, such as mentorship and flexible work initiatives, are essential steps toward ensuring the retention and advancement of women in technology.

## 3.3 WOMEN'S PERFORMANCE IN SOFTWARE ENGINEERING

Comparing the performance of female and male developers reveals important nuances about how productivity is measured and perceived. As previously noted, productivity in software engineering is often assessed through quantitative metrics, such as lines of code produced or hours worked (Pereira; Silva; Costa, 2016). However, these metrics fail to fully capture the challenges faced by women, such as the impact of family responsibilities and micro-inequities, which may indirectly influence their productivity.

Studies indicate that women's performance is more likely to be recognized and valued in diverse teams. In inclusive environments that encourage collaboration and peer support, women show productivity levels equivalent to or exceeding those of their male colleagues (Vasilescu; Devanbu; Bird, 2019). In contrast, exclusionary environments that undervalue gender diversity contribute to a negative perception of women's productivity, resulting in unfair evaluations and limited growth opportunities.

Furthermore, women tend to rate their own productivity lower than men, even when objective results are comparable. This phenomenon can be attributed to the lack of recognition and implicit bias present in the workplace (Sarma; Storey; Ford, 2019). The gap between perceived and actual productivity highlights the need to revisit traditional metrics and incorporate qualitative dimensions that more accurately reflect the value of women's contributions.

## 3.4 CHALLENGES IN RESEARCH ON WOMEN'S PRODUCTIVITY

### 3.4.1 Low Representation of Female Authors

The low participation of women in software engineering, previously discussed as a barrier to retention and career advancement, also significantly affects research in the field. The lack of diversity in workplaces and leadership roles is mirrored in academic studies, resulting in major challenges, such as the underrepresentation of women in both research authorship and participant samples. This imbalance restricts the scope and depth of findings, perpetuating the absence of a female perspective in addressing industry-specific challenges.

According to United Nations Educational, Scientific and Cultural Organization (UNESCO) data (UNESCO, 2021), only 30% of researchers in STEM fields are women. Consequently, much of the academic output in software engineering is conducted by male-dominated teams, which may introduce unconscious biases and hinder a thorough understanding of the specific barriers women face (Turek et al., 2020). Studies such as *Do You Really Code?* show that women's representation, both as authors and participants, remains a minority, limiting the development of equitable, effective solutions.

### 3.4.2 Limited Availability of Data on Women in Software Engineering

In addition to the low presence of female authors, there is a notable lack of gender-disaggregated data in research on software engineering productivity. Many studies do not report the gender distribution of participants, making it difficult to assess the specific conditions and outcomes for women. For instance, in *Factors Affecting Software Development Productivity: An Empirical Study*, there is no clear information on how many women participated, only a mention of the importance of gender diversity (Pereira; Silva; Costa, 2016). Conversely, *Today Was a Good Day: The Daily Life of Software Developers* states that 80% of participants were men, 19.9% women, and 0.1% other, but fails to clarify their respective roles in the study's findings (Meyer; Murphy; Zimmermann, 2022). This lack of transparency limits the ability to draw meaningful conclusions about the factors that uniquely affect women's productivity.

### 3.4.3 Consequences of the Data Gap

The lack of robust data and low representation of female authors in research on women's productivity in software engineering results in an incomplete understanding of the challenges these professionals face. Without detailed information about women's experiences, research outcomes tend to be biased, hindering the development of effective inclusion and retention policies. This scenario reinforces the invisibility of women in the field, reducing the availability of role models and discouraging others from entering or staying in the profession. The absence of specific data directly impacts the formulation of gender-sensitive solutions and limits the effectiveness of diversity initiatives.

## 3.5 INEQUALITIES AND BARRIERS IN SOFTWARE ENGINEERING

Women's presence in software engineering remains marked by structural and cultural inequalities that affect their entry, retention, and advancement in the field. These barriers often begin in academia, where dropout rates among women in technology courses are significantly higher than among men (Brasília, 2018). This reality reflects a learning environment that frequently fails to support or welcome women, leading many to abandon the field before their careers even begin.

In the workplace, these inequalities become even more pronounced. Wage gaps and limited promotion opportunities are not only reflections of implicit bias but also symptoms of organizational neglect regarding diversity. As previously mentioned, women earn less and are less likely to be promoted, even when equally qualified. This impacts their motivation and retention, while also limiting team innovation and productivity (FMI, 2018; Sloan, 2022).

Work-life balance is another critical issue. The burden of the "double shift," combined with the lack of policies that support family-care responsibilities, contributes to high levels of stress and burnout among women. Although flexible work arrangements and family support programs are known to improve retention, few companies implement these measures consistently. This underscores the urgent need for organizational policies that respond to gender-specific realities.

These challenges are not limited to the workplace. Women's underrepresentation in academic research is another manifestation of systemic exclusion. As previously discussed, the absence of women as authors and study participants limits the analysis of gender-specific issues. This results in generic, ineffective solutions that fail to address the root causes of exclusion (Turek et al., 2020; UNESCO, 2021). To make research in software engineering truly inclusive, greater female representation is required at all stages of the academic process.

While diversity-focused initiatives have begun yielding positive results, as discussed earlier, significant progress is still needed. Inclusive policies must go beyond numerical targets and directly address implicit bias, micro-inequities, and the lack of strong support networks. Building a truly equitable and inclusive environment in software engineering demands deep structural change, both organizationally and academically, and a genuine commitment to transforming existing systems.

## 3.6 GENDER BIAS IN SOFTWARE ENGINEERING

Gender bias remains a persistent and complex barrier to equity in software engineering, even in environments that are considered diverse or inclusive. While previous sections have addressed structural inequalities and the underrepresentation of women, it is essential to understand how implicit and explicit biases shape women's experiences in the field and contribute to productivity disparities.

Research shows that gender bias often manifests in subtle, systemic ways that disadvantage women, regardless of their qualifications or performance. In some cases, women are evaluated more harshly, receive less credit for collaborative work, or are overlooked for leadership roles, even in female-majority environments (Cundiff; Vescio, 2022). These biases are frequently unconscious but have tangible effects on performance evaluations, promotion opportunities, and job satisfaction.

A study by Prime et al. (Prime; Salib; Carter, 2021) developed and validated the Gender Bias Scale for Women Leaders, revealing that women in leadership roles across various industries frequently encounter biased assumptions about their competence, emotional stability, and authority. Such biases contribute to workplace cultures that undermine women's confidence and reduce perceptions of legitimacy, particularly in technical and decision-making contexts.

Moreover, McKinsey's *Women in the Workplace 2024* report (Company, 2024) highlights that while female representation has improved in entry-level tech roles, advancement into leadership remains limited. Women in technical fields report higher levels of burnout and lower feelings of psychological safety compared to their male colleagues. The report also underscores that women of color face compounded biases, often being the most underrepresented and least supported demographic in the sector.

In software engineering, these biases intersect with productivity metrics, shaping how women's work is perceived and valued. For example, contributions in mentorship, documentation, or inclusive practices, often undertaken by women, are frequently excluded from traditional performance evaluations. This perpetuates the invisibility of critical labor and contributes to a culture where women feel less recognized and more likely to disengage (Vasilescu; Devanbu; Bird, 2019; Damian; Blincoe; Church, 2023a).

Additionally, perceived gender discrimination has been shown to negatively impact career satisfaction and increase turnover intentions. Women who experience frequent bias are more likely to consider leaving their positions, especially in the absence of inclusive leadership and formal career support structures (Sabir; Shahid, 2021). This cycle of underrecognition and attrition not only affects individual careers but also weakens team cohesion and innovation.

Addressing gender bias in software engineering requires a multi-faceted approach that goes beyond numerical diversity. It involves revising productivity metrics to value collaborative and invisible labor, training managers to identify and interrupt biased evaluation patterns, and fostering workplace cultures that actively support equity. Only through such intentional, systemic efforts can the industry create environments where women are fully recognized for their contributions and can thrive professionally.

# 4 METHODOLOGY

This research is classified as **Applied Research**, as it aims to generate practical insights applicable to the real-world context of software engineering, focusing on analyzing and understanding the productivity and performance of women in this field. The relevance of this classification lies in the potential to inform the development of inclusive workplace policies based on empirical evidence.

In terms of approach, this is a **Mixed-Methods Study**, combining quantitative and qualitative strategies. The **quantitative** dimension was designed to statistically analyze productivity-related perceptions through structured questionnaires, offering objective insights into productivity metrics, work environments, and demographic patterns. The **qualitative** dimension, in turn, sought to deeply explore individual experiences, perceptions, and contextual challenges through semi-structured interviews.

This is also an **Exploratory Research**, as it investigates an underexplored domain in software engineering literature, how gender affects the perception and evaluation of productivity, and how traditional metrics may fall short in capturing the contributions of women. While this study does not aim to propose new metrics, it highlights relevant analytical patterns that may inform future efforts in this direction.

From a technical standpoint, this study qualifies as a Survey. The survey was distributed to professionals in the field to capture broad quantitative data, while qualitative interviews were conducted to gain an in-depth understanding of the challenges encountered by women in various professional roles.

## 4.1 DATA COLLECTION PROCESS

This research was conducted in two phases:

**1. Quantitative Phase – Survey:** The online survey collected 85 valid responses from women working in software engineering across different regions of Brazil, between January 20 and February 27, 2025. It was disseminated through institutional Slack channels, LinkedIn, WhatsApp communities, and other professional networks, ensuring broad regional and organizational representation. The link to the questionnaire is provided in the Appendix of this document for reference purposes.

The questionnaire included a total of 30 questions, comprising both multiple-choice and open-ended formats, structured into the following categories:

- **Demographic and Career Background** – Age, years of experience, and current role.
- **Workplace Environment and Personal Factors** – Perceptions of bias, inclusivity, microaggressions, team dynamics, and organizational culture.
- **Productivity and Evaluation** – Metrics used for performance measurement, recognition of contributions, and perceived fairness.
- **Diversity and Inclusion** – Inclusion policies, leadership representation, and access to support networks.

**2. Qualitative Phase – Interviews:** Semi-structured interviews were conducted with 20 participants, including developers, technical leads, and engineering managers, between January and March 2025. Each role followed a tailored interview guide of approximately 18 to 24 questions, aligned with the main themes of the survey but designed for deeper reflection and personal narrative. For developers, the questions focused on how they perceive and experience productivity metrics in their daily work. For technical leads, the emphasis was on the dual perspective of being evaluated while also guiding others. For engineering managers, the questions centered on how they assess productivity, manage team dynamics, and incorporate such metrics into decision-making. The full set of interview scripts, along with the anonymized analysis report, is available in a shared drive linked in the Appendix of this document.

All interviews were conducted online and lasted between 30 minutes and one hour. The analysis followed three methodological axes:

- **Horizontal Analysis**: Comparing responses across participants for each shared question.
- **Vertical Analysis**: Exploring each interview holistically to understand the full context of the respondent's experience.
- **Cross-Profile Analysis**: Identifying convergence and divergence among the three professional groups regarding productivity, recognition, and workplace dynamics.

