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Studying Female Engineers' Experiences in the Egyptian Labor Market

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ABSTRACT

With an aim to investigate and analyze the active participation of female engineers in the Egyptian labor market, this qualitative research study argues that gender-biased cultures embedded within formal educational and employment engineering institutions marginalize and undermine the representation of highly educated female engineers. Based on women's shared experiences, it becomes apparent that their personal interests are not sufficient to ensure an engineering career. Other determinants–primarily in the form of impending challenges–during the pre-university, university and employment stages of life impact women's lived experiences. On the one hand, challenges faced before graduation include: a) gender-based stigmas and stereotypes surrounding specific engineering majors, b) family disapproval, c) score-based qualification systems, and d) lack of practical educational experiences. On the other hand, the primary challenges of the formal labor market include: a) discriminatory hiring processes and lack of sufficient employment opportunities for female engineers in male-dominated disciplines, b) limiting female employment to office roles, d) denial of legal rights and benefits and e) conditioning female employees to social expectations of women's roles in the private sphere. Nonetheless, female participants unanimously highlighted the absence of written discriminatory laws and their continuous effort to achieve work-life balance amidst the challenges faced in employment.

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Chapter I: Introduction

In a fast-paced, evolving world where reliance on knowledge and innovation is increasing, gender parity in Science, Technology, Engineering, and Mathematics (STEM) fields is nonexistent. In fact, the disparity is more evident in professions, like engineering, which are commonly gendered as 'masculine.' The reasons have varied depending on the specific geographic location, time or analytical framework of study. Yet, the problem still persists–women are underrepresented in engineering education and employment, globally. A wide plethora of research exists on women in STEM education, but research on female engineers' lived experiences in education and employment settings is scarce, especially in the Middle East and North Africa (MENA) region. The majority of existing literature is led by Western researchers targeting Western contexts. Accordingly, this research study aims to address the gap in analysis of female engineers' lived experiences by looking specifically at the Egyptian national context.

Using qualitative research methods, 19 female engineers from 10 different engineering disciplines within the formal Egyptian labor market were interviewed to analyze their lived experiences and challenges. The findings underscore that participants' experiences were influenced by a myriad of factors, many of which are external and beyond their control. In engineering undergraduate education, such external factors include: a) gender-based stigmas and stereotypes surrounding specific majors, b) family interference in career choices, c) score-based qualification systems, and d) low-quality or nonexistent practical training. Moving on to labor market experiences, the challenges faced by female engineers were primarily in the form of: a) discriminatory hiring processes and lack of sufficient employment in male-dominated disciplines, b) positioning female engineers in offices and rejecting them on sites, c) denial of legal rights and benefits and e) conditioning female employees to social expectations of women's roles in the private sphere.

1.1 *Background*

Female engineers continue to face persistent–at times similar–economic and social policy problems on the national and global scales that significantly and negatively impact

their personal lives and professional careers. On the national scale, there is minimal data on women in engineering education and employment. In the contextual analysis chapter, data provided by the Central Agency for Public Mobilization and Statistics (CAPMASb, 2021) highlights that higher percentages of graduates from natural sciences (i.e. biology, chemistry, and physics), mathematics, statistics, and health and wellbeing majors were female. However, looking at the total number of graduates from other practical STEM colleges such as engineering and engineering technology, male graduates far outnumbered their female counterparts. The dominance of male graduates from engineering colleges is certainly not related to student's academic performance, ability or subject interest since females represent the larger share of students and graduates from other demanding colleges such as medicine, pharmacy, and mathematics.

More importantly, data from the 2019 Trends in Mathematics and Science Study (TIMSS) illustrated that girls in eighth grade scored higher than boys in all mathematics content, including numbers, algebra, geometry and data and probability. They similarly scored higher in science, including biology, chemistry, physics and earth science. Girls did not only score higher than boys in the theoretical content of these subjects, but also in cognitive domains such as knowing, applying and reasoning in both mathematics and sciences (Mullis et. al, 2020). Egypt is not a participating country in the OECD Programme of International Student Assessment (PISA); however, the TIMSS data on girls' performance in school and CAPMAS data indicating higher female graduates from science and mathematics colleges is sufficient to prove girls' interests in STEM subjects and professions and their academic ability to do well in those fields.

However, students' interests are not the only determinants of their eventual career progression. Certain features of the Egyptian public school and university education systems play a determining role in students' career options. For example, all public school (*thanaweya amma)* students must choose from one of two tracks in secondary school: either the science and mathematics track or the humanities track. To enroll in the science and mathematics track, students must achieve higher grades than those choosing the humanities track. Within the former generic science track, students must also choose whether they want a sub-track focusing on the natural sciences or mathematics-related science majors such as engineering. Therefore, a student's decision to enroll in an engineering college comes at an

early stage, even before they commence their undergraduate tertiary education. However, their enrolment in their specific major for college depends on their final grades in *thanaweya amma* and their allocation based on the *tanseeq* (university and college allocation) system which allocates students based on a score range for each major, college capacity and geographic location. Lastly, all enrolled engineering students are once more subjected to a score-based assessment in public universities after completing the mandatory preparatory year in engineering college in order to qualify for their desired major. Consequently, these score-based allocation and track systems place additional burdens and rigid educational frameworks that could discourage students from studying engineering.

Globally, the share of women from all STEM graduates increased from 30% in 2003 to 34% in 2013 when Engineering, Manufacturing and Construction (EMC) and sciences are considered (Schmuck, 2017). However, when only engineering colleges are considered, female graduates have only increased by 2% during this decade (UNESCO Institute for Statistics, 2015); representing an even smaller percentage of potential female engineering professionals. With regards to geographic location, female engineering graduates are disproportionately distributed around the world, with some regions encompassing higher levels than others. With 25% of the world's graduated women from EMC, the MENA region ranks third after Central and Eastern Europe with 29% and East Asia and Pacific with 27% of female EMC graduates (UNESCO Institute for Statistics, 2015). The high percentage of female engineering graduates is not sufficient to ensure their active participation in the labor market. Therefore, a closer look at labor market dynamics is important to rightly analyze the education-to-work transition in many MENA countries. Labor force participation and market dynamics are further analyzed in the following chapter.

1.2 Statement of Purpose

The focus on female engineers' experiences is an example of the broader, more generic challenges faced by the educated female labor force in Egypt. Since females represent almost half the total working age population (Hendy, 2015; CAPMASa, 2020), research on their experiences and challenges within the labor market is essential to achieve the country's national goals and objectives as outlined in its *Sustainable Development Strategy (SDS): Egypt Vision 2030*. Generally, labor market research produced during the past two decades

has largely focused on the quantitative indicators of economic activity and labor force participation (Krafft & Assaad, 2014; Hendy, 2015; Assaad et. al, 2018; Krafft et. al, 2019; Assaad, 2020). However, it is also important to understand why a specific group, such as female engineering university graduates, are largely marginalized and underrepresented in the Egyptian labor market. The ensuing unemployment or underemployment of a significant percentage of the working age population will hinder any progress towards an inclusive, knowledge-based national economic transformation (CAPMASa, 2020; Assaad, 2020). If the Egyptian government is keen on promoting growth and productivity during the upcoming decade, it will need to incorporate its educated, skilled female labor force in its formal labor market.

1.3 *Research Questions*

For that reason, this study aims to investigate why the field of engineering is largely dominated by male students and employees alike, resulting in the marginalization and underrepresentation of female engineers. The following research questions are addressed to better analyze female engineers' lived experiences in Egypt, as the primary source of data on real-life challenges and factors influencing their career. Lastly, the necessary and possible policy solutions to change this status quo are addressed to promote women's active labor market participation, especially in productive and knowledge-based sectors.

a) What are the challenges and enabling factors resulting in female engineers' gender-based marginalization: before and after joining the Egyptian formal economy?

b) How are professional female engineers navigating the labor market and achieving work-life balance?

c) What are the recommended female-friendly policies needed to promote women's equitable active employment in male-dominated engineering professions?

1.4 *Policy Relevance*

Committed to the United Nations Sustainable Development Goals, which dedicates Goal 5 to *"Achieve gender equality and empower all women and girls*," Egypt has signed and ratified several international agreements and conventions against gender discrimination and

inequality. OECD (2014) underscores that despite the country's ratification of global conventions such as the UN Declaration for Human Rights and the Convention on Ending All Forms of Discrimination Against Women (CEDAW), in addition to explicitly prohibiting gender-discrimination in its 2014 constitution and amended 2003 Labor Law, Egyptian women continue to face discrimination in their search for employment opportunities, within their working environment, and in retaining their positions (OECD, 2017). Gender discrimination in employment takes several forms, including: unequal pay for equal roles, positions and responsibilities, unsatisfactory maternity leaves (less than the ILO's recommended 14 weeks), no child benefits, women's ban from working night shifts or in 'heavy-duty' jobs in specific sectors, inadequate or absent social protection, disqualification from vacancies requiring travel, among many others (OECD, 2017; World Bank, 2018).

In order to achieve the goals of national and international strategies aiming to more justly, equitably and efficiently integrate women in the public sphere (politically, economically, and socially), structural and economic reform must be rightly implemented and sustained. The National Council for Women's National Strategy for the Empowerment of Egyptian Women 2030 includes an economic pillar which explicitly targets:

> "*expanding the provision of support services to working women and ensuring a safer working environment; eliminating discrimination against women in securing job opportunities; promoting a culture of entrepreneurship among females; providing training and capacity building programs for females including the marginalized; and providing access to financial services*" (National Council for Women, 2018).

However, without addressing the impediments to female employment, little progress will be made on this front. As outlined by Sustainable Development Goal 5:

> "*insufficient progress on structural issues at the root of gender inequality, such as legal discrimination, unfair social norms and attitudes, decision-making on sexual and reproductive issues and low levels of political participation, are undermining the ability to achieve Sustainable Development Goal 5*" (SDG Education).

Therefore, it is important to underscore women's lived experiences in male-dominated and female-unfriendly professions to better understand the negative impacts of increasing female inactivity and unemployment on economic growth and transformation in Egypt. The need to expand economic growth and productivity will require a shift from the reliance on sectors requiring low-skilled and low value-added services to knowledge-based growth and innovation requiring high-skilled employment and means of production. According to OECD

and World Bank reports, a knowledge-based economy is an "economic development model which emerged in the late 1990s…to provide an environment where competition is vital (Barkhordari et. al, 2018). It is characterized by four main pillars that are necessary for the effective transformation of any economy, which are:

> *"(1) An economic and institutional framework that provides incentives for the efficient creation, dissemination and use of knowledge to promote growth and increase welfare; (2) An educated and skilled population that can create knowledge and use it; (3) Innovation systems that can tap into the growing stock of global knowledge, adapt it to local needs, and transform it into products valued by markets are necessary; (4) Dynamic information infrastructure is required that can facilitate effective communication and processing of information"* (Barkhordari, Fattahi, & Azimi, 2018).

The transformation to a knowledge-based economy is essential for MENA countries that have largely depended on the exploitation and exportation of natural resources since the late twentieth century. While the reliance on revenues from natural resources opened up economies to global trade and resulted in local development and growth, they are not reliable or sustainable factors of growth. In the case of Egypt, economic growth has been reliant on three main pillars: 1) the Suez Canal, 2) tourism and 3) workers' remittances. Yet, with any global crisis, such as the financial crisis of 2007 or the COVID-19 pandemic, these sources of economic revenue are prone to being severely hit. For that reason, a knowledge-based economy relies on an educated and skilled labor force, innovation, resilient institutional frameworks and dynamic infrastructure in order to increase productivity, incentivize business activity and reduce the effect of economic shocks.

