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"Recoding Gender":

The intersectional experience of female immigrant programmers in the Swedish IT sector

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Abstract

Computer programming is historically constructed as a male domain, and the underrepresentation of women and other marginalised minorities is recognised as a global phenomenon in most countries of the world. However, limited attention has been paid to women who choose to enter this field. The lack of intersectional and cross-national analysis on the relationship between gender and technology remains a feminist concern in current science and technology studies (STS).

Addressing this concern, this thesis explores the intersectional experience of immigrant women who are studying and working with programming in the Swedish IT sector, where opportunities and barriers, equality and discrimination are co-existing. By exploring their perceptions, motivations, challenges and strategies to persist in this male-dominated field, this thesis tries to understand how women's experiences are shaped in different social and cultural contexts. Furthermore, drawing on feminist thoughts on the intertwined relation of gender and technology, as well as their diverse visions on the future of technology, this thesis discusses how programming and technology can be a means of empowerment with the potential problem of creating inequality.

Keywords: *programming; IT; immigrant women; technofeminism; intersectionality; Sweden*

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It has been a long journey to put an end on my master's study at Lund University. Two years ago, I would never imagine I could do coding myself, and I would write a whole paper about it. I would like to thank all the women who have participated and helped me in the writing. Your experiences are a valuable aspiration for all the women out there who want to study programming and become a programmer.

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1. Introduction

Women have been making achievements in almost every field in the 21st century. However, the underrepresentation of women in information technology (IT) remains a significant concern worldwide. Regardless of women's early access and significant appearance in computer programming in the 1940s and 1950s (Abbate, 2012), programming has become a male-dominated field in most countries of the world today, with the participation of women in programming education and professions remaining low and even declining (Hill et al., 2010; Margolis and Fisher, 2003; Misa, 2010).

In the context of Sweden, the gender gap in computer programming and the IT sector has also been identified as an issue. Even though Sweden has been ranked as one of the most gender-equal countries in the world (World Economic Forum, 2018), the education and the labour market in Sweden are still strongly segmented by gender, where foreign-born women are in an especially marginalised position with the lowest employment rate (Statistics Sweden, 2018b).

The Swedish IT sector is growing rapidly, and the subsequent huge demand for technical jobs is not being filled. A report initiated by the Swedish IT & Telecom Industries (*IT&Telekomföretagen*) has predicted a deficit of 70,000 programmers by 2022. With the trend of increasing integration of digital technology in everyday work, namely the digitalisation, IT-related jobs are becoming more and more essential in every sector of society. Given the importance of the IT sector to Sweden's economic growth, the lack of programmers and the absence of female programmers have an impact not only on the economy but also on the future development of computing.

The huge demand for programmers and the gender gap in the Swedish IT sector has created opportunities and space for immigrant women who are disadvantaged in the labour market to actively engage in the practice of programming. Meanwhile, the progressively implemented "gender equality" and "anti-discrimination" framework in Sweden's political agenda and legislation has also helped to tackle the issue regarding immigrants' employment. In this vein, many Swedish non-profit organisations and educational institutes have emerged to provide vocational programming courses for immigrants.

From a feminist perspective, this thesis tries to tell stories of the efforts and struggle of immigrant women trying to find their places in a foreign country through their endeavour in a male-dominated field. In the first part, by reviewing existing literature, this thesis tackles the hidden history of women in computer programming, and how this once "feminised" occupation became "masculinised". It draws on existing literature in explaining the underrepresentation of women and masculine culture in the field of programming, with awareness and critique of said literature's west-centred point of view. Built on the theoretical framework of feminist technology and science studies (STS), this thesis attempts to bring forth an intersectional analysis of the relationship between gender and technology.

From in-depth interviews with 10 immigrant women who study or work with computer programming in Sweden, the thesis profiles their diverse experiences and intersectional identities, exploring their motivations, challenges and strategies to persist in their pursuit of programming education and career. It intends to understand the power dynamic in this male-dominated field in the specific context of Sweden, where equality and discrimination are co-existing and shaping immigrant women's experiences, as well as their resistance. Furthermore, by drawing on feminist thoughts on the intertwined relation between gender and technology and their diverse visions on the future of technology, this thesis explores how programming can be a means of empowerment, as well as a way of creating inequality.

1.1 Definition

Before going any further, it's important to first clarify the definition of important terms used in this research that might be unfamiliar to the reader.

Computer programming and programmer

Computer programming (or simply *programming*) is the activity of designing and building computer programs using programming languages to accomplish computing tasks and solve computing problems[1]. Programming is essential to the development of software, and by extension,

[1] https://en.wikipedia.org/wiki/Computer_programming

computers. A *programmer* (or *coder*) can be referred to the person who writes code to create computer programmes or a specialist in one area of computers[2].

In this thesis, programming is used in a broader sense, which includes not only the production of code but also the work that involves code. In this sense, programmer is defined as the person who utilises computer programing in his/her daily work. It includes: (1) technical positions related to programming directly, such as web and software developer, computer and software engineer, IT architects; (2) occupations using programming as a tool but not related to programming directly, e.g., data administrator and analyst, user experience designer; (3) leader or management positions such as product manager in a tech company. Also, for the purpose of the research, the term programmer used in this thesis will also include those who are still studying programming to become a programmer.

IT sector

Generally, the IT (Information technology), or ICT (information and communication technology), or the digital sector is a diversified field. In this research, IT sector is defined according to the Swedish IT & Telecom Industries (2017). It includes "all activities that in any form create, develop, deliver and operate systems, services and products with digital content in the form of hardware or software", and "other activities where the final products are not IT products in themselves but, for example, vehicles, financial services or travel where computer hardware and software are essential components" (ibid. p.6). In other words, it is a sector where IT skills, such as programming, are crucial in everyday work.

1.2 My encounter with the topic and research questions

My interest in this topic started from my own exploration of programming. At the beginning of 2019, I started the journey of learning to code myself. After some research online, I got a chance to participate in a workshop organised by a non-profit organisation called Pink Programming[3] which focused on inspiring and encouraging more women to become programmers. Later on, I

[2] https://en.wikipedia.org/wiki/Programmer
[3] See: https://www.pinkprogramming.se/en/

encountered another organisation called HackYourFuture[4] that provided 6-months free coding courses for immigrants and refugees to become full-stack web developers. From those events, I expanded my network and got to know many talented immigrant women who were motivated to study to become a programmer, as well as those who had successfully forged careers in computer programming. Being immersed in a supportive environment created by female peers, I felt a sense of empowerment myself. It didn't come solely from the beauty of code, but also the fact that programming is presumed to be a male-dominated field. I am impressed by those women who ventured into this field with some of them completely lacking a background in programming-related subjects. I started wondering: what motivated them to choose to enter programming? What are the challenges they are facing, and what are their strategies to conquer them?

Being both curious about the IT industry in Sweden and the gender perspective behind it, I choose to focus on immigrant female programmers who are studying or working with programming in the Swedish IT sector and explore their intersectional experiences in this highly male-dominated field. The purpose of this thesis is to explore the relationship between gender and programming through a feminist lens and to understand immigrant women's unique experience in Swedish IT sector where opportunities and barriers, equality and discrimination are co-existing. Furthermore, I intend to discuss the empowering potential and underlying problem of programming and technology in general, which is posted as an important theme in current technofeminist studies.

Based on this aim, the research questions are structured as follows:

1) How do immigrant women perceive programming in their diverse cultural backgrounds, both in their home country and in Sweden?

2) What are immigrant women's motivations, challenges and strategies to persist in the field programming in the context of Sweden?

3) In what ways can programming be a means of empowerment and what's the potential problem?

[4] See: https://www.hackyourfuture.net

2. Research Review

This thesis takes a feminist approach, and this chapter is situated on the theoretical foundation of feminist technology and science studies. The chapter firstly introduces the theoretical framework of the feminist critique on technology and science studies, particularly focuses on the entangled relation of technology with gender. Then it reviews the history and previous research on women and other underrepresented minorities in computer programming, and the current situation in the IT sector of Sweden where gender equality and discrimination are co-existing. Departing from previous studies, this chapter will also discuss how this research is positioned on the foundation of previous research, and how it can contribute to this body of literature.

2.1 Feminist critiques of technology and science studies

From the early rise of technology and science, it has usually been viewed as a gender-neutral, unbiased field. Whereas, the thinking, creating, and loving of technology are dominated by male, with masculinity encoded in the practice of technology and the social construct of technical competence. Women have been using machines and technologies in varies settings and contributed greatly to its development, but they are "considered passive beneficiaries of the inventive flame" (Bray, 2007) and "hidden from history" (Wajcman, 2000).

Departing from the long-standing concern of women's marginalised and excluded position in science, engineering and technology, feminist scholars and practitioners have come a long way in theorising and contesting the power dynamic in technology and science where gender is a non-neglectable construct. American physicist Evelyn Fox Keller (1985) and philosopher Sandra Harding (1986) have both analysed the masculine ideology of science, and Sara Delamont (1987, cited in Wajcman, 2000) commented the gender-blindness in science studies. They turned the feminist critiques of science from "woman question" in science into the "science question" in feminism, which opened a new area of social studies of technology. In the 1970s and 1980s, feminist concern of technoscience is centred on women's equal access to scientific and technical education and professions (Wajcman, 2004). Numerous studies have shown the structural barriers to women's participation in technology and science, such as sex stereotyping in education and gender discrimination in employment (Keller, 1985; Harding, 1986; Wajcman, 2007). The liberal

feminist tradition in this period situated the problem in terms of women. They offer solutions to the problem by bringing more women to the field of science and technology by focusing on the socialisation process of girls and equal opportunities policies (Wajcman 2004 & 2007). However, this approach subtly assumed technoscience is unbiased, objective and gender-neutral, in which they ignored the gendered power relation behind those subjects. To criticise this perspective, radical feminism and socialist feminism positioned their analyses on the process of technology development in which gender divisions and inequalities are constructed. While radical feminists and ecofeminists concentrated on the technological incursion and control over women's body and nature (Spallone and Steinberg, 1987), socialist feminism emphasised the production of machinery where masculinity was embedded (Cockburn, 1985; Wajcman, 1991). From a historical perspective, socialist feminist scholars articulated how the capitalist division of labour has emerged since the industrial revolution, which excluded women from the designing and skill learning of technology (Bradley, 1989; Cockburn, 1985; Milkman, 1987). This perspective has a profound impact on the analysis of the gender division of labour in modern society where women are assigned to the domestic and private sphere, and jobs such as caring, administration, cleaning, service and preschool teachers are considered as "women's job" which are devalued, while occupations in technology and science are encoded with masculine traits and highly-valued.

