A New Approach Towards Ensuring Gender Inclusive SE Job Advertisements

Tanjila Kanij, John Grundy, Jennifer McIntosh
Faculty of IT, Monash University
Australia
[tanjila.kanij,john.grundy,jenny.mcintosh]@monash.edu

Anita Sarma
School of Electrical Engineering and Computer Science, Oregon State University
USA
anita.sarma@oregonstate.edu

Gayatri Aniruddha
International Centre for Radio Astronomy Research, Curtin University
Australia
gayatri.aniruddha@postgrad.curtin.edu.au

ABSTRACT

A majority of software engineers are male, perhaps, because of the very way that software engineering (SE) roles are advertised is gender biased. Thus far, only word-based checking tools are available to identify gender biases (e.g., "analyst" is considered a masculine word). However, such word-based analyses end up identifying the skills required for SE job positions as masculine words, and therefore, not sufficient. In this work, we present a more nuanced mechanism to check for gender bias in SE job advertisements by building on the GenderMag method, which has proven to be successful in gender bias detection in software interfaces. From a survey of 44 software practitioners, we identified 16 factors where male and female participants differ and based on a thematic analysis we derived three SE job applicant persona facets. We verified the facets with a small survey where SE candidates related to the descriptions of those factors. We conducted a pilot study using these facets to evaluate four SE job advertisements and identified gender related biases in two of those.

CCS CONCEPTS

• **Social and professional topics → Employment issues**.

KEYWORDS

Job advertisement, gender bias, cogitive walkthrough, persona

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LAY ABSTRACT

The software engineering (SE) workforce is dominated by male employees. This is potentially because SE job advertisements are gender biased toward men. SE job advertisements are often checked for potential gender bias using word-based bias detection tools. However, these do not take software engineering specific words into consideration. For example the word 'analyst' is considered male using the word-based tools, and therefore any SE analyst position would be seen (incorrectly) to be biased toward men. As a result, such word-based tools are not good enough to accurately assess for gender bias in SE job ads. We present a more nuanced mechanism to check for gender bias in SE job advertisements by building on the GenderMag method. GenderMag has proven to be successful in gender bias detection in software interfaces. This method identifies five dimensions of problem solving (referred to as facets) on which male and female software users differ. From a survey of software practitioners, we identified factors where male and female SE job applicants differ. We grouped the similar factors together and derived three facets that were important to predict job application behaviour of SE job applicants. We validated these facets with some SE candidates and used them to develop 'new' Tim and Abi personas from the facets and evaluated four SE job advertisements. We identified gender related biases in two of these.

1 INTRODUCTION

The benefits of a gender-diverse workforce within information and communication technology include improving organization's performance and reputation, developing new solutions with a variety of perspectives, and increasing creativity and productivity. Research also suggests that companies with a more diverse workforce (i.e gender, ethnicity and so on) perform better financially [3]. According to Australia's STEM workforce report from 2016, in all information technology work industries, including in software engineering, females are severely underrepresented [2]. The report of "Equality in the tech industry" published in early 2021 by Dice.com states that 58% of women believe gender discrimination is present in tech industry compared to 31% men who think similarly [1]. The report also found that 38% of women believe there is gender discrimination in hiring practices. Gender biased job advertisements are one of the prominent examples of gender discrimination. Software Engineering (SE) - or more generally technology job advertisements - are considered mostly biased towards male candidates [19, 29]. This discourages female candidates from applying even though they might have the same or higher level of capability than their male counterparts, which impacts career progression and retention, and potentially puts women off from studying Software Engineering.

There have been some attempts to avoid gender bias in job advertisements [8, 15, 17, 21]. Most of them have been based on word-based language checking [17]. In the most popular word-based

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approach, common English language words are classified as female or male, and based on the number of masculine and feminine words found, a job is coded to be biased toward males or females. While these can be helpful for job advertisements in some domains, this is problematic for SE job advertisements. For example, according to the word-based checking approach, "analyst" is a masculine word, however for a business analyst/system analyst role, this word is going to be used frequently in job advertisements. What that implies is any business analyst/system analyst role will be classified as a male-biased job advertisement. Due to the terms used in SE and other IT domains, such word-based checking imposes many limitations with incorrect detection of biases in job advertisements. Merely the frequency of words appearing in job advertisements without consideration of the context of the words and domain usage of the words, can lead to incorrect detection of gender bias. Therefore, a better gender bias detection approach is of utmost importance for SE job advertisements.

In an exploratory survey, we asked hiring managers how they check their SE job advertisements for gender bias. Most of them referred to the word-based checking methods, while some of them said they request peers or HR colleagues to read the job advertisement before they post it. However, no systematic approach for gender-bias checking was applied. This reinforces the necessity for a systematic approach to gender bias detection within SE job advertisements. This work aims to find a solution to this issue. GenderMag is a technique that helps to find gender bias in problem-solving software interfaces using personas and cognitive walkthroughs [25]. We were inspired by its success in this domain to see if the same approach could be used to detect and resolve biases in SE job ads. GenderMag uses three personas based on five facets where individual gender differences exist in problem-solving styles: 1. motivation for using technology, 2. self-efficacy about using technology, 3. level of acceptable risk, 4. information processing, and 5. style of learning new technology. It then uses a cognitive walkthrough approach using personas that are applied to the software under evaluation. The tool has so far been used to determine gender inclusiveness in problem-solving software and/or prototypes to inform the redesign of the software and/or prototype if necessary [36].