As mentioned earlier, this research focuses on the human capital component and the reforms, policies and frameworks necessary for its development. Having a large population does not mean that rapid growth and productivity are the default gains. In fact, one of Egypt's primary challenges is the creation of more jobs in the short, medium and long terms for its large labor force. While the past three decades witnessed a movement of labor from agriculture to lower value-added service sectors, this primarily resulted in the enlargement of the informal sector that is characterized by "low-paid, low-quality and low-productivity jobs" (Barkhordari, Fattahi, & Azimi, 2018). Changing this status quo will require a transformation of employment generation policies and creation of jobs within the formal economy. Given the halt on public sector employment due to existing labor pressure and financial resource

constraints, this economic transformation must rely on the private sector under government regulation.

Chapter II: Literature Review

Based on the multitude of research on the topic, the sections below provide an overview of the primary perspectives and theses addressing female engineers' education and employment experiences globally.

2.1 *Shifting perspectives: analyzing female engineer's lived experiences*

The majority of literature on STEM fields establishes the fact that engineering is a male-dominated profession with gender-stereotyped working cultures; accordingly, it becomes important to understand female engineers' lived experiences within their profession. By analyzing qualitative studies specifically focusing on female engineers' lived experiences, it becomes apparent that the challenges faced by female engineers are not unique to Egypt; in fact, there are similarities in female engineers' employment experiences around the world. In 1999, Dryburgh conducted in-depth interviews, focus groups and participant observations to study the professionalization of women enrolled in engineering (Dryburgh, 1999). The primary notion of investigation was how female engineers adapted to the professional culture and/or internalized the professional identity of an engineer. To do this, Dryburgh found that female engineers largely operate in marginalizing working cultures that lead them to utilize coping strategies and impression management (Dryburgh, 1999). As explained by Goffman, (1959), impression management is a tactic used by engineering students and professionals to display or establish a specific self-impression and provoke a desired response or interaction from others. The primary motivation for adopting this strategy is to manage others' impression of them as professional engineers and gain their trust, acceptance and confidence (Goffman,1959; Dryburgh, 1999; Powell, Bagilhole and Dainty, 2009).

Building on the historical studies and theoretical underpinnings of their predecessors, several, more recent, studies continued using qualitative research methods to analyze female engineers' education and employment experiences. Trying to understand how women in engineering professions in the USA "construct their professional identity in response to workplace interpersonal interactions that marginalize it," Hatmaker (2013) conducts

semi-structured interviews with employed female engineers that focus on the relation between their personal and professional identities, sense of self, and belonging in an engineering discipline. While such strategies could result in positive outcomes and a higher sense of belonging, confidence, and acceptance in the workplace, they could also burden female engineers and force their subordinate or ambivalent roles in professional work settings (Dryburgh, 1999). The importance of investigating women's lived experiences enriches research on women's roles and challenges faced in gendered STEM careers. It contributes to the existing literature by expanding knowledge and awareness of "women's identity construction in engineering and forces for change in the engineering culture" (Hatmaker, 2013). It is not sufficient to acknowledge the gender gap in certain STEM careers in order to confirm that the engineering field of work, for example, is known for the marginalization of women; instead, it is as important to highlight women's agency, actions and navigation of these systems to either sustain or change working cultures.

Nonetheless, collecting data and accurately understanding women's lived experiences is not always easy, especially when women themselves become complacent or assimilate with the status quo. Assimilation has been addressed in several studies as one of the coping strategies that female engineers use or eventually succumb to in order to 'fit in.' Dryburgh (1999) argues that "assimilation is actually a process of professionalization by engineering students (women and men), which requires their adaptation to the professional culture and their internalization of the professional identity, and solidarity with others in the profession" (Dryburgh, 1999). This phenomenon has been addressed and mainly problematized by feminist studies analyzing how female engineers' attempt to 'fit-in' or 'undo' their gender to enter or retain their professional status and position in a male-dominated workplace essentially does more harm than good (Powell, Bagilhole and Dainty, 2009; Bastalich et. al, 2007). This perspective relies on theories of gender and identity construction to explain the underlying gendered interpersonal interactions in male-dominated working environments where female engineers or workers are underrepresented and marginalized.

In another study also aiming to investigate women's experiences in the engineering field based on gender, race and ethnicity, the authors found that female engineering students and professionals largely believe that entering and succeeding in the field is based on merit and hard work (Doerr, et. al, 2021). The majority of female respondents negated experiencing

any form of marginalization or discrimination based on their gender. When challenged and questioned for further information and experiences, some female respondents shared discriminatory or undermining situations; however, they were quick to explain or justify them based on 'individual lack of experience or knowledge.' The refusal to acknowledge and label such forms of discrimination using a gender analysis was also highlighted by Dryburgh (1999) as a tactic to assimilate and maintain their professional identity at the expense of their gendered identity. Based on their findings, the authors argue that female engineers have developed a "gender-blind frame to make sense of their experiences and interactions at work" (Doerr et. al, 2021), which allows them to navigate their work environment, and in some cases even adapt to the underlying gender and race-based hierarchical systems in place. Nonetheless, when women were faced with more than one factor of discrimination, such as gender and race together, they were quick and honest to acknowledge that reality. Thus, the experiences of women of different races and ethnicities varied, with white women being more accepted in predominantly white male workplaces.

Accordingly, a significant portion of the existing literature focuses on analyzing female engineers' lived experiences in education and employment institutions from a gender-analysis perspective. Such studies aim to problematize the social constructions of gender and advance feminist theories challenging the binary understanding of differences between male and females based on biological differences or socially constructed gender roles and stereotypes (Faulkner, 2006; Gherardi, 1994). As Bastalich et. al, (2007) underscore, it becomes important to investigate how well female engineers navigate the gendered culture and masculine conceptualization of the profession instead of how they leave the profession or negatively adapt to discrimination and rejection. The authors, thus, argue that "it is important to foreground the passion, competence and integrity that women engineers bring to engineering work" in addition to their technical, managerial and skill competency (Bastalich et. al, 2007). To be able to do that, researchers rely on women's individual experiences and work dynamics to pinpoint and better understand the underlying causes to women's underrepresentation and marginalization in certain careers.

While no prior research specifically focused on female engineers' lived experiences in the Egyptian labor market, Barsoum's (2018) qualitative analysis of the lived experiences of educated married and unmarried women addresses this paradigm shift from a national

perspective. By focusing on women's specific case studies and lived experiences, the author moves beyond generic conclusions or culturalist views to analyze women's labor participation in Egypt. Women's decisions to work or opt out of the labor market are always influenced by a multitude of factors–both personal (i.e.. marriage, children, family or community disapproval, education) or external (i.e.. lack of demand, discrimination, harsh conditions, etc.). Despite the similarities shared by many women and the overarching economic framework influencing employment dynamics in the Egyptian labor market, the author underscores the need to avoid painting all women's stories with the same brush.

Therefore, it is integral to listen to and understand individual cases, find commonalities relating to the hindrances of an existing status quo, while also acknowledging women's abilities and the intersectionality of their personal and professional lives. Moving beyond Euro-centric culturalist arguments and looking at labor market dynamics and social policies does not negate the role of culture, as Barsoum argues; nonetheless, it is important to understand the structures and theories explaining how culture is created, accepted and made authoritative in any society. Using a similar methodology to conduct this research study, the utilization of qualitative tools to analyze women's individual experiences is important to fill the gap in literature on female employment in productive and knowledge-based professions such as the field of engineering, especially in Egypt and the MENA region.

2.2 *Women in STEM education*

To become an engineer, students must prepare for this career choice earlier in their schooling years. Several studies address the impact of education systems, teachers, classroom dynamics and learning material on students' career choices, skills and self-perceptions. In certain education systems such as the British GCSE, students choose their desired subjects to prepare them for their desired career path. In their study on women in engineering in the UK, Slim & Crosse (2014) describe the route to engineering using the notion of "leaky pipelines" to reflect the fact that along the way, there are 'leaks'' causing girls to lose interest in engineering as their field of study or career path. According to the authors' research, the percentage of engineering professionals who are female is influenced by differences in educational systems and their ability to attract women into engineering. In UK schools, students move from a low-secondary GCSE system to the A-level secondary curriculum,

which leads to early specialization and restricts student's career paths based on their choice of subjects. Thus, girls choose to not continue in an engineering career path when they choose to opt out of STEM-related subjects (mathematics, physics, chemistry, biology, etc.) during the transition between GCSE and A-levels. Girls' choices do not necessarily represent their cognitive ability as data has shown that "while the popular perception that boys are better than girls at science persists, girls who go on to pursue science achieve better exam results than their male counterparts in physics and further math at A-level" (Slim & Crosse, 2014). Therefore, the first 'leak' is experienced in the secondary stage within the education system when girls' interests or academic abilities are not nurtured by educators or clash with embedded gendered perceptions regarding specific professions. A similar leak is also witnessed in the Egyptian education system at both the secondary high school stage and in universities when engineering students complete the preparatory year.

However, Forgasz, Leder & Tan (2014) argue that their study on "Public views on the gendering of mathematics and related careers" revealed that the majority of respondents to an online survey covering 81 countries do not have gender-stereotyped views on stem careers; in reality, they view that mathematics–as a core requirement for a career in STEM–should be accessible for both male and female students alike. While some of the 784 respondents had gender-stereotyped views favoring male students, they represented a minority vote. The survey data was also supported by findings of internationally accredited testing assessments such as the OECD's Program for International Student Assessment (PISA) and the Trends in Mathematics and Science Study (TIMSS) which consistently illustrate, in varying degrees, that girls have outscored boys in mathematics and science in several MENA countries such as Qatar, Oman, and Kuwait and the United Arab Emirates, Palestinian National Authority, Jordan, Bahrain, and Oman during several testing rounds (OECD, 2019; OECD, 2016; Forgasz, Leder & Tan, 2014).

Another 'leak' is also witnessed post-graduation, when female engineering graduates either do not find employment opportunities within their fields or choose not to work in engineering. The gender gap in engineering fields varies across the different sub-disciplines. For example, the authors indicate that "female applicants for chemical, process and energy engineering have not fallen below 25 per cent in the past decade, whereas mechanical engineering has the lowest share of female applicants, at 5 percent of total applicants" (Slim

& Crosse, 2014). The lower share of female graduates and applicants in mechanical engineering in comparison to other sub-disciplines such as chemical or energy engineering is also common in Egypt.

Similarly, Silbey (2016) also conducted a longitudinal study where she annually surveyed 700 engineering students in four schools (elite private college, public land-grant institution, engineering-only college, and single-sex college) during their four years of college and then again five years after they graduated to examine the different approaches to engineering education and students' career paths after graduation. The data findings indicated that while 20% of engineering graduates are female, only about 13% are part of the engineering workforce in the U.S. Moreover, almost 40% of female engineering graduates either quit their jobs or never enter the profession; thus, making engineering the most male-dominated profession in the fields of STEM and perhaps the most male-dominated profession in the U.S. (Silbey, 2016). These statistics are also shared in several reports by Singh et al. (2013) who found that "approximately 30% of women who enter engineering, a male-dominated field, ultimately leave the profession" in addition to citing 'organizational climate' as the primary reason causing a third of female engineers to leave their job (Singh et al., 2013 qtd. in Dresden et.al, 2018). For that reason, analyzing the literature on women's educational experiences in engineering schools is also important to understand when and how female engineers disconnect from their field of study or profession and how educational institutions play a role in their alienation as well. In many cases, the discouragement experienced by female engineers after graduation could be influenced by their educational experiences as early as basic education.