Since the 1990s, feminist scholars are focusing more on the liberating potential of technoscience for women and the possibilities of transforming gender relations rather than a pessimistic approach (Wajcman, 2007). This consideration is parallel with the emergence and development of information and communication technologies (ICT) which has drastically changed the way we perceive information and interact with others. Postmodern cyberfeminists celebrate the possibilities and potentials of digital technology in shifting the power relation and liberating women. For instance, Plant (1998) sees digital technologies like the Internet as a way of facilitating new relationship between machines and human, women and men, which replaces the tradition hierarchies with more flexible and fluid networks. In a more radical way, Donna Haraway (1994) uses "cyborg"—a fictional organism lives in between human and machine—to embraces the great power of technology in creating new entities and to contests the dualism between human and machine, object and subject, nature and culture, the public and private, the body and mind. While contemporary literature on gender and technology has celebrated women's ownership and intensive

consumption of media and digital technology (Gill, 2002), the reality of women's absence in the making and designing of technology has not changed.

The recent development of postcolonial technoscience also highlights the predominantly western perspective in Science and Technology Studies (STS) (Wajcman 2007), and the absence of cross-cultural comparison and intersectional understanding of the gendering in technology is criticised by scholars in this field (Mellström, 2009; Lagesen, 2008). The concept of *intersectionality* has been considered as one of the most important contributions and debates in feminist studies. It was first introduced to feminist debate by black feminist Crenshaw (1989 & 1995), who intends to articulate how gender and race are interwoven in shaping the experiences and struggles of women of colour. As an analytical tool, intersectionality can be seen as "a way of understanding and analysing the complexity in the world, in people, and in human experiences" (Collins and Bilge, 2016). It examines how power relations are intertwined and mutually constructing. That is to say, the gender dynamic and the social inequality and injustice produced with it should be considered in relation of other social and cultural constructs of one's identity, such as race, class, ethnicity, sexuality, nationality, age, dis/ability, etc.(Crenshaw, 1991; Yuval-Davis, 1997; Collins, 2002). Moreover, the interplay between different categorisations should be seen as a mutual constructing process, instead of simply adding new categories (Lykke, 2010). However, there are few studies include intersectional analysis in STS research, or conducted in non-western contexts. In today's world where information technologies are transforming drastically, the relation of gender and technoscience are becoming more and more complex and ambiguous, and feminist account of technoscience studies has grown into a diverse and broad field (Wajcman, 2007). Mellström (2009) and Lagesen (2008)'s account for the female dominance of computer science in Malaysia points out the western bias of gender and technology studies, and the need to address an intersectional and cross-cultural analysis in order to reveal the complexities and ambiguities of the relationship between gender and technology. It is crucial for future feminist technology and science studies to focus more on the ongoing process of the mutual shaping of gender and technology across time and space.

2.2 Women and underrepresented minorities in programming: the history and the present

To understand the experience of immigrant women programmers, it is important to first introduce the history of women's changing participation in computer programming.

It would be a shock for most people who are unfamiliar with this history to discover that women actually had a significant appearance and made a great contribution in the early years of computing. Born in 1815, the English female mathematician Ada Lovelace is recognised as the first programmer of the world because of her ground-breaking introduction of programming concepts, which later became the foundation of the first modern computer in the 1940s (Fuegi and Francis, 2003). Later, the team who designed one of the world's most famous and earliest electronic computers ENIAC (Electronic Numerical Integrator And Computer) was assisted by a group of six women (Ensmenger, 2010, p.122). During World War II, women were the majority of the first programmers in the US and UK due to the urgent need, and they had great influence of the early development of computer industry (Abbate, 2012, p.18). In the 1980s, women in the US earned around 40% of all bachelor's degrees in computing and constituted a large number of the computing workforce (Hill et al., 2010).

Today, even when technology is booming rapidly, women are still the minority in programming and other STEM (Science, technology, engineering and mathematics) fields, both in education and workplace. Research in the US has shown a dramatic falloff of women's enrollment in Computer Science education (Misa, 2010, p.6), as well as in the transition and employment in the workplace (Hill et al., 2010, p.15) while women's participation in other STEM fields is growing. In addition, women are also marginalised in programming professions and excluded from high-level positions (Misa, 2010). The phrase "gender gap" is reoccurring in the existing literature of women's participation in STEM and programming, and it's recognised as a global phenomenon (Kanny et al. 2014). In the 2019 annual Developer Survey launched by StackOverflow (2019)[5], 91.7% among 90,000 programmer respondents from 179 countries are identified as male. Within programming jobs, the gender gap also exists. While there are dramatically more men than women in different

[5] Stack Overflow is world's largest question and answer platform for programmers with more than 10 million registered users. See: https://stackoverflow.com/

categories of programmer roles, women have the highest representation as front-end developers, designers, data scientists, data analysts, educators, etc. (ibid.)

While most literature focusing on women's declining participation in STEM and the relation of gender and technology, some also start to pay close attention to other underrepresented minorities who are marginalised in those fields. Aspray (2016) reviews the history of higher education in science, technology and computing focusing on women, African Americans, Hispanics, and American Indian in the US, which contributes to a better understanding of the underlying causes of their underrepresentation. In addition to historical research, a large body of literature also takes the underrepresented minorities' distinct experience in the STEM fields into account. For example, Thomas et al. (2018) explore black women's experience in Computer Science in the US, showing the challenges they are facing, and their strategies to mediate and resistant towards oppression. Hodari et al. (2016) focus on the experience of women of colour, discussing their strategies in advancing themselves in computing. Those studies have shown the intersectional perspective which is lacking in previous research. However, compared to the literature of women's participation in programming, fewer researches have been done focusing on other underrepresented minorities regarding gender, race, class and other identity markers. In addition, most existing researches of women and other underrepresented minorities in programming were conducted in the context of the US, UK or other western countries with a focus on programming-related higher education. As Wajcman (2007) and Mellström (2009) suggests, a cross-cultural and intersectional analysis is needed.

2.3 Explanation of the underrepresentation

Why women's participation in computer programming today is so low and even declining? What has driven them away from this fast-growing field?

In early literature focusing on the underrepresentation of women in STEM discipline and the effort to broaden their participation, the metaphor of the "pipeline" was commonly used. Camp (1997) defined the problem of the decreasing number of women in computer science from high school to graduate school as a "shrinking pipeline", which led to the even smaller percentage of women in the job market. According to this point of view, becoming a professional in computing can only be

achieved by attending high school courses and later participating in programming-related subjects through higher education. As a result, retaining and attracting women and other minorities into the "pipeline" at young age would be the solution to the problem. However, as Kulis et al.(2002) and Hill et al. (2010) argue, simply enlarging the number of female in programming-related higher education will not eliminate the gender disparity in the labour market. The road to the job market in programming and other STEM field is not a linear process from classroom to workplace, since many people would take different and untraditional pathways into the programming occupations, such as vocational training and online course (Cohoon and Aspray, 2006).

Thus, it is essential to understand the power dynamic and knowledge production in programming, namely, the masculine culture of programming. In the historical point of view, women's dramatic leaving in programming in the 1980s is parallel to the rise of personal computers (Misa, 2010, p.8). Ensmenger (2010&2015) explains this phenomenon in terms of the creation of masculine identity in programming along with the rise of the Internet revolution, personal computer and computer gaming, which embraced the "male nerd" image into those fields. Even though programming had an "ambiguous gender identity" in the early years as it "began as women's work", it was transformed into a scientific and masculine field by the professionalisation and the construct of male identity (ibid.). Ensmenger (2010, p.121) claims that the culture of computing, "a culture that is perceived to be inherently (and excessively) masculine" is "one of the most significant barriers to female participation in computing". The masculine image has made programming a less attractive occupation for women, and it causes their avoiding or voluntary leave from this field. In analysing interviews with professionals in the IT industry and students in computer science from Sweden, Boivie (2010) explores the metaphor of describing, thinking and feeling about programming, e.g., mathematical/logical problem solving and programming as construction work, revealing the cultural images of technology and technical artefacts, practices and knowledge, within which masculinity is constructed.

A large body of literature also focuses on the individual and structural factors that impeded women's participation in programming and other STEM fields. The influence of biological difference between male and female in abilities and personalities was discussed by many early scholars in the 1970s and 1980s (e.g. Benbow and Stanley, 1983). However, its significance is unfounded. By reviewing 20 years of data, Ceci et al. (2009 & 2011) conclude that the biological

evidence of women's underrepresentation in STEM is "contradictory and inconclusive", and sociocultural factors have a stronger influence on women's choices to enter STEM field. Through a systematic review of chronicle forty years of STEM-related literature in the US, Kanny et al.(2014) identity five themes in explaining the gender disparity in college-level STEM majors, which are: (1) individual background characteristics, e.g., race and socioeconomic status; (2) structural barriers in compulsory education, such as pedagogy and classroom experience; (3) psychological factors, values and preferences, e.g., self-confidence, concept, and sense of belonging; (4) family influences and expectations, and their impact on socialisation and self-concept; (5) perceptions of STEM. Similarly, in reviewing existing literature, DuBow et al. (2017) define "inhibiting factors" and "supportive factors" in analysing women's persisting in computing. Inhibiting factors include personal interest, early access and exposure to computing, sense of belonging, while supportive factors can be seen in preparatory privilege, social support from community and peer (ibid.). Morganson (2010) focuses on social coping in affecting women and men's commitment to STEM subjects.

However, this analytical model of "exclusion" is criticised by some scholars. Using Malaysia women's dominance on computer science education as an example, Lagesen (2008) suggests an "inclusion" framework to investigate the co-production of gender and computer science which is different from what is commonly believed in western research. Furthermore, Mellström (2009) intends to bring intersectional and cross-cultural comparisons in the analysis of gender and technology relations which are embedded in diverse cultural contexts.

2.4 The Gender Gap in the Swedish IT sector

In recent years, Swedish society is under digital transformation, namely digitalisation, thanks to the development and integration of digital technology and services in every sector. According to OECD's report (2018), Sweden is one of the leading countries in using and diffusing digital technologies, and among the top ten exporters of ICT services worldwide. In addition, IT sector has become one of the main driven forces for Sweden's economic growth and helped Swedish companies to focus on digital services with high added value such as marketing and product design, instead of manufacturing (ibid.).

Under the trend of digitalisation, the demand for people with IT-related skills are increasing rapidly (Swedish IT & Telecom Industries, 2017). A report of the trend and forecast on Sweden's population, education and labour market shows that by 2035, the need for programmers in Sweden is expected to continue growing (Statistics Sweden, 2017). The deficiency of IT-educated individuals will continue to exist in the long term, and by 2022 there will be 70,000 employees needed in Sweden's IT sector (Swedish IT & Telecom Industries, 2017).

Sweden has been ranked as one of most gender-equal countries around the world (World Economic Forum, 2018), with gender equality being an essential theme in Sweden's policymaking, national representation and branding (Government Offices of Sweden, 2019; Jezierska and Towns, 2018). Nevertheless, Sweden's labour market is still strongly divided by gender. The division of care and breadwinning is closely related to this segregation and the gender gap in wages and incomes, where women tend to work with more feminised professions such as health care assistants and preschool teachers with comparably lower income (Borchorst, 2012; Statistics Sweden, 2018). IT sector is one of the most gender-segregated fields, both in education and labour market.