In this project we extended the application of the GenderMag approach from problem-solving software to de-biasing software engineering job advertisements. Since GenderMag is designed to identify gender bias in problem-solving-oriented software interfaces, the facets are relevant to problem-solving behavior. We conducted a broad range survey to identify the facets related to job application behavior. We defined the personas used in GenderMag with the new facets so that GenderMag can be applied to detect biases in SE job advertisements. We conducted a small survey to find out whether SE candidates related to the facets we identified. We also conducted a pilot study using the GenderMag walkthrough to analyse a small set of SE job advertisements with the redefined personas.

Our proposed new approach will help hiring managers to check their advertisements for any potential gender bias before they are posted. This increases the chance of attracting more qualified candidates of both genders. We believe this will be a first step towards more gender inclusive SE workforce.

The rest of the paper is organized as follows: Section 2 describes the background and brief review of literature, Section 4 and Section 5 presents methodology and result, respectively, Section 6 presents some threats that can invalidate our findings, Section 7 discusses our findings with implications, and finally Section 8 concludes the paper with future work plan.

2 BACKGROUND

According to many studies [2, 16, 22, 28], by far the majority of IT professionals are male. The lack of diversity, including gender diversity [22, 28], in SE has been a concern for many years [12]. Various approaches have been explored to help address the gender imbalance and bias in SE education and the profession [22, 28].

One area of concern is *gender bias in SE job advertisements*. This includes use of language, orientation of role towards males or females, and lack of diversity-supporting information. Often different language is used to describe people of different genders. According to the Social Dominance theory [32], societies contain group-based social hierarchies depending on age, gender and other arbitrary social factors. Therefore, gender bias in a job description can arise from the existing gender grouping within an organization. It can also be a result of the gender ratio for particular roles as suggested by role based theory SRT [14]. According to SRT there are a majority of males in certain roles and a majority of females in other types of roles. Since the majority of males perform certain roles, male-attributed traits are looked for in the people to perform those roles. Research has found that while describing male and female candidates in recommendation letters, more standout terms such as "outstanding", "unique" were used for male candidates compared to female candidates [32]. Hannák et al. reviewed ratings and reviews given to workers in two freelancing platforms and found that they are influenced by perceived gender and race of the workers. They found that female workers received fewer reviews than others [20]. This has been shown in other disciplines to seriously impact interest in professions starting from high-school course choices, women's choice of their major in college, choice of entry level roles to increased gender pay gaps and ultimately dissuading women from taking on leadership roles [5, 17, 21].

Several studies have looked at aspects of this problem in IT/SE. This includes using text analysis [8] on job advertisements, targeted interviews to better understand influences on IT recruiting [35], better job advertisement text via natural language generation informed by feminist and queer HCI qualities [33], issues that alienate women during recruitment processes [38], and negative experiences women have had in IT roles, including during the recruitment processes and advertisements [23]. However there is still a serious lack of studies investigating the reasons for gender imbalance in IT and the impact of any (successful) interventions used to try and address this [18].

3 GENDER INCLUSIVENESS IN JOB ADVERTISEMENTS

The influence of job advertisements on the job application in the context of the gender of the applicant has been investigated by Bem and Bem around 50 years ago [7]. Based on two different studies, they concluded that women were interested to apply for

male-dominated jobs when the advertisements were presented in an unbiased way by either encouraging both male and female candidates to apply, or by advertising the jobs under a common column rather than sex-segregated columns in newspapers. In a controlled experiment Horvath et al. found that due to the use of masculine form of language competent female candidates were less fit for leadership positions compared to male candidates [35]. Arceo-Gómez et al. predicted gender based on non gender targeted job advertisements i.e. jobs that are advertised for candidates of all genders. They found t hat the pay gap is higher in those compared to targeted job advertisements i.e jobs advertised specifically for male or female candidates [15]. Askehave and Zethsen reviewed a number of executive job advertisements and extracted words describing leadership traits. The traits are then identified by the potential candidates as mostly masculine traits [5].

Use of language that is biased towards a gender shows stereotypical views about certain jobs and unfortunately increases the possibility of gender imbalance in the workplace. It also raises the possibility of losing more competent candidates of one gender only due to use of biased language towards the other gender. Gaucher et al. describe a series of studies that conclude there are gendered wordings used in job advertisements (either deliberately or unintentionally) and that changing masculine words with parallel feminine words creates more interest among women candidates [17]. However they also refer to Rudman and Glick's findings that "feminizing" job advertisements may lead to adding some requirements that in turns can introduce more discrimination against women [30].

3.1 Gender inclusiveness in IT job advertisements

Recent work of Breese et al. [9] analysed three types of technology job advertisements based on a gender word dictionary proposed by Gaucher. They found that more feminine words were used in the job advertisements compared to masculine words. They compared their results to those of Gaucher et al. and also verified the findings on another technology job advertisements dataset from 2017. Their comparison indicates that there is a major shift in gendered words in the job advertisements, from using more masculine words (2011) to using more feminine words (2017). The shift in using gendered words however does not reflect much change in the IT workforce, unfortunately. Most studies look at job advertisements in general. Some of these specifically focus on IT and/or computing. However, we found there is a lack of studies investigating different software engineering job advertisements.

3.2 Existing approaches to overcoming bias in job advertisements

Any bias within job advertisements is usually introduced by the use of language. There are suggestions in existing literature that a Gender Fair language (GFL) can help to avoid gender bias that is introduced by the language [31]. Several studies have looked at the aspects of this problem in job advertisements. Böhm et al. propose a tool that looks into the language of German job advertisements and proposes replacement words that will help to alleviate gender bias [8]. Another study with English and Swedish candidates showed that using gender-fair language such as using pronoun pair (he/she) or newly created gender-neutral pronouns were helpful in eliminating male bias in job advertisements [24]. The research also found that gender-neutral singular pronouns such as "they" were not helpful in eliminating male bias. Tang et al. proposed an algorithm to analyse job advertisements which were applied to job advertisements over 10 years. They found that wording in the job advertisements were skewed towards male candidates [35]. However, other biases may exist in SE job ads e.g. presence or absence or ways of describing things like salary, specific work conditions, flexibility, role descriptions, location and so on, where genders have different needs or preferences for some or all of this content. Strengers et at [33] recently proposed a natural language generation approach inspired by feminist and queer HCI qualities and theories. The idea is to produce text – including, potentially, for job advertisements – that draws on language norms from feminist and queer theories to better represent a more diverse (potential) workforce.