In a study titled, "The Increasing Prevalence of Girls in STEM Education in the Arab World: What Can We Learn?" Dajani, Dhawan, & Awad (2020) argue that the unique context and social dynamics within some Arab societies has recently enabled and encouraged an increase in girls' enrollment in STEM education. Contrary to common perceptions, the authors also highlight data from the PISA results of the 2012 cycle proving that Arab countries such as Jordan, Qatar and the UAE are the only countries where females test better and feel more comfortable in mathematics than males. With varying degrees, girls in these Arab countries also outscore boys in other categories such as science and problem solving, which are necessary for a career in STEM. Moreover, other sources of data such as a

UNESCO study from 2015 showed that "34–57 percent of stem graduates in Arab countries were women" (UNESCO, 2015) which was a range exceeding that of female graduates from universities in the US and Europe. According to the authors, the reasons behind this increase in girls' STEM education is that a) the high prevalence of primary and secondary single-sex education de-emphasizes gender as a basis for developing an interest in stem and results in girls' elevated sense of confidence, b) the representation of female teachers of STEM-related subjects as role models from an early age) the association of STEM fields with prestige and high score achievement, d) flexible working hours in certain health fields such as pharmacy and nursing (Dajani, Dhawan, & Awad, 2020).

The high percentage of women in STEM education in several MENA countries was also illustrated in Schmuck's (2017) book on *Women in STEM Disciplines: The Yfactor 2016 Global Report on Gender in Science, Technology, Engineering and Mathematics*. After conducting an online global Yfactor survey and qualitative research on women's experiences in STEM fields, the author argues that this is the only study of its kind that "provides insights on the two key reasons for which women are still under-represented in STEM: orientation and employment" (Schmuck, 2017). Schmuck comparatively analyzes data on women in both STEM education and employment in eight different geographical regions. By analyzing MENA data, the findings underscore that although "25% of the world's graduated women from EMC [Engineering, Manufacturing and Construction] are within the MENA region" (UNESCO, 2015), women's employment in STEM fields remains scarce in the region. In addition to low rates of employment, the drop-out rate of graduated women is 2.5 times higher than the rate of women in other fields (Schmuck, 2017). Accordingly, the author argues that the high attrition rate is due to three key reasons: "(1) lack of career expectations (lack of promotion, gender imbalance in salary); (2) the impossibility to achieve work/life balance, a state of equilibrium between work and private obligations, is more difficult to reach after the birth of a child; (3) organization and environment; this includes "unfriendly" surroundings, where women are few, which leads to isolation and then to exclusion" (Schmuck, 2017). This study is, thus, considered one of the very few covering a global overview and proves that women's enrollment or graduation from STEM education does not ensure their active and formal employment in the field.

The global comparison of women in STEM illustrates a very important distinction between the challenge of increasing women's *enrollment* in STEM education, as identified in Western contexts, and women's *continuation* in STEM fields, as identified globally with a specific focus on the MENA region. The latter struggle is more concerning within the MENA context due to the fact that a significant percentage of all female graduates from EMC colleges around the world are within the region. Moreover, girls' excellence and academic achievements in mathematics and science in several Arab countries indicates their interest and capability to join any STEM field. Thus, it becomes apparent that women's standpoint with regard to STEM education and careers differs across the world, despite sharing common challenges and impediments once they join the field–whether during undergraduate education or in formal employment. Acknowledging the initial point of gender imbalance is important to address the root causes of female engineers' underrepresentation in STEM depending on a specific context.

2.3 *Impediments to an engineering career*

Previously, women's participation in the labor market, or the larger public sphere, was primarily analyzed using the discourse of culture, tradition, patriarchal social norms and gender stereotypes alone. While all of these factors played a key role in limiting women's opportunities and roles in society–and continue to influence in more subtle and discreet ways–they have been acknowledged and addressed in the majority of developing cities through better social and public policies that improve women and girls' education, health and social protection status. Yet, the fabric of gender-discrimination is also embedded in institutional structures; thus, creating working cultures and settings that are unwelcoming of female employment, especially in the field of engineering.

The field of engineering is among the sectors that have traditionally been inaccessible to female employment and are commonly labeled as 'masculine' professions –with specific focus on sectors such as oil and gas, mechanics and construction. In their article, Cardador & Caza (2018) underscore female engineers' lived experiences in the U.S. labor market and the stressors making them leave their field of work and study. In their qualitative study, the authors interviewed and surveyed 330 engineers in the U.S. during a four-year period to find that female engineers experience both direct and subtle stressors–due to the gendering of

tasks and roles– that cause them to feel undervalued within the profession. Additionally, the data findings showed "that women are disproportionately likely to move away from the most technical career paths and toward roles that involve technical supervision or management as their careers progress" (Cardador & Caza, 2018). As will be highlighted in the data findings section, female engineers are mainly employed in office-jobs that require project management or technical supervision with minimal site-work.

In comparison to the majority of studies which focus on the reason's women leave the engineering profession and their inability to 'fit in' or succeed in a prosperous career, Ayre, Mills and Gill (2013) investigate why and how women stay in engineering professions. Building on the theoretical and earlier work deconstructing engineering workplace culture (Faulkner, 2006; Watts, 2009), the authors conducted a study of all female civil engineering graduates from a specific Australian university using an online survey and semi-structured interviews to explore their retention stories and issues. Addressing all the previously mentioned challenges of being a minority group within a male-dominated profession that is known by its 'masculine' nature and workplace culture, the authors focused on how the female professionals navigated through and retained their jobs. The common denominator between all the interviewed women was their confidence, passion and sense of belonging towards the engineering profession.

However, to maintain these positive attitudes towards their career they employed three main strategies: a) understanding and mastering the technical and social skills required by the profession, b) demanding and enforcing their respect by proving themselves and being assertive towards their male colleagues and superiors, and c) deliberately changing their workplace if they do not feel a sense of belonging or are directly discriminated against or undermined due to their ability to benefit from female or family friendly policies (Ayre, Mills & Gill, 2013). Surprisingly, the study highlighted that some female engineers opposed being beneficiaries of female or family-friendly policies due to being alienated or gendered by ineligible colleagues in highly hostile workplace cultures. For that reason, the introduction of female or family-friendly policies in order to promote work-life balance should be accompanied by a full-fledged endorsement of their objectives by institutional frameworks, authority figures and all employees alike.

Moving to the Middle East and North Africa (MENA) region, the literature on female engineer's education and employment experiences is scarce and only recently addressed in some Gulf Cooperation Council (GCC) countries such as the United Arab Emirates and Qatar under the larger context of women in STEM. Analyzing some of the existing relevant studies, Baytiyeh (2013) investigates female engineers' preparedness to face the challenges of an engineering profession in Lebanon as a case study. Her study is driven by an aim to understand the motives and influences behind women's decisions to choose engineering as their major course of study and their perceptions regarding the essential skills for a successful engineering career (Baytiyeh, 2013). Similar to this study, the author's specific focus on female engineers' as a target group is due to the shortage or complete absence of data about the integration and lived experiences of female engineers in Arab societies. The study's importance lies in its findings, which rely on the data of 327 female engineers gathered by conducting an online survey. Confirming common perceptions about the profession, the author presents that while female engineers have exhibited a genuine interest in the field, they remain underrepresented. As the author concludes, "this is most likely due to the lack of support from both parents and social organizations. Therefore, women are left to struggle in a male-dominated environment" (Baytiyeh, 2013). Accordingly, once again and in a completely different region, female engineers are faced with external obstacles that primarily undermine their potential and career progression based on their gender. More so, the findings of this study affirm previously discussed comparisons between women's experiences in STEM education around the world and the specific challenge of nurturing girls' interests and desire to continue in STEM fields in the MENA region.

2.4 *The importance of work-life balance*

Due to the vivid alienation of women and their discouragement from finding and retaining their jobs–especially in male-dominated professions such as engineering–several studies began addressing the challenges that women face during employment and their possible policy solutions. Accordingly, research on work-life balance and the promotion of female or family-friendly policies and regulations to support and protect female employment in the private sector expanded during the past few years. In a study assessing work-life balance, family-friendly policies and quality of work-life, Shweta & Rakesh Belwal (2014)

study employers' perspectives of working women in Oman to promote Family Friendly Policies (FFPs) as one of the policy interventions needed to improve women's experience in the Omani labor market. Concluding their study, the authors have underscored that state support and government-led initiatives are required for women to achieve quality of work-life.

Extending these recommendations will also apply to the eradication of biases and stereotypes governing work in certain sectors such as engineering. Moreover, the authors also explained that to promote healthy workplace practices, several measures must be undertaken, such as: establishing formal complaint or request mechanisms, offering open door policies to women, developing culturally-sensitive infrastructure, promoting social awareness on FFPs, garnering support within and outside households, and encouraging research on WLB, QWL, and FFPs in the local context. These measures must, however, be integrated within an overall transformation of the economy and labor market towards inclusive, sustainable and knowledge-based growth. In addition to the adoption of these female-friendly policies, other policy recommendations were also highlighted in the literature targeting female employment in the engineering sector. As listed by Faulkner (2006), some very important policies (which will be further explained in the policy recommendations chapter) include: a) providing engineers with quality hands-on training in their discipline, b) providing training to managers to support junior engineers through better mentoring, and c) providing ongoing support, development, career advice and networking opportunities for engineers.

Therefore, it is also important to highlight the specific concern of achieving work-life balance within the engineering profession, especially for female engineers. In a qualitative study, Watts (2009) analyzes female civil engineers' experiences within their profession in the United Kingdom. Focusing specifically on why female engineers are underrepresented in the profession, the author investigated how they negotiate their place in the highly male-dominated field. The study's findings underscore that while some women manage to retain employment in male-majority workplaces and professions, they do so at the cost of maintaining healthy work-life balance, in addition to their psychological and physical wellbeing. It becomes apparent that women are also faced with the challenge of gaining the acceptance and respect of their male managers as well as their colleagues alike (Watts, 2009). Consequently, in some cases, this working environment forces women, as Watts argues: "into

adopting male success criteria and the same presenteeism culture as male colleagues," (2009) as opposed to challenging this status quo and working towards gender equality and representation in professional workplaces. Reflecting the above-explained coping strategies addressed in earlier studies, the author's findings confirm female engineers' persistent challenges and inability to achieve work-life balance in their profession.

Accordingly, while the overall nature and policies shaping labor markets differ from one country to another, gender-related employment problems share common grounds and causes across most capitalistic economic and patriarchal social orders. For example, assessing the United States' national system of work-life protections, Fuentes (2017) discusses the findings of Boushey's book *Finding Time: The Economics of Work-Life Conflict* (2016) to underling the absence or inconsistent application of paid sick and family leaves, universal child care and anti-discrimination policies in workplaces. Among others, these policies and benefits protect workers, especially the most vulnerable, and promote women's employment. Essentially, the author demonstrates how these policies also "create an economic cycle that boosts family income and human capital, which translates into increased business profits and economic growth" (Fuentes, 2017). Thus, they are not economically disastrous as others may argue; instead, they promote economic growth and productivity while maintaining healthy and stable family dynamics. The author also highlights how women have usually been disregarded from the policy-making process and considered primarily for their reproductive and caretaking roles within the household. For that reason, the discourse on introducing female and family-friendly labor policies and gender-stereotypes is critical to challenge the current status quo. This discussion in relation to the Egyptian labor market is, thus, presented in the findings and policy recommendations chapters.

