

# Diversity in Software Engineering

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## ABSTRACT

<sup>1</sup>Studies about diversity in Software Engineering (SE) are important to understand the disparity occurring nowadays at information technology workplaces. The goal of this work is to analyze the characteristics of diversity in SE and how to adapt SE practices when we have teams with diversity characteristics. We collected data by conducting a Systematic Literature Review (SLR) and semi-structured interviews aiming to identify what impacts of diversity can be observed in software development teams. We found that there are several challenges and barriers encountered in the work environment, and that inclusion and diversity can affect the software development teams positively.

## CCS CONCEPTS

• Software and its engineering → Software creation and management;

## KEYWORDS

Diversity, Software Engineering, Workplace, Team

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## 1 INTRODUCTION

Diversity in the IT workforce presents multiple dimensions regarding ethnicity, age, gender and people with disabilities [1], such as perspectives on how people perceive themselves and how they perceive others, and that these perceptions affect their interactions in the work environment [2].

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Culturally diverse teams in the work environment are needed, and their effects could impact performance, processes, organizational outcomes and even technological advances [1]. Moreover, diversity of employees makes the companies more suitable to attend external customers and present a better understanding of requirements [2]. Diversity management allows to get the potential of employees and gain a competitive advantage [2], such as achieve productive stage earlier [3], increase effectiveness [4] and most robust final products [5].

Increasing diversity in computing is important to design more robust end products on the market and because the issue of inclusion to be more representative of society [5]. Studies also mention that diversity is important for SE because creates better teams, with improved teamwork and efficiency [3]. In a software organization people are their most significant asset besides being expensive to recruit and retain competent professionals, then is necessary to manage people to work on respect for differences, equal treatment, valuation and motivation to form a cohesive and strong group capable of dealing with unexpected problems and situations [6].

Although some studies demonstrate that teams with a presence of minorities and diversity are beneficial in the work environment [3-5], other studies show that the Information Technology (IT) sector is homogeneous in several aspects, being composed mostly of males and non-minority people [8] [5] [7].

In this context, this paper proposes to explore the aspects that involve diversity in SE to evaluate the impacts, efforts, and challenges of a diverse software development team.

## 2 BACKGROUNDS

Challenges and opportunities of diversity impact all the nations around the world and can be strong emotional for those who deal directly or indirectly with this theme. Individuals need to have tolerance, respect and understanding these differences, besides being a moral responsibility of each one. Valuing diversity in the work environment can maximize workforce productivity and competitiveness organizational, as well as promote positive publicity of the company [9].

A study made in Germany IT sector investigate gender gap and suggest that managers prefer to employ women in socially oriented tasks such as project management or quality. This perception is stereotyped, which in some cases may lead to organizational segregation [10]. Guerrier et al. [7] conducted similar research in the United Kingdom focused on the under-representation of women in the IT sector. The outcomes evidence that a gender identity continues to be done in a

traditional way, identifying women based on a soft skill and a less technical profile.

Since the 1960s, when the first IT opportunities emerged outside a military environment, the number of jobs increased significantly, but the female presence grew little and in some periods even decreased [11]. The same occurs in the academic world although women have increased their presence in traditionally male courses such as medicine, law, and management, in IT courses female participation has fallen [8].

Although there are factors that discourage women from joining the field of computing [12], there are ways that combine technical skills with social skills which are opportunities for women to enter the job market [7]. According to Hazzan et al. [12] collaboration and sharing, communication, reliability and positive relationships are characteristics any good management style, however, their literature research also attributes this style to women management. For this style, the agile environment can be very suitable. Women can feel more comfortable in this environment, eliminating barriers and allow more women to be recruited to the IT industry [12]. For organizations a way forward is the diversity management that aims to establish an inclusive organizational culture and can support the management of human resources in the retention of highly qualified women [13].

Concerning people with disabilities, challenges include issues of accessibility, environmental adaptation, and communication. Also, the lack of encouragement by individuals with whom they interact is often the most significant integration barrier [14]. According to Krutz et al. [15] efficient and effective communication is an integral part of most software projects, but for the hearing impaired this can be a barrier and challenge to overcome. There are reports of deaf people who felt unwanted on the team as well as co-workers that had difficulties communicating and interacting with them. This type of obstruction affects not only the software industry but also academia, so further research is encouraged to improve knowledge and education in computing as a whole. Problems with poor interpersonal communication create conflict and stress in the team as well as harming companies struggling to attract, develop, and retain software developers.