3.3 GenderMag

GenderMag (Gender Inclusiveness Magnifier [11]) is a method that employs the cognitive walkthrough technique to identify gender bias issues in problem solving software interfaces and workflows [36]. The GenderMag method was designed using empirical evidence of five *facets of problem solving*, for which there is a demonstrated empirical evidence for differences based on gender. These five facets are motivation, risk averseness, information processing style, computer self-efficacy and learning style [11].

The differences in these facets arising from gender is captured in three personas, named Abi (containing facet values mostly seen in females), Tim (containing facet values mostly seen in males) and Pat (combining facet values for both genders). The personas are then used to perform cognitive walkthroughs on the problem-solving software to identify potential gender biases. A set of goals, subgoals and actions are defined that are performed as part of the cognitive walkthrough process. A set of questions are designed based on the actions with possible answers of yes/no/maybe. An evaluator considers a persona while performing the actions on the software interface and tries to answer the associated questions using the facets of the persona under consideration. The evaluator also needs to provide a reason for the chosen answer for a particular question. After reviewing all the questions, the evaluator then takes the no and maybe questions into consideration to find possible issues arising from gender bias.

4 STUDY DESIGN

We were inspired to try out the GenderMag approach as a new, complementary way of ensuring SE job advertisements are not gender biased. Our idea was to review the personas and their facets used by GenderMag to see if they, or some of them, could be applied to the process of a candidate reviewing and taking action on a job advertisement. Analogous to problem solving with an interface, we wanted to try and identify – via a cognitive walkthrough of a job advertisement with personas representing traits of male SE job candidates, female SE job candidates and mixed traits – potential biases in the advertisement. These might cause candidates of a particular gender to be put off from further reading the advertisement

or from applying for the position. Identifying aspects of the job advertisement that are potentially problematic for one gender of candidates would allow us to modify the advertisement to make it more universally appealing for good fit candidates. Unlike conventional job advertisement reviews and word-based analysis, this GenderMag-based approach would be much more nuanced to SE job candidate characteristics and their SE job advertisement reading and interpreting.

4.1 GenderMag Persona and Facet Review

We reviewed the GenderMag personas and more specifically the facets that are defined in the personas. We found that information processing style is relevant to job review behavior, since applicants need to collect information while reviewing job advertisements to decide whether to apply for the job or not. The way they collect information from the job advertisements can be predicted with information processing style, however, the remaining facets could not be directly linked to job application behavior. For example, learning style for Abi was described as "Abi leans toward process-oriented learning, e.g., tutorials...doesn't like tinkering with software" – while this can impact Abi's viewing the ad in the job portal, it would not impact her decision to apply for the job. Computer self efficacy for Abi was described as "if a problem arises with their technology, Abi often blames themselves for this problem" – this is somehow irrelevant while reviewing job applications to decide whether to apply or not. The other facets were also similar.

The GenderMag facets needed to be identified and defined for our case, since a job application review is not directly a problem-solving task itself, even when using a computer to review the ads or apply for the job. Therefore, not all GenderMag persona facets are the most suited to evaluate SE job application behavior. Other factors such as the candidates' career goals, expectations and frustrations with specific SE aspects can play a bigger role. In order to identify the facets that are directly related to SE job seeking via review of job advertisements, we conducted a survey of SE candidates. The aim of this was to identify the key facets that are relevant to SE job application behavior, and specifically on which preferences do male and female candidates differ. We could then develop new personas embodying these gender differences and similarities.

4.2 SE Job Candidate Survey

In this survey, we aimed to identify the facets that are relevant for SE job application behaviour and decision making by SE candidates. Based on a review of the literature, including grey literature, and brainstorming by the authors, we prepared a survey for SE candidates to better understand their (1) short and long term career goals, (2) challenges to achieving their goals, (3) plans to overcome the challenges, (4) expectations about their SE roles and employers, frustrations, (5) ways to keep up to date with technology, (6) approaches to solving SE problems, (7) views on voluntary SE contributions, (8) approaches to reviewing SE job advertisements, (9) importance and attractions of information within SE job advertisements, and (10) specific actions performed when applying for jobs. We believe most of these are considered by SE candidates while reviewing job advertisements and can play important role with respect to job application behaviour. There were in total 38 questions. The questionnaire was prepared based on well established industry sources [34, 37]. This was an anonymous online survey and we invited participants via emails from our personal contact lists and advertised through our LinkedIn networks. People who are working in SE roles or graduates who are looking for SE roles were encouraged to participate through our email and LinkedIn invitations. Based on the survey responses, the facets that differed between male and female SE candidates were identified, and a male (Tim) and a female persona (Abi) were created.

4.3 Facet Validation Survey

We conducted a second survey to validate the SE job seeker personas and their facets. The aim of our second survey was to find whether SE candidates could relate to the facets we identified or not. To do this, we presented the facets that we identified in our previous SE candidate survey and used to create new Tim and Abi personas. We then asked the participants in this second study to indicate whether, for each persona facet, they relate to Tim or Abi or neither, when reading and taking action on SE job advertisements. We also asked them to explain why. We recruited participants via email and phone numbers on one of the authors' contact list. All the participants had experience working in SE.