In summary, the existing literature on female engineers' experiences in education and employment around the world confirms the fact that engineering is by far a male-dominated profession where women are marginalized and underrepresented. More importantly, the majority of existing research studies on female engineers' experiences are within Western contexts; however, dating back to mid-twentieth century, the multidisciplinary studies address several perspectives and challenges faced by female engineers within the profession using qualitative research tools. Consequently, it became apparent that to find and retain employment in 'masculine' disciplines, female engineers initially adopt coping mechanisms

such as: impression management, gender-blind perspectives, and assimilation to ‘fit in’ their working environment. Initially, the majority of literature investigated women's identity construction in the engineering workforce. More recently, however, feminist studies problematized the focus on gendered analysis and the need to only understand why women leave engineering.

Instead, a shift in perspective allowed for an assessment of structural and external factors hindering women’s career choices or progression. An analysis of education systems, family influence, and working environments highlighted that women’s interest in engineering is not sufficient to enter or stay in the profession. The leaks begin as early as primary education, include girls’ undergraduate learning experiences and continue to post-graduation experiences. Throughout these three stages, gender-discrimination is embedded within formal education and employment institutions; thus, hindering women’s activity in direct and indirect forms. While women's marginalization and underrepresentation in engineering is a global phenomenon, there are differences in their experiences depending on individual country or regional contexts. In western contexts, the problem begins with Unfortunately, research on women in STEM fields and specifically in engineering is scarce in the MENA region. While a few countries such as UAE, Qatar, Lebanon and Jordan recently began addressing the general topic of women in STEM, studies on the specific experiences of female engineers–the most underrepresented STEM professionals–are almost nonexistent. For that reason, this study aims to address this gap by looking at the lived experiences of female engineers in the Arab Republic of Egypt as a stepping stone in the direction of promoting active female labor participation in vital, knowledge-based and productive economic sectors.

Chapter III: Methodology

This study aims to fill the gap in qualitative research on women's lived experiences in the Egyptian labor market. While there is a plethora of quantitative data and research analyzing Egyptian labor force dynamics, there is scarcity in research focusing on women's real-life experiences within the labor market. Given this study's limited scope, the focus is on female engineers' employment experiences and their work-life balance. The aim of a qualitative study is to hear from the target group who are the primary sources of information in order to underscore a few of the underlying actual market dynamics discussed and analyzed in existing literature. Targeting to answer a set of specific research questions, the data collection process follows an objective and deductive approach to finding and analyzing evidence.

This research study is conducted in several phases, representing an evolutionary, loosely structured approach. Triangulation was used to diversify the sources of data and the research process was divided into two phases: the pre-empirical and empirical stages. In the pre-empirical stage, an extensive review and analysis of the existing literature was conducted to identify the most relevant secondary sources to highlight the strengths and gaps within the literature. In addition to the secondary sources, it is crucial to closely analyze the Labor Law (2003) as a *primary source* and the supposedly guiding document to labor dynamics in Egypt. Other forms of data were collected from national and international accredited sources such as Egypt's Central Agency for Public Mobilization and Statistics (CAPMAS), the Economic Research Forum (ERF), World Bank, OECD and UN Agencies. In the empirical stage, a total of 19 semi-structured individual interviews were conducted with a sample of female engineers to gather data on their actual experiences and challenges within the Egyptian labor market.

3.1 *Sampling approach*

Due to this study's focus on a specific target group–Egyptian female engineers–purposive sampling was utilized to identify the interview sample. In total, 19 in-depth interviews were conducted with female engineers who are all employed or were previously employed. Participants' ages ranged between 24 and 65 years of age. This specific

age group range was a result of a choice to interview employed female engineers with at least one year of experience; accordingly, the youngest interviewee was 24 years old with one year of experience, given that engineering fresh graduates range between 22-23 years of age (since engineering is a 5-year undergraduate program). The 65-year old age cap was chosen due to the fact that four participants were within the 60-65 age group (or above the retirement age) and were still working or only recently retired. More importantly, they represented older generations when female higher-education attainment, especially in engineering, was almost scarce. All interviewees attained high levels of education from public and private institutions, with university degrees or above. Female graduates from private institutions represented the youngest group of participants; however, their enrollment in newer, private universities did not impact their subjugation to several challenges during their education–many of which were similar to experiences of other female students from public universities. The participants in this study also represent the upper-middle or high social classes. With regards to their marital status, four participants were single, five were engaged, eight were married and two divorced. The 19 participants come from different engineering disciplines as they graduated from mechanical (mechanical power and mechatronics majors), architecture, construction, civil, chemical, electrical, petroleum and petrochemical undergraduate programs. The sampling approach was first reliant on reaching out to personal and professional circles and then followed the snowballing technique to diversify the pool of participants.

3.2 *Data collection time*

Data collection lasted for approximately six months and the interviewing process was conducted in two phases. The first set of interviews were conducted in June and July, 2021 and the second set of interviews were conducted during October and November, 2021. All interviews lasted for approximately 30-45 minutes. The interviews were semi-structured and guided by a set of 15 questions (see Appendix) that were initially influenced by the data and patterns in existing literature. However, the number and order of questions varied in each interview depending on the flow of conversation, depth of data shared and participants' unique experiences. Overall, the entire research study was conducted in several phases. It initially began in October 2020 with a research question that led to a thesis proposal.

However, only after obtaining the IRB approval in March 2021 did the data collection process begin.

3.3 *Process and place*

Due to the COVID-19 pandemic, all interviews were conducted on the phone and recorded as a Zoom meeting. All recorded audio data was saved on the researcher's personal and secured laptop in an individual folder. The data collection process was conducted in Cairo with national participants who are living and working in Egypt. Upon completion of the interview, transcripts were manually typed by the researcher and saved on the researcher's personal, secure laptop. The data collection design was iterative and allowed for flexibility in building on the initial set of interview questions based on the experience gained from the first set of interviews. Following a loosely-structured approach and asking open-ended questions enabled participants to more deeply and freely engage and share their lived experiences.

3.4 *Analysis approach*

Data analysis was conducted following a deductive approach. The researcher maintained an objective standpoint and avoided applying any preconceived hypothesis on the collected data. Grounded theory was the primary analysis approach in order to focus on the raw data collected from the interviews with little to no bias or anticipation of the findings. Breaking the data collection process into two phases allowed for an evolutionary semi-structured method and reliance on participants' narratives as the primary source of data. Accordingly, content analysis was undergone to underscore the similarities and differences in participants' stories. Coding was used to identify specific patterns and underlying causes by reading and re-reading the transcripts and organizing the analyzed data thematically; additionally, reliance on the chronological order of events was also utilized to underscore the three main phases influencing a female engineer's experience in the labor market. These phases were identified from similarities in women's shared experiences and the different factors of influence initially identified from data presented in the literature. This chronological separation of events facilitated the in-depth analysis of participants' lived experiences and the identification of patterns and

3.5 *Conceptual Framework*

Based on these qualitative tools, this study hypothesizes that gender-biased formal institutional cultures embedded within engineering education and employment establishments marginalize and undermine the representation of highly educated female engineers in vital productive and knowledge-based industries in the Egyptian economy. Although girls in primary and secondary school outperform boys in mathematics and science, their career aspirations are not only based on their personal interests and academic abilities. This is due to a merge between hegemonic gender stereotypes and biases towards female engineers in male-dominated engineering sectors and structural weaknesses such as: 1) the lack of accountability measures and assessment of gendered power dynamics within formal establishments, 2) weak regulation and implementation of labor law and employment benefits, and 3) absence of female-friendly policies and working cultures. Generally, the engineering sector requires greater attention, investment and regulation in Egypt, in order to facilitate the state's intended knowledge-based economic transition through the promotion of innovation and inclusive, productive employment.

3.6 *Ethical considerations*

This research study abided by all ethical considerations and the core principles of conducting ethical research. *Respect for persons, Beneficence,* and *Justice* were the values and principles guiding the research design, data collection and analysis stages. In order to obtain the IRB approval, the researcher underwent the necessary training and evaluation for conducting ethical research. Prior to conducting interviews, the researcher explained the purpose of the research study, what is expected from the participant, how their data and shared information will be used and the absence of any intended-risks or harms associated with the research. Interviews were only conducted after the researcher acquired oral and written consent from the participants. The IRB-approved signed informed consent form was shared with all participants via email. To protect participants' identity and maintain confidentiality of all personal information, pseudonyms were used instead of participants' real names and names of employment institutions were not used. There are no risks associated with this research study and the benefit of participating is to improve the existing

employment experiences of the target population. The Institutional Review Board (IRB) approval was obtained on March 30, 2021 before conducting this research study.

3.7 *Limitations*

There are several limitations to this study caused by the COVID-19 safety precautions which dictated that all interviews are conducted virtually; thus, limiting one-to-one interaction and the analysis of body language, facial expressions, tone of voice, and interactions with the surrounding. Moreover, the scope and time limitations of the study allowed for only a certain number of interviews to be conducted, which is not a national representative sample. Nonetheless, the interviewees represent diverse backgrounds and employment experiences that provide the necessary depth and relevant information needed to formulate an understanding of female engineers' experiences.

Chapter IV: Contextual Analysis

Moving to a more focused national contextual analysis, it becomes apparent that several of the challenges addressed by existing literature are present in Egypt. Due to the scarcity of research on the specific topic of female engineers' lived experiences in Egypt or comparative analysis of Egyptian women's employment experiences in STEM fields, this section highlights the gendered patterns within the higher education system and focuses on labor force and market dynamics. Understanding the characteristics of the Egyptian labor force and market dynamics provides an overview of the challenges faced by new entrants and the existing workforce, especially when categorical and sector-based data is scarce.

Due to a series of political upheavals, ongoing reform policies, social unrest and the COVID-19 pandemic, the Egyptian economy was negatively and severely hit several times during the past decade. While recent macroeconomic indicators have shown a gradual 'recovery' from these negative shocks, it has largely been a 'jobless' one. This is due to the fact that Egypt's recent positive economic growth did not lead to or was based on the creation of sufficient, high-quality, formal and inclusive employment opportunities for the population's total labor force (Assaad, Krafft, & Yassin, 2018). While both men and women have been negatively affected by these economic shocks–which was highlighted by a recent decrease in labor force participation, the shortage of labor demand, and presence of low quality and informal jobs–the female working age population was more severely affected than the male working age population. For that reason, an overview of economic and labor force data is important to situate some of the underlying root causes of women's low participation in engineering and non-engineering fields in Egypt.