As a field where skills and competence matter, IT sector usually requires employees to have a certain level of related education. In Sweden, this education can include: higher education programmes in computer science and information technology; vocational college education in computer / IT equivalent to at least one year of full-time studies; and other short-term vocational training or self-studies. However, according to the Labour Force Survey(*Arbetskraftsbarometern*) launched by Statistics Sweden (*Statistiska centralbyrån*), within programming-related education, female graduates only count for 3% in computer and communication technology (*Dator- och kommunikationsteknik*) at high school level, 15% in electrotechnology and computer engineering (*elektroteknik och datateknik*) at university level, and 14% in civil engineering programs of electrotechnology, computer engineering and automation (*Civ.ing.utb: Elektronik, datateknik och automation*) (Statistics Sweden, 2018a). It also shows that around 70% of employers experience a shortage of newly graduated programmers (ibid.).

Besides the lack of competencies in education, gender disparity is also an issue within the workplace in the Swedish IT sector, where professions with requirements for in-depth university-level competence in IT are male-dominated. In 2018, only 22% of system and IT architects, 20% of software and system developers, 14% of game and digital media developers, 32% of system

testers, 28% of system administrators, 14% of IT security specialists, and 29% of other IT specialists are female (Statistics Sweden, 2019d).

Overall, the development of the IT sector in Sweden is facing challenges due to the lack of competence, where women are especially underrepresented. In the meantime, this huge demand also creates numerous opportunities for people who want to enter this field.

2.5 Immigrants in the Swedish Labour market

Unlike the United States or other migrant countries, Sweden has been viewed as a relatively homogeneous country in terms of its ethnic and culture (Romani et al, 2017). Until the end of World War II, the number of migrants started to grow due to Sweden's economic expansion (ibid.) In the 1980s, and after the 2000s, the flood of migrants and refugees came to Sweden for seeking protection from war-torn zone (ibid.; Statistics Sweden, 2019b). In 2015, more than 160,000 asylum seekers arrived Sweden, which was doubled compared to 2014 (OECD, 2016). Sweden's population register shows that in 2018, foreign-born people constitute 19% of Sweden's total population (Statistics Sweden, 2019b).

Immigrants in Sweden are facing various challenges, among which the integration to the labour market has gained most concern. According to Statistic Sweden (2019c), a large portion of immigrants are with low education levels. In 2018, 10% of foreign-born persons held only primary or lower-secondary education, and for immigrant women, the figure is 11% (ibid.). The unemployment rate[6] among foreign-born persons was 15.4%, while the figure was only 3.8% for Swedish-born (Statistics Sweden, 2019a & 2019c). Among the foreign borns, immigrant women have the highest unemployment rate which was 15.6% (ibid.). Additionally, immigrants are overrepresented in low-pay and temporary positions (Siim, 2013, cited in Romani et al., 2017). On the structural level, some aspects of policymaking also hinder immigrants' integration in the long term. For instance, the long processing time for assessment and recognition of foreign qualifications have impeded highly educated immigrants to successfully be employed (OECD, 2016. p.15). Sweden's housing shortage also posted issues on immigrants', especially refugees' early settlement which can affect their integration over a long period of time (OECD, 2016, p.53).

[6] Unemployed rate refers to unemployed persons as a percentage of labour force.

On the other hand, the discourse of "gender equality" and "diversity" has been progressively incorporated in Sweden's political agenda and legislation. Sweden has launched law against gender discrimination as well as ethnic discrimination, which obligates employers to work for equitable conditions in the process of recruitment, employment and wage in terms of gender, sexual orientation, ethnicity, and other cultural backgrounds (Romani, 2017). Sweden has also developed longstanding integration policies to tackle the issue regarding immigrants' employment, such as a two-year introduction program to help newly-arrived humanitarian migrants gain Swedish language skills and prepare them for employment, as well as a fast-track initiative to recruit skilled refugees into demanding professions (OECD, 2016, p.14).

Overall, the labour market and more specifically the IT sector in Sweden is where opportunities and barriers, equality and discrimination are co-existing. In this context, how immigrant women enter and persist in programming which is conceived as a male-dominated field can be a topic that worth considering.

3. Methodology and Method

This chapter discusses and reflects on the methodology and method adopted in this research. Firstly, I will introduce the methodological framework within which this study is designed. Then I will go through the process of how I conducted the research. Finally, I will reflect on the study, concerning the role of the researcher and ethical considerations.

3.1 Feminist Methodology and Intersectionality

This thesis is built on the theoretical framework of feminist technology and science studies, within which different feminist methodological principles are taken into consideration. the first and foremost principle is to depart from women's interest, perspective and experience as standpoint feminism argues (Lykke, 2010, p.147). In this research, the experience from a specific group, namely, immigrant women, is centred in the research question and the construction of research design. In the light of Harding (2004), the idea of this research is to question the "androcentric, Eurocentric conceptual frameworks" in current science and technology studies, to question the social neutrality of science, and to produce knowledge for the oppressed. In this vein, the intersectional identities of the informants are taken into consideration throughout the research. Informants are from diverse background, but what's in common is that they are women who are studying or working with programming which is considered as a male domain, and they are immigrants who are facing various challenges in Swedish society where they may encounter other obstacles in terms of their age, pregnancy, and other identity markers. The intersectional aspect of their identity will shape the experience and knowledge in which they are inscribed.

Secondly, inspired by postmodern feminist thought of deconstructing and problematising the "stable and secure foundations of scientific knowledge production" (Lykke, 2010, p.210), this thesis attempts to contest the western notion of "the masculine culture of programming", and to locate it in diverse cultural and social contexts, instead of accepting it as a global view. Taking a qualitative and interpretive approach, this research tries to understand the meaning-making of people, the motivation behind human behaviours and the diversity of societies and cultures (Della Porta and Keating, 2008).

3.2 Finding and selecting informants

Based on the research question, the general criteria of selecting informants for this study are: (1) female coming from countries other than Sweden; (2) currently studying programming to become a programmer in Sweden or working as a programmer in Sweden.

Because the core of this study is to understand the unique experience of individuals rather than represent the larger general group, informants of this study are found in a small group of people who are directly linked to the research topic. I used snowball sampling to look for informants who are connected with the network I have. In addition, to consider the intersectional perspective of this research, I intentionally selected women from diverse background and avoided choosing women from hegemonic countries.

The searching of informants has been a back and forth process. It started with a coding event organised by Pink Programming, a non-profit organisation in Sweden focusing on bringing more women to the programming world. On that sunny Sunday afternoon, I sat with 15 women with diverse backgrounds, learning how to write code to deal with data. It was a fun and inspiring experience and I got a chance to mingle with the women there. After the event, I added some of them on Facebook. However, it was not a successful attempt to find qualified informants since most of them neither had experience of coding before, nor would start any programming course any soon, and I intended to find people with more experience and understanding of the IT industry in Sweden. Luckily, I got another chance to attend a workshop of web development organised by HackYourFuture (HYF), an organisation providing free coding courses for immigrants and refugees in Sweden. I connected with some of the female participants and mentors, telling them about my thesis at the event. We connected each other on Facebook and Linkedin[7], and later on I sent out invitations of interview to them.

At the same time, I started actively looking for more informants for my research through Linkedin. Choosing to search on Linkedin rather than keeping looking through offline events is based on two considerations. Firstly, Linkedin users have to present their real personal information and identity, including gender, nationality and occupation, if it is not fake, which is helpful to target potential

[7] Linkedin is one of the world's largest professional networking websites.

informants. Secondly, thanks to the algorithm of Linkedin's suggestion section, it automatically recommended users who have common connections with me, and who have similar occupations or education backgrounds with the persons I recently connected. Because of my connection with some female programmers and students of Pink Programming and HYF from previous workshops and events, I have easily found women who are eligible informants by scrolling through the "Suggestions for you" section on Linkedin. I sent out message, telling them who I am—a master's student in Social Studies of Gender, Lund University, and my intention of connecting with them—I am doing a research about female immigrant programmers in Sweden for my thesis. I asked them if they are willing to participate in the research by having an interview with me. among 6 women I connected on Linkedin, 2 women have accepted the invitation for the interview. In the end, 10 informants were selected, and they participated in the next step of the research.

In general, the informants of this thesis largely came from my network. There are 6 informants coming from my direct contact in coding events and workshops in Lund and Malmö (cities in the south of Sweden), 2 from introduction and reference within the network, and 2 from my active search on Linkedin.

3.3 A presentation of the informants

All 10 informants are coming from 10 respective countries and regions, including Australia, USA, Ethiopia, Russia, India, Syria, Iraq, Mexico, Mainland China, Taiwan. Their age span is from 23 to 42 years old, and their years of living in Sweden are between 1-10 years.

They came to Sweden originally with different purposes, with 3 of them as students, 2 as refugees, and 5 for their partners. All informants live in the south of Sweden, including cities of Malmö, Lund, Helsingborg or their outskirts.

All informants hold at least a bachelor's degree, and the highest education background is at the doctoral level. 4 of them have a degree in the STEM field, such as computer science, computer engineering, astrophysics, and they have worked in related professions such as IT support, computer programmer, and PhD student. They all had previous study or working experience of programming in their home country. The rest of them studied subjects in social science, law, marketing and economics with diverse working experience including marketing, sales, customer

service, administration, tour guide, teacher, writer, and personal assistant. They had no programming experience before coming to Sweden.

All informants are studying or have studied in programming training programme since settled in Sweden, with 8 in offline vocational training and 2 in online courses.

By the time of the interview, 2 informants have full-time job, which includes front-end developer and project manager. Among the rest, 2 are doing internship as data administrator and UX designer; 2 have finished the course and they are actively looking for internship or job in programming, such as developer, tester, and other programming-related positions; 4 are still studying in the course.

3.4 Conducting interview

Before conducting the interview, an interview guide (see Appendix 1) was designed. To answer the research question, there are three themes which focus on immigrant women's perception of programming; motivation, challenges and strategies to persist of programming in Swedish IT sector; the empowering potential of programming.

The interview is in-depth and semi-structured lead by the interview guide. Each interview took about one hour, but the structure of every one of them varied depending on how the dialogue proceeded with each informant. With 2 informants from Mainland China and Taiwan, the interview was conducted in Chinese. With the rest 8 informants, we talked in English. 9 interviews were conducted face-to-face in places informants have chosen, and one interview was conducted by phone because she was unable to meet in person. The quality of the voice call was good, but without meeting in person, it was difficult to make use of and interpret the body language and expressions which can be a disadvantage (Bryman, 2012, p.488). But considering that the analysis is focusing more on the storytelling, this obstacle can be overlooked.

At the beginning of the interview, I introduced the purpose of the research and addressed ethical issues. I asked for their permission to record the interview, informed them of their rights to not answer questions and to stop the interview if they don't want to continue. I also talked about the transcribing process and how the data will be stored and used. All names used in this thesis are

pseudonyms which I chose randomly but in accordance with their nationality/ethnicity after all the interview was done, so it was not brought up during the interview.