## 4.2 RESEARCH ACTIVITIES

The research process was organized into the following stages:

- **Instrument Design and Validation:** A survey and interview scripts were designed and refined based on existing literature. Each instrument aimed to address the research objectives and capture the lived experiences of women in software engineering.
- **Data Collection:** The survey was distributed digitally through relevant platforms, and interviews were scheduled with participants across different professional levels and regions.
- **Data Analysis:** Quantitative data was analyzed using descriptive statistical techniques. Interview transcripts were analyzed thematically, enabling the identification of recurring patterns and context-specific challenges.
- **Synthesis and Reporting:** The integration of quantitative and qualitative findings provided a comprehensive view of the research problem. While this study does not propose new productivity metrics, it identifies gaps and patterns that will inform future research and recommendations.

This methodology enables a robust examination of how gender influences productivity in software engineering and contributes to the academic debate on inclusivity, recognition, and organizational change. Future work will build upon the analytical insights presented here to explore the development of alternative productivity evaluation frameworks better suited to the realities of an increasingly diverse workforce.

## 4.3 CONTRIBUTIONS

It is worth noticing that this research process led to the development of the article "Bridging the Gap: A Data-Driven Analysis of How Traditional Software Engineering Productivity Metrics Overlook Women's Performance", which was submitted and accepted at the 45th Congress of the Brazilian Computer Society (Congresso da Sociedade Brasileira de Computação (CSBC) 2025). The article presents the preliminary results of the quantitative phase of this study and will be formally presented in July 2025.

# 5 QUANTITATIVE ANALYSIS

This chapter presents a comprehensive quantitative analysis based on the responses collected through a structured digital survey applied to Brazilian women working in software engineering. The primary aim is to identify and quantify structural, cultural, and organizational factors that influence female productivity in the field, especially in light of limitations inherent to traditional productivity assessment methods, such as Lines of Code (LOC), commit frequency, or sprint velocity.

To ensure alignment with the research focus, the survey specifically targeted women professionals in the field. Nearly all respondents identified as women, reflecting the intended demographic. The survey was distributed via professional networks, messaging groups, and women-in-tech communities, ensuring representation from a variety of geographic regions and industry sectors across Brazil.

These results provide a descriptive and inferential analysis of the collected data. It aims to highlight how productivity is perceived, assessed, and influenced for women in this industry, establishing empirical ground for the later development of new, inclusive productivity metrics. The following sections provide a detailed breakdown of the respondents' profiles, their work environments, challenges they face in terms of productivity, and the contextual conditions that shape their professional experience.

## 5.1 DEMOGRAPHIC AND PROFESSIONAL PROFILE OF THE RESPONDENTS

The demographic data collected in the survey reveals a strong presence of young women in the Brazilian software development landscape. Among the 85 participants, the majority (61%) were younger than 30 years old. This suggests an encouraging trend of early-career entry by women in the field, possibly reflecting recent efforts by educational institutions and diversity programs to attract more female professionals to STEM areas. However, this age distribution also introduces an important interpretative bias: many respondents are likely still in the early stages of their careers, which may limit their exposure to certain professional experiences. As a result, their perspectives may reflect challenges specific to junior roles, including reduced visibility, lower confidence in asserting expertise, and limited access to leadership development opportunities. This must be taken into account when analyzing broader patterns of gender inequality and professional advancement in the industry.

The high prevalence of younger professionals might also suggest a potential attrition of women as their careers progress, an issue consistently highlighted in the literature on gender and technology (Almeida et al., 2021; Nafus, 2012). The low representation of women in the older age brackets underscores the urgency of implementing retention strategies focused on mid- and senior-level female engineers. This absence not only reflects structural barriers to career longevity but also limits the scope of productivity analysis across different career stages. Without the perspective and data from more experienced women, it becomes difficult to understand how long-term career progression, leadership roles, and accumulated expertise impact female productivity in engineering environments. As a result, the discussion on gender and performance remains disproportionately focused on early-career professionals, overlooking the systemic challenges faced later on.

Another noteworthy data point concerns leadership: only 12% of participants reported holding formal leadership positions such as technical leads, team coordinators, or managers. While this may reflect structural inequities such as biased promotion practices or lack of sponsorship, it also mirrors the predominantly junior composition of the sample. Therefore, caution must be taken not to interpret this figure as representative of all women in software engineering, but rather as reflective of the early-career majority surveyed. This information is detailed in **Table 1**.

Occupationally, approximately 81.7% of the respondents reported working in traditional corporate software development environments. Smaller yet significant groups were engaged in startups, academic institutions, freelance roles, or transitioning from educational contexts. These paths reflect the diversification of career opportunities for women in tech but also underscore variations in access to benefits and organizational support structures, particularly concerning work-life balance and inclusion.

This profile establishes the baseline from which to analyze how gendered barriers manifest in the workplace, offering valuable insights into the productivity perceptions of early-to-mid-career professionals. However, complementary studies with more senior participants are necessary to fully understand the trajectory and persistence of these barriers across different career stages.

Table 1 – Age and Professional Experience Distribution

| Age Distribution | |
|---|---|
| **Respondents aged less than 20 years** | 1.2% |
| **Respondents aged 20–29 years** | 59.8% |
| **Respondents aged 30–39 years** | 28% |
| **Respondents aged 40–49 years** | 9.8% |
| **Respondents aged 50 years or older** | 1.2% |
| **Professional Experience** | |
| **Junior professionals (or less than 2 years)** | 43.9% |
| **Mid-level professionals (2–5 years)** | 36.6% |
| **Senior professionals (more than 5 years)** | 19.5% |

**Source:** Lorena Seabra (2025).

## 5.2 WORKPLACE ENVIRONMENT AND GENDER-RELATED INEQUITIES

This section explores how women in software engineering experience inclusion, participation, and recognition in their work environments. While many organizations promote diversity and inclusion (Diversity and Inclusion (D&I)) rhetorically, the data from this study reveals that formal inclusion does not always translate into structural equity. Evaluating inclusion and the sense of belonging is crucial when investigating productivity metrics, as these social factors directly influence motivation, engagement, and the ability to contribute meaningfully to a team. Environments where individuals feel excluded or undervalued can lead to decreased performance, higher turnover, and underutilization of talent outcomes that are rarely captured by traditional productivity indicators. This analysis draws from both multiple-choice and open-ended survey responses, particularly focusing on questions related to team composition, leadership representation, workplace inclusivity, and gender-based challenges.

### 5.2.1 Team Composition and Perceived Inclusivity

When asked about the gender makeup of their teams, 69.2% of participants reported working in male-majority environments. Despite this imbalance, 62.8% considered their workplace inclusive or welcoming to women. This contrast points to a frequent disjunction: environments may appear inclusive at the surface level, even while structural or cultural barriers persist. One explanation may lie in the normalization of gendered hierarchies in tech teams, where women adapt to existing norms rather than experience full inclusion.

A similarly ambivalent trend emerged regarding company openness to D&I discourse. Although 59% affirmed that their workplace promoted or allowed open discussion on gender and diversity, only 12% of respondents reported holding a formal leadership role, and 46.2% highlighted the lack of women in decision-making positions. This suggests the presence of a symbolic inclusion that does not translate into actual influence or power. Such findings align with the concept of the "glass ceiling" as discussed by Cotter et al. (2001), which describes the invisible barriers that prevent women from advancing to higher levels of leadership despite apparent equality of opportunity (Cotter et al., 2001).

### 5.2.2 Experiences of Exclusion, Interruption, and Dismissal

Gender-based challenges were widely reported. When asked whether they had faced any such challenges, 48.7% of respondents said yes. Among these, 41.2% had been ignored or had their contributions dismissed in technical meetings or collaborative spaces. Open-ended responses frequently described episodes where women's input was disregarded until echoed by male colleagues, or where their presence in technical discussions was minimized.

A particularly striking figure is that 74.1% of women reported being interrupted during technical conversations, an experience often referred to as *manterrupting* in gender and communication literature (Karpowitz; Mendelberg; Shaker, 2012; Tannen, 1994). These interruptions not only degrade the speaker's authority but also create emotional fatigue, inhibit idea-sharing, and reduce perceived credibility.

Several participants also shared examples of disrespect, sarcasm, or condescension, such as being excluded from decision-making, having their promotions questioned, or facing inappropriate jokes. As one participant described, "I had to repeat the same idea three times. A man said the same thing, and only then it was accepted."

### 5.2.3 Access to Strategic Work and Recognition

Workplace inequities extend to task assignments and access to impactful roles. While no direct multiple-choice question in the survey explicitly asked about access to high-impact work, the correlation analysis and qualitative responses revealed that 32.9% of respondents felt excluded from major technical decisions, and 29.4% reported being consistently assigned to lower-visibility or support tasks. These assignments are often misaligned with skill level and disproportionately affect women, many of whom described being highly qualified and proactive but repeatedly overlooked.

This trend echoes the findings from the previous sections, where glue work (e.g., documentation, onboarding, and team support) was both necessary and invisible. By excluding women from strategic initiatives and confining them to background roles, these patterns restrict visibility, hinder promotions, and reinforce gendered divisions of labor. As a result, they distort how female software engineers perceive productivity and how their contributions are measured highlighting the central claim of this thesis that traditional productivity metrics fail to capture the realities shaped by gendered organizational dynamics.

### 5.2.4 Structural Implications

Taken together, these findings reveal that *presence* in a team is not equivalent to *participation* or *recognition*. Women are often welcomed into technical teams but are not granted equal space to lead, influence, or be heard. Inclusion without power reproduces exclusion in subtle forms, such as in meetings, task allocation, and evaluation processes, all of which directly impact how productivity is both expressed and assessed. When women are systematically sidelined from visible, high-impact tasks or strategic decision-making, their measurable performance can appear lower, not because of skill or effort, but because of unequal access to opportunities that traditional productivity metrics tend to value.

This paradox, wherein women are present in technical spaces yet marginalized in their influence, creates not only short-term distortions in how their productivity and performance are interpreted, but also long-term consequences for their confidence, retention, and professional advancement. These marginalizations often lead to a misalignment between actual contributions and perceived value, reinforcing biased evaluations and limiting promotion prospects. These results underscore the need to critically assess not only the representation of women in software teams but also the quality of their participation and the fairness of how their contributions are recognized and rewarded. As will be explored in the qualitative chapter (Chapter 6), many women internalize these patterns of exclusion, which erode their self-assurance, create a sense of isolation, and ultimately shape constrained and uneven professional trajectories, further distancing them from conventional definitions of productivity and success in engineering environments.