4.4 Pilot Evaluation

Finally, with the redefined facets for the Tim and Abi personas, the authors performed a cognitive walkthrough on four randomly selected SE job advertisements for project manager, programmer, analyst and tester roles. The selection of these four job roles was inspired by the work of Capretz et al. [12]. The cognitive walkthrough was performed for the following scenario:

<Persona> reads the job advertisement collecting the information presented in the job. Assuming the required skill set match with <persona's> skills, will <persona> apply for the job?

We selected the background of the personas such that both would have the requisite basic SE skill and experience set for the job advertisements. We documented the step-by-step process of doing the cognitive walkthrough and provide reasons for decisions the persona would take when reading parts of the advertisement.

In order to find whether the cognitive walkthrough reflected the behavior of the SE candidates, we presented the same job advertisements to 10 SE job candidates and asked them to document their actions and the reasons for their decisions. We recruited these 10 candidates from the authors' personal contacts. All of them had experience in SE. We compared the actions and reasons behind the decisions provided by the authors during the cognitive walkthrough process with those provided by the SE candidates for the same job advertisements. We identified where the walkthrough and candidates made the same decisions or different decisions at each stage of reviewing each advertisement.

All three phases are summarized in figure 1.

We have made the instruments used in our studies available as a supplementary materials PDF to this paper. These include surveys, personas and job advertisements.

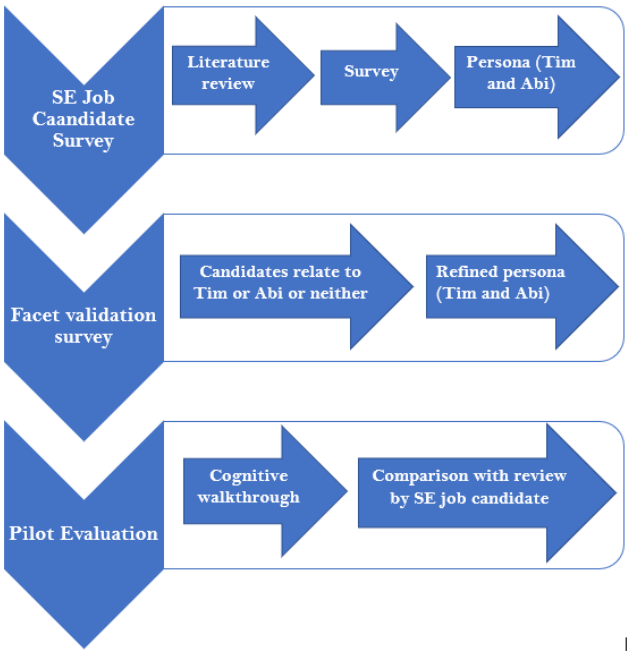

Figure 1: Research Design

5 RESULTS

5.1 SE Job Candidate Survey

We received a total of 44 (26 male, 18 female) responses to our SE job candidate online survey. Since we sent open invitations though LinkedIn, how many people actually read the invitations cannot be found. Consequently, deriving a response rate is impossible since the actual size of the population (who received our invitation) is unknown. Approximately 93% participants were between 18 to 36 years of age. The majority of them were programmers (55%), among the remaining participants there were solution architects (9%), UX designer/developers (9%), Analysts (9%), managers (5%) and so on. Around 18% had less than one year of experience, around 66% had between 1 to 5 years of experience and the rest had more than 5 years of experience. Only 25% of them were actively looking for SE jobs, 64% were not actively looking for jobs, while the rest were unsure.

Both male and female participants reported that during their free time they go to the gym or watch TV/YouTube/Netflix. Female participants reported they perform domestic works such as cooking and cleaning while male participants mentioned video games. We asked participants whether they make any voluntary SE work contribution e.g. to open source projects or community volunteering, and most of the participants said they did not. Two male participants said they built apps/platforms for free use. The majority of the participants mentioned that they sometimes checked for updates on technology. The most popular answer to where they checked for updates was "online/Google search". Male participants also mentioned checking some platforms regularly such as, blogs, changelogs for updates.

Frustrations & Challenges. Participants mentioned many things about SE practices that frustrated them. These included gender bias, ever changing technology, heavy workload and so on. A close look at the data revealed that male participants listed far more frustrations than female participants. Most common frustrations included poor documentation, organizational issues, frustrations with colleagues and so on. Female participants, on the other hand, complained mostly about gender bias and work pressures. The following comment is indicative of their views: *"No matter how hard a task is, male team mates try to make it [our task] seem like it is a piece of cake. We are given easier tasks".*

Both groups of participants said that lack of knowledge and experience is a challenge to achieve their career goals. Male participants said that procrastination, competition, and lack of time management are some of their main challenges. Female participants said their gender and the need to prove themselves is always the biggest challenge. When asked how they want to deal with the challenges, male participants said having a more specific set of tasks, changing routines, checking updates weekly, improving focus and detailed skill development. Female participants on the other hand mentioned more generic measures such as hard work.

Career Goals. When participants were asked about their career goals, some participants were very specific, such as "<getting> 2 promotions <in 5 years"> or "doing MS". On the other hand some mentioned where they want to see themselves in the future. We found that in the short term female participants wanted to get promoted to more managerial types of roles, and male participants wanted to get promoted to more senior technical roles. In the long term, male participants wanted to build startups/own company and female participants wanted more financial independence.