I consider the interview as a discursive construction of meaning, and as a researcher, I am telling the story in which I'm a part (Lykke, 2010. p.5). Within Donna Haraway's postconstructionist and intersectional version of standpoint theory, the term situated knowledge is "based on the assumption that scientific knowledge is not value-neutral, but embedded in its context of production", and it demands for a reflection on the researcher's position "in terms of time, space, body and history, and in terms of the context of intersecting power differentials in which she or he is inscribed" (Donna Hraway, 1988; Lykke, 2010). In the research process, I have to constantly reflect on my own positionality, what kind of knowledge I possess and how it can affect the power relation and knowledge production of this research. As an immigrant woman myself who is also learning programming in Sweden, I found myself being both insider and outsider of the group I'm studying. On the one hand, I have easy access when approaching informants, and I can understand their struggles in terms of learning, job-seeking, and other challenges they are facing. For example, coming from a similar cultural and social context, I feel especially connected with two informants from Mainland China and Taiwan. This similarity has created a "common ground" (DeVault and Gross, 2007) which helped me to engage and ask more meaningful questions. On the other hand, as an outsider to each woman's experience, I remained curious about the unfamiliarity. I consider this positionality as an advantage rather a barrier, as I have shown my interest in the topic we discussed and engaged in a high level of rapport (Bryman, 2012, p.492). I shared my experience in the dialogue with my informants and attempted to create a non-hierarchical relationship.

3.5 Analysing material

All interviews were recorded with my cell phone and transcribed into scripts. For English interviews, I made sure that the transcripts were exactly the word the informant used. With the 2 interviews conducted in Chinese, I translated them into English. Chinese is my first language, and to translate Chinese into English can be limited by my understanding of the English language. I acknowledge that my interpretation and knowledge is embedded in the translation process. There are certain words in Chinese which I was struggling, such as "填鸭教育" (Tianya Jiaoyu) which I

translated into “teaching to the test” has lost some cultural meaning in the context of Chinese language.

After the transcription and translation, I use thematic analysis to examine the data and extract core themes (Bryman, 2012, p.578). I read through the printed interview transcripts which made it easier to make notes and highlight the themes occurring in the text. Following the guideline of Saldaña (2015) of coding, I have read the text repeatedly and adding codes manually on the paper which I found relevant. Having the list of codes identified, I sorted them into categories, and finally defined them into themes.

4. Immigrant female programmers' perception of programming

Before asking what makes computer programming appealing and possible for those women, it is crucial to understand the start point of their journey of programming: what's their perception of programming in different cultural contexts before coming to Sweden, and whether it has changed when they chose to study or work with programming in Sweden? This section will discuss those women's perception and experience of programming during their upbringing, education, and professional work in the context of their home countries.

4.1 Early encounter of programming and the developing of interest

Growing up in respective sociocultural, economic, and historical contexts, women's experience and perception of computer programming differ. Even though all informants are studying or working with programming now, it's important to bring up the question: what was their encounter and perception of programming in their early years of upbringing and education? Were they appealed, or deterred by it? Why did they choose or not choose to study programming-related subjects?

According to DuBow et al. (2017), there are "inhibiting factors" and "supportive factors" which contribute to women's persisting in computing. Among informants, personal interest and early access to programming is a reoccurring theme, which belongs to the category of inhibiting factors. Many of them tend to attribute their choice to personal interest. When asked how she became interested in programming, Rawan says:

> I think it's because it has a lot of math. I love math. I was not sure if I wanted to study computer or math at the beginning. Then I thought, computer is something advanced, and has a lot of math. I think at my school before I got to university, we had programming basics, and I found that interesting and it's something I could work with. And I always thought that people work at programming are smart. I found that really cool. (Rawan, Syria)

Laura from Mexico holds a bachelor's degree in computer system engineering as well as a PhD in Astrophysics. Her passion started at an early age:

> I studied astrophysics because that is my passion. Since I was a little girl, I love the space and stars and everything about them. (Laura, Mexico)

Although interest and exposure to technology at an early age contributes to individual's choice of education and career in programming later in life, it doesn't correlate strongly to young women's decision of pursuing computer science education (Cheryan et al. 2015). For Youyou, computer and even programming wasn't something alien to her when she was young, and this early exposure did spark her interest. Nevertheless, her fond of programming did not persist, but diminished over time.

> We had a computer at home quite early. At that time, not so many families had computers. [...] I actually had a basic programming course in primary school, it was using code to draw patterns on the screen. That was pretty fun, and I was REALLY good at it, top of my class. But I just didn't see it as something I would be doing, I couldn't imagine that. All my friends are girls and none of them liked it. Also when I was home, my parents didn't allow me to play with it. So I kind of lost interest. (Youyou, China. My translation)

She failed to develop a sense of belonging, namely, feeling fit or rewarded when she made accomplish in programming. This sense of belonging doesn't come solely from herself, but was affected by the social supports surrounding her, from friends and family, which in her case are negative. In some other cases, informants regard the influence and support from family as one of the reasons for their pursuit in programming education and career.

> My father encouraged me a lot to do that. We don't have boys at home, maybe that helped me. My father was really proud, and he pushed us to be stronger and told us you should have confidence in your life. (Rawan, Syria)

While the lack of access to computer and technology and the insufficient social support are factors that impede women's development of interest in programming (DuBow, 2017), for example, women from low-income, less-educated families will have less preparatory privilege in pursing programming education and career, it is not the case for the informants. All informants are from middle and upper-middle-class in their home countries where they have enough resources and supports in their upbringing and early education. Even in societies with more traditional culture, this support from family can have a great impact on women's gender-role socialisation which contributes to their choice of programming later in life. Rawan recalls:

> In middle east, they tend to push girls into marriage very early. But it depends on the family. In my case, I wasn't allowed to think about marriage until I'm done with my education. (Rawan, Syria)

Diya gained her bachelor's degree in Computer Science India, and she also had similar support and aspiration from her family:

> My mom's mother is from the village side, but the knowledge she has is like, awesome. I'm really close to her, and she doesn't feel that women should only stay at home, cooking and doing something like that. For her it's like, we should stand alone, we should work, we should be so good. (Diya, India)

In addition, structure barriers in compulsory education is another factor that affects women's perception and experience in the STEM field. In the light of Kanny et al. (2014). Those barriers have been illustrated in terms of pedagogy, classroom and peer interaction, teachers, curriculum, etc. (ibid., p.137). In Youyou's case, her giving up on STEM major didn't come from her personal interest, instead, it is a result of the structural barriers from her education.

> In middle school, my math, chemistry, biology and other science subjects were top of the class. At that time, I wanted to study something related to chemistry or biology (in university), and we will split into two directions in the second year, either social science or natural science. But in the first year of high school, my grade of physics just dropped. I really need to get my grades up, but the teacher was bad and I just hated everything about it. Then one day my teacher told me "it's okay, you can choose social science. Girls don't need to study those difficult subjects at university". And I thought, okay, maybe it's not for me. (Youyou, China. My translation)

She continued to study social science subjects in a University in China and gained her master's degree in related field in Sweden. But until now, she still feels "regret" in this important decision of her life.

> when I think about it, I might be a chemist or biologist now if I continued working on my physics. But it's hard when everybody tells you it's tough for girls, and it became harder at that time. (Youyou, China. My translation)

Another informant also reflects on the structure barrier in Taiwan, where the education system is similar to China's.

> Our schools don't really promote women in science subjects, and this method of "teaching to the test" doesn't really tell us the purpose of study or inspire us to have interest. We just do it for scores, instead of learning. (Zoe, Taiwan. My translation)

Overall, both inhibiting and supportive factors have shaped those women's unique experience with programming at an early age. Some of them have developed an interest in STEM subjects and programming, and some were deterred by it. While those women's perception and choices regarding programming in their early upbringing are influenced by their personal interest or ability, the social and cultural factors behind those choices should be acknowledged and amplified. How interests are developed, and what kind of social constructs are behind those choices should be taken into close consideration, which will be discussed more in the next section.

4.2 A male-dominated and masculine field

According to Wajcman (2004), science and technology is not a gender-neutral field. From its early design by male and its association with patriarchal values, women are excluded in the process of defining its culture. As discussed in previous literature, women's absence and exclusion in programming are recognised as a global phenomenon. Unsurprisingly, 9 out of 10 informants has described programming education and occupation in their home countries as "male-dominated" except one informant from India.

This "male-dominated" impression is based on two aspects. Firstly, it comes from the fact that women are the underrepresented minority in programming education and profession. Most informants with a former programming-related degree have experienced being the underrepresented minority in class. Rawan has a bachelor's degree in computer engineering in Syria, and in her class, "less than one third were women". Another informant also had similar experiences:

> When I started computer systems engineering, we were 15 students, and we were just 3 women. I can see there is a huge difference between men and women when they study this. (Laura, Mexico)

In some contexts, the gender disparity is not limited in STEM subjects such as programming, but exists in other areas of education, and largely the education system as a whole. Aida talks about the inequality of education in Ethiopia:

> During the socialism 30 years ago, it used to be even. But now there are social pressure towards women. There are a lot of early marriage, and very few people get the chance to go to college. Out of that, people just think why not giving the chance to people who are actually gonna do something with their degree instead of women who are gonna get married, have kids and stay at home. And who are those people? They are men. […] There are more boys than girls in education anyway, not just for programming. I think there are 70% men and 30% women in general, but when you go to the natural sciences, the ratio (of men) gets even higher, and women are encouraged more to go into accounting, management, marketing and so on. I don't know about computer or software engineering, but in electrical engineering in our school, out of 18 classes there was just one girl. So it's really male-dominated. [...] In our law class, there were 18 dudes and 10 girls. So it's not just about programming, the whole education is more towards men. (Aida, Ethiopia)

This inequality within the education system limits women, the poor, the powerless and other marginalised groups of the society to acquire equal education opportunities. Luckily, Aida is from an upper-middle-class family which enabled her to attend "fancy school among the most elite" with "more than enough education resources", where "boys and girls were treated the same" (Aida, Ethiopia). Even though, when asked if she has been treated differently in university, she recalls: "I'd like to sit with girls, because if I sit with a (male) friend, people would be mad. It's more like a class thing than gender as well. a lot of the guys had a lot of money than us. […] In 5 years, maybe I talked to 2 guys because they avoided us a lot, they wouldn't be in the same place we would. They wouldn't even say hi, and maybe even worse. Imagining you go to the same class for 5 years as somebody, the same assignment, the same for everything, but you have no idea of them. It's crazy." In University, her former advantage of resources disappeared. She became the marginalised in terms of gender and class. This gender segregation in school results in women's isolation, especially in faculties where male students are the majority.

In the IT workplace, the gender gap and the underrepresentation of women also exist. In some cases, women don't persist in programming jobs after their education. For example, even with a bachelor's degree in Computer Engineering, Rawan didn't choose to work as a programmer when

she graduated. She worked as an IT support in a government institution, then a teaching position in university where her main responsibility is to “prepare students to enter programming”, and she describes it as “a routine job without much of developing and creating new stuff”. Nadia has been working as a programmer since gained a bachelor’s degree in Computer Science in Iraq. However, she also states the similar: “In Iraq, there are many women has educated as a programmer, but they don't work as a programmer. The idea is that when they get married, they try to get an easy job.”