To facilitate a clearer view of the gap between perceived inclusion and lived experience, Table 2 summarizes the key findings related to gendered dynamics in the workplace

Table 2 – Perceptions of Inclusivity and Gender-Based Challenges

| Survey Item | Reported Percentage |
|---|---|
| **Perceived inclusive/welcoming workplace vs. discussion on gender and diversity** | 62.8% vs. 59% |
| **Lack of female leadership representation** | 46.2% |
| **Experienced gender-based challenges** | 48.7% |
| **Being ignored or dismissed vs. interrupted in technical conversations** | 41.2% vs. 74.1% |
| **Excluded from major technical decisions vs. assigned to low-visibility tasks** | 32.9% vs. 29.4% |

**Source:** Lorena Seabra (2025).

## 5.3 PRODUCTIVITY METRICS AND THE INVISIBILITY OF KEY CONTRIBUTIONS

This section analyzes a set of survey questions that included both multiple-choice (multi-select) and open-ended responses, aiming to understand how women in software engineering perceive the way their productivity is measured and what aspects of their work are overlooked by conventional metrics.

### 5.3.1 Structured Response Analysis

Among the structured responses, 58.8% of participants reported that their productivity was evaluated primarily through technical and quantifiable indicators, such as Lines of Code (LOC) and commit frequency. Additionally, 47.1% cited sprint velocity as a key measure used in their teams. While these metrics are widely adopted for their ease of tracking and perceived objectivity, participants consistently emphasized their inability to reflect the full scope of technical contributions.

LOC often rewards verbosity over code clarity or architectural soundness, while commit frequency favors quantity over the quality of changes. Sprint velocity, although useful for short-term delivery tracking, tends to ignore the complexity of tasks, collaborative problem-solving, and planning efforts, flattening multifaceted work into a numerical output. These metrics promote a narrow view of performance, focused on speed and volume, and fail to capture essential dimensions such as maintainability, testing depth, and cross-functional support.

In contrast, only 35.3% of respondents reported that collaborative efforts, such as peer feedback, teamwork, documentation support, or mentoring, were considered in performance evaluations. Even among those who did report some level of recognition for these contributions, most emphasized that such elements held significantly less weight than technical outputs in formal assessments. This imbalance suggests a systemic disregard for process-oriented and relational labor, which is fundamental to software team cohesion and long-term quality. These forms of work, often performed invisibly and disproportionately by women, remain untracked and unrewarded, reinforcing a productivity model that fails to reflect the collaborative and multidimensional nature of software development.

### 5.3.2 Open-Ended Response Themes

Further insights emerged from open-ended responses to the question: *"In your opinion, what aspects of your work are not captured by traditional metrics?"* All closed-ended questions in the survey were mandatory, and most of the open-ended ones required input as well. As a result, this question gathered 85 detailed responses, revealing a wide range of overlooked contributions. Several major themes included:

- **Mentoring and onboarding:** Previously captured in quantitative responses by 52.9% of participants, these activities were described as emotionally intensive and vital to team health, yet rarely acknowledged in reviews.

- **Documentation and process improvements:** Reported by 48.2% of participants, these tasks were viewed as foundational to product scalability but generally dismissed in performance assessments.

- **Conflict resolution, emotional mediation, team planning:** Frequently cited in qualitative answers as essential to maintaining project momentum and reducing friction, but not documented in platforms like Jira or recognized in formal feedback.
- **Context, effort, and task complexity:** Respondents noted that debugging legacy systems, integrating isolated features, or resolving unexpected technical issues require disproportionate time and focus, efforts that rarely surface in commit logs or velocity charts.

### 5.3.3 The Problem of "Glue Work"

These invisible efforts reflect what the industry often refers to as *glue work*, the connective, integrative labor that ensures software projects move forward effectively. As Rosser (2005) explains, such traits have been historically gendered and undervalued in technical domains (Rosser, 2005). Work associated with empathy, communication, and coordination, frequently seen as feminine-coded, is often excluded from what organizations define and reward as "technical excellence." This historical bias contributes to a structural flaw in performance evaluations, where those performing glue work accumulate fewer measurable outputs and, therefore, face stalled recognition and advancement.

### 5.3.4 Support Needs and Recommendations

One survey question specifically asked participants: *"What kind of additional support (tools, policies, benefits) would help improve your productivity?"* Among the most cited suggestions were:

- **Access to mental health support:** Programs like therapy and wellness initiatives were highlighted as crucial to managing burnout and maintaining engagement.
- **Flexible schedules and remote work options:** Especially for those with caregiving responsibilities or health fluctuations, remote and asynchronous work was viewed not only as beneficial, but necessary.
- **Recognition for qualitative contributions:** Participants called for formal structures that credit mentorship, documentation, peer support, and conflict resolution as part of

performance evaluations.

- **More inclusive evaluation criteria:** Respondents emphasized the need for performance reviews that incorporate team impact, task complexity, adaptability, and learning capacity.

### 5.3.5 Participant Dissatisfaction and Systemic Issues

Notably, 64.7% of respondents explicitly stated dissatisfaction with how current productivity metrics reflected their real contributions. Many described how their most valuable work, such as unblocking peers, supporting decision-making, and maintaining morale, was neither tracked nor rewarded. As one respondent expressed, *"I mentor junior devs, document processes, lead retrospectives... but in the end, they only ask how many tickets I closed."*

This disconnect has far-reaching consequences. Women who disproportionately perform glue work accumulate fewer "points" in systems optimized for output volume, leading to slower promotions, diminished visibility, and increased risk of burnout. This creates a paradox where those who uphold team performance are systematically undervalued by the very structures they sustain.

The findings in this section support the central hypothesis of this research: traditional productivity metrics in software engineering do not adequately capture the multifaceted contributions of women. Both quantitative and qualitative data reveal a pattern of invisibility and undervaluation, especially for relational, strategic, and integrative work. To foster more inclusive and accurate evaluation systems, productivity must be redefined to include collaboration, complexity, sustainability, and contextual impact, not just lines of code or delivery speed.

## 5.4 EXTERNAL FACTORS AND THE IMPACT ON PRODUCTIVITY

This section is based on both open-ended and multiselect survey questions, focusing on external and contextual factors that influence the productivity of women in software engineering. While productivity is often framed as an internal attribute or technical output, the lived experiences of respondents reveal that external responsibilities, workplace environment, and biological factors play a significant role in shaping their performance.

### 5.4.1 The Double Burden

A central issue discussed is the **double burden**, the combined pressure of professional obligations and domestic responsibilities. As outlined in gender studies literature, women in Brazil dedicate nearly twice as many hours per week to unpaid household tasks compared to men (21.4 vs. 11 hours) ((IBGE), 2021). This imbalance severely limits the time and energy available for career advancement, continuous learning, and even rest (Glass et al., 2013; Cha; Weeden, 2013). In the survey, 85% of respondents reported that domestic responsibilities significantly impacted their productivity, particularly by reducing their ability to focus, engage in professional development, or manage time effectively. One participant described the situation concisely: *"After finishing a full workday, I start a second shift at home. That's also labor, but it doesn't get counted anywhere."*

When asked to assess their work-life balance, respondents gave an average satisfaction rating of 3.78 out of 5, indicating moderate contentment. However, qualitative responses revealed underlying stress and emotional exhaustion. Several participants mentioned difficulty in managing professional expectations alongside childcare and household obligations. This reflects findings from Hochschild and Machung (2012), who describe the *"second shift"* as the unpaid domestic labor that women perform after formal work hours, an effort that often goes unacknowledged but has measurable impacts on well-being and productivity (Hochschild; Machung, 2012). Psychological studies suggest that many women internalize these burdens as a norm, distorting their own perception of balance (Rojas; Kornrich, 2021).

### 5.4.2 Mental Load and Cognitive Burden

Another key factor is the **mental load**, reported by 71.8% of respondents. This concept refers to the invisible, ongoing cognitive work required to plan, anticipate, and manage simultaneous personal and professional tasks. The data was collected through a multiselect question where respondents chose all the factors they felt negatively impacted their productivity. The mental load was among the most frequently selected items. Research in cognitive psychology confirms that this constant multitasking leads to decision fatigue, decreased focus, and emotional burnout (Daminger, 2019; Mederer, 1993). Mederer's (1993) and Daminger's (2019) studies further suggest that women disproportionately carry this cognitive burden due to ingrained expectations around planning, emotional regulation, and relational labor.

### 5.4.3 Physiological Factors and Health Impacts

Beyond cognitive and emotional strain, physiological factors also emerged as significant. In response to a direct question, 80.8% of participants stated that their productivity is affected by their menstrual cycle, citing symptoms such as migraines, fatigue, irritability, and difficulty concentrating. These symptoms were reported to impair the ability to perform cognitively demanding tasks, especially in high-pressure environments. Although the health impacts of hormonal fluctuations are well-documented in medical literature (Szymanski et al., 2023), they remain largely ignored in workplace policies or productivity evaluations. One participant suggested that having the option for remote work or low-demand days during such periods could mitigate these challenges, but noted that requesting such flexibility would likely be interpreted as a sign of weakness.

The normalization of this silence reveals a broader cultural issue. Many respondents described discomfort in discussing menstrual symptoms or reproductive health at work, either due to fear of being perceived as less capable or because such conversations were considered taboo. This erasure reinforces an ableist and masculine model of productivity that assumes all workers operate with the same physical and cognitive conditions every day.

### 5.4.4 Structural Inequality in Performance Evaluation

These findings are further compounded by workplace expectations that ignore contextual challenges. When women are evaluated using the same output-focused metrics as their male peers, without accounting for caregiving duties, cognitive overload, or hormonal cycles, they are placed in a structurally unequal position. As one participant summarized: *"My productivity is judged in comparison to someone who never had to deal with what I deal with every day."* This discrepancy not only affects formal evaluations and promotion opportunities but also impacts self-perception and mental health.

Moreover, survey respondents were asked to describe what kind of support would improve their productivity. A large number called for flexible hours, remote work, psychological support, and recognition of non-visible labor. These suggestions echo previous findings (discussed in Section 1.4) and indicate that structural accommodations, not only individual effort, are crucial for sustained productivity.

This section confirms that external and contextual factors, often invisible in traditional performance metrics, play a decisive role in shaping the productivity of women in software engineering. The data underscores the need for systemic change: organizations must move beyond a one-size-fits-all approach and develop inclusive frameworks that recognize caregiving, mental load, health cycles, and emotional labor as legitimate and impactful dimensions of professional performance.

## 5.5 CORRELATIONS AND CROSS-ANALYSES: MAPPING SYSTEMIC PATTERNS

This section delves into the statistical relationships identified within the dataset, exploring how different factors intersect and contribute to patterns of undervaluation and slowed career progression for women in software engineering.

Beyond descriptive statistics, this analysis employed a **manual cross-referencing approach**, in which the most frequently answered questions from different sections, particularly those concerning external challenges, health, well-being, and perceptions of equity, were compared with answers to the productivity-related questions. This process allowed for the identification of co-occurring patterns across dimensions such as gender bias, invisible labor, mental and physical health, and lack of recognition. While these relationships do not imply direct causality, they offer meaningful insight into the compounding effects of structural and cultural variables in shaping workplace outcomes.