4.1 *STEM education*

According to data published by the Central Agency for Public Mobilization and Statistics (CAPMAS) within its annual bulletin of higher education and higher degree graduates in 2020, there were more female graduates from two of the four STEM categories listed: Natural Sciences, Mathematics and Statistics, Engineering, Manufacturing and Construction (EMC), Computer and Information Technology and Health and Wellbeing (See

Table 1). These two categories were the Natural Sciences, Mathematics and Statistics category with about 60% female graduates and the Health and Wellbeing category with 62% female graduates (CAPMASb, 2021). By looking closely at the specific colleges and disciplines within each category, many misconceptions and stereotypes about female students' interests, skills and abilities are challenged, as was previously highlighted by several studies (Forgasz, Ceder & Tan, 2014; Slim & Cross, 2014; Schmuck, 2017). For example, female graduates outnumbered their male counterparts in physics, mathematics and statistics, which were previously seen as challenging or unfit majors for female students. Validating other stereotypes, however, especially regarding female students' inclination to professions involving human interaction, emotions and immediate impact, females represented the vast majority of graduates from majors, such as medicine, dentistry, pharmacy and nursing (Schmuck, 2017). Nonetheless, expectations regarding the lack of potential job opportunities and gendered labor market dynamics could also play a role in female students' decisions.

Total graduates of higher education from STEM fields (2020)				
Category	**Female**	**%**	**Male**	**%**
Natural Sciences, Mathematics & Statistics	14,393	60%	9,789	40%
Communication & Information Technology	13,074	29%	31,636	71%
Engineering, Manufacturing & Construction	15,738	26%	44,126	74%
Health & Wellbeing	58,931	62%	35,829	38%

Table 1: Total graduates of higher education from STEM fields by gender and category in 2020. Source: CAPMAS, (2021, November). Annual Bulletin of higher education & higher degrees graduates 2020.

Moreover, the other two categories with more male than female graduates also confirmed the gendered dynamics within STEM fields. For example, male graduates represented almost 74% of all graduates from Engineering, Manufacturing and Construction (EMC) disciplines in 2020, or about three times their female counterparts. This was also common in engineering undergraduate education across the world, with the MENA, Central and Eastern Europe and

East Asia and Pacific regions ranking as the highest three with female graduates from EMC (Schmuck, 2017). Looking at the specific engineering disciplines, female graduates were vastly outnumbered in 28 of all 32 engineering and engineering technology colleges within public and private universities across Egypt. The four engineering colleges graduating more female students were Architecture, Chemical, Biomedical and Medical, and Engineering and Computer Science (See Table 2).

Total University Graduates of Engineering & Engineering Technology Colleges (2020)				
College	**Female (headcount)**	**%**	**Male (headcount)**	**%**
Architecture	1394	59	980	41
Biomedical & Medical	122	54	106	46
Civil	583	14	3466	86
Chemical	138	58	100	42
Construction	465	15	2736	85
Engineering & Computer Science	282	58	208	42
Computer Engineering & Control	270	28	690	72
Electrical	46	11	386	89
Electronics & Communications	522	35	982	65
Mechanical	150	11	1266	89
Mechatronics	51	15	300	85
Petroleum & Mining	9	2	441	98
Petroleum & natural gas refining	36	17	173	83

*Table 2: Total University Graduates of Engineering & Engineering Technology Colleges by Gender in 2020. **Note: Only 13 colleges were included from the listed 32.*
Source: CAPMAS, (2021, November). Annual Bulletin of higher education & higher degrees graduates 2020.

Yet, it is also important to note that the percentage of female graduates within each of the four colleges does not exceed 59% of all graduates. This is a larger representation of female graduates from STEM fields in comparison to data from the United States (Singh et. al, 2013; Silbey, 2016) and United Kingdom (Slim & Crosse, 2014). On the contrary, male domination of other disciplines in Egyptian universities could reach up to 98% in petroleum & mining, for example, and averages around 85% across the remaining 27 colleges (CAPMASb, 2021).

These numbers, thus, confirm the findings presented in the following chapters regarding the gendered dynamics of STEM fields. While female engineering students outnumber their male colleagues in these four majors, they are still subjected to the hegemony of gendered and biased employment dynamics of the Egyptian labor market upon graduation; thus, validating a pattern in gendered employment dynamics within engineering disciplines (Baytiyeh, 2014; Cardador & Caza, 2018). For that reason, it is important to address the primary characteristics of the Egyptian labor force and employment dynamics in the following sections.

4.2 *Low female labor participation*

Analyzing women's labor market participation in Egypt, it becomes clear that two main policy problems arise: a) low female participation in formal, private sector jobs and b) an increase in female discouraged unemployment. There are a number of factors influencing this status quo. In their study, Krafft, Assaad, & Keo (2019) rely on data gathered by the Egypt Labor Market Panel Surveys (ELMPS) of 1998, 2006, 2012 and 2018 to underscore the growth, composition and changing patterns of labor force participation. The author's main findings highlight that "rates of participation have steadily declined among educated Egyptian women since 1998" (Krafft et. al, 2019). This decline in participation was especially witnessed as female educational attainment increased and the gender gap in education decreased during the past two decades. From 1998 to 2018, the gender gap in education decreased from seven percentage points to four percentage points in Egypt as "the proportion of women attaining university education or higher increased from 6% to 17%, compared to from 13% to 21% for men" (Krafft et. al, 2019). Ironically, however, the female labor force participation rate has decreased to remain at the same 21% in 2018 as it was in 1998–with a short-lived increase to 27% in 2006 (Krafft et. al, 2019). This phenomenon is quite ironic and unique to the MENA region–labeled the MENA paradox–as women's higher education attainment has been met with decreasing female labor force participation (World Bank, 2013; Assaad, Hendy, Lassassi & Yassin, 2018).

This paradox is even more visible in STEM fields where female employment is scarce or underrepresented, which was also previously highlighted in a comparative study of women's enrollment and employment in STEM fields across the world (Schmuck, 2017). Looking at the minimal data available, only 45% of all STEM researchers in Egypt in 2018

were female. Moreover, the total headcount of female STEM researchers only increased by three percent within a five-year period from 2013 to 2018 (UNESCO Institute for Statistic, n.d). The vast majority of these researchers were employed by higher education institutions or public entities, where working cultures are commonly female-friendly. Consequently, the challenges faced by women in STEM is further exacerbated by their absence or underrepresentation in a variety of disciplines and fields of work, especially within the private sector. Thus, the third 'leak' as underscored by Slim & Crosse (2014) takes place during female engineers' transition to the labor market.

The steady decline in female labor participation since the late 1990s is largely attributed to the Egyptian government's adoption of the open-door (*infitah)* policy and implementation of the Economic Reform and Structural Adjustment Program (ERSAP). These policies primarily focused on economic liberalization and private sector expansion during the late twentieth century while public sector hiring gradually decreased until it completely halted. The public sector has been the primary employer of female labor, especially due to its female and family-friendly working characteristics (shorter working hours, longer maternity leave, formal employment, pension, and stable income) in comparison to the private sector. Hence, without an increase in private sector employment, especially with increasing female educational attainment, the female labor force participation rate has been steadily declining and discouraged unemployment increasing among both women and men.

4.3 *Discouraged Labor*

Moving on to the second policy problem, discouraged unemployment has been identified in recent economic research as the state during which working-age individuals are no longer actively searching for jobs, while they are eligible and desiring to work. The percentage of discouraged labor force is calculated as the difference between the broad market labor force and the standard market labor force (Krafft et al., 2019). While discouraged unemployment increased among both men and women, the latter have been more severely impacted as "the rate of growth of discouraged unemployment between 2012 and 2018 was a dramatic 23% for women, as compared to 11% for men" (Krafft et al., 2019). The increase in discouraged unemployment is very unique to the Egyptian labor market due to its

governing policies and its labor force characteristics. However, educated women's discouragement was also common in other MENA countries such as Jordan, Algeria and Tunisia.

In comparison to a multitude of literature, Assaad et. al, (2018) use quantitative tools to analyze Labor Force Survey data and conclude that educated women's low labor force participation is due to adverse developments on the demand side of the labor market rather than supply-side factors. Previously, factors such as women's age at marriage, fertility, and patriarchal gender norms were predominantly cited as causes for women's low labor force participation. Challenging this argument, the authors argue that such examples of supply-side factors, among many others, "have evolved in a direction that is conducive to greater participation among educated women" (Assaad et. al, 2018). Thus, the real problem lies in the dramatic slowdown in public sector hiring–which was the primary employer of educated women since the 1970s–and the incommensurate increase in formal private sector employment. This was witnessed in the Egyptian labor market with public sector hiring of new entrants of educated women decreasing from 60-80% during the late 1970s to only about 25% in 2010. On the other hand, only about 10-15% of educated women were hired by the private sector in the same year (Assaad, et. al, 2018). Consequently, women's participation rates have been falling for both the secondary and tertiary education groups; thus, reflecting an increase in unemployment which changes to discouraged unemployment when eligible females stop searching for employment.

Discouragement is primarily due to the lack of demand for labor, especially among the educated females. According to an analytical report of the 2019 Labor Force Survey data, the estimated Egyptian labor force comprised 28.3 million individuals in 2019, and only 15.3% of the employed labor force were women (CAPMASa, 2020). More so, 36.4% of the female labor force are university graduates in comparison to only 17.2% of the male labor force. The increase in percentage of university graduates among the female labor force reaffirms the MENA paradox previously mentioned caused by their lack of employment. In addition to that, it was also apparent that the highest percentage of employed females were within the 50-59 age group at 21.3%. They were followed by the 40-49 age group at 20.6% (CAPMASa, 2020), which indicates that female labor participation increases and stabilizes after women complete rites of passage such as marriage, pregnancy and raising children. This

phenomenon reflects labor market dynamics and the discouraging working cultures within formal institutions for younger women.

4.4 *Population growth and future labor supply*

It is not sufficient to discuss labor force dynamics without addressing one of Egypt's most notable challenges: rapid population growth. The country's economic growth trends determine its employment generation potential, including the quantity and quality of employment and absorption of the large labor supply. Rapid population growth places extra stressors and burdens on the labor market, especially during slow economic growth or low employment generation. Recent data shows that despite the GDP growth witnessed during the past decade, "going from 1.8% per annum (p.a.) in 2011 to 5.5% p.a. in 2019," employment generation has been low in comparison to the population growth. In fact, as Assaad (2020) highlights: "the employment-to-population ratio continued to decline steadily from a high of 47.8% in 2010 to 38.5% in 2019, its lowest level since 2000" (Assaad, 2020). The decline in ratio is highly attributed to the Egyptian population's expedited population growth during the past decade, which was a result of the youth bulge that took place during the 1980s (Krafft, et. al, 2019; Assaad & Roudi-Fahimi, 2007). Rapid population growth was due to several factors including a decrease in child mortality and an increase in fertility rates.

With a slow growth of the economy, rapid population growth and a lack of sufficient job opportunities, labor force pressures increase and result in a high unemployment rate–as witnessed between 2000 and 2005. Although the unemployment rate decreased during the period between 2015 and 2018, it was due to a slowdown in the youth population and an increase in discouraged unemployment, especially among women, rather than an employment expansion (Assaad, 2020). Nonetheless, the youth population of the 1980s reached prime child-bearing ages during the period between 2006 and 2014, which will result in an echo youth generation that will start entering the labor force during the upcoming two decades (Krafft & Assaad, 2014; Assaad, 2; Krafft, et. al,2019). As Assaad projects, "the growth of youth (15-24) entering the labor force will accelerate substantially from 1.1% p.a. in 2020-25 to 3.1% p.a. in 2025-30 to 3.8% p.a. in 2030-35" (Assaad, 2020). This will create another youth bulge and increase pressure on the labor market if labor demand continues to be much lower than the labor supply and population growth rate. Accordingly, addressing the issue of

population growth provides depth and a better understanding of labor market dynamics and the Egyptian labor force potential–especially when assessing ways to increase female labor participation through the creation of more jobs.