The social pressure on women is one explanation of why women are excluded from programming education and workplace, especially within the IT field. Women choosing to work with “easy job”, and more feminised and routine job reflects the underlying relation of gender and work. Women’s role in the private sector is more important compared to their performance in the public sector. In order to have more time to take care of family and kids, Rawan chose to work in an easy job where she can be home early without taking any work home with her. This gender division of labour is also embodied in how programming becoming a challenging field for women. Because women are expected to take their roles in family, some women are not prepared to take challenges, or have lost confidence in competing with men in a male-dominated area. Even women with competence tend to leave programming when they are struggling with family and work.

Secondly, the masculine culture of programming is another important theme. According to Wajcman (2007), the masculine image of technoscience means not only the dominance of men, but also its symbols, discourses and values connected with masculinity. When asked about if they think programming is a masculine field, informants describe their opinion differently. 6 out of 10 informants had no previous programming experience or education in their home countries, and their perception of programming was either constrained or stereotyped before coming to Sweden.

> I used to think it's a nerd thing. Maybe because of all those movies, and the people you see who are programmers. They are always guys wearing glasses and sitting by the computer. (Aida, Ethiopia)

This nerd image of programming is a perfect example of how masculine stereotypes has encoded in the practice of programming. Ensmenger (2010, p.138) argues that “ideas about how computing should be done corresponded closely with perceptions of who should be doing the computing”. As discussed earlier in the part of computer programming’s history, programming has not been a

traditionally male-dominated discipline, but was transformed from a routine, feminised, low-status clerical job to a highly-valued and professional field, within which the nerd culture and masculine identity of programming were constructed. The social construct of the masculine and "nerdy" image of programming may deter women from choosing such subjects, because they may feel that they don't belong. The masculine image also made programming a less attractive occupation for women and causes their avoiding or voluntary leave. The interview has shown that the masculine stereotype is ingrained in women's growing up and education, excluded them from choosing programming and other STEM subjects.

> I never played around with computers when I was young, and I was never into gaming. I think that kind of stuff is more masculine. Because of how we were all raised, boys and girls like different toys, and men tend to work in that industry because they have the interest longer. (Alice, Australia)

On the other hand, informants with early encounter and interest in STEM or programming have different opinions. When asked if she thinks programming is a masculine field, one informant says:

> I never thought that way. I don't think there are many masculine jobs. The only thing I see between men and women is strength. Of course when you need to carry big heavy sacks of responsibility in other things, it's easier for men than women. But intellectually I don't see any difference. So it doesn't really affect me. I've never seen any job that is for just men or women. (Laura, Mexico)

Another informant also describes the similar:

> Depends on the definition. It's a masculine occupation if you look at the programmers, and most of them are men. But the profession itself is not masculine. It's no gender I would say. It's just coding and it's not for women for men. (Nadia, Iraq)

For them, programming is not a masculine job and there is no intellectual difference between men and women in performance.

It is important to contest the idea of the masculine culture of programming in diverse cultural contexts. Diya from India tells a different story other than the narrative of "male dominance" and

“masculine”. When asked about the gender ratio of the class in her bachelor’s education of Computer Science in India, she recalled:

> In my class, 45%, nearly 50% are girls. […] And I would say equally. It's not only for guys or something like that. Anyone can choose any field. When you are looking for a job, they just see what skills they have based on the interview. (Diya, India)

The case of India is one of the examples that break the western perception of masculine programming. Similar as the case Mellström (2009) and Lagesen (2008) have studied about Malaysia women’s dominance in computer science, Diya’s experience has shown a more diverse understanding of gender and technology which should be considered in specific social and cultural contexts.

5. Start Coding in Sweden: motivations, challenges and strategies to persist

Each informant's unique experience and perception of programming has determined their different starting point in their programming journey in Sweden. Even though there are a few exceptions, most informants regard programming as a "male-dominated" field in different social and cultural contexts, and the masculine culture is prevalent in relation to their experience of upbringing, education and career in their home countries. But why do they choose to become a programmer after coming to Sweden, especially for those who have no previous programming education and experience at all? What are the social and cultural factors in Sweden that influence their decisions? This section will discuss how those immigrant women perceive programming as a profession in Swedish IT sector after migrating to Sweden, why they chose to study or work with it, and what kind of challenges they are facing.

5.1 A shortcut to enter the Swedish labour market

Although the Swedish IT sector is still heavily dominated by male, the shortage of programmers in Sweden has created numerous opportunities for people with programming skills and attracted many women to enter this field. Among them, immigrant women are a special group. All informants came to Sweden with different purposes, e.g., for study, family or seeking asylum, but finding a job and succeed in the labour market is one of their priorities. When asked why they choose to become a programmer in Sweden, most informants mention their intention as related to finding a job, e.g., "it's easy to find a job" (Tasha, Russia), "programming is really in demand as a job in the industry" (Alice, Australia), "I feel like whenever you see a job advertisement, it's an IT-related job" (Aida, Ethiopia). According to Statistics Sweden (2017) and IT&Telekomföretagen (2017), the demand for programmers in Sweden is expected to continue growing, and women's underrepresentation has been recognised as a problem in the Swedish IT industry. This situation has created plentiful opportunities for immigrant women who are marginalised in the labour market. As one informant reflects:

> There is really an embrace for women in programming at the moment, I think they really identify that in an area that is really male-dominated. (Alice, Australia)

Another informant also states a similar impression of the IT industry in Sweden:

> In here it's like, they are begging for women. I feel like if you are a woman who can do programming, especially if you are in another ethnic group, probably you can easily find a job, because you check all the boxes for the diversity. (Maria, USA)

The "embrace of women", "check all the boxes for the diversity" shows the uniqueness of the Swedish IT sector. Although it still remains as a male domain, the huge demand for employees has created accessible pathways for immigrant women who are in need of a job. Moreover, along with the progressively implemented principle of gender equality and diversity by Swedish law (Romani, 2017), it becomes an appealing option for immigrant women who are marginalised and excluded from the job market.

So what causes immigrant women's exclusion from the labour market? There are several reasons emerged in the interview. The language barrier is one of the biggest challenges for most of them to successfully find a job. In spite of the fact that the general knowledge of English is high in Swedish society, "speaking Swedish" is still a common requirement for most job positions. Immigrants in Sweden are expected to learn Swedish, and the government has introduced language programmes specifically designed for them. Zoe from Taiwan is currently taking the programme *Svenska som andraspråk* (Swedish as second language) offered by Komvux[8]. Even so, not being able to speak Swedish fluently, together with her uncompetitive education background, has impeded her job searching:

> I studied media and communication which is a really broad subject and I didn't learn any special kind of skill. […] I worked with international sales before. I speak English really well, otherwise it's really hard to find a job. In Sweden, it's not a really strong background for me to get a good job. I'm learning Swedish, but it still will take some time for me to speak fluently, and it takes longer to speak as good as native speakers. So I don't have any advantage in terms of competence. But if I have some skills, I might get a better chance. (Zoe, Taiwan. My translation)

For some informants who have skills, the language barrier remains a non-negligible factor. Diya had a bachelor's degree in Computer Science, and she has worked as technical support in India for

[8] Komvux is the school in Swedish municipals that offers various subjects of adult education.

many years. When she was trying to apply for similar positions in Sweden, she encountered difficulties because this type of job requires her to "speak Swedish as good as native speaker" (Diya, India). Being able to work is an important aspect of those women's lives. Diya came to Sweden from India to live with her husband, and she has been feeling the pressure and emotional burden from not getting a job:

> Initially when I came, when I was in India, I'm that kind of person surrounded by people. Very soon I become friends with everyone, my neighbours, colleagues. I'm very close to my family, I've never been left out by them. After marriage, only he and me, we came to this beautiful place, so calm and nice, I love it. But suddenly there are no people talking to you for an entire day, and you are eagerly waiting for your husband to come home. […] The first few months were fine, then I broke down with my emotions, I cried a lot, I miss my family and I want to go back. But my husband said, if we are going back to India, we should have something proud to tell them, you should have a job and you should be on the top. So I think eventually I need to have a job to have a life. then I can be busy Monday to Friday. (Diya, India)

Since programming languages are developed based on the English language, understanding English is crucial in learning and working with it. Thus, the tolerance and acceptance for non-Swedish speakers in the Swedish IT industry are much higher than any other sectors. For Zoe, studying programming becomes a way to improve her competence in the labour market without being restrained by the language barrier. Diya has been taking programming courses online to enhance the technical knowledge she needs in a system administration job she has applied for. It doesn't require her to speak Swedish, and she has successfully gotten into the interview.

The lack of resource is another important factor that can exclude immigrant women in the Swedish labour market. From the interview, the resources that the informants are in need are training (including language training, skill training and other professional training related to CV and interview) and social network. As a welfare state, Sweden is generous in offering resources for immigrants in terms of training to help them integrate. For instance, there are introduction programmes for newcomers to gain language skills and necessary knowledge of the labour market, and the fast-track program for skilled immigrants to enter a demanding profession (OECD, 2016). Once registered in the Swedish Population Register, immigrants will be able to enrol in Swedish

language program SFI (*Svenska För Invandrare*)[9] for free and get help from the Swedish Public Employment Service Agency (*Arbetsförmedlingen*) [10] for job searching, career consult, professional training when becoming unemployed.

When talking about programming, the existing resource is even more abundant. Compare to some other STEM subjects requiring intensive training in the laboratory, which is not accessible by everyone, programming is special in a way that it doesn't demand equipment more than a computer. The wealth of resources online is open and free for people who want to start learning. Youyou and Diya are taking online courses offered by EdX [11], Codecademy [12] and other online learning platforms. In addition, there are plentiful organisations and institutions in Sweden offering vocational training programmes that only require students to speak English, and even free of charge. For example, HYF is the one that most informants are taking. It's an initiative originally comes from the Netherlands as a reply to the refugee crisis in Europe, aiming to educate immigrants and refugees, as well as providing IT industry with more employees. Later, an organisation in Sweden called Foo Café[13] adopted the concept and started providing a free, 6-month programming course specially designed for immigrants and refugees. according to informants, the programme prepares them with the latest programming knowledge in the industry, helps them to expand their network, and connect with companies. According to the project manager of HYF, 75% students of the program have finished successfully, and everyone passed the examination have a job today. One informant talks about her impression of HYF: "HYF is only 6 months. It's free, and it's on Sundays once a week. So I figured there's nothing to lose basically. If I want to quit I could. It's not like you signed up in computer science program in university" (Maria, USA). The abundant resources of learning programming available enable the informants to get into the field of programming quickly without too much investment.