### 5.5.1 Perceived Bias and Productivity Assessments

One of the strongest correlations observed concerned the relationship between perceived gender-based challenges and dissatisfaction with productivity evaluation. Among the 48.7% of participants who reported experiencing gender bias or discrimination in the workplace, 64.7% also stated that the way their productivity is currently measured does not reflect the reality of their work. This overlap suggests that bias in visibility and credibility directly translates into biased assessments, reinforcing a feedback loop of undervaluation. In open comments, many women described having to defend their ideas multiple times or rely on male colleagues to validate their input before it was accepted, dynamics that not only affect confidence but also influence formal recognition.

### 5.5.2 Invisible Labor and Career Stagnation

Another relevant correlation emerged between invisible labor and slowed professional growth. Among those who frequently reported engaging in onboarding, mentorship, documentation, or process improvement, 52.9% and 48.2% of respondents, respectively, 43.5% also reported slower career progression compared to their peers. These activities, while essential to the functioning of any software team, are rarely tracked by standard performance metrics and often categorized as non-promotable work. As discussed in previous sections, they require significant cognitive and relational effort but do not contribute directly to technical output as measured by commits or delivery speed, which explains why women who disproportionately take on these roles are left behind in promotions and raises.

### 5.5.3 Domestic Responsibilities and Missed Opportunities

The data also reveals a connection between domestic responsibilities and reduced access to growth opportunities. Among the 54.1% of respondents who indicated that household or caregiving duties limited their ability to engage in professional development, 32.9% also stated that they had been excluded from strategic or high-visibility projects. This suggests that high domestic workload may lead to self-exclusion from optional opportunities like tech talks, leadership bootcamps, or overtime-intensive initiatives, but also that organizations may be selecting candidates based on perceived availability rather than merit. As Cech (2010) argues, the idea of meritocracy itself is often shaped by biased assumptions about presence, availability, and commitment (Cech; Blair-Loy, 2010).

### 5.5.4 Mental and Physical Health and Perceived Recognition

A more subtle but equally significant pattern was observed regarding mental and physical health, particularly hormonal fluctuations, and self-perceived recognition. Among the 80.8% of participants who reported that their mental and physical health affected their productivity, many described symptoms related to menstruation, such as migraines, fatigue, irritability, and reduced focus, as factors that disrupted their ability to deliver at full capacity. This group substantially overlaps with those who reported dissatisfaction with how their work is evaluated (64.7%), suggesting that women experiencing cyclical or health-related fluctuations in performance are also more likely to feel unfairly judged by current evaluation systems.

Although this does not constitute a causal relationship, it reveals a thematic convergence: current workplace metrics lack any mechanism to account for gender-specific health patterns, thus contributing to skewed assessments and reduced career advancement. Recent studies confirm that menstrual symptoms can have a measurable impact on cognitive function and workplace performance, particularly in fields that demand sustained concentration and problem-solving (Szymanski et al., 2023; Daminger, 2019).

### 5.5.5 Inclusion Perception vs. Leadership Representation

Finally, the survey highlighted a dissonance between perceived inclusivity and actual representation. While 71% of participants reported feeling that their workplaces were welcoming to women, only 12% held formal leadership roles, and 54% stated that they rarely saw women in decision-making positions. This contrast suggests that superficial inclusion, through discourse or branding, is not translating into equitable career progression. The absence of women in leadership not only limits role models and mentorship opportunities but also reduces the likelihood of structural changes being championed from within.

### 5.5.6 Synthesis and Implications

Together, these correlations illustrate how various forms of bias, structural, cultural, and institutional, intersect and accumulate, reinforcing a cycle of invisibility, overload, and underrecognition. The combined impact of unmeasured labor, unequal domestic expectations, health-related productivity variations, and gendered credibility gaps presents a serious barrier to equitable evaluation and advancement in software engineering.

These findings emphasize the necessity of developing productivity metrics that are not only broader and more inclusive but also sensitive to the contextual realities of the people being evaluated. More importantly, they validate the mixed-methods approach used in this study, demonstrating that quantitative data becomes more powerful when interpreted through the lens of real-world lived experience.

To complement the findings discussed in this section, Table 5 below summarizes the key cross-correlations identified in the dataset. These correlations highlight the structural interplay between gendered labor dynamics, productivity evaluation practices, and workplace inclusion, reinforcing the need for more holistic and equitable performance assessment frameworks in software engineering.

Table 3 – Summary of Key Cross-Correlations Identified in the quantitative analysis

| Cross-Correlated Factors | Observed Relationship | Implications |
|---|---|---|
| **Gender bias perception (38.5%) and dissatisfaction with productivity metrics (64.7%)** | Respondents who experienced gender bias also reported higher dissatisfaction with how productivity is measured. | Suggests that biased dynamics influence both visibility and fairness in evaluations. |
| **Engagement in glue work (mentoring: 52.9%, documentation: 48.2%) and slower career progression (43.5%)** | Those who engage in invisible labor report less advancement. | Reinforces that essential, non-quantified work hinders recognition. |
| **Domestic responsibilities (54.1%) and exclusion from high-visibility projects (32.9%)** | High domestic load correlated with reduced access to key opportunities. | Indicates structural barriers to meritocracy and career progression. |
| **Health impact on productivity (80.8%) and dissatisfaction with evaluation fairness (64.7%)** | Women affected by hormonal and mental health challenges also feel less fairly evaluated. | Reveals lack of accommodation for cyclical health conditions in assessment systems. |
| **Workplace perceived as inclusive (71%) vs. leadership representation (12%)** | Many view their environment as inclusive, yet few women hold leadership roles. | Highlights the disconnect between inclusive discourse and power structures. |

**Source:** Lorena Seabra (2025).

## 5.6 SUGGESTED IMPROVEMENTS AND FINAL REFLECTIONS

This section analyzes a specific set of open-ended questions included throughout the survey. In addition to structured multiple-choice questions across four thematic areas, productivity, workplace environment, mental and physical health, and gender-related experiences, each section concluded with an optional open-ended field. Furthermore, the survey ended with a mandatory open question inviting participants to suggest changes that could improve their productivity and well-being. All 85 respondents answered this final question, resulting in a rich collection of reflective and solution-oriented comments. The purpose of this section is to synthesize these qualitative contributions and highlight the participants' direct proposals for creating more inclusive, equitable, and productive work environments.

### 5.6.1 Flexible Work and Hormonal Cycle Accommodations

Among the most frequently mentioned proposals was the need for greater flexibility in work arrangements, particularly during menstruation or emotionally demanding phases. A total of 68% of respondents explicitly advocated for flexible scheduling during hormonal cycle periods. Participants emphasized that rigid 9-to-5 structures often fail to accommodate the biological and emotional fluctuations many women experience. Several suggested implementing *"low-stimulation"* workdays to focus on documentation, planning, or mentorship, tasks that remain productive but require less cognitive and emotional load. This approach reflects a broader call to redefine productivity to include the ability to adapt one's work rhythm without penalty.

These suggestions align with data from earlier sections. For instance, 80.8% of women reported that mental and physical health factors, many related to the menstrual cycle, directly affect their performance. Yet these impacts remain invisible in standard evaluations, reinforcing the perception of misalignment between workplace expectations and lived realities.

### 5.6.2 Remote and Hybrid Work Models

Closely related to the demand for flexibility was the widespread support for remote or hybrid work arrangements. A total of 75% of respondents praised the benefits of working from home, particularly for those with caregiving responsibilities or high domestic workloads. As shown in section 1.5, 54.1% of participants indicated that household responsibilities limit their ability to pursue professional growth. Remote work was seen as a structural support mechanism that enables better balance, reduces commuting fatigue, and enhances autonomy over one's daily schedule.

For many women, the ability to work remotely is not simply a benefit, it is a precondition for sustained engagement and performance, particularly when managing dual responsibilities at home and at work.

### 5.6.3 Leadership Representation and Inclusive Metrics

Another recurrent theme was the need for greater female representation in leadership roles. While 54% of participants reported feeling isolated in male-dominated teams or decision-making spaces, their concerns extended beyond symbolic inclusion. As previously discussed, women in leadership tend to be more attuned to issues like caregiving, health-related fluctuations, and mental load, and are more likely to advocate for evaluation frameworks that recognize these realities.

Participants emphasized that female leadership fosters context-aware management and promotes the development of alternative productivity metrics that go beyond technical output to include mentoring, emotional support, and problem-solving contributions. This call is directly aligned with prior findings: for instance, 52.9% of respondents regularly engage in mentoring and 48.2% in documentation, yet these tasks remain undervalued in performance reviews.

### 5.6.4 Recognition of Invisible Labor

A significant number of respondents called for formal recognition of invisible labor. This includes activities such as mentoring, onboarding, documentation, and emotional mediation, frequently mentioned in both open and closed questions. Some participants suggested the creation of new performance categories such as *"organizational contribution"* or *"team stewardship"*, which could formally acknowledge contributions that sustain team performance but are not captured by metrics like lines of code or ticket closure.

The correlation with slower career advancement for those performing this kind of glue work (as shown in section 1.4) underscores the urgency of rethinking how value is defined and rewarded in technical teams.

### 5.6.5 Mental Health and Wellness Support

Finally, mental health emerged as a central concern. 47% of respondents explicitly called for expanded wellness initiatives, including therapy access, flexible leave for emotional recovery, and burnout prevention strategies. These suggestions are consistent with earlier findings: 71.8% reported mental load as a barrier to productivity, and many shared that the emotional demands of work, especially in biased or high-pressure environments, are rarely addressed or supported.

Respondents expressed a desire for environments that acknowledge emotional well-being as integral to professional performance, not as a personal issue to be managed alone.

### 5.6.6 Summary and Transition to Qualitative Analysis

Taken together, these open-ended responses reinforce and expand upon the statistical insights discussed throughout this chapter. They illuminate not only what hinders productivity for women in software engineering, but also what could be done to change that reality. From menstrual leave and hybrid work to revised performance metrics and increased female leadership, the suggestions provided form a compelling blueprint for inclusive organizational reform.

These reflections bridge the quantitative and qualitative dimensions of this research. While the next chapter will dive into in-depth interviews, the open survey responses presented here already signal the importance of moving beyond numeric indicators to capture the full spectrum of labor, experience, and contribution that define women's work in software engineering.

# 6 QUALITATIVE ANALYSIS

This chapter presents the qualitative dimension of the study, grounded in a series of in-depth interviews with Brazilian women working in software engineering across roles such as developers, technical leads, and technical managers. While the quantitative data previously presented (Chapter 5) revealed statistical patterns and general trends, the qualitative findings offer a deeper and more nuanced understanding of the lived experiences behind those numbers. These narratives explore how gender intersects with productivity, recognition, leadership, and personal well-being within the tech workplace.