4.5 *Gendered employment generation*

Based on the above population growth expectations, the total labor force is also expected to grow by 1.9% to 2% in the upcoming decade (Assaad, 2020), when the echo generation starts entering the labor force. To avoid another unemployment crisis and stagnation of productivity, the economy will need to create "575,000 jobs per year on average in the first half of the decade and 675,000 jobs per year in the second half just to keep pace with the growth of the labor force (Assaad, 2020)." Accordingly, the creation of job opportunities and their availability to all is a necessary policy change to support the economy's GDP growth and inclusive development.

Nonetheless, the economy's inability to expand employment generation to absorb the labor supply was in fact worsened by the recent unproportionate addition of jobs. As underscored by the Labor Force Survey analytical report for 2019, 102,000 new jobs were added to the labor market in 2019 while there were 2.2 million unemployed individuals at the same time. Interestingly, when analyzing the employment patterns based on gender, the data underscored that while 151,000 men were hired in transformational industries, 20,000 female employees lost their jobs within this sector. More so, while 185,000 men were employed in the sector of custom trading, spare parts and motor-vehicle repair, 127,000 employed women lost their jobs within this sector. Surprisingly, sectors known for the selective employment of women–or the feminization of jobs–such as education and household care lost 198,000 and 152,000 female employees respectively (see Table 3). In the end, it became apparent that between 2018 and 2019, 780,000 female jobs were lost while 843,000 male jobs were added to the labor market. Thus, the 102,000 jobs that were added to the labor market in 2019 were primarily occupied by men (CAPMASa, 2020). Consequently, these numbers underscore the intrinsic gendered employment generation policies that prioritize male employment at the expense of female active labor market participation.

Jobs added/lost to the labor market based on the economic sector during 2018-2019		
Transformational Industries	+151,000	-20,000
Custom trading, spare parts and motor-vehicle repair	+185,000	-127,000
Education	-42, 000	-198,000
Household care	-1,000	-152,000

Table 3: Jobs added/lost to the labor market based on the economic sector during 2018-2019. Source: CAPMASa, (2020, June).

In order to increase job creation and labor demand for all, economic growth rates must also increase. To accommodate the increase in labor supply, an increase in GDP growth should reach 6% at minimum (or aim higher towards 6.5-7%) (Assaad, 2020). Real, long-term, knowledge-based economic growth demands high-skilled, productive and inclusive work. Therefore, the increasingly educated labor force must be upskilled and re-skilled in order to meet market needs. Educational attainment alone is not sufficient, especially if university curricula are not updated and do not prepare graduates for practical market experience. Accordingly, structural reform, effective regulation, and a change in market dynamics must take place for that to happen. Due to the absence of these factors, discouraged unemployment has been on the rise during the past few years. Given the increase in labor force discouragement due to insufficient labor demand, the Egyptian labor market will need to increase employment at an average 2.7% per year (Assaad, 2020). With the expansion of jobs, specific attention needs to be directed towards female employment, especially in STEM fields.

In sum, understanding the Egyptian national context is integral to better investigate female engineers' current status quo and lived experiences within their professional disciplines. Looking at labor market dynamics and their influence on the country's labor force, it becomes apparent that the working age female population suffers from two primary policy problems: low rates of labor participation and increasing discouraged unemployment.

As identified in the majority of literature, the primary reasons behind these problems include the imbalance between labor supply and demand and the ensuing unavailability of jobs. These dynamics are a result of several factors including rapid population growth, slow economic growth, and insufficient and gendered employment generation. All of these factors result in a labor market where educated women are underrepresented. The underrepresentation of professional women is exceedingly visible in STEM fields such as engineering, as male graduates vastly outnumber their female counterparts in 28 out of 32 disciplines across Egyptian private and public universities. For that reason, the following chapter provides further analysis based on the lived experiences of 19 Egyptian female engineers as they navigate the challenges presented within formal education and employment institutions.

Chapter V: Findings

Given the gender focus of this study, data gathering was conducted through in-depth interviews with 19 female engineers who are employed or were previously employed. The interviewed sample offers a range of perspectives and different lived experiences of women within the 24-65 age group in Egypt. Analyzing the interview data was undergone using a deductive approach and coding techniques to underscore the similarities and differences in women's education and employment experiences. The following sections analyze themes and patterns identified in participants' stories to underscore the key challenges and factors shaping female engineers' educational and employment experiences in Egypt.

It becomes apparent, however, that young women's decisions to join the engineering profession is influenced by a myriad of factors that could start from as early as childhood. More importantly, their career choice undergoes continuous testing during a) secondary school: when they decide on their career path, b) university: when they declare their major or engineering discipline, and c) employment: when they take decisions relating to their career goals and work-life balance.

The challenges faced by female engineers could be divided into external influences impacting women's career choices and progression and existing institutional structures that are embedded with gender-biased working cultures and policies. Based on these continuous challenges, which represent a merge of cultural and structural factors, policy recommendations will be highlighted in the final chapter. In addition to the shared challenges, it is important to note that all participants also shared a strong stance on the importance of self-empowerment and knowing one's priorities and interests before deciding to join a career in engineering.

Findings I: Impediments to an Engineering Career

5.1.1 *Score-based allocation systems*

Thirteen out of the 19 participants chose the field of engineering because they loved and enjoyed math and physics (as well as chemistry for those enrolling in chemical

engineering specifically) from an early age; thus, being the subjects most related to and required by all fields of engineering studies, from their perspective, it was a natural career path. Representing almost 70% of the interview sample, these participants noted that their career choice was primarily based on their academic interests and areas of strength. In addition to their admiration of the academic subjects, half of them also underscored their passion for trouble-shooting, problem solving, innovation, design and critical thinking–which are all skills demanded by any engineering discipline and field of work. Accordingly, girls' choices to enroll in one of the STEM fields was a deliberate choice that was primarily based on personal interests and skills. As highlighted in the literature and contextual analysis, girls' interests were also portrayed by their academic achievements and excellence in mathematics and science subjects from as early as eighth grade (Mullis et. al, 2020).

Nonetheless, fulfilling this desire and eventually enrolling in an engineering school is influenced by other factors. Students' grades first determine whether they are eligible for their desired secondary national curriculum (*thanaweya amma)* track and their final grades determine if they will be accepted in their preferred university and school of education. Following the national university allocation system (*tanseeq*), a lot of graduating students' first choices are influenced by social perceptions of prestigious professions and universities, especially if they are among the highest score achievers, making them eligible candidates. The impact of education systems such as the Egyptian *thanaweya amma* or British *GCSE* has been previously highlighted in the literature as one of the earlier 'leaks' reducing women's enrollment in engineering disciplines. This is due to the fact that students' higher education prospects rely on their chosen subjects and rigid scoring criteria during secondary school (Slim & Crosse, 2014). Underscoring how these factors influenced her decision to join engineering, Dalia, a civil engineer who eventually left the engineering field, said:

> *"I was leaning towards math and basically, like anyone who graduates from thanaweya amma, the target is to join the top-notch universities (koleyet el qema)–so my choice was between the top two that take highest scores but since computer informatics was a new college and its future was undetermined and it didn't have a syndicate, I joined engineering" - Dalia, (40 years old, Civil Engineering, Self-employed outside engineering, Married).*

Dalia's ability to choose between the two majors was based on her *thanaweya amma* score which made her an eligible candidate with a freedom of choice. However, the influence of existing grading and qualification systems was more detrimental when it came to students'

major choices during their university years. This was due to the fact that all enrolled engineering students in public universities (and some private universities) first undergo a preparatory year where they take core courses to prepare them for their majors and concentrations. Based on an existing criterion, students' final grades at the end of the preparatory year determine which discipline they can major in. In fact, several interviewees stated that they did not end up joining the field of engineering they desired because of this qualification system. For example, Amal, a self-employed electrical communications engineer, outlined that her career was shaped by the university grading system as she described her experience saying:

> *"I really wanted to major in architecture because I like colors and drawing but it required a grade of 'Very Good' in the preparatory year, while my grade was only 'Good' so I joined electrical engineering based on the allocation [tanseeq] system not based on my own preference" -Amal, (62 years old, Electrical Communications Engineering, Retired & Self-Employed, Divorced.*

While she was able to succeed and excel in electrical engineering to the point of establishing her own company, Amal still remembered her frustration for not being able to choose her desired major. Her inability to do so was solely based on the university's score-based allocation system which demands a specific score or range for each engineering discipline. Thus, Amal's major choice and entire career were shaped by her individual score after completing the preparatory year in engineering college. Therefore, students' interests and preferences are, once again, not the only factor influencing their career choices; their grades must first qualify them for their desired major. At this stage, students could end up switching majors due to this scoring system.

More importantly, it also became apparent that the majority of participants actually switched their desired STEM field or engineering major at least once after graduating high-school. Only seven female engineers knew the specific engineering discipline they wanted to join after high school and were successful in joining and graduating from them. The remaining 12 participants either switched from medicine to engineering or changed their desired engineering major during their course of study. The reasons for switching disciplines varied, but were largely based on the fact that students followed an elimination approach depending on which courses they enjoyed most during their preparatory year. The problem with an approach of elimination is the lack of direction and focus on areas of interest and

skills from an early stage. Without guidance from an early stage, students experience great frustration when they have to switch their major. Additionally, other factors beyond students' control also played a role in their choice of specialization, which include: a) the unavailability of their desired discipline, b) gender-based stigmas and stereotypes surrounding specific majors, c) dissatisfaction with the curriculum or d) family disapproval.