[9] See: https://www.skolverket.se/undervisning/vuxenutbildningen/komvux-svenska-for-invandrare-sfi
[10] See: https://arbetsformedlingen.se/for-arbetssokande/valj-yrke/hitta-yrken
[11] A massive open online course provider which hosts a wide range of university-level courses for students around the world. See: https://www.edx.org/
[12] See: https://www.codecademy.com/
[13] See: https://foocafe.org/

Another considerable resource for immigrants in their successful employment is network. Six out of ten informants have mentioned network as one of the most significant elements in their job searching.

> Finding a job is difficult because you need recommendations and network which is probably the most important thing for Swedish employers. As an expat or an outsider, it is hard to break into that. But if you know someone from the work, it makes you jump the queue even you are less experienced. Also I heard that many jobs are already taken by someone with reference when you see the advertisement online. The ad is there because it's required by the law." (Youyou, China. My translation).

Tasha also states the same:

> Network is really important in Sweden. People would usually hire someone who can get a recommendation. For immigrants that is impossible sometimes. (Tasha, Russia)

The lack of recommendation and network is common for immigrants, which makes it difficult to compete with Swedish job seekers who have a broader network. However, the current situation in Swedish IT sector is different. Numerous institutions, organisations and companies are arranging regular events and workshops to introduce and inspire newcomers to get into programming, as well as expanding their network. Pink Programming is one of them, which focuses on bringing more women into the IT industry. I met Diya from India in Pink Programming's Sunday Coding event, and later got to know some other informants from HYF's workshop in web development. I have experienced the power of network myself, and for informants, it could be an even more powerful factor in looking for a job. Rawan successfully found landed on a job as a front-end programmer in a tech company. She says:

> Both HYF and MatchIT[14] helped me to build a network here. In MatchIT we had a lot of breakfast with companies, you have chance to introduce yourself to other people, to show them your CV. I started to know which companies are there in Lund and Malmö. Before that I didn't know anything. (Rawan, Syria)

[14] MatchIT is an EU funded programme designed to provide supplemental ICT skills to newcomers to Sweden who already have some kind of ICT education, skills or experience. See: https://ideon.se/career/matchit/

In addition, some immigrant women are less competent in the labour market in terms of the intersectional dimensions of their identity. For instance, some of them are full-time housewives who have been out of work for a long time, or mothers who are busy taking care of their children, or they are older compared to newly graduates. It is important to note that those dimensions of one's identity are not separated, but mutually constructed which shapes one's experience. The intersectional identity of those women has subjected them into a more vulnerable position in the process of job hunting. One informant reflects on her motivation for learning programming:

> Since I've been out of work, having my children, it is smart to choose an industry that needs a lot of people. Also to study here in English, there isn't so many choices, and programming is one of the few. (Alice, Australia)

Similarly, Maria from the US is also a housewife who has been absent in the job market for years. When they finally decided to return to the labour market, they found it difficult to start because of the lack of experience, understanding of Swedish culture and language, and social network. After finished the programming course at HYF, Maria started an internship and finally landed on a job. She notes: "In here, I'm an immigrant, I can program, and I am a woman, all companies will be like 'we need this'" (Maria, USA). In general, programming becomes a shortcut to enter the labour market for immigrant women who are having a hard time finding a job, and helps them to bypass the obstacles of the language barrier, lack of resources and their marginalised position. For them, the high salary, flexible working time also make it an attractive position.

5.2 A steppingstone for future education and career

In Sweden, where digitalisation is currently transforming society and closely entwined with economic growth (OECD, 2018), information technology is widely used in the creation of digital products and services. Thus, digital skills are becoming extremely important, and programmers are needed in every sector.

For informants who have no previous programming experience, having the knowledge of programming will add up their competence and create possibilities to enter the field of their interest. Unlike many other informants who have changed their entire professional path by learning to programme, two informants have clear career goals other than just being an entry-level developer.

Being influenced by her husband, Alice started developing an interest in programming: "I want to see whether programming is something I can do. My husband is a programmer, so I started thinking maybe that's something I could get into" (Alice, USA). During the programming course at HYF, her career goal of being a User Experience (UX) designer became clear: "I really like user research, and the whole experience of things. And I think my personality is more suitable for this kind of job, you know like, talking to people, rather than thinking about the pixel-perfect design. I want to become a designer myself, it would be helpful for me to know something about programming, to communicate with programmers, and to know how to design for the Internet" (Alice, USA). After the course, she started her education in Interaction Design at a Swedish university. She explains how programming can be helpful in pursuing her goal:

> We do a lot of programming for design, like making icons, CRM[15]. You have to know how the website and design work in order to get feedback from users. […] When companies hire people, they are gonna take the programmer knowing something about design over the designer who knows only a little about programming. So I've noticed that there are a lot of programmers who move into the UX sector, and the competition will raise up soon. (Alice, USA)

Although she is not aiming to become a developer, learning programming enhances her competence in the labour market. Combining programming with her interest in design, she successfully gets enrolled in the university program and finds an internship as a UX designer. Similar to Alice, Tasha also tells her story of how programming becomes a steppingstone of her career. Tasha got interested in programming because of the influence from her boyfriend: "He helped me to gain some interest, otherwise I would not pay attention to that" (Tasha, Russia). She chose to study programming at HYF after gaining a master's degree in Economics from a university in Sweden. She explains her goal of learning programming:

> I can see that be(ing) a developer is not my goal, because I don't think I will enjoy it. But if I can use programming skills in some other work, like a statistician, it would be great. They also work with programming languages. […] So in HYF I will give a chance to try, to gain the skills and see. (Tasha, Russia)

[15] Customer relationship management (CRM) is referred to a tool that is used by companies to connect customers and improve business relationships. see https://www.salesforce.com/eu/learning-centre/crm/what-is-crm/

Tasha wants to gain programming skills while utilising her degree in her future career, other than giving up what she has obtained from previous education:

> Why I don't have a goal to be a developer is because I don't want to become someone who can't use my education. I would waste 7 years of my life […] Plus from what I know, when you work as a programmer, there are probably a lot of companies search for that. But if you want to grow, you probably need a degree. (Tasha, Russia)

Having both interests and understanding of coding, she starts an internship after the course as a data analyst dealing with statistics. The job does not require her to write code, but "understands the market" and "how code is written" helped her in the work and possibly the future collaboration with other programmers.

When looking at informants who have a degree in computer science or other programming-related field, taking the vocational programming course can also be a steppingstone to advance and excel in their future career. It's a puzzling situation that even with related experience and education background, getting a programmer job is not easy for some without taking the course as a beginner. Besides the language barrier, the lack of resources and other disadvantages mentioned in the last section, the changing nature of programming is also one of the reasons. As a constantly changing field, computer programming has developed radically in the past decades and is still developing on a daily basis. Programmers holding a degree from five or even ten years ago will need to upgrade their knowledge and skills constantly to be able to solve new problems. For informants with programming education before, participating in vocational training can validate and renew their skills, thus add up their competence for their future career. As Rawan says: "I'm 38 years old, it's not easy to start in university again. I feel like all my knowledge of computer is not accountable, I forgot a lot. So I'm actually starting from zero, with kids. So it's never late" (Rawan, Syria).

While acknowledging that taking vocational programming training programme can be a steppingstone for immigrant women's future education and career, it is important to note that those courses can also be problematic. All informants learn programming in Sweden through untraditional pathways, namely, education other than university-level programmes. The priority of such fast-track vocational programming training like HYF is to help people who are marginalised and disadvantaged in the labour market to get into work quickly regardless of their background. To

promote more women to enter this field, their selling-point is usually focusing on how programmers are highly paid, and women will be able to take care of the family because of its flexibility. However, interest is sometimes overlooked, and it potentially creates inequality within IT sector, which will be discussed further in the later chapter.

5.3 Gendered classroom and workplace

As discussed in the previous chapter, being the underrepresented minority in the classroom and workplace is a common phenomenon among informants who have previously studied programming. For others, programming is also seen as male-dominated area in their home countries. How is the situation of programming classroom and workplace in Sweden, and how can it affect immigrant women's experience?

Except 2 informants take online programming courses, 8 informants have participated in offline vocational programming training. Among them, 7 informants study at HYF, and one studies at Kommvx. When asked about the gender ratio in their programming class, most informants say that their classroom is gender-balanced, and the number of male and female students are almost even. In some classes, there are even more female students than male. When asked how they feel about the gender parity in class, most informants express positively, e.g., "it feels comfortable in class because it's balanced" (Zoe, Taiwan).

According to Kanny et al. (2014), the classroom experience is one of the structural barriers that limit women's interest and participation in the STEM field. In terms of female peer, most informants don't view "having female peers" as a significant factor that influences their personal experience because of the support they can get from male fellows.

> I try to think without gender, but it's impossible. I talked to both guys and girls in class. Guys usually have no problem talking to me and help me. […] It's not like I need a girl in my group otherwise I cannot handle it. At the same time, I never heard people say "she's a girl so she's not good at it". (Tasha, Russia)

However, they see it as a structure factor which would benefit women in learning. Tasha says: "it's important because 25 people is a big group, and if you see more diversity, people of different

gender and background, and we can learn from and help each other." Aida also expresses her concern for a hegemonic environment:

> If you are the only girl in class, you feel like you are representing something. If you make a mistake you will be like "I'm shaming my entire gender". So I would prefer there's a bunch of us. It's weird, but the collective actually makes you feel more individual. It becomes more like "you are not good at this", other than "girls are not good at this". So yes, it makes me feel more motivated, and freer to ask questions, stupid questions even. Your intention will be more straightforward if there are more women. If it's just you, something you say might be taken as a statement, you know, there will be room for speculation if there's just one of you. (Aida, Ethiopia)

At the same time, having female role models can have a more profound impact on women's experience in the classroom. Aida talks about female role models in the class:

> The best of our class, maybe top 4 are girls. […] Actually, these 4 girls are better than any of the guys there, and they put a lot of work there. I think one of them said she said she studied 8 hours a day. (Aida, Ethiopia)

Similarly, Alice reflects the course where female mentors and women in managing position can be aspiring to her female fellows:

> The project manager is woman, and she's trying to bring more women into the class. Every couple of months, she holds a "women in programming" course where women come to our school for a day and have an introduction for coding. They don't need to do that, but they want to encourage as many women as possible. […] We had similarly great mentors who are women, and they often tell us stories about being the only woman in class and in team, where there are enormous men. (Alice, Australia)

Having women who excel in programming, as well as role models in the frontier of the field, more women will be inspired and encouraged to develop interest and persist in programming.