The 20 participants interviewed included 9 developers, 2 technical leads, and 9 engineering managers, some of whom held hybrid roles combining technical and leadership responsibilities. Although most were based in the Recife metropolitan area, the sample also included professionals from other Brazilian regions and international locations, contributing to a geographically diverse perspective.

The age and experience profiles reveal a significant presence of mid-career and senior professionals: **78.9%** of participants were over 30 years old, and **47.4%** had more than ten years of experience in the field. While no participant reported less than two years of experience, exactly half (**52.6%**) had between two and ten years, indicating a balanced composition between consolidated and developing careers.

In terms of personal context, **57.9%** of participants were married, and **47.4%** reported having children or caregiving responsibilities. These aspects frequently emerged in the interviews as factors influencing availability, time management, and perceptions of productivity and advancement opportunities. Table 4 summarizes the sociodemographic profile of the interviewed participants, providing context for how individual responsibilities intersect with workplace expectations and influence professional experiences.

The qualitative data collection was conducted through semi-structured interviews held online via Google Meet. Each session lasted between 30 minutes to one hour. The interview guides were tailored to each role: For **developers**, the questions concerned experiences with performance evaluations, challenges in male-dominated environments, recognition, mentorship, and growth opportunities; **Technical leads** were asked about perceptions of team productivity, behavioral patterns, and strategies for promoting equity. Managers focused on evaluating productivity within teams, gender dynamics in performance assessments, and institutional

Table 4 – Sociodemographic Profile of Interviewed Participants (N=20)

| Category | Distribution | Category | Distribution |
|---|---|---|---|
| **Age Group** | | **Years of Experience** | |
| **20–30 years** | 21.1% | **2–5 years** | 26.3% |
| **31–40 years** | 42.1% | **5–10 years** | 26.3% |
| **41–50 years** | 31.6% | **More than 10 years** | 47.4% |
| **Over 50 years** | 5.3% | **Geographic Location** | |
| **Marital Status** | | **Northeast (Brazil, mostly Recife)** | 47.4% |
| **Married** | 57.9% | **Southeast (Brazil)** | 15.8% |
| **Single** | 36.8% | **Portugal** | 15.7% |
| **In a stable relationship** | 5.3% | **Central-West (Brazil)** | 10.5% |
| **Children or Caregiving Responsibilities** | | **South (Brazil)** | 5.3% |
| **Yes** | 47.4% | **United States** | 5.3% |
| **No** | 52.6% | | |

**Source:** Lorena Seabra (2025).

practices to support women's advancement.

Each guided interview included approximately 18 to 24 open-ended questions. Although all interviews explored shared thematic categories, the order of questions was adapted to the natural flow of conversation. Responses were typed in real time by the interviewer, who also documented relevant emotional cues, such as hesitations or emphasis, to enhance the richness of the analysis. No audio recordings were made, and all responses were anonymized to preserve confidentiality. A Google Drive folder will be attached to this thesis, containing the complete interview templates used for each participant category, along with an anonymized summary of the responses collected.

This chapter is structured into three sections: it first presents insights from technical managers, followed by the experiences of developers and technical leads, and concludes with a comparative analysis. The goal is to examine how gendered dynamics influence the perception and evaluation of productivity across different roles in software engineering.

## 6.1 PERSPECTIVES OF TECHNICAL MANAGERS

This section presents the perspectives of 9 women who currently hold managerial positions in technical teams. The primary goal of these interviews was to gain a leadership-level understanding of how productivity is evaluated, what challenges women face in technical environments, and what kinds of support and structural changes are perceived as necessary. The questions explored their career trajectories, the composition and diversity of their teams, differences in behavior and performance evaluation across genders, and how inclusive practices can influence team dynamics. As summarized in the sociodemographic table (Table 4), data regarding age, marital status, and parental or caregiving responsibilities were collected. Notably, **47.4%** of the 20 women interviewed reported having children, highlighting how caregiving responsibilities intersect with perceptions of availability, leadership potential, and productivity. Most participants have academic backgrounds in technology-related fields such as Computer Science, Engineering, or adjacent disciplines, often transitioning from developer or tester roles into management. These interviews provide critical insight into how gender and productivity are perceived from a position of formal authority and how institutional structures can either perpetuate or challenge inequality.

## 6.2 REFLECTIONS ON PRODUCTIVITY EVALUATION

When discussing productivity, the consensus was clear: traditional productivity metrics fail to capture what truly matters. Hours worked, tickets closed, or lines of code are inadequate when assessing not just the quality of the work but the unique contributions often made by women. These include mentoring, conflict mediation, documentation, and project coordination, activities that are vital to a team's success but remain largely invisible in standard evaluations.

Based on the responses obtained during the interviews, the discussions about productivity with the managers primarily addressed whether traditional productivity metrics (such as deliverables, commits, velocity, and hours worked) fairly reflect performance, their limitations, and what other metrics might be more appropriate. They also explored external factors affecting women's productivity, such as caregiving responsibilities and the double burden—and recurring observations about patterns of self-confidence and self-criticism among women, and how these influence their performance and visibility at work.

Some managers shared how they personally approach performance evaluation beyond traditional indicators. While they did not define a formal set of alternative metrics, they emphasized the importance of qualitative and contextual judgment. Several stressed the value of considering the complexity of tasks, the quality of deliverables, and the less tangible contributions such as mentoring, collaboration, initiative, and emotional labor. One leader emphasized the importance of a personal and humane approach, including attention to health and emotional well-being during sprint evaluations. Another highlighted adherence to deadlines and requirement fulfillment as key indicators, while others valued attention to detail and consistency as differentiating factors. These views reinforce the need for evaluation frameworks that reflect the full scope of contributions, not just visible outputs.

### 6.2.1 Observations on Team Dynamics and Gender

Among women in managerial positions, there is a clear tension between formal authority and perceived legitimacy. All interviewed managers reported leading teams with predominantly male members, often with female representation as low as 10% to 20%. Despite holding leadership roles, many face resistance and informal hierarchies that undermine their authority. Situations where their decisions were bypassed or challenged in favor of male colleagues were frequently mentioned, reflecting a persistent gendered perception of technical competence.

Several managers noted that technical credibility often needs to be reaffirmed, particularly for those who do not have a traditional engineering background. In many cases, occupying leadership roles was not sufficient to secure recognition, which had to be reinforced through additional qualifications or constant demonstrations of assertiveness. This reveals a double standard in how authority is granted and maintained.

There was also a strong critique of traditional productivity metrics. Many participants questioned the validity of using hours or output volume as indicators of performance, especially in tasks that require relational and contextual sensitivity. These metrics were seen as insufficient to evaluate contributions that depend on interpersonal skills, emotional intelligence, or mentorship—elements often undervalued in predominantly technical assessments. This reinforces the need for more human-centered and context-aware evaluation frameworks, particularly in diverse teams.

### 6.2.2 Challenges Related to External Responsibilities and Self-Perception

The interviews also highlighted how external responsibilities, such as caregiving and emotional labor, continue to fall disproportionately on women. Situations involving childcare or family health issues were commonly cited as sources of additional stress and workload imbalance. Although the interviewees acknowledged that these responsibilities do affect their productivity, many reported being so accustomed to managing this double burden that its impact often goes unspoken, absorbed quietly at the expense of their physical and emotional well-being.

Another recurring theme was women's tendency toward self-criticism and lower self-confidence. Managers observed that female professionals in their teams frequently underestimated their own performance, even when objective results indicated otherwise. Compared to their male peers, women were more cautious in evaluations and more aware of points for improvement, which sometimes translated into harsher self-assessments.

This dynamic appears to be shaped by both structural biases and the limitations of conventional evaluation criteria. Since standard productivity metrics often overlook collaborative, supportive, and communicative aspects of work, women may internalize the idea that their contributions are less valuable. The lack of recognition for invisible labor reinforces these perceptions, contributing to a cycle of self-doubt and undervaluation of essential yet non-quantified work.

### 6.2.3 Institutional Barriers and the Role of Management

From a managerial standpoint, these insights are critical. Not only do they affect how women progress within organizations, but they also point to a broader failure of current systems to measure, support, and value productivity equitably. Several managers stressed the importance of being proactive in career development, advocating for female team members, and creating feedback systems that account for gendered differences in self-perception and expression.

Finally, they emphasized the importance of building a culture of intentional inclusion, where equity is not just a value but a structured practice. This concern is further reinforced by the challenges described by the managers themselves. Many reported leading teams with very low female representation, and often facing skepticism or resistance, particularly when their backgrounds were not traditionally technical. They described needing to prove their technical and leadership competence repeatedly, sometimes relying on overqualification or emotional restraint to navigate male-dominated environments. Without systemic measures to support retention and recognition, especially of junior women professionals, such disparities are likely to persist. One participant concluded: *"Having more junior women than senior women in the company isn't only about discrimination, it's because they're only now entering the field. But unless we create systems that retain them, that's where they'll stay."*

## 6.3 PERSPECTIVES OF TECHNICAL LEADS AND DEVELOPERS

The experiences shared by technical leads and developers bring forth a layered and emotionally charged account of working in environments where male dominance remains the norm. This section groups both roles into a single analysis due to the significant overlap in their reported experiences and challenges, despite their differences in seniority. Out of the total interview sample, at least 9 developers and 2 technical leads were identified. While individual interviews did not consistently report demographic details, the survey data provides contextual support: the majority of respondents were between 20 and 29 years old, with additional representation in the 30–39 and 40–49 age ranges. Information regarding marital status was not collected, but several women reported having children and managing caregiving responsibilities, though the age of children was not specified. In terms of experience, 8 respondents identified as junior developers (less than two years of experience), and 5 as trainees or interns.

Given the shared patterns across their narratives, such as the need for constant validation, lack of recognition for collaborative contributions, and emotional strain related to gendered workplace dynamics, analyzing developers and technical leads together enables a more coherent and integrated examination of how structural barriers and traditional metrics shape their professional experiences.

### 6.3.1 Early Gender Bias and Academic Influence

Many participants described early signs of gender bias during their academic journey, a theme that emerged exclusively in interviews with developers and technical leads, as this topic was not included in the interview scripts for managers. These interviews included open-ended questions about formative experiences and early influences, which allowed participants to naturally reflect on their academic paths. Several women recounted being the only female student in classrooms dominated by men, which shaped their sense of belonging and confidence long before entering the workforce. One developer recalled, *"In college, I was excluded from group projects just for being a woman. They laughed when I entered the classroom."* This statement illustrates how exclusion and ridicule in academic settings can leave lasting emotional impacts, reinforcing internalized doubts and diminishing one's perceived legitimacy in technical spaces. These early experiences of marginalization contribute to long-term challenges in visibility, recognition, and confidence, factors that directly affect how women's productivity is performed, perceived, and rewarded in their professional careers.