5.1.2 *Family Influence*

In fact, family members played a significant role in influencing girls' choices to join the field of engineering. Nine participants mentioned the influence of family members on their career choice, with fathers and/or siblings being the primary sources of inspiration. The influence of parents came in three main forms: a) being engineers and passing on the expertise and passion for the profession and/or specific discipline, b) cultivating their daughter's interests and skills at an early age and approving her career choice, and c) accepting her choice to join the school of engineering but disapproving the major due to gender-based conceptions. Below are participants' testimonials highlighting how their family played a role in influencing their career choice. To start off with the positive impact that parental figures could have on their daughters, the case of Magda, a retired electrical engineer, was inspiring, as she shared:

> *"I really wanted architecture engineering in the beginning because my dad was an architect and I was raised with him in his office…Since I was in 4th grade, my father used to play with my friends and I by giving us challenging calculation problems and I used to get intrigued by it. I was fascinated by numbers and mystery solving." - Magda, (61 years old, Electrical Engineer, Retired Deputy Minister, Married).*

The fact that Magda's father was keen on challenging her and exposing her to his field of work planted in her the interest and passion for math and the profession from an early age. His attention to Magda's interests and areas of strengths played a role in her confidence and ability to decide to join engineering. Similarly, Sara, an employed civil engineer, also highlighted the influence of her family members on her choice to join the profession. She noted:

> *"My father was an engineer and he planted in us the love for engineering so since I was in grade 3, I wanted to become an engineer. All my siblings are engineers as well and even my uncles are almost all engineers in various fields."- Sara, (Civil Engineering, Assistant General Manager, Married).*

Like Magda, Sara's father also played a significant role in nurturing her love for engineering. The fact that other male family members were also engineers did not limit her career choice or prevent her from following her dream of joining the profession. These cases, thus, affirm the argument concerning the influence of family members on children's mindsets and career goals from a young age. However, the influence of family members could also be neutral or negative in other cases. For example, when asked about her family's role in influencing her career choice, Fadwa answered:

> *"[My Parents] never told me which university to enroll in and even when I switched majors they never said anything about that. They always told me it's my life and my choices." - Fadwa, (64 years old, Chemical Engineering, Professor, Divorced)*

In her case, Fadwa's parents' neutral approach towards her career life and their encouragement of her independence led her natural direction towards the field of engineering. Her parents allowed her to freely choose the career choice and discipline she desires, which is how any child should be raised and allowed to make their own decision. However, in the case of Rana, her parents' intrusion and dictation of which engineering field is permissible caused her to change her career path and join another 'acceptable' or 'female friendly' discipline. Describing this transition, she confessed:

> *"To be honest, I was going to enroll in petroleum engineering at first, then I found that it involves working with many laborers and in the desert. I did not have a problem with that, but my parents did so I found that the closest major to petroleum engineering was chemical engineering." - Rana, (28, Chemical Engineering, Teaching Assistant, Single)*

In Rana's case, her parents' own preferences and what they deemed to be acceptable or unproblematic was what determined her major choice. While they did not object to her enrollment in engineering, they played the primary role in shaping her career path within the engineering field. Rana's case reflected the conclusion reached by (Baytiyeh, 2013), who emphasized the negative influence of the lack of support from both parents and social organizations on female engineers' preparedness and career challenges in Lebanon. Consequently, it became apparent that a female student's decision to join the engineering profession is greatly influenced by whether her father, specifically, or more than one family member are engineers. Girls usually also have to gain their parents' approval of the specific discipline they wish to pursue.

5.1.3 *Undergraduate Discrimination*

After choosing to enroll in engineering and specializing in a specific discipline, girls start experiencing different dynamics during their undergraduate learning journey in comparison to their male counterparts. To begin with, several participants believe that the effectiveness of the education they received and their sense of preparedness upon completing their degrees was significantly affected by their gender. This was primarily due to prejudice, bullying or marginalization that undergraduate female engineering students were subjected to. Based on the participants' testimonials, this form of gender-based discrimination was perpetrated by professors, male colleagues, and trainers alike. Accordingly, the majority of participants believe that the quality of their learning experience and preparedness for the labor market was impacted by their experiences in university.

To start with, Amal, an electrical engineer, stated that her relationship with fellow male colleagues drastically changed during the time of their graduation project when they switched from being friendly to refusing any female addition to their group. She described the dynamic, saying:

> *"Unfortunately, the boys never saw that we were capable or good enough to produce good end-results. They always thought that we wouldn't do anything and would ruin the project for them. So, we used to beg them to take us in their groups and would even ask them: "what makes you think we won't work or that we are failures?" - Amal, (62 years old, Electrical Communications Engineering, Retired & Self-Employed, Divorced*

In fact, she also added that this undermining attitude was also directly projected by their supervisor who once asked graduating female students: *"so should we ask you about the project or about cooking in the kitchen?"* Amal was very clear on pinpointing the time when this change in attitude took place during her educational journey, as she noted:

> *"This was the beginning of bullying when we were getting seriously involved in the project and working with the male students; before that they were very friendly."*

Before sharing these encounters, Amal had spoken about her university and the friendly relationship between most students and the professors who were keen on helping them and providing the best quality education. However, Amal's undergraduate experience transformed during her senior year when she, along with all other engineering colleagues, had to work on the final graduation project in order to graduate. Given that their careers depended on it,

Amal's male colleagues did not want to risk her addition to their group on the basis of her gender and their underlying judgments of her skills and intelligence.

Although these problematic encounters were experienced in a public university during the 1980s, similar encounters were experienced by female engineering students in a private university more than 35 years later. The age gap noticed between the 19 participants did not prevent younger generations from experiencing the same alienation and discrimination faced by their female predecessors in engineering disciplines. While the marginalization of female students in projects and mixed groups was not as direct as it previously was, two participants highlighted that they faced several obstacles with purchasing materials for projects due to their availability in specific workshops in underdeveloped and remote areas where girls are unwelcomed or usually prone to sexual harassment. Mayar, a recent mechatronics engineering graduate described her experience:

> *"As an engineering student, most of our assignments were projects and the main challenge was being a female while most of the students were male, so you find yourself stuck in a corner having to purchase materials from very far and uncomfortable places. They don't accept the presence of a girl there, but because you are an engineer it is acceptable a little. When we divide the tasks among the group members, they never assign this role to a girl. But I used to get stubborn and wanted to take on this task." - Mayar, (25, Mechatronics Engineering, Program Networking Engineer, Engaged).*

According to her description, Mayar felt unwelcomed and unsupported by her male colleagues and vendors of necessary project materials and equipment. Due to the likelihood of experiencing harassment or other endangering incidents in remote public and densely populated areas, female engineering students like Mayar felt caged within their own disciplines. This was also a challenge faced by Malak, a recent architecture engineering graduate, throughout her undergraduate educational experience due to the lack or scarcity of vendors offering the equipment required for their projects. She explained some of the obstacles she faced as an undergraduate student saying:

> *"Also, you might need to leave your house at 2 or 3AM to go print for a project–so it is not always okay for my father. Printing and laser cutting were also very expensive or crowded in New Cairo during finals so we used to go to Duwei'a and other slum areas to be able to print at lower prices and to find the specific workshops that do that." - Malak, (25, Architecture Engineering, Junior Architect Designer, Engaged).*

In addition to the risk of going to remote or female unfriendly areas, Malak was also faced with the challenge of accommodating her curfew and objecting father. In fact, she stressed on how difficult it was for her parents to accept her partnership and late-night work culture with male colleagues. Nonetheless, from their description of the challenges they faced, the participants acknowledged the importance of their work and accepted the need to work on projects to gain practical experience and improve their learning journey; however, the source of frustration lies in the lack of accommodation and acceptance of female presence within these engineering departments or their supporting facilities (workshops, material shops, labs, etc.). Their inability to be present in the aforementioned areas or during late night hours due to other cultural or family regulations negatively impacts their sense of belonging within their fields.

Moreover, the frustration could also be coupled with gender-based discrimination in the form of sexist comments on female engineering students' appearance in comparison to socially constructed beauty standards. In addition to being rejected from joining male-dominated graduation group projects, other participants were also verbally assaulted based on their physical looks. Amal, a retired electrical communications engineer, was keen to mention that she faced these stereotypes by stating:

> "*But of course, there were comments about our looks and comparisons with girls from other majors such as literature or business, for example: they would call us men."*

However, Amal was not the only participant highlighting this form of sexual harassment. Lara, a much younger civil engineer also mentioned that:

> *"There's always the joke that girls who major in civil engineering are actually boys. But from the very beginning, I wanted to fight this stereotype--even if I did that subconsciously. - Lara, (27, Environmental-Building (Civil) Engineering, Acoustic Engineer, Single).*

The specific type of verbal harassment that both Amal and Lara encountered is largely based on socially constructed and accepted beauty standards and differences in physical appearances between male and female students. The comparison between female engineering students and students from other 'feminine' disciplines indicates one of the ways by which female engineers are mistreated to forcefully feel unwelcomed and outcasted. The discrimination experienced by these female students validates the definition of gender-based harassment provided by Berdahl (2007), who explains that the hostility towards female

engineers is due to the fact that they are "individuals who violate gender ideals" within the male-dominated profession (qtd in Dresden et. al, 2018). Thus, it became apparent that gender stereotypes and different forms of alienation were part of female engineers' educational experiences. The above-mentioned comments and encounters emphasize the discrimination experienced even before graduation.

Lack of acceptance of female students was part of the culture embedded in male-dominated engineering disciplines such as mechanical, petroleum, civil, and construction engineering. On the contrary, almost all participants described chemical and architecture engineering as female-dominant disciplines, with a female majority in student ratio as well as staff ratio in chemical engineering. Due to the categorization of disciplines based on the gender of students, a lot of gender-based work dynamics persist. For example, a mechatronics graduate said:

> "*Before I enrolled, I used to be discouraged from mechatronics because it was not female-friendly. From a 200+ batch, there were only about 20 girls - Marwa, (25 years old, Mechatronics Engineering, Control Engineer, Single)*.

Although she was discouraged from enrolling in this specific discipline, Marwa had the confidence and freedom of choice which allowed her to pursue the career she desired. However, several others are discouraged and choose more female-friendly disciplines to find employment opportunities upon graduation, as explained by Rana, who also changed her engineering major due to her parents' influence:

> *"The only engineering sector that hires females is architecture. Civil engineering is all about working from the field so female engineers are scarce. Electronics, only if they work in big telecommunications corporations like Vodafone–they would hire girls of course and not discriminate. Also, computer science graduates may find jobs, but usually they prefer males because they make them stay late at work and work hard–don't know why they don't prefer girls. Petroleum is almost impossible because it's not applicable. In mechanical engineering, if there are 10 male engineers, they might hire one female engineer. Other than that, females are hired in all other majors–medicine, business, pharmaceuticals. But in engineering, it's a 60-40 probability, with the majority being that they won't find a job." - Rana, (28 years old, Chemical Engineering, Teaching Assistant, Single).*

Through this description, Rana provides an overview of several engineering disciplines from the perspective of a female engineer that is based on commonly shared stereotypes and real-life encounters of female engineers in the labor market. The circulation of these

characteristics among students could significantly and involuntarily impact their decisions from an early age. However, there are still other factors influencing female engineers' experiences and career choices in Egypt.

5.1.4 *Lack of training opportunities*

While there were gender-related challenges faced by female engineering students, there were other more generic characteristics of engineering students' experiences in universities in Egypt. When asked if they felt prepared to join the labor market, eight participants stated that they were not, specifically because the curriculum was very theoretical and lacked real-life knowledge and experience. Some of the eight dissatisfied engineers also highlighted that the learning material was outdated and did not relate to present-day work needs. For example, an electrical engineer affirmed that:

> "*what you learn in university does not allow you to understand or know what you will work, so you graduate without really understanding the nature of the job" -Nelly (38 years old, Electrical Engineering, Operations Management, Married)*.