On the other hand, for two informants who have work experience in the Swedish IT sector, they report that the gender disparity is more prevalent in workplace: "I'm doing an internship right now, and there are all European guys in my office" (Maria, USA); "I was at an event for statisticians, and they are mostly men, maybe only 20% women in such a big group" (Tasha, Russia). This

gender imbalance in the workplace seems to have limited effects on them. Maria says her colleagues are “really nice”, “open to new ideas and other point of views”, and they appreciate when she “comes from a different angle”. When asked about if they have experienced any discrimination in terms of their gender, ethnicity, etc., most informants report that never faced any discrimination, and they don’t tend to think about their experience in a gendered or racialised way. Some compare their experience in Sweden with their home country: “I only have (programming) experience in the Malmö area, and I can't imagine what it will be if I work in Silicon Valley California as a programmer. In Sweden I feel like I can be hired anywhere, but in the US, the situation is totally different. There are racism and sexism and so many aspects that would be against me. I'm a Mexican woman who is older, it would be really difficult for me to compete with other younger programmers” (Maria, USA). As one of the forerunners in terms of gender equality, Sweden has developed and implemented the anti-discrimination law that prohibits all forms of discrimination in working life (Government Offices of Sweden, 2015). As a result, it helps to reduce the discrimination in the classroom and workplace, however, it also means that discrimination usually happens in a more subtle and hidden way.

Discrimination does exist in settings of programming classroom and workplace in Sweden, and immigrants’ awareness of discrimination, as the percentage of those who feel discriminated against, is lower (OECD, 2016). Alice talks about her experience in the classroom, saying that she often receive remarks from other students that they are surprised she is still in the course, because of her identity as a mother of two children:

> They maybe didn't mean to, but they often said “I thought you would have been quit by now”, so I find that surprising. […] Sometimes people say that “I don't know how you have kids and do this as well”, like it's hard to juggle. So maybe there is this kind of bias there. But they don't mean it in a negative way, It's just there. (Alice, Australia)

Also, she felt that “people don't take me as seriously as some of the other men”. Those feelings are subtle, as Alice says “that may not because I'm a woman though. It could be I said something stupid.” Nadia also reflects on her experience in a job interview:

> I don't want to mention it because maybe somebody didn't understand it. But a company didn't want to take me because I'm a girl. They just wanted to take a guy. Especially I have two kids.

> Also I got an interview, then the company directly asked me, "do you have education in programming", I said yes, they said, "oh, really". Sounds like it's something hard to believe. (Nadia, Iraq)

Laura talks about her experience of facing discrimination in terms of her pregnancy in a job interview:

> When I was looking for an internship, I was getting help from an organisation for women and they found one for me, so I went to an interview with them. It was actually for doing a webpage for them, and they really liked me. […] It really felt they wanted me to work there because of the way the spoke to me and how they were already making plans with me. I had asked this organisation that if they thought it's okay for me to mention that I was pregnant, they said it shouldn't be a problem. But it was. At almost the end of the interview, I mentioned it. I told them that I'm pregnant, and I had to go to parental leave in seven or eight months. And the whole environment changed after that. I could really feel that their faces changed. I went back home and the next day the organisation told me that they said no, I didn't have the requirement that they wanted. So I felt that I was discriminated at that moment. (Laura, Mexico)

From their storytelling, it is clear that the programming classroom and workplace for them are gendered space where informants can face various discrimination. However, their perception and awareness of those discriminations are usually not clear, and they tend to rationalise their experience by attributing them to personal reasons: "it could be I said something stupid" (Alice, Australia), "maybe somebody didn't understand it" (Nadia, Iraq).

5.4 Balancing family and programming

8 out of 10 informants have partners in Sweden, and 5 of them have kids. Balancing family with studying or working life in programming is a challenge for most of them. Although in Sweden, the gender roles inside the family are more towards equality, most informants report that they do the majority of the work in the family, such as housework and raising children. As Alice reflects:

> I really do majority of the work. He takes care of the children when I go to school on Sunday for four hours, that's it, really. For the rest of the week, it's my job to take them to kindergarten, and pick them up, and do everything they need. (Alice, Australia)

Having responsibilities at home while learning programming is a tough challenge, especially for informants with kids. Maria is trying her best to balance family and study which becomes “two full-time jobs”:

> When my kids go to preschool, I would study for HYF from 8 am to 4 pm. Monday to Friday. HYF is hard, because it's on Sunday, then I only have Saturday with them. My husband usually works one day in the weekend too, so he usually works on Saturday while I am with the kids. And on Sunday I went to HYF, so we never saw each other for that whole time. (Maria, USA)

It should be acknowledged that Sweden’s welfare policy has enabled and supported the possibility of women’s equal participation in the labour market. Laura reflects on her experience: “I know from Mexico for example, if I had a problem with my kid, it would be a big issue for me to go on with my job. And here, I've noticed that it's not like that. They want you to be happy with your family and take care of your family, and they support that. So if you need to leave, you can usually leave. That's something I like from Sweden”.

Except devoting time in the domestic work, the emotional work that has designated in those women’s lives is also an important aspect. Maria says: “even though we divide the housework equally, the mental load is all on me. I would worry about the kids, and worry about what needs to be done at home. I think that's the biggest difference, because mentally we are doing much more.” Rawan has also been struggling in coordinating family and her career. She works as a developer in a tech company, and the technical aspect of her work contradicts with her family life where she needs to engage and devote emotionally. She says:

> It is very hard. I feel like this is the hardest thing, because although my kids are little bit older, they are not so young and needy, but anyway, moving to a new country is also a challenge for them. I feel like sometimes they need more time, they need help emotionally, because they left their country and all their friends, I feel like they need me. But at the same time, I have to work for my career, so it's a little bit hard combination. I couldn't sleep that much because I have to balance my life and my career. (Rawan, Syria)

To persist and excel in programming, informants are devoting incredible efforts and developing their own strategies to positively facing the challenge of coordinating programming with their family life. Some spend longer time to study programming: “[I do programming] basically every

hour of the day without my kids. As soon as they went to förskolan (kindergarten), I worked on it. And when they went to bed, I worked on it again. I would often work from 7 pm until midnight every night." Some organise their schedule tightly in order to balance the different aspects of their lives: "[I would] think about balance my whole life, my whole day. When I wake up I have this many hours to do this, and do that, from morning to night. […] I have to be organised to make it work" (Maria, USA). And some have strong wills and aims in conquering the barriers: "The hardest is, it's myself. I want to do the very best I could possibly do on every aspect of my life. […] I just tell myself, 'you should be better at this'" (Diya, India).

5.5 Challenges of settlement and opportunities

Living in Sweden as immigrants, informants have experienced the language barrier, the lack of resources as mentioned in the previous chapter. At the same time, they come to Sweden with different purposes. Based on the type of residency when they first came to Sweden, among 10 informants, 3 of them came as students, 2 as refugees, and 5 for their partners. Their various identities have posted diverse challenges in terms of settlement and opportunities.

Living with her boyfriend in a small city, Zoe has faced challenges in terms of the lack of opportunity and difficulty of relocation:

> Generally, there are so much more opportunities in big cities, and the place I live in such a small city. I sent out my CV in the region I live, and nobody replied me. But then I applied some IT support job in Stockholm, I immediately got a reply. They asked me about my background, and if I could manage the accommodation if I got the job in Stockholm. But in Stockholm you need to wait for at least 5 years to get accommodation. It's so difficult to get a rental apartment. Also the hosing price is crazy. We don't have enough money to buy a house there. It's the biggest problem. So it's not that easy to relocate. […] Finding job is easier than finding accommodation. (Zoe, Taiwan. My translation)

According to OECD (2016), the housing shortage in Sweden is a structural problem across municipalities, especially in larger cities such as Stockholm, Gothenburg and Malmö, where the population is most dense, and immigrants often choose to locate. The demand for accommodation is much higher than the supply, especially in the rental market, and the waiting time for getting a

first-hand contract is long. It should be noted that the housing problem is not merely faced by immigrants, but also by Swedish citizens. However, it's a structural problem which has greater impact on those with limited socioeconomic resources. For Zoe, not being able to afford the time and money to relocate has impeded her plan or relocating and further the successful participation in the labour market.

Coming to Sweden as refugees, Rawan and Nadia also faced numerous challenges. Unlike other informants who came to Sweden with their partners or as students, refugees are more marginalised in society, and they are in need of more support from the state. Rawan says: "My life didn't start until 1 and half year [since I arrived in Sweden] because we were waiting for the residence. You are not even existing in Sweden". Even for refugees as Rawan and Nadia who are highly-educated in the field of computer science and computer engineering, they have to overcome difficulties that other people cannot imagine. At the same time, both of them have used to time waiting for the residence permit to learn Swedish, which becomes a huge plus in their searching for job.

In addition, Youyou talks about her experience in terms of the challenge as a foreign student:

> I think foreign students here are actually more disadvantaged sometimes. I studied in Sweden for 2 years, I gained my master's degree here, but still, I can't find a job. I didn't get too much time to study Swedish, and I only have a permit for 6 months after my graduation which is a short time for looking for a job. But for refugees or people coming here for their boyfriend or husband, they have no worry in terms of residency, and of course, there are more opportunities for them to have free education. But as a foreign student, you really have no advantage if you want to stay in Sweden. The government will just kick you out if can't find a job. (Youyou, China. My translation)

Discussing which group of immigrants are more marginalised and disadvantaged is beyond the scope of this study. But it can be seen from the interview that informants are facing different challenges based on their unique intersectional identity, and the individual, social and structural barriers have posted challenges in their path of learning and working with programming. Meanwhile, those challenges have not designated them into passive victims. By actively engaging their agency, immigrant women have come a long way to pursue a successful career in this male-dominated field.

6. Programming as empowerment

6.1 Transforming the masculine narrative

The empowering potential of technology has been discussed by feminist within the STS studies. While radical feminists fear the potential of technology in controlling women's body and nature (Spallone and Steinberg, 1987), and socialist feminists analyse the masculine typecast in the production of machinery (Cockburn, 1985), postmodern cyberfeminists offers valuable account on the complex and contradictory relation of gender and technology and this ambiguity of boundaries (Donna Haraway, 1994; Lagesen, 2008), and it's potential of transforming the power relation and liberate women (Wajcman, 2007).

Regardless of the challenges they are facing, informants have embraced programming in their path of pursuing a meaningful life through reconstructing the masculine narrative of programming. Informants have described their opinion of how programming can be a suitable role for women:

> A friend of mine has two kids, she's a single mother, she needs to get money in any way. She thought it would be a big challenge for her to do coding. But I told her to be a programmer means to solve problems. And always, women are good persons to solve problems. Because we have single mother with kids. The best persons to be programmers are girls. (Nadia, Iraq)

Women's ability to solving problems at home is used by informants to draw an analogy on solving problems in programming. Maria also expresses similar opinion: "We solve so many problems at home, we can think so many aspects, think which one is the best solution, check other people's idea and opinions. Women can definitely provide better overall experience within programming". and Alice says: "Women tend to be better at multi-tasking and have attention to details which are the key factors of working in programming". Similarly, the communicative aspect of programming is also addressed:

> (Communication) is very important. Sweden is an individual society, but when it comes to work, it's very important to cooperate with your team. It will make your work easier, and you will do it easier. Our team is working in front-end, so sometimes we write a piece of code only, and we should really communicate before and after. We have A LOT of talking, sometimes

> we spent hours to choose a name for a function, we have meeting for hours. […] programming is suitable for women, because we are better communicators. (Rawan, Syria)

Drawing on the importance of problem-solving, attention to details and communication aspects of modern programming, informants have reconstructed their discourse around "who is suitable for programming" and linked it closely to their feminine qualities as better problem-solvers, multitaskers, and communicators.