### 6.3.2 Perceptions of Productivity and Invisible Contributions

When reflecting on productivity, many interviewees questioned the relevance of traditional metrics. While some acknowledged that indicators like commits and delivery time could offer partial insights, most pointed out their inability to capture the full scope of contributions. As previously mentioned in the quantitative analysis, tasks often referred to as *glue work*, such as mentoring, documentation, maintaining team cohesion, and unblocking others, were again identified here as essential but frequently invisible. These responsibilities, also noted in the survey responses, tend to fall disproportionately on women and are rarely considered in evaluations or recognition processes, despite their critical role in team effectiveness.

### 6.3.3 Overperformance and Communication Dynamics

A recurring theme in the interviews was the need to overperform in order to be perceived as competent. While a few participants mentioned supportive teams or managers, most described the emotional toll of constantly having to justify their presence and skills. Unlike male colleagues, who were often assumed to be competent until proven otherwise, women reported that they needed to repeatedly demonstrate their abilities before receiving the same level of trust. A single mistake was often enough to overshadow an entire history of strong performance, revealing a heightened pressure to maintain an unbroken record of excellence.

Communication dynamics further reinforced these disparities. Many participants recounted being interrupted, talked over, or only acknowledged when their ideas were repeated by male colleagues. To gain visibility and credibility, several women reported modifying their natural communication styles, speaking more assertively, intervening early in discussions, or anticipating resistance before contributing. These strategies, while sometimes effective, were also described as emotionally exhausting and unsustainable over time.

The cumulative effect of this constant self-monitoring, managing tone, defending technical decisions, and navigating subtle forms of bias, was identified as a significant drain on focus and well-being. Participants emphasized that the challenge was not the technical work itself, but the effort required to navigate a workplace culture that often failed to recognize their contributions equitably. Even when women produced the same measurable outputs as their male peers, such as lines of code or number of commits, their work was frequently perceived as less valuable. This indicates that productivity metrics are not interpreted in a vacuum, they are filtered through systemic biases that shape perceptions of merit. As a result, equal output does not guarantee equal recognition, perpetuating a cycle of undervaluation.

### 6.3.4 Caregiving Responsibilities and Work-Life Balance

Work-life balance was also a strong theme among developers and technical leads. Among the 11 women in this group, at least 4 explicitly mentioned having children, and, given their younger age profiles compared to managers, it is likely that many of them are caring for small children or infants. This reality adds significant pressure, especially in professional environments that reward hypervisibility, constant availability, and participation in extra initiatives. Several interviewees described the challenge of managing caregiving with work expectations. One mother shared that in order to be perceived as engaged, she would need to attend extra meetings, contribute to side projects, and be continuously visible online, yet with a toddler at home, this level of engagement was unfeasible, leading to perceptions of lower commitment. These dynamics highlight how caregiving responsibilities intersect with biased expectations, reducing opportunities for recognition and directly impacting how productivity is assessed and valued.

### 6.3.5 Strategies for Change and Representation

Despite these challenges, many participants expressed strong commitment to remaining in the field, often motivated by the desire to create better conditions for future generations of women in technology. Several interviewees reported having proposed changes within their organizations, such as revising promotion criteria, advocating for inclusive leadership training, or recommending greater visibility for non-technical contributions. Some companies were described as taking concrete steps to improve diversity, including affirmative hiring programs, public diversity goals, and efforts to recruit women for technical internships and junior roles. In certain cases, these initiatives were led or influenced by women already in the company, reinforcing the importance of representation in driving institutional change. The presence of female mentors or managers was consistently cited as a protective factor, helping to reduce self-doubt and offering a relatable model of leadership. Conversely, participants who lacked access to female role models or sponsors reported feeling isolated and undervalued, even in environments that claimed to support diversity. They noted that, despite inclusive discourse, strategic and technical leadership roles remained predominantly male, reinforcing a gap between intention and actual influence. As one participant observed, inclusion efforts often feel superficial when decision-making power remains unchanged.

### 6.3.6 Redefining Productivity in Practice

The interviews with developers and technical leads revealed that productivity in practice is heavily shaped by factors that remain invisible to traditional metrics. These women often carry out essential tasks such as technical support, conflict mediation, documentation, and mentorship, yet these contributions are rarely acknowledged in formal performance evaluations. They also face frequent interruptions, must continuously prove their competence, and carry the emotional burden of overperforming just to remain visible. The interplay between interpersonal biases and systemic flaws in performance measurement creates a context where effort does not translate into recognition, establishing real barriers to professional growth and perceived impact.

## 6.4 COMPARATIVE, HORIZONTAL, AND VERTICAL ANALYSIS OF INTERVIEW DATA

This section combines three analytical approaches to interpret the interview data. The *comparative analysis* contrasts perspectives across roles (developers, tech leads, managers). The *horizontal analysis* identifies recurring themes across key topics, such as productivity, workplace dynamics, and external factors. The *vertical analysis* examines how these experiences evolve across different career stages. Together, these lenses highlight structural patterns that shape women's productivity in software engineering.

### 6.4.1 Comparative Analysis: Managers, Technical Leads, and Developers

Technical managers often navigate a double bind: they are expected to uphold institutional productivity frameworks while simultaneously recognizing their limitations when applied to female team members. Managers described being aware of the emotional and logistical toll placed on women, especially those with caregiving responsibilities or who are newer in their careers, yet they often lack the tools or institutional support to advocate for more inclusive metrics. As one manager explained, *"I know this woman is doing essential work, but I don't have a way to quantify it in our system."*

In contrast, technical leads and developers experience these structural gaps from below. Gender biases and the invisibility of their work often force them into a pattern of overperformance just to remain visible and validated within their teams. This overperformance, however, is rarely captured by traditional metrics or recognized by most leaders. As a result, it leads to emotional exhaustion, burnout, and a persistent sense of undervaluation, especially when their most impactful contributions, such as team support, coordination, and conflict mediation, remain overlooked.

What unites all three groups is a shared critique of traditional productivity metrics, which are widely seen as incomplete and biased. Managers question the validity of time-tracking and commit frequency; developers reject the idea that delivery speed equates to performance; and technical leads describe being penalized for investing in team cohesion rather than raw code output. Across all roles, there is a consensus: the current system does not capture what women contribute to software teams. These findings are summarized in **Table 5**, which consolidates the main insights discussed throughout this chapter.

### 6.4.2 Horizontal Analysis: Thematic Threads Across Interviews

Certain themes consistently emerged across all interviews, regardless of participants' role, years of experience, educational background, or age. These recurring patterns offer a horizontal view into the cultural architecture of gender in software engineering.

- **Need for Constant Validation:** From junior developers to senior managers, many

Table 5 – Challenges, Biases, and Insights Across Roles and Gender

| Managers | Technical Leads and Developers | Share Insights |
|---|---|---|
| **Tension between applying metrics and acknowledging their limitations for women** | Face bias and invisibility, leading to constant overperformance | Consensus that traditional metrics are inadequate |
| **Recognize caregiving and early-career burdens but lack institutional support to act** | Overperformance not recognized by metrics, resulting in burnout and undervaluation | Perception that metrics reward visibility and speed over quality and support |
| **Criticize reliance on time-tracking and commit frequency** | Penalized for focusing on team cohesion rather than speed or volume of output | Agreement that the current system overlooks critical contributions by women |

**Resource:** Lorena Seabra (2025).

women described the recurring need to prove their competence in ways not expected of their male peers. This validation often involved overqualification, excessive preparation, and emotional labor. While these behaviors enhance team cohesion and quality, they remain unrecognized in performance systems centered on visible outputs, such as code commits or task velocity. Traditional metrics disregard the invisible cognitive and emotional effort required to constantly reassert one's legitimacy, leading to underestimation of actual performance.

- **Impact of Gendered Expectations:** Interviewees frequently noted that their behaviors, such as overpreparing, anticipating objections, or rehearsing technical points, differed from male colleagues who, despite sometimes being less informed, were perceived as more confident. These gendered expectations not only affect communication dynamics but also create a productivity paradox: the effort women expend to meet or exceed expectations is rarely reflected in their metrics. Because performance systems do not capture this anticipatory labor, women's contributions are systematically undervalued.

- **Structural Blindness in Performance Evaluation:** Despite increasing awareness of bias, most organizations still rely on rigid productivity indicators like LOC or sprint velocity. These metrics fail to account for mentorship, support work, and documentation, forms of labor disproportionately performed by women. This structural blindness not only reduces the visibility of their contributions but weakens team performance by ignoring the elements that promote collaboration and sustainability. The reliance on narrow measurements leads to a distorted view of who is productive and why.

- **Emotional and Psychological Toll:** Long-term exposure to the dynamics above, dismissal, undervaluation, invisibility, contributes to emotional fatigue, imposter syndrome, and self-doubt. These psychological burdens directly affect performance by reducing focus, motivation, and well-being. Moreover, because such internal struggles are not reflected in metrics, performance drops may be misinterpreted as lack of capability rather than symptoms of cumulative stress, leading to further penalization.
- **Role of Mentorship and Representation:** Access to female mentors and leaders was consistently described as a mitigating factor. These relationships offered technical guidance and emotional validation that helped participants maintain engagement and navigate hostile or indifferent environments. While mentorship positively affects confidence and, consequently, performance, its indirect nature means it is not considered in traditional evaluations. The absence of representation, on the other hand, deepens feelings of isolation and can erode long-term productivity by detaching individuals from aspirational models and support networks.

### 6.4.3 Vertical Analysis: Deepening by Profile and Career Stage

When analyzed vertically, by role and career stage, the data reveal how gendered dynamics evolve over time. Younger developers, particularly those in their first roles, often experience intense insecurity and a desire to *"do everything right"*. They described struggling to assert their voice and often refrained from speaking up in technical discussions until they were absolutely sure of their correctness, resulting in reduced visibility and perceived passivity.

Mid-level technical leads frequently act as cultural translators, mediating between managers and junior teammates, while simultaneously grappling with the weight of their own visibility. This group is uniquely exposed to both top-down expectations and bottom-up support burdens, making them particularly vulnerable to burnout. *"I am the one everyone turns to for help, and the one who gets the least credit"*, one lead explained.

Managers, despite holding formal power, often reported needing to assert authority more frequently than their male peers. Several noted being questioned, bypassed, or second-guessed, particularly when working with external clients or senior male stakeholders. The pressure to perform, and to maintain emotional composure while doing so, was a recurring source of strain.

Notably, the intersection between motherhood and leadership was a major topic in managerial interviews. Mothers in leadership positions described the challenge of being *"always on"* in both domains, and the guilt of having to compartmentalize either family or work during critical moments. They also described a lack of flexibility in existing systems to accommodate their needs, despite being in positions of influence. These findings are summarized in **Table 6**, which outlines the main challenges reported by participants and their perceived impact on productivity across different roles.