Diversity management requires an inclusive work environment; on the other hand when establishing measures to address specific groups, stereotyped attributions ("women", "Muslims", "homosexuals") can be introduced that not benefit target groups [13]. Technology workers are often humorously stereotyped as being socially awkward or lacking communication skills, may be constructed as 'problems' rather than ideal workers [7]. This kind of label is no laughing matter, because for many workers with atypical profiles or people with disabilities their condition may be the result of some neurodiverse deficiency [16]. Visually impaired people also face difficulty in integration at work because of the bias on the part of employers that blind or visually impaired people do not interact with computers [17].

Patrick et al. [2] conduct a research among the top 15 IT organizations of India. Their outcomes showed that admitting prejudice and bias were considered the most effective strategy to increase awareness about workplace diversity followed by recognizing diversity and learning to respect differences by rejecting myths about other people. To achieve this effectiveness, it is necessary to overcome language barriers and stereotypes, which may require a mental elimination of pejorative terms and a different view of individuals [2].

### 3 METHODOLOGIES

This is an ongoing study that aims to identify the challenges faced by software development teams to deal with diversity. We first conducted a systematic literature review (SLR) about diversity in software engineering. The goal was to identify studies about this topic and relate the type of diversity with a SE domain using the SWEBOK Knowledge Areas (KA) as the framework of analysis [18]. We also conducted semi-structured interviews to collect more information about how diversity manifests in the work environment and better understand this in the field.

#### 3.1 Systematic Literature Review

According to Wholin [19] studies of systematic literature review have emerged as a way to synthesize evidence, allowing researchers to arrive at a common understanding of the state of a research area. To do this review, two research questions were elaborated:

RQ1 – Which studies have been published about diversity in SE, and what are its characteristics?

RQ2 – How does diversity impact the software development process?

Using a snowballing approach, we identify the papers and included studies that were published in magazines, conferences, workshops, and books. We look for studies using Google Scholar. It is a useful resource and a good alternative to avoid bias in favor of some specific publisher [19] and also provides links to relevant papers and does not require a subscription [20].

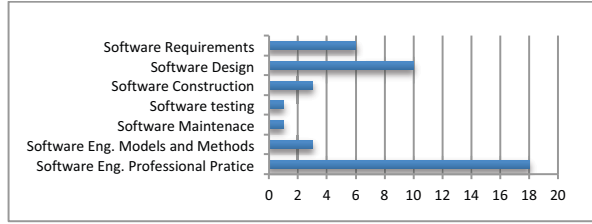
In the research, the following keywords were used: software engineering, diversity, workplace development, disabilities, and disability.

Snowballing uses the reference list of an article or its respective citations to identify other related papers. For the execution of the method, a search in the databases is generated, generating an initial list of papers. These papers go through a more careful selection that aims to exclude those who are out of scope or who do not respond to the search query, resulting in the Start Set [19].

On the Start Set, the first iteration is performed applying the snowballing process. The review of bibliographic references is called Backward Snowballing (BS), and the search for citations is called Forward Snowballing (FS). If new papers are identified at the end of the first iteration, the process is repeated, and so on until there are no more new references to include.

**Table 1- Correlation among Knowledge Areas of SWEBOK and diversity types found in each paper of Systematic Literature Review.**

	Gender	Ethnicity	Disabilities	Age	Personality	Generic
SE Professional Practices	P1, P2, P3, P4, P11, P13, P17, P22	P2, P11, P16	P5, P6, P7,, P11, P14, P16	P11	P15	P9, P10, P12
Software Design	P18, P19, P20, P21,P24, P23, P25, P26, P27					P12
Software Construction	P25, P27, P28					
Software Testing	P24					
Software Maintenance	P18					
SE Models and Methods			P7, P7			P12
Software Requirements	P13, P17, P19, P25				P15	P12

**Figure 1: SWEBOK KA and papers found in the SLR.**

The first interaction browsing Google Scholar resulted in a total of 2390 papers. We first read the title of the article. If it is tentatively paper to include, then is read the abstract. When the abstract proved insufficient, then the material was examined thoroughly. Most papers did not have relation with SE, and several had no relation to IT. A significant number of IT papers was related to human-computer interaction not answering the research questions neither aggregating to study. Only 11 papers and one book were selected to compose the Start Set (P1 – P12). In the first iteration using BS, six more papers were judged relevant and included (P13 – P18). Then we ran another iteration and added three more papers (P19 - P21) using BS. The third interaction we added two paper using BS and three using FS (P22-P26). After that, we run two additional iterations, including one paper using BS (P27) and this paper has one citation using FS (P28). After that, no more new relevant studies were found.