Job Application Behavior. When we asked participants how often they checked for new job advertisements, the majority of the male participants said they checked weekly. No common theme was found for female participants. We asked our participants what attracted them most in a job ad, both groups of participants responded with the role itself and the requirements for the role. Male participants noted added potential for growth, and the possibility of using new technology and the challenges involved. When we asked them what they looked for in an employer, both groups of participants mentioned flexibility, with female participants saying they expected employers to be understanding and male participants they expect them to be transparent and ethical.

Participants from both groups said they read job advertisements in full or selectively or sometimes selectively and sometimes in full. Nine male participants said they read the title or some other information first and then they decided whether to read in full or not. We asked the participants if they are selective, what parts do they check first; male participants mentioned major required skills. More female participants mentioned salary than male participants to this question.

We asked participants whether they changed their resume before applying for every job or keep the resume the same. The majority said they changed their resume, with no significant difference between genders except that more male participants said they do not change their resume for every job. We asked what percentage match they expect with their skills and the required ones before applying for a job; most said more than a 50% match. A noticeable difference

was that more male participants apply with 80% or greater match than females. In response to which characteristics they look for in the SE team, both groups said teamwork and inclusive culture. Male participants also said no politics, good communication, open, collaborative, harmony. Female participants on the other hand said there should not be any gender stereotyping.

Gender Differences. We reviewed the responses provided by male and female participants and identified 16 factors where they differed. These were hobbies/leisure time activity, SE problem-solving approach, voluntary contribution, checking updates, frustrations, short and long term career goals, challenges, plan, reading style, most attractive information in jobs advertisements, most important information in job advertisements, selection of job advertisements, application, updating resume and SE team expectations.

The authors reviewed the importance of the factors to job application behavior and concluded that 10 of them are mostly important in order to predict SE job application behaviour. Based on our thematic analysis of responses, we grouped these 10 highly relevant factors into three broad facets: SE views, career goals and job application behaviour. We consider the facets are the broad dimensions of differences between male and female candidates that are important to predict SE job application behaviour. Table 1 presents a brief definition of each of these factors.

Table 1: Facets and Factors for SE job candidates

Facets	Factors	Definition	Importance to job application
SE views	SE team expectations	What characteristics they expect in the SE team they will join	Very important
	Frustration in SE	What within SE frustrates them	Somewhat important
Career goals	Short term career goals	Where they want to see them in next five years	Very important
	Long term career terms	Where they want to see themselves in 10-15 years	Very important
	Challenges	Perceived challenges in achieving those goals	Somewhat important
	Plans	Planned measures to overcome the challenges	Somewhat important
Job application behaviour	Reading style	Whether they read job advertisements selectively or sequentially	Very important
	Attraction	Most attractive information in jobs advertisements	Somewhat important
	Importance	Most important information in job advertisements	Very important
	Selection	What factors do they look for to decide to apply	Very important

5.2 Facet Validation Survey

17 participants (10 male, 7 female) completed our facet survey. In total 22 people were invited to complete this survey. The response rate for this survey was 78%. Two of the participants had less than a year of experience in SE, 7 of them had between 1 to 5 years of experience and the remaining 8 participants had more than 5 years of experience in SE. For 5 factors, the participants always related to either Tim or Abi. Those were SE team expectations, reading style, importance, attractions and selection. For the remaining 5 factors – frustrations, short and long term career goals, challenges and plans – few of our participants could not relate to Tim or Abi. For frustration and short and long term career goals 2 participants, and for challenges and plans 1 participant each, said "none". Figure 4 show the number of participants who related to Abi or Tim for each of the 10 factors. Sometimes participants mentioned they relate to both. We counted those as relating to both Abi and Tim, as shown in Figure 4.

Considering the 10 factors as a spectrum, we defined the two end values of the spectrum and put those in our new Abi and Tim personas. We took the descriptions used for the factors from analysis of the open ended survey responses by the participants where possible. In other cases, we summarised the findings on a factor and described them with a sentence to put into our new personas. The resulting personas are shown in Figures 1 and 2.

Figure 1 indicates that when considering SE jobs and SE job advertisements our Tim persona is looking for:

- an open, collaborative team culture
- lack of politics, disorganisation, technology volatility in job
- roles that will lead to technical lead opportunities and/or opportunity to run own company
- roles enabling him to address time, procrastination and competition challenges
- roles that help him improve his routine, technology skill enhancement and overcoming short term challenges
- he tends to read job advertisements selectively, potentially missing some critical information if not clearly in title/standout text
- he looks for opportunities for growth, working with new technologies, has challenge and opportunities for social good contributions
- information about team and employer characteristics, location and leadership opportunities are important to him
- he seeks information about provided benefits and job flexibility

In contrast, Figure 2 indicates that when considering SE jobs and SE job advertisements our Abi persona is looking for:

- gender equality in team culture
- she will be given her share of challenging tasks
- there will be be an over-large or unfair workload
- roles that will lead to managerial opportunities and financial security
- roles that provide challenges, ability to demonstrate her work ethic, time management, and commitment and focus
- she tends to read job advertisements in full to find all required information she needs
- she looks for jobs that meet her role expectations and technical skill set
- she looks for roles supporting her career and skill growth
- flexibility provided by employers is important to her

5.3 Pilot Evaluation

Two of the authors performed cognitive walkthrough with Abi persona on three job advertisements. The rest of the walkthroughs were performed by one of them. A third author then checked all the cognitive walkthrough results and added their comments. During the walkthroughs, we took each job advertisement and persona,

Table 2: Pilot evaluation

Job Role	Cognitive Walkthrough (CW)			Participant review	Comparison
	Persona	Decision	Facets used to make decision (apply/not apply)	Decision made by participants	% of times the reason for CW decision was found in the participant comments
Project manager	Tim	Maybe	Career goals, job application behaviour	Yes – 3 No – 6 Maybe - 0	45%
	Abi	Maybe	SE views		
Programmer	Tim	No	SE views, job application behaviour	Yes – 5 No – 3 Maybe - 0	30%
	Abi	No	Career goals, SE views		
Analyst	Tim	Yes	SE views and job application behaviour	Yes -5 No – 1 Maybe - 2	57%
	Abi	Maybe	Job application behaviour		
Tester	Tim	Maybe	Job application behaviour	Yes – 3 No – 4 Maybe - 1	55%
	Abi	Yes	SE views, job application behaviour and career goals		

Tim

SE Views

The characteristics Tim expects in the SE team he will join are teamwork, inclusive culture, no politics, good communication, open, collaboration and harmony. There are many things within SE that frustrates Tim, such as insufficient documentation, organizational issue, ever changing technologies resulting in needs to learn new languages, frameworks, libraries, tools, etc.