Table 6 – Challenges and Impact on Productivity by Role

| Role | Challenge | Impact on productivity |
|---|---|---|
| **Developers** | Low confidence, reluctance to speak in meetings, fear of mistakes, need to prove competence. | Reduced visibility, perceived passivity, emotional exhaustion from constant validation. |
| **Tech Lead** | Pressure from both junior and senior sides, responsible for team cohesion, invisible support tasks. | Burnout, lack of recognition, fewer opportunities for technical growth or promotion. |
| **Managers** | Questioned authority, need to over-assert, external skepticism, balancing leadership and caregiving. | Emotional strain, limited availability, underestimation of leadership capacity. |

**Source:** Lorena Seabra (2025).

### 6.4.4 Conclusion of Qualitative Analysis Section

Overall, the qualitative analysis reveals a complex interplay of systemic biases, gendered expectations, and structural limitations that significantly impact women's experiences and perceived productivity in software engineering. While individual efforts to overcome these challenges are evident, obtained data strongly suggest that organizational frameworks and traditional metrics consistently fail to capture, recognize, and value the full scope of women's contributions, leading to emotional toll, career stagnation, and a distorted understanding of team performance. Addressing these deeply ingrained patterns requires a holistic shift in how productivity is defined, measured, and rewarded within tech organizations.

# 7 CROSS-ANALYSIS: CORRELATIONS, CAUSAL PATTERNS, AND STRUCTURAL DYNAMICS IN WOMEN'S PRODUCTIVITY

Building upon the findings from the previous sections, this integrated cross-analysis combines quantitative and qualitative data to uncover patterns, causal relationships, and systemic dynamics that influence the productivity of women in software engineering. By aligning survey responses with insights from interviews conducted with developers, technical leads, and managers, the aim is to deepen the understanding of how productivity is defined, experienced, and evaluated through a gendered perspective.

Rather than viewing individual experiences or statistical trends in isolation, this analysis highlights how these dynamics unfold across different stages of the professional journey. Junior developers frequently reported a lack of recognition and interruptions in meetings; senior leads emphasized the persistent burden of glue work and its invisibility in evaluations, while managers acknowledged systemic issues but faced institutional constraints in changing performance criteria. These perspectives reveal how gendered expectations and traditional evaluation frameworks interact in distinct ways depending on career level.

To structure these insights, this section adopts both a horizontal and vertical approach. The **horizontal analysis** identifies recurring themes across the main areas explored in the study, including external pressures, performance metrics, and workplace dynamics. The **vertical analysis**, in turn, focuses on how these patterns shift across career stages, from entry-level developers to senior professionals and leadership roles. Together, these dimensions provide a comprehensive and empirically grounded view of the systemic factors that shape productivity for women in the field.

## 7.1 THE CYCLE OF INVISIBLE LABOR AND STAGNATED RECOGNITION

A recurring theme across all roles, junior developers, technical leads, and managers, was the persistent invisibility of "glue work": tasks that are essential to team cohesion and long-term project success, yet systematically excluded from formal productivity evaluations. These tasks include mentoring, onboarding, documentation, process organization, emotional mediation, and quality assurance. According to the survey, 52.9% of participants reported frequent engagement in mentoring or onboarding, and 48.2% contributed to documentation and process improvement. However, only 35.3% felt these efforts were acknowledged in performance assessments.

Interviewees consistently expressed frustration over this disconnect. Many reported that a significant portion of their time was dedicated to keeping their teams operational and aligned, but these efforts were invisible during feedback cycles. They felt penalized in evaluations focused narrowly on quantifiable outputs, such as feature delivery or code commits, despite being integral to the team's functionality and success.

This disconnect reveals a structural sequence of exclusion: women are more likely to perform tasks that ensure team effectiveness, yet these contributions go unmeasured and unrewarded. As a result, their chances of recognition, promotion, and leadership advancement are reduced. Over time, this dynamic reinforces gendered assumptions about the nature of women's work, often collaborative, relational, and maintenance-oriented, as less valuable than high-visibility, technical tasks typically attributed to men. As Rosser (2005) argues, these patterns are not incidental, but rooted in longstanding associations between femininity and undervalued labor in technological environments.

This cycle of invisibility is further exacerbated by organizational practices. Several leaders admitted that glue work is often assigned to women because they are perceived as more reliable or meticulous. Although not always intentional, this pattern entrenches the distribution of invisible labor along gender lines. Consequently, women become the foundation of team stability, yet remain peripheral in systems that reward visibility and measurable output, intensifying the emotional burden, limiting career progression, and perpetuating structural inequality.

## 7.2 WHEN METRICS FAIL: MISALIGNMENT BETWEEN PERFORMANCE AND MEASUREMENT

Survey results indicated that 58.8% of respondents reported having their performance evaluated primarily through traditional software engineering metrics, such as lines of code (LOC), commit frequency, and sprint velocity. Despite their prevalence, 64.7% of participants expressed dissatisfaction with these indicators, asserting that they do not accurately capture the scope or impact of their contributions. This concern was echoed in the interviews, where participants explained that such metrics prioritize visibility and quantifiable output over less tangible, yet essential, forms of work like documentation, mentoring, onboarding, and team coordination.

Several senior developers noted that their efforts to produce maintainable and well-documented code often resulted in slower delivery rates, making their performance appear less significant compared to colleagues who delivered rapidly, even at the cost of long-term quality. However, they emphasized that their work reduced technical debt, prevented bugs, and facilitated smoother onboarding, outcomes that are rarely reflected in performance metrics.

Managers also acknowledged the limitations of these evaluation models but described feeling constrained by institutional expectations heavily tied to traditional metrics. One manager observed that, even when they attempted to promote professionals based on broader contributions, leadership continued to demand quantifiable evidence such as graphs and code-related outputs. This reflects a systemic issue: the illusion of objectivity embedded in these metrics conceals deeply subjective processes, including who receives complex tasks, who is interrupted, and who is considered for leadership.

These flawed measurements fail to account for the long-term impact of integrative, collaborative, and preventative work, roles disproportionately carried out by women. Consequently, women often appear less productive within systems they actively sustain. As a result, performance assessments not only fail to reflect actual value but also reinforce existing gender disparities.

To address this misalignment, several respondents proposed the inclusion of new dimensions in productivity evaluations, such as peer support, architectural planning, and technical communication. These elements are foundational to team performance and morale but remain largely invisible within the prevailing evaluation frameworks.

## 7.3 THE EMOTIONAL TAX OF PROVING VALUE

As a consequence of the previously discussed biases, women are also subjected to an ongoing emotional burden. A staggering 74% of survey respondents reported being interrupted or dismissed during technical discussions. This emotional toll, the effort of continuously proving one's competence, was consistently described as exhausting. One developer admitted, *"Sometimes I rehearse what I'll say before every meeting because I know I'll only get one chance to say it without being cut off."*

These microaggressions contributed to broader consequences: 61% of affected women felt disengaged from their teams, 34% considered leaving their roles, and 46% experienced imposter syndrome. As one lead developer shared, *"Even after years in this field, I still have to defend every decision twice as much as my male peers."*

Managerial participants also faced demeaning scenarios. One recounted being questioned about her raise with the phrase, *"But doesn't your husband earn enough?"* Another described the frustration of her client ignoring her advice until it was repeated by a male junior.

These experiences highlight that emotional labor and invalidation are not only prevalent but deeply harmful to long-term engagement, confidence, and innovation. Furthermore, they intersect with the issue of glue work, women not only handle invisible structural tasks but must also fight to have their voices heard while doing so. This compounds stress and undermines both well-being and professional satisfaction.

## 7.4 GENDERED IMPACTS OF CAREGIVING AND THE IDEAL WORKER MYTH

Transitioning from the psychological to the structural, another layer of inequality emerges through caregiving responsibilities. While the survey did not directly inquire whether participants identified as caregivers, 54.1% reported that household responsibilities limited their availability for additional professional opportunities, such as conferences, courses, or after-hours networking. This suggests that a significant portion of respondents balance caregiving duties alongside their professional roles. These limitations were further illustrated in the interviews, where several participants described declining events or visibility-related initiatives due to domestic obligations. As one lead developer explained, *"I skip most of the evening meetups, and that's where the mentorship and career connections happen."*

Only 18% of surveyed participants had access to formal caregiving accommodations like flexible hours or asynchronous work. This scarcity was felt differently across career stages. Junior developers expressed difficulty in negotiating even minor flexibility, often fearing judgment from peers or supervisors. Mid-level professionals found themselves torn between increasing responsibilities at work and home, lacking institutional support to reconcile both. Senior leads, while sometimes granted informal leniency, highlighted how the absence of structured policies limited their participation in leadership pipelines, particularly when visibility in networking events or cross-functional initiatives was essential. The lack of systemic support led many to compensate by working nights and weekends, which often resulted in burnout.

Burnout, in turn, has been shown to significantly reduce cognitive functioning, decision-making quality, and work engagement, ultimately impairing individual and team performance (Maslach; Schaufeli; Leiter, 2001; Hoda; Salleh; Grundy, 2021). Chronic stress and exhaustion not only jeopardize well-being, but also hinder the achievement of professional goals, making it harder for women to meet productivity expectations, especially when these are based on constant availability and uninterrupted focus.

This situation also leads to perception bias. Women who leave at the official end of the workday, decline extra projects, or request flexibility are often perceived as less committed than colleagues who remain available beyond regular hours. This judgment persists even when performance is unaffected. For instance, some participants reported being overlooked for promotions or excluded from strategic discussions despite consistent deliveries. As one developer shared, *"Even when I leave right on time and deliver everything, I get the look, the silent judgment."*

Interviews revealed that many women downplay their parenting status to avoid being seen as less committed. This double burden, performance and concealment, further distances women from growth opportunities and contributes to emotional exhaustion. In practice, the ideal worker is one unencumbered by care responsibilities, a profile that disproportionately disadvantages women and contradicts the collaborative reality of modern engineering teams.

## 7.5 MENTORSHIP, REPRESENTATION, AND PROTECTIVE FACTORS

Despite the many challenges discussed, the presence of female mentors and leaders emerged as a powerful mitigating factor. Women who had at least one female leader or mentor reported higher professional confidence and satisfaction. One junior developer said, *"My mentor taught me to document my work and speak up without sounding aggressive. Without her, I'd have left this field."*

The contrast was striking: according to survey data, in companies without women in leadership, 41% of participants reported a desire to leave the industry, compared to 15% in companies with inclusive leadership. These mentors not only offered advice, but provided visible proof that success was possible.

Mentorship emerged as a key factor in sustaining productivity across different career stages. For junior developers, having a female mentor helped accelerate onboarding, improve confidence, and reduce the hesitation often experienced in male-dominated environments, leading to more active participation in team tasks. Mid-level professionals reported that mentorship enabled them to manage workload more strategically and navigate biased evaluation scenarios, helping them maintain consistent performance. Senior professionals, though often in mentoring roles themselves, noted that seeing women in higher leadership positions validated their approaches and alleviated the pressure to constantly conform to dominant norms. As one interviewee summarized, *"She didn't just show me what to do, she showed me it was okay to exist here."* This sense of legitimacy and belonging was echoed throughout the interviews and was closely tied to a more stable, confident, and sustained engagement with work.