### 3.2 Semi-Structured Interview

In addition to the SLR, we conducted separately two in-person interviews with software development professionals whose working in an international software company that has three pillar business, being one social and economic justice. In this company is diverse friendly then all employees already have some knowledge about diversity and inclusion. Each interview lasted between 30 and 40 minutes.

One interviewee had a leadership position with a long career managing development teams. Another was a developer with considerable experience. Both already worked in different companies, places and they are self-identified as minorities.

General open questions were asked about diversity in the workplace. First, we asked, "Is diversity important for you in your personal life?" and "Describe how you see the presence of diversity in the workplace?". According they related their

experiences, we asked How it can impact software development with their point of view? Based on their background asked if was possible describe positive or negative experiences encountered by them during working days in their career.

## 4 RESULTS

To get a better understanding of types of diversity and its manifestation in SE we analyzed papers selected in a SLR and its correlation among the SWEBOK KA and diversity types summarized in [Table 1](#). As the Table shows, the majority of studies were focused on gender diversity aspects followed by disabilities, Ethnicity, age, and personality. However, some papers discussing diversity generically without any type specifically.

According to [Figure 1](#) we observe that the most discussed KA in the selected studies was SE Professional Practices (64.28%). The second comes Software Design with 35.71%. The third is Software Requirements with 21.42%. Fourthly comes SE Models and Methods and Software Construction both with 10.71%. Moreover, then Software Testing and Software Maintenance with 3.56%.

In the interviews, we found evidence that the participation of minorities during the development process from the initial phase contributed to better creativity in finding solutions for different projects. Both interviewees spoke about the importance of ideas in the initial phase of the project as one interviewee said:

"Several points of view have generated interesting and even unexpected discussions in a solution software project with multidisciplinary innovation requirements. There were a great variety and quantity of ideas that impacted on the final result".

The other interviewee (developer) said:

"Diversity provided richer communication with different experiences and visions as well as being culturally enriching, but as a woman many times my ideas were not considered in the design of the solution. Men's ideas are always discussed while women's often are not even heard."

During the development phase, both worked with people with disabilities and said about the importance of to adapt the environment. At this stage one of the interviewees (developer) described a difference in task assignment:

"In general, there are always visual or non-technical tasks for women, and this is a barrier to growth."

The leader interviewed mentioned difficulties in performing some visually impaired tasks on a distributed team:

"We found some difficulty in distance pairing with the visually impaired, as an alternative solution we put teams working on the same story locally including the visually impaired, which solved the problem without loss of speed. Also concerning the limitations we avoid visual tasks and pass more technical tasks." He also mentioned that some inconvenience happened during the development:

"There were some complaints from the women of the team regarding how they were treated by the customer".

"Although the project was a success in delivery phase, a transgender developer of the team was not comfortable in technical visits in loco, and due physical limitations some members with disabilities avoid moving to the customer because there is no adaptation in the workplace environment."

## 5 DISCUSSION AND CONCLUSIONS

First of all, this paper has limitations. Diversity has several dimensions that could affect diverse teams in different ways, according to culture, place, etc. therefore is hard generalize a deep, broad theory or conclusion generic about this subject. Our interviews are not a representative sample, and the results cannot be generalized in the fields of SE. The limitations suggest several prospects for further research.

Below we discuss the answers to the research questions:

RQ1 – Which studies have been published about diversity in SE, and what are its characteristics?

In the SLR was possible to find several studies addressing different topics about diversity. Highlights on most of the papers are about gender issues and professional practices, showing that although men mostly populate the workplace, environment studies could help to make IT more heterogeneous. There are barriers and challenges to be overcome especially in teamwork. Reports of women considered to be technically inferior in the work environment are common although no study showed a significant difference between genders in performing tasks. The disparity at workplace begins in the academic environment. Courses related to IT, do not attract minority groups that are also a factor that reflects in the job market.

RQ2 – How does diversity impact the software development process?

This study demonstrates our research on the relationship between diversity and SE practices. According to the results it was possible to observe that practices related to the work environment could contribute to inclusion as well as to organizational results. Diversity could impact positively on aspects such as innovation efficiency and teamwork on different phases of software development and KA.

Difficulties have been encountered concerning equality in academia and the IT industry, as well as barriers to inclusion of people with disabilities.

Finally, the IT environment still consists of a majority of men unequally representing society, so there is an open field to the study of practices that promote inclusion and a better understanding of this phenomenon to promote the equity of opportunities within the scope of SE.

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