In addition, the informants also transform the idea of "what is programming", and disregard the stereotypical ideas. The most common stereotype of programming is that it's a math-intensive subject, which could be intimidating to some women:

> Before getting into HYF, I thought programming is all about math, and I don't want any math. But then I realised that it's not about math at all, it's just another language to learn. (Maria, USA)

Also, one informant thinks that programming will soon make it a "basic skill that everyone should know":

> I think just knowing how to code is becoming a general skill. Even now in schools, earliest in the first grade, they started teaching programming. In my kids' generation, it will soon be a basic skill that everyone should know, so you will be left behind if you don't know how to program. (Alice, Australia)

To acquire and use technology is a crucial aspect of empowerment, especially for those who are marginalised in terms of their intersectional identity. Programming is historically constructed as a male domain which is excluding in nature. But today, programming has changed drastically. Unlike other machinery, programming in the digital age is surprisingly accessible with numerous possibilities. Learning programming doesn't require you to have too many resources, but only a computer, even a smartphone with an internet connection. While the ownership and usage of digital technologies are changing, women are more suited to life in the digital age (Wajcman, 2007).

When asked what is most needed in programming, informants give their answers such as "passion", "patience", "practice", "time". Those words are detached from specific masculine criteria such as "math", "logic", "technical", and so on. Youyou talks about her option:

> I think when I start to learn programming myself, it really breaks the stereotype I had before. What you need in programming really is practice, just like you practice cooking or singing, to do anything. And yet cooking is viewed as women's job. That's not logical. (Youyou, China. My translation)

By referring programming to "just another language to learn", or "a basic skill that everyone should know", or skills such as "cooking or singing", informants reconstruct the notion of programming which was predominated by the culture of masculinity.

6.2 Creating new Inequality?

Entering the IT industry with a six-month vocational training, or even a one-month online Bootcamp can be tempting. Scrolling through the bestselling web development courses on Udemy[16], one of the leading learning platforms on the internet, headlines such as "becoming a web developer in 20 days", "From Zero to Hero", "the only course you need to learn web development" has been prevailing.

For those women who are new to the country, participating in such fast-track education can be a shortcut to enter the IT industry and getting a fair share of this growing field. For organisations such as Pink Programming and HackYourFuture, promoting women to participate in coding seems to be a good solution for the gender gap in the IT sector. However, it is problematic in a way that new hierarchy inside programming occupations has been created. Stack Overflow (2019)'s annual Developer Survey has revealed this underlying hierarchy in the IT industry. In 2019, among 90,000 respondents from 179 countries, 91.7% are identified as male, and women have higher representation in roles such as front-end developer, designer, educator, etc.. Taking web development for example, the roles are usually divided by the "front" and "back"—front-end developer focuses on what we see on a web page, e.g. the visual design and user interface, and back-end developer works with what we can't see, e.g. the server and more complex programming languages. Also, there is "full-stack" developer who is able to handle both, but this role is often required intensive back-end knowledge. Women have higher representation as front-end developers, specialising in works of design, user experience, and front-end coding which are

[16] See: https://www.udemy.com/

regarded as more feminine work. On the contrary, back-end developers are usually occupied by men who have a degree in Computer Science or Computer Engineering, and the salary is comparably higher. Among 10 informants, 5 of them have set their goal to work in front-end web development, which is the easiest way to enter the industry since it doesn't require years of experience with other more complex back-end programming language. As an immigrant whose priority is to enter the job market, choosing to study in fast-track training programmes seems like a smart option. However, the problem here is that some women are attracted by the easy access to job market without considering their true interest or passion, which makes them hard to grow in the field of programming. As Tasha says:

> It's wrong to push somebody who has no interest in the field. I don't think somebody who don't want to be a developer will be a good developer. It's not a job you can work even you hate it. Someone will soon see it and change you with other people. (Tasha, Russia)

On the other hand, the changing nature of programming has also raised concerns. Aida expresses her fear of the future of web development:

> There's a growing fear in my mind of how many people are doing it. Everyone is trying to do a course and learn it. Maybe 30 years ago, managing Microsoft would be a really great thing on your resume, but now everybody can do that. So I just feel like maybe someday the skill of building a website will becoming a thing that everybody can do, or maybe there will be AI or something that makes it too easy. Right now, there are so many framework and library. It's a replicable field. So once I get a job, I need to focus on something like machine learning or data science, something deeper and more advanced before machine takes all the job. Also I feel like you should learn more skills, not just focusing on one skill. That will make you irreplaceable. (Aida, Ethiopia)

Just like what socialist feminists have warned, technology development may negatively affect women's work, and it will lead to "deskilling, with jobs fragmented into routine and standardised tasks subject to the control of the machine" (Wajcman, 2007). Nowadays, programming-related occupations have changed significantly compared to 20 years ago. The evolving of Artificial Intelligence (AI), the development of numerous libraries and frameworks for each programming language has made human's work less burdensome. Nevertheless, it also means that some programming job can potentially be replaced by the computer itself, especially those less skilled

and less competitive positions. Compare to programmers with a computer science degree, those self-taught programmers or graduates from fast-track training or Bootcamp are generally less competitive. Just like the female punch card operator at the beginning of computer history, those more “feminine” and less valued positions such as front-end developer might vanish one day with the developing of more advanced technologies.

7. Conclusion

From the storytelling of 10 female immigrant programmers in the Swedish IT sector, this research profiles their intersectional identities and diverse experience with programming, exploring their motivations, challenges and strategies to persist in their journey to forge a successful education and career in this field. It analyses the specific social and cultural context of Sweden, where equality and discrimination, opportunities and obstacles are co-existing and shaping informants' experiences. Taking feminist thoughts and concerns on the future of technology into account, the empowerment potential and possible problem are also discussed. Throughout the analysis, the research questions can be answered as follows:

How do informants perceive programming in diverse cultural backgrounds, both in their home country and in Sweden?

Growing up in different cultural and social contexts, informants' perception differs. While 9 informants regard programming as male-dominated in their home country, one informant Diya from India has shown a different case, and the masculine culture of programming is challenged. Informants' early encounter and perception regarding programming have determined their starting point before they choose to study and work with programming in Sweden. While those women's interests and perceptions at an early age and their unique experience of education and work can influence their experience in Swedish IT sector, it does not determine their choice later in life. 6 of 10 informants did not study STEM subjects at university and have no programming experience before coming to Sweden, yet they chose to enter the field of programming, which is unfamiliar, or even a little bit frightening to them. The often-used metaphor of "pipeline" in research of women's absence in STEM (e.g. Camp, 1997; Espinosa, 2009) cannot explain why women with limited training would enter this male-dominated field. Even though having the opportunity to study programming-related subject in university is a foundation for future programming career, not every programmer in the industry have a Computer Science or other IT-related degree, and many of them achieved successful career with associated degree, vocational training or even self-studying. As discussed in previous literature (e.g. Misa, 2010; Kulis et al. 2002; Hill et al., 2010), the gender gap in programming is more than a "pipeline" problem, because women's foray into programming cannot be viewed as a linear and singular process, but with many different pathways.

What are informants' motivations, challenges and strategies to persist in programming in the context of Sweden?

Firstly, informants regard programming as a shortcut to enter the Swedish labour market, and bypass the obstacles presented by the language barrier, the lack of resources of training and network, compounded with their marginalised identities, which have contributed to their excluded positions from the job market. The shortcut has been made possible by the huge demand for programmers in the Sweden IT sector, which has created opportunities for their entry. Secondly, some regard programming as a steppingstone for their future education and career, in which they are able to use programming skills together with their interest.

In terms of challenges, informants are experiencing the gendered classroom and workplace where discrimination usually happens in a subtle and hidden way. Their awareness of this discrimination is low and unclear. Also, some of them are struggling with balancing the family and programming, which has shown the traditional gender division of labour at home. In addition, they are also facing challenges in terms of settlement and resources which has impeded them from success. It is important to note that women are not designated as victims in the challenges and difficulties of learning and working with programming, and their agency and capacity should be addressed. Informants' experience has illustrated how women can create their path to success through their agency, instead of being constrained by gender roles.

In what ways can programming be a means of empowerment and what's the potential problem?

The empowering potential of programming is demonstrated in the accounts of the informants. They each relate how they embrace programming in their pursuit of a meaningful life, and attempted to transform the masculine narrative in which their feminine identities and qualities are constructed. By transforming programming into a suitable role for women, a general skill that everybody should learn, they detached the masculine criteria in the practice of programming, and challenged the masculine notion of programming.

The potential problem is a concern for the creation of new inequality within programming. Most informants entered this field with fast-track vocational training, and were typecast into the more

feminine roles among programming occupations, such as front-end developer and designer. Drawing on socialist feminism's thought of technology's negative effects on women's work, I reflect on this potential problem which is a trend left unchallenged and likely to further cement gender inequality in the IT industry.

Overall, the relationship between gender and technology is always deeply embedded in cultural contexts shaping the use, design and production of technologies and their co-production of gender and technology (Lagesen, 2008; Mellström, 2009). Even though the masculine culture in programming is understood as a global phenomenon, a more cross-cultural analysis is needed. By exploring immigrant women's struggles and resistance in this field, this thesis attempts to contest the notion predominated in western STS research by providing an intersectional understanding of the relationship between gender and technology. However, a more theoretical critique is beyond the scope of this study which is left for future scholars to debate.

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9. Appendix

Appendix 1. interview guide

1. Personal background

1.1 Demographic information: age, nationality, education background, occupation.

1.2 Do you have any former experience of studying and working with computer programming before coming to Sweden? If so, in what sector, and what kind of assignment?

2. Perception of programming

2.1 What's your perception of programming and the IT sector in your home country?

2.2 What's your perception of programming and the IT sector in Sweden?

2.3 Do you consider programming and the tech sector as a masculine occupation? In what sense?

3. Motivation of programming

3.1 Why do you choose to study programming in your home country (if applicable)?

3.2 why do you choose to study programming in Sweden?

4. Experience of programming in Sweden

4.1 What's your experience with programming in Sweden?

- (If study) In what ways are you learning or have learned? For how long?
- (If work) In what sector, and what kind of assignment? For how long?

4.2 How do you experience the classroom situation and workplace? Is there any gender disparity and how do you feel about it? Examples.

4.3 What significance are there for you to have female peers in the classroom? Workplace? Describe in what sense.

4.4 Have you faced any sexism, discrimination, racism in the classroom or workplace? Examples? How do you deal with it?

4.5 What challenges are you facing as a woman? As an immigrant? Are there other challenges you are facing related to tour background? What strategies are you using when facing these challenges?

5. Programming as empowerment

5.1 Do you consider programming as an empowerment for you? Describe in what ways.

5.2 Do you consider programming as an empowerment for immigrant women? Describe in what ways.