In environments lacking this representation, organizational diversity efforts often felt hollow. Slogans and social media campaigns did not compensate for the absence of women in decision-making positions, leaving many participants feeling disillusioned and unsupported. This lack of representational leadership impacted productivity not only by reducing motivation and psychological safety, but also by limiting access to advocacy, mentorship, and inclusive decision-making, factors that directly influence visibility, recognition, and long-term professional growth.

## 7.6 CONCLUSION: SYSTEMIC CORRELATIONS AND THE LIMITS OF TRADITIONAL METRICS

This section consolidates the main findings of the quantitative and qualitative analyses, illustrating that productivity in software engineering is not a neutral or purely technical construct. It is shaped by socio-cultural dynamics, organizational blind spots, and systemic omissions that disproportionately affect women.

Throughout the research, several recurring patterns emerged. Women consistently reported performing essential but undervalued tasks, such as documentation, onboarding, mentoring, and team coordination, that are rarely recognized in performance evaluations. While **64.7%** of survey respondents stated that their contributions are not accurately represented by current metrics, only **35.3%** indicated that collaborative or process-oriented work was considered in their evaluations. Meanwhile, **52.9%** regularly engage in mentorship or onboarding, and **48.2%** contribute to documentation and process improvements. This disconnect between contribution and recognition is at the heart of a distorted productivity model.

To better illustrate these interrelated dynamics, Table 7 summarizes the key correlations identified across roles and data sources.

Each pairing reveals not only correlation, but feedback loops that reinforce inequality. For example, caregiving responsibilities reduce availability, which limits access to strategic initiatives and affects how performance is perceived. Frequent interruptions reduce participation and confidence, pushing women away from visibility and into undervalued support roles.

Table 7 – Summary of Key Cross-Correlations Identified

| Action/Factor | Correlated Outcome | Data Source | Observed Implications |
|---|---|---|---|
| **Performing glue work** | Lower visibility, stunted promotions | Survey + Interviews | Contribution not quantified in evaluations |
| **Commit frequency focus** | Misjudged quality-focused developers | Survey + Interviews | Volume over accuracy incentivized |
| **Frequent interruptions** | Emotional fatigue, disengagement | Interviews | Repeated invalidation reduces participation and innovation |
| **Caregiving responsibilities** | Reduced participation in strategic initiatives | Survey + Interviews | Less availability interpreted as lower ambition |
| **Lack of mentorship or role models** | Increased turnover intention, imposter syndrome | Interviews | No navigation model → self-doubt and isolation |
| **Traditional performance metrics** | Misaligned assessments, stalled growth | Survey | Overlooks soft skills, planning, mentorship, and collaborative impact |

**Source:** Lorena Seabra (2025).

The consequences are clear:

- Glue work remains essential yet invisible, creating cycles of under-recognition and career stagnation.
- Conventional metrics reward volume and speed over quality, planning, and collaboration.
- The emotional labor required for self-affirmation corrodes engagement and psychological safety.
- Structural caregiving burdens penalize availability and reinforce unrealistic expectations of the "ideal worker."
- The presence or absence of mentorship radically shifts confidence, resilience, and retention.

These interconnected dynamics reveal not isolated gender disparities, but a systemic failure in how productivity is conceptualized and rewarded. The data demonstrate that what is perceived as a performance gap is, in fact, a measurement failure, one that ignores the collaborative, relational, and preventative labor essential to software development, and disproportionately undertaken by women.

Rethinking productivity metrics is therefore not just a matter of equity, but a strategic necessity. It affects innovation, retention, and team sustainability. Inclusion cannot be operationalized without redefining what counts as value.

The next section builds on these findings to propose a framework for more inclusive and context-aware productivity evaluation in software engineering.

# 8 CONCLUSION

This study set out to explore the limitations of traditional productivity metrics in software engineering and how these metrics often fail to reflect the realities, contributions, and constraints experienced by women in the field. Through a mixed-methods approach combining survey data from 85 Brazilian female software engineers and 20 in-depth interviews across three career levels, this research offers a grounded perspective on gendered productivity, workplace dynamics, and the systemic structures that shape professional advancement. It is important to note that the analysis is socially and geographically contextualized, with particular focus on the Brazilian reality and significant representation from the state of Pernambuco, which may influence the nature of the findings.

As discussed in the state-of-the-art review (Chapter 2), no studies specifically collect productivity data exclusively from women in software engineering. Existing research on software productivity is predominantly based on mixed-gender samples, and when gender composition is disclosed, women represent a small minority of participants. None of these studies addresses the specific dimensions of female productivity or considers gendered factors in the evaluation of productivity itself. This evidence a significant gap in the literature and reinforces the originality and relevance of this work.

## 8.1 FINDINGS AND IMPLICATIONS FOR SOFTWARE ENGINEERING

### Key Findings

- **Traditional metrics are insufficient:** 64.7% of participants believe their contributions are not accurately represented by metrics like Lines of Code (LOC) or sprint velocity, which overlook essential tasks such as mentoring, documentation, and process improvement.
- **Invisible work is prevalent and unrecognized:** 52.9% regularly engage in onboarding and team support, while 48.2% contribute to documentation. Only 35.3% report that these efforts are acknowledged in performance evaluations.
- **Structural and social inequalities persist:**
  - Only 12% of participants hold leadership roles.

  - 54% report limited female representation in decision-making processes.
  - 74% have experienced microaggressions, such as interruptions and idea appropriation.

- **External factors impact productivity:**
  - 85% cite domestic responsibilities as limiting their availability.
  - 42.3% report that hormonal cycles affect focus and performance.

- **Career progression is slowed by invisible tasks:** Women who frequently perform relational or emotional labor report fewer opportunities for advancement and lower access to strategic roles.

- **Lack of mentorship and representation undermines retention:** The absence of female leaders increases feelings of isolation and disconnection from long-term career growth.

**Implications for the Field**

- **Productivity is not neutral:** The current system rewards speed, visibility, and individualism, excluding collaborative, relational, and preventive labor—types of contributions more often made by women.

- **Redefining productivity is urgent:** Future metrics must account for mentoring, mediation, coordination, emotional regulation, and team resilience. These are essential for software sustainability, not secondary tasks.

- **Inclusion requires structural change:** Simply adding women to male-dominated environments is insufficient. Evaluation systems and cultural expectations must shift to acknowledge diverse contributions and redefine what counts as value.

- **This study offers a roadmap for change:** Although it does not propose a final metric model, it identifies the necessary dimensions for a fairer evaluation of productivity in software engineering.

The findings reaffirm that productivity must be analyzed as a contextual, social, and gendered construct. Without adjusting our understanding and measurements, we risk perpetuating a system where essential contributions go unnoticed, advancement is uneven, and the full potential of diverse teams remains untapped.

## 8.2 CONTRIBUTIONS OF THE STUDY

This study offers a relevant contribution by documenting the experiences of Brazilian women in software engineering across different career stages. Although the sample is still limited in size and scope, the data collected help illuminate structural and cultural challenges that remain largely invisible in traditional productivity evaluations. Rather than offering definitive answers, this work provides a foundation for future studies, especially those aiming to extend data collection and develop inclusive productivity metrics.

The publication and acceptance of the article *"Bridging the Gap: A Data-Driven Analysis of How Traditional Software Engineering Productivity Metrics Overlook Women's Performance"* at the 45th Congress of the Brazilian Computer Society (CSBC 2025) marks a key milestone in making this issue visible to a wider technical and academic audience. It signals the urgency and relevance of this conversation at national and international levels.

More than evidence, this research brings visibility to overlooked contributions and persistent inequalities in the tech industry. It serves as a resource for women to reference, for managers to reflect on evaluation and retention practices, and for institutions committed to advancing systemic change in how productivity is understood, measured, and valued.

## 8.3 LIMITATIONS

This research has several limitations. The majority of survey participants were in the early to mid stages of their careers, and the qualitative sample, while rich, is bounded to the Brazilian tech ecosystem, with a particular focus on the Northeast region and the state of Pernambuco. Most interviews were conducted with women who, to the best of our understanding, identified as white and heterosexual, which may limit the representation of racial, sexual, and gender diversity within the findings.

The data is self-reported, which can introduce subjectivity, although triangulation with interviews provides analytical robustness. Future studies should include larger, longitudinal, and more demographically diverse datasets, particularly in terms of race, sexual orientation, and regional representation, to strengthen the generalizability and inclusivity of findings.

## 8.4 FUTURE WORK

While this thesis does not formally propose new productivity metrics, it lays the empirical foundation for doing so. Future work will involve:

- The co-creation of inclusive productivity indicators based on mentorship, sustainability, documentation, and collaboration;
- The validation of these indicators within real software teams, through participatory action research and feedback loops;
- The extension of data collection to a broader and more diverse sample, including professionals from different regions of Brazil and international contexts, in order to improve generalizability and account for cultural and organizational variations;
- The submission of new papers to expand this conversation within academic, corporate, and community settings.

Future studies may also explore intersectional dimensions, such as how race, parenthood, disability, and Lesbian, Gay, Bisexual, Transgender, Queer, Intersex, Asexual and others (LGBTQIA+) identity intersect with productivity experiences in tech environments.

## 8.5 FINAL REFLECTIONS

This thesis is more than an academic contribution. It is a declaration of value, a redefinition of what matters in software work, and a challenge to the systems that continue to render women's labor invisible. It highlights the gap between what is done and what is seen, between who builds and who is credited, and it calls for a shift not just in measurement, but in mindset.

Redefining productivity is not a technical fix. It is a feminist, cultural, and strategic transformation.

Women in software engineering deserve to thrive, not in spite of the system, but because we are finally willing to change it.

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# APPENDIX A – RESEARCH DATA AND MATERIALS

This appendix provides access to the raw data and supplementary materials collected during the development of this research. All documents are organized in a Google Drive folder to ensure easy access and reproducibility of results. The folder includes:

- **Qualitative Interview Questionnaires:**
  - Questionnaire for Technical Leads
  - Questionnaire for Managers
  - Questionnaire for Developers
- **Overview of Interviews (Anonymized):** A summary of the interviews conducted, with participant identities anonymized.
- **Survey Questionnaire:** The complete set of questions used in the quantitative data collection.

**Access Link to the Research Data and Materials Folder:**
https://drive.google.com/drive/folders/1AE9Bek_3S7cYjlYb0JVx5-ftSG6qu4t3?usp=sharing

**Note:** To ensure participant privacy and confidentiality, all sensitive information has been properly anonymized. Access to the folder requires an internet connection and was last verified on **May 22, 2025**.

The full version of the quantitative survey form, used to collect data on productivity metrics and workplace experiences, is available at the following link:

**Access Link to the Quantitative Survey Form:**
https://forms.gle/AWyZ6kwNoCkimX4v8

**Note:** This link directs to the Google Forms survey. Last verified access on **May 22, 2025**.