Career Goals

In short term Tim wants to see himself in senior technical roles, in long term Tim plans to develop start-ups/own company. Tim considers procrastination, competition and improper time management are challenges to achieve this goal. Tim wants to improve his routine, dedicate some time to know about technology and put some focus on short term goals to overcome the challenges.

Job application behavior

Tim is selective while reading job advertisements, he checks the title or other selective parts first and then decides to read in full. The most attractive information in the job ad are opportunities for growth, working with new tech, challenges involved and possibilities of making social impact. The most important information in a job ad is the required technical skills and potential for growth. Tim also gives importance to the information on the team/employer, leadership opportunities and location of the job. While selecting the job Tim prefers flexibility provided by the job provider, he also checks what benefits are provided by the job.

Figure 2: Tim persona

Abi

SE Views

The characteristics Abi expects in the SE team she will join are teamwork, inclusive culture, and no gender stereotyping. Abi does not like when she is given easier tasks as female. Sometimes the male teammates make it look like a piece of cake! She is also unhappy when given a lot of work.

Career Goals

In short term Abi wants to see herself in general managerial roles, in long term Abi plans to achieve financial security/independence. She thinks as a female having to prove herself at every stage is a challenge to achieve this goal. Abi is determined to work hard and do more work, to improve her time management and focus to overcome the challenges.

Job application behavior

Abi prefers to read job advertisements in full, however sometimes she is selective. The most attractive information in the job ad are requirements of the role. The most important information in a job ad is the required technical skills and potential for growth. While selecting the job Abi prefers flexibility provided by the job provider.

Figure 3: Abi persona

read the job advertisement with respect to the different information seeking needs and behaviours as summarised above, and made decisions about whether the role as advertised fit each persona's career goals, team and organisational preferences, provided required or desired information about the role, team and organisation, likelihood of the persona finding and interpreting information they seek, and what final decision they would make about applying for the advertised job.

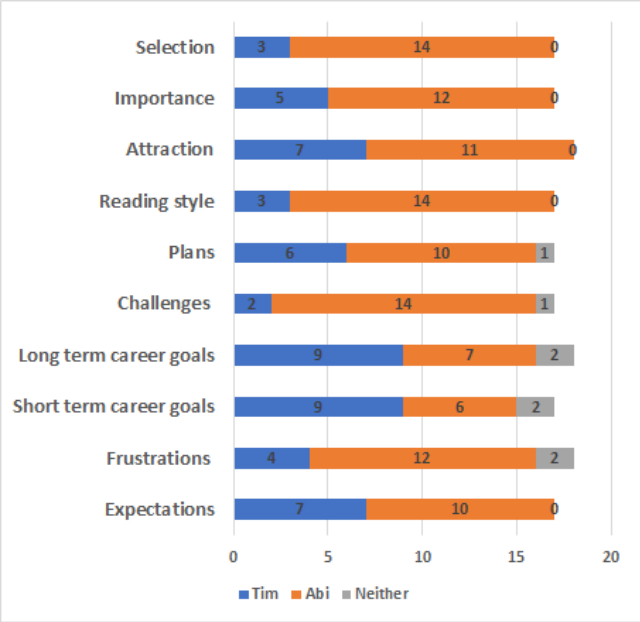

Figure 4: Facet Survey

We found that for the project manager and programmer jobs both Tim and Abi took the same decision for the scenario. For the *project manager role*, Tim read selectively - title then responsibilities and finally skills required. Tim would find that the position offered some leadership opportunities, however it was missing opportunities to work with new technology and any prospect of senior technical role. Abi read sequentially and had the impression that the workload would be very high from the quote "capacity to manage high stress situations". This is one of her frustrations about SE.

For the *programmer role*, Tim had an impression that the job was looking for specific skills and there was no indication for potential growth or leadership opportunities. Abi's impression was there was nothing about the team or inclusivity or managerial opportunities.

For the*analyst role* Tim was happy to apply, however Abi decided "maybe". For the *tester role* Abi was very confident to apply however Tim decided "maybe" for the given scenario. A close look at the tester and analyst job advertisements and the reasons listed behind Tim and Abi's decisions revealed that for the analyst role clear information on the team gives a good sense of organization structure, potential for making social impact is mentioned, and flexibility and other benefits are clearly mentioned—all these are attractive to Tim. Abi was attracted to the team environment and the diversity, however, she was put off by no mention of potential to growth and by the photo in the job ad. For the tester role, information was presented in a nice way with attractive headings and the information on inclusivity was highlighted which was positive for Abi, however the opportunity to work with new technologies was unclear that made Tim give the job advertised a second thought.

To verify whether our cognitive walkthrough reflected the behaviour of SE candidates we presented the four job advertisements to 10 SE candidates, 9 (4 male, 5 female) of them completed the review. 4 of the participants had between 1 to 5 years experience in SE and the remaining 5 had more than 5 years of experience.

The number of times the participants made different decisions among themselves for the same job advertisements indicates that the cognitive process of decision making by SE candidates differs based on their specific preferences. We thus looked into the reasons they provided for making a decision and compare those with reasons we listed during our cognitive walkthrough process. This was calculated as the total different reasons provided by the participants and how many of those matched with what was written in the cognitive walkthrough process.

For the project manager, analyst and the tester advertised jobs, around 50% of the times, the reasons listed in the cognitive walkthrough process was found in the reasons provided by the participants. For the other 50% of the time, our participants provided other reasons for their decisions. For the programmer job, only 30% of the time the cognitive walkthrough reasons were found in participants' comments. Table 2 summarises these findings. We also list the facets that were relevant to make the decision in the cognitive walkthrough process.

In our evaluation we reviewed the number of times different reasons were listed by the participants to that of the cognitive walkthrough. For project manager roles, the reasons mentioned by participants that did not match with CW reasons were— having to email HR to apply, salary not matching with skills required, interesting challenges and focus of the role being clear. For the analyst role the reasons not found in our cognitive walkthrough were—the type of job (fixed term contract), providing new challenges, and matching with skill and interests. For the programmer role, the differing reasons were ownership of projects, not interested in daily pays, lack of skill/experience and so on. Finally, for the tester role the differing reasons were—not interested in testing, employee ratings, matching skills, missing information on contract/full time opening. Some of the reasons were based on personal circumstances such as matching the skills and experiences. Some reasons such as preferring contract/full time jobs could be incorporated in the facets of further personas.

6 THREATS TO VALIDITY

Construct validity: There is a possibility that the scenario used in our pilot study does not reflect real actions of SE candidates while applying for jobs. Before designing the scenario, we consulted with seven SE experts (candidates, researchers and hiring managers) to find out what actions SE candidates perform to review job advertisements. There is also a possibility that the personas designed for SE candidates do not reflect actual candidates. The personas are generated from a broad ranging survey of SE candidates and the facets are selected only when male and female participants differed significantly. This is corroborated in our facet validation survey, where majority the participants could relate to the facet definitions.

External validity: Our application of the GenderMag approach was based on four job advertisements and a small sample of candidates. A common threat of this kind of small-scale pilot study is that it does not generalise for all test scenarios. We plan to apply this approach on more SE roles and with more SE candidates to try and mitigate this threat. However, there is great variations in

both SE roles and SE job candidates, and some SE roles require very specialised skills and experiences that candidates must meet.

Internal validity: Our findings may be biased based on how we collected SE job advertisements, given that we used only one job board. However, it is very unlikely that the job advertisements would be significantly different based on the platform. The qualitative data in the broad ranging survey can be skewed towards what the participants we recruited think. However, this is a common threat of this type of research. We ensured participants with varying experience in reviewing SE job advertisements were recruited to reflect different views. In the facet survey, we found that the participants related with Tim more than they related to Abi on the defined facets.

7 DISCUSSION

7.1 Implications for Practice

Systematic gender de-biasing: Using our new Abi and Tim GenderMag personas, hiring managers can evaluate their job advertisements before posting those for any potential gender biases and take necessary actions to de-bias them. A cognitive walkthrough of the a job advertisement using each persona prior to release helps to identify aspects that may miss one gender's preferred elements, may not sufficiently emphasise them, or may emphasise facets of one persona much more so than the other. Corrective action can include adding missing or too limited information appealing to a persona; reducing or removing information that only appeals to one persona and is not balanced by information appealing to the other; highlighting or making more prominent important information for each persona when deciding on SE job advertisements; or combinations of these actions. This ensures making the job advertisement equally attractive to the broader community of the candidates and avoiding the risk of being unable to find potentially equal or more qualified candidates of different genders.

Gender bias detection: Our application of the GenderMag approach on selected SE job advertisements was overall successful. We found that the reasons documented during cognitive walkthrough were similar to those provided by SE job candidates. Applying a cognitive walkthrough with our two personas to an SE job advertisement will thus highlight potential areas for investigation of potential gender bias in the advertisement. For example, our job advertisement analysis process found that two of the four selected job advertisements (analyst and tester) had quite different views and behaviours from Tim and Abi. Thus, we concluded after the application of GenderMag on the four job advertisements two are identified as likely having some biases against particular gender candidates. To verify this finding, each of these two jobs were given to a hiring manager and a SE candidate (who didn't participate in any of the previous surveys) for independent review. Both hiring managers and SE candidates indicated the analyst job as gender biased and the tester job as not sure about having a gender bias.

Gender de-biasing: If cognitive walkthroughs of a job advertisement with different personas highlights different decision making, hiring managers can consider if changes to the job advertisement will result in similar decision making despite different gender. For example, we analyzed the reasons listed during cognitive walkthroughs with our Tim and Abi personas on the analyst and tester job advertisements. We found that for the analyst role which had no clear indication for potential for growth, it was an issue for Abi. For the tester role there is no clear information on working with new technologies, which was an issue for Tim. Modifying the advertisements to address these results such that both personas will make similar decision about taking up the job roles.

Key examples of such job advertisement changes that might be required that we identified include, but are not limited to: (a) make job role, team culture, organisational culture prominent; (b) clearly itemise benefits, flexibility, career growth, opportunities for developing leadership skills and experience, potential for social good contributions; (c) clearly emphasise organisational and manager commitment to gender inclusively, including work assignment, development, and in team and company values; (d) ensure all key job role decision criteria for both genders is not only included, but is sufficiently itemized/highlighted; and (e) be cautious about overstating the volume and detail of technical skills and experience required. Balancing appealing information for both personas in the job advertisement can also be considered i.e. more or less equal aspects of the role appealing to both personas.

Inclusivity statements are not enough: Interestingly, in our evaluation the programmer job advertisement used contained a statement on inclusivity of the team, and yet the role overall was not appealing to the female persona and some of the study participants. This indicates that just specifying inclusivity values of the employer is not enough to avoid gender bias in SE job advertisements. Some biases can be implicit in the way the information is presented in the job advertisements and in such scenarios our modified GenderMag personas and cognitive walkthrough approach can play a crucial role in detecting and addressing these.

Male and female SE role facets: Our 16 identified SE job advertisement review factors can give hiring managers and project managers a better idea of the role, work style, team and organisational preferences of SE candidates. Even if using the GenderMag cognitive walkthrough approach is infeasible for them due to time and resource availability, they can still consider these factors before they design the job advertisements.

For example, we found SE candidates have two major styles of reading job advertisements, selectively and sequentially. This indicates that hiring managers should present the information in job advertisements in a way that important information stands out and is not lost by those using selective reading. Similarly, long, dense job advertisement text may contain all information for candidates, but information critical for decision making by different gender SE candidates may be lost in the detail. Some job ads miss factors that our participants rated as very important in their SE job search process, but are missing from many SE job advertisements. Hiring managers should carefully consider whether to include these factors in their SE job advertisements.

Better SE role design: Our application of GenderMag can go beyond the scope of job advertisements. This can help managers and hiring managers design the requirements for their SE roles as well as use when building SE teams culture and work practices. Some factors we identified – such as expectations of SE teams and frustrations within SE, desire to develop leadership skills, and desire to contribute to social good projects – give managers some ideas of what is expected and desired by their SE job candidates

and team members and what frustrates them. They can keep these in mind while building their SE team work practices. Some other identified factors which were not included in personas can also be helpful, such as how candidates keep up to date with technology and address problems encountered during SE work. These may be useful for staff development, mentoring and coaching purposes.

Using SE candidate personas: In the process of applying GenderMag to detect gender bias in SE job advertisements, we created one persona for male and female SE candidates each. The personas are important for application of GenderMag, however those can be useful on their own. The personas represent SE candidates which might be helpful for entrepreneurs and managers to better understand them, for the purposes of setting up SE start ups and for building SE teams. The personas may also be helpful for new SE professionals to understand their peers and get an impression of what diverse SE teams are like.

Easy-to-learn tool: The approach applies a cognitive walkthrough method to find gender related biases within job advertisements. Cognitive walkthrough is a usability inspection method that involves completing tasks step by step to reveal usability problems in the interface [26]. The process is easy to learn, especially for hiring managers who are generally experienced stakeholders.

7.2 Implications for Researchers

Further persona development: It would be possible to develop further personas from our data that emphasise more strongly some factors over others. With further data collection, it may be possible to identify factors more important for some SE jobs for the majority of candidates, or new factors that we did not identify. These can also be used in further persona development, testing on SE job advertisements, and validation with SE job candidates.

Studying Other Types of Inclusiveness: Ensuring gender diversity within the SE workforce is one step towards more inclusive SE workforce. However, there may be other biases with respect to ethnicity, culture, age and so on in SE job advertisements [4, 6, 13, 27]. Our initial evaluation with the GenderMag approach was promising in identifying some gender bias issues. This encourages us to try and apply the Inclusiveness Magnifier (InclusiveMag) [10] approach to address other biases within SE.

Automation Support: The overall process of using GenderMag is time and human resource expensive, which may discourage hiring managers from adopting it. Thus, we plan to incorporate automation to support the approach. For example an interface with job review scenarios can be presented to the users where they mark the decision points within the job advertisements and list the persona facets used to make the decisions with simple clicks. Such automation could also be used with the InclusiveMag approach to help address other biases in SE job advertisements.

Multi-dimensional view: This work is focused on biases arising from gender only. However, it is also possible that the different biases can be a result of different combination of multiple factors such as gender, age, job roles and so on. For example, the preferences of the following three people of same gender can be different: a 23 year old female (who is single) starting their career as programmer, a 38 year old female with three kids who is a business analyst, and a 54 year old female who is a project manager who has adult kids. Along with considering different inclusiveness issues separately, research is also needed to consider the combined effect of these factors.

Inclusion of non-binary gender: As a first step to achieve gender diversity we considered two binary genders in this work. To achieve complete gender diversity, we hope to investigate differences in preferences arising from non-binary genders in future.

8 SUMMARY

One of the reasons the SE workforce is gender imbalanced may be the way SE job advertisements are written, attracting more male candidates and discouraging female candidates. Existing approaches to check job advertisements for gender bias is insufficient. We reviewed the feasibility of applying the GenderMag method to identify gender bias in SE job advertisements. To our knowledge this is the first attempt of applying GenderMag on job advertisements. We conducted a survey of SE job candidates to identify which factors differ between males and females. We identified 16 factors, 10 of which we decided were relevant to SE job application behavior. We redefined Tim and Abi personas from GenderMag with three broad facets to make them relevant for the SE job application domain. We conducted a facet validation survey where SE job candidates indicated whether they related to Abi or Tim on each of the facets. We performed a pilot evaluation with the new personas on four randomly selected SE job advertisements, comparing the outcome of a cognitive walkthrough with those of real SE job candidates reviewing the same advertisements. We found that the cognitive walkthrough resembles the cognitive process of real SE candidates to a great extent, and can help identify potential gender biases in SE job advertisements. We plan to replicate our SE candidate survey with greater and more diverse participants. We also aim to perform cognitive walkthroughs on more SE job roles and apply the InclusiveMag approach to help diagnose other biases in SE job advertisements.

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