Due to her lack of practical experience and inability to meet the job's duties and responsibilities at first, Nelly dedicated the first three years of her career to rotating around the different offices within her department and gaining all the relevant experience and knowledge to help her specialize. Without the opportunity to do so, Nelly attested that she would not have progressed in her career the way she did. Similarly, below are other testimonials underlining engineers' shared perception of their undergraduate educational experience. Starting off with Rana, a teaching assistant who continued working in the same institution she graduated from, she noted:

> *"Yes, the professors were good and the material was good, but it was all lacking the practical side. We needed to know how things were in real-life, so that was the only thing that was missing." - Rana, (28 years old, Chemical Engineering, Teaching Assistant, Single)*

Rana also indicated in her interview that she did not feel prepared for the labor market after graduation due to the lack of real-life practical experience during her undergraduate degree. Accordingly, the high quality of teaching and educational material is insufficient to prepare engineers for the early years of employment in the labor market. They must be supported with practical experience in the form of training and real-life experiences. Similarly, Mayar,

who is now working as a Program Networking Engineer, attested to this weakness in the education system by saying:

> *"There is a gap between the education we receive at university and the labor market -- but I was lucky to enroll in a 6-month program to get all the experience that I need." - Mayar, (25, Mechatronics Engineering, Program Networking Engineer, Engaged)*

Due to the gap between theory and practice, Mayar was keen on getting the training she needed from a 6-month program, which then qualified her for her current position. Unlike Mayar, not all participants were able to find a decent and enriching training program during their undergraduate years or even after graduation. Sharing her employment experience, Donya underscored the absence of sufficient training opportunities saying:

> *"I hoped training opportunities were more available in addition to the studious work. This is important in order to better determine one's major. If students are trained in each of the specialties, then they would better determine which major they would like to join without having to rely on others' experiences or advice." - Donya (38 years old, Power Mechanical Engineering, Project Manager, Married).*

Donya's testimony indicates that she was not content with her undergraduate major choice or the decisions she made, by "rely[ing] on others' experiences or advice," which is, unfortunately, a common occurrence in the absence of career guidance, counseling or sufficient training opportunities. Yet, the scarcity of training opportunities was not the only problem faced by female engineering students. In Manal's case, a petrochemical engineer, finding a training opportunity was not the primary problem. Instead, the problem she faced with the quality of the training opportunity was due to her gender, as she recalls:

> *"Since we used to mainly train in the offices because we were girls, our training experience was not great." -Manal (29 years old, Petrochemical Engineering, Project Management, Engaged).*

The ineffectiveness of her training experience could have also been negatively influenced by the fact that she was a female petrochemical engineer in a male-majority discipline. Based on these experiences, it is evident that not all engineering students felt that they were prepared for the labor market upon graduation. In fact, their unpreparedness was sometimes amplified due to their gender, as girls either could not find any training opportunity or were only trained in offices–thus, lacked the real-life experience of working on project sites.

Findings II: Labor market experiences

5.2.1 *'Masculine' Disciplines*

A different set of challenges arose post-graduation as female engineers started searching for employment. Based on participants' stories, architects easily found jobs in comparison to other engineering disciplines. According to their testimonials, this was because the field of architecture is dominated by females, thus, the labor market is accepting and demanding of female architects. Additionally, there are also plenty of small-to-medium size startups and studios in Egypt that create constant demand for architects and allow for rapid employment after graduation. As Lina, a recent architecture engineering graduate attests:

> *"Generally, there are a lot of studios and firms here so demand for female architects or interior designers is present. It is not difficult and there are different forms of employment: remote, from the office or freelance." - Lina (25 years old, Architecture Engineering, Architect, Engaged).*

Due to this, Lina was able to find a decent job opportunity upon graduation, in a regional firm that specializes in interior design and apartment furnishing. In comparison to Lina's smooth transition, other participants found difficulty in finding employment, especially in the petrochemical or mechanical sectors, known to be 'masculine' fields of engineering. This is due to the working culture within these disciplines that causes female employment to be scarce or nonexistent in certain specializations or areas of work. The alienating nature of engineering workplaces has been addressed in the majority of western studies analyzing the gendered dynamics of engineering as a 'masculine' profession in the U.S (Faulkner, 2006; Faulkner, 2009a; Faulkner, 2009b; Faulkner, 2011). Below are two examples describing how female engineers who majored in petrochemical and mechatronics disciplines eventually decided to accept the jobs available to them after searching or waiting for employment within their specialties without any luck. In the first example, Manal graduated from petrochemical engineering and tried searching for employment within her field without finding any opportunity. She recalls her experience saying:

> *"The problem is not finding job opportunities after graduation in your specific major. So, in the end 90% of what you learn in university is unnecessary. I really wanted to work in my field and spent a lot of time searching; if there is any opportunity now I*

> *will take it. Women are not hired to work off-shore or in the desert, but if I was offered a job even if in the office, I wouldn't mind." - Manal (29 years old, Petrochemical Engineering, Project Management, Engaged).*

Thus, Manal's experience underscores the scarcity of job opportunities for female engineers in certain engineering disciplines–this results in women's disappointment and overall discouragement towards finding decent employment in their field. In Manal's case, she was willing to compromise her dream of working in the field by at least working from an office within her field. In comparison to Manal, other graduates like Mayar, who graduated from mechatronics engineering actually did not even expect to work in their discipline, so she decided to switch careers and accept the first job she got in a renowned multinational company. She described her rationale and decision saying:

> *"I didn't spend a long time trying to work in mechatronics. I applied to other vacancies and the first opportunity was in program networking in a multinational company and it was a program that would educate me well regarding networks. I trained for 6 months and now I have been allocated for the past 4 months working on a project." -Mayar, (25, Mechatronics Engineering, Program Networking Engineer, Engaged)*

Mayar's decision indicates how some female engineers adapt to the labor market dynamics and either lower their expectations of working in their fields of study or switch to more-accepting and accommodating engineering disciplines at one point in their careers. Cases like Mayar reflect examples previously highlighted by the literature explaining how female engineers' coping mechanisms alternate and differ depending on their individual context (Ayre, Mills & Gill, 2013). The hardship experienced by female engineers in the fields of petroleum, mechanical, civil and construction engineering is exacerbated by the almost nonexistent presence of females on work sites. Thirteen of the interviewed participants were within these commonly labeled 'masculine' fields and only one was in a position that involved field work and being based on-site for long durations. Nonetheless, this exceptional case was represented by Layan, a 25-year old chemical engineer who works in a multinational private company that tries to advance gender-equality and the presence of female engineers on-site.

5.2.2 *Gender-based harassment*

Despite the fact that some international private companies are committed to promoting gender equality and workplace ethics, female employees are still subjected to various forms of gender-based harassment in their workplaces. Looking more closely at the case of Layan, who was the only female engineer with offshore work experience and long duration placements in remote project sites, the young chemical engineer still experienced different forms of gender-based harassment as early as the hiring process. She describes encounters when her presence in the company or on an offshore team was questioned:

> *"I was directly told: "What are you going to do on the team?" and was made to feel that I don't have a place in the company, because they need men. And this is grounds for harassment." (Layan, 25, Chemical Engineer, Associate Technical Professional [Entry-level Engineer], Single).*

When asked for more details about these incidents, Layan emphasized that they were perpetuated by her manager, who is a person of authority. Therefore, she always felt challenged to prove him wrong and to do her best to secure her place on the team that was working from the site. This was only applicable when her manager "*was moved around"* indicating that he was transferred to other departments and later heard *"good things about her"* from other authority figures, as she also noted. As will be shown in other examples, Layan was not the only female engineer who had to deal with a demeaning manager who questioned her qualifications and value added to the team.

The other twelve engineers within the 'masculine' disciplines either experienced various forms of rejection of their presence on site or were not able to gain any site experience at all. Accordingly, all encounters cited and described by female engineers as gender-based challenges were a result of a) constant undermining and questioning of women's abilities, b) lack of segregated resting or support facilities (i.e.. caravans and toilettes) and c) direct or indirect forms of harassment (i.e.. visual, verbal, etc.). Another example that included several of these discriminatory challenges was Lara's experience as a construction engineer working on a national mega-project requiring site visits and work in locations throughout one of the metro lines. She describes her experience saying:

> *"For example, in the metro, it was a huge project and I went to several locations to take measurements: al Waraq, El-kitkat, Imbaba, Aburawash, Zamalek,*

> *Mohandeseen, basically handling the entire line and meeting many engineers, who were all men. I was the only female I found. And every time I was faced with astonishment that I am the only female on site…I was always faced with a confused look and a lot of flirtation. I always wanted to tell them to treat me like an equal." - Lara, (27, Environmental-Building (Civil) Engineering, Acoustic Engineer, Single).*

Although she was finally able to work and be present on a large-scale project, Lara's personal encounters underscore how her presence was perceived as an odd occurrence. Consequently, she was addressed and treated according to her gender, as a woman, instead of being treated as a professional engineer. This gender-based treatment included verbal harassment in the form of flirtation or mockery of her presence and physical appearance. In fact, her experience with such forms of gender-based and unethical violations began even before she was able to secure a position at her current company. She stressed that "*some advertisements specifically state that they want a male engineer and in other cases, it is part of the filtering process."* Thus, by the time that Lara was able to find a job opportunity, she was either rejected by several workplaces on the basis of her gender or could not even apply and compete equally with other male engineers.

Similar to Lara's presence as the only female engineer on the project, Mayar was also the only female engineer working on a high-profile project for a governmental entity implemented by an international networks company. When describing the working culture, she explained how she experiences impediments and hindrances because of her gender on a daily basis. She says:

> *"I am now working in a military zone and daily, I negotiate my entrance at the door. I have to speak with my manager and supervisor daily and prove that I am an engineer working on a project. On a daily basis, there is a different soldier and they are not culturally accepting that a female engineer works or is on the project. There is a judgmental look questioning why I am working among all these men. Before, I used to shy away and wait around the corner but now I fight with them daily and I started to stand up for myself." - Mayar, (25, Mechatronics Engineering, Program Networking Engineer, Engaged)*

The shift in Mayar's attitude resembles persistence and resistance to the gendered and alienating status quo. Due to her fierce character, in addition to support from her colleagues and acceptance as a qualified engineer by the mother company, Mayar was able to stand her ground and maintain her integral position. While these examples of female engineers were able to sustain their jobs and work in challenging projects that require work on-site, there are

other examples of women who had to quit their jobs or switch careers due to the extremely harsh working conditions and lack of accommodation to the presence of female engineers. Mona, a very successful chemical engineer, reflected on how this existing status quo discourages undergraduate female engineers or fresh graduates from the entire field of engineering. She recalled:

> *"There are girls who graduated and were looking forward to that experience [working from the field] but got discouraged when they did not find the opportunity. So, it should be open to all and the decision should go back to the person."- Mona (35, Chemical Engineering, Drilling Engineer, Married)*

To her benefit, Mona was able to work on site when she decided to shift to another department within her company and was accepted in the drilling department. Although she first experienced rejection from another department due to being pregnant, Mona was accepted and encouraged to join the drilling department–considered one of the company's vital departments. Nonetheless, confirming the discouragement channeled to undergraduate engineering students, Lara, who recently graduated from one of the prestigious public universities noted:

> *"The recruitment process is actually directed towards male candidates. And this was exported to all college students--that a female engineer's place is in the office, so girls no longer apply for site engineer vacancies. It became more of a rule." -Lara, (27, Environmental-Building (Civil) Engineering, Acoustic Engineer, Single).*

Although there was an almost 10-year difference between when Mona and Lara were undergraduate students, they both underscored the same stereotypes and demands of the engineering labor market. The lack of job prospects and limited job opportunities discourages female students from applying to many job opportunities from fear of gender-based rejection, alienation or workplace harassment. In comparison to Mona who was fortunate to find a job opportunity in her field despite the discouragement she faced as a student, Rana, who was also a chemical engineering graduate, was unable to find any employment opportunities in factories or companies with site-work. She shared:

> *"I always wanted to work in a field and I even applied a lot to work from the office but within factories, but it was very hard because all factories want to hire male engineers because they can work night shifts. From all the factories that I applied to, I would get rejected because of that." - Rana, (28 years old, Chemical Engineering, Teaching Assistant, Single)*

The fact that Rana was openly rejected because of her gender is both a violation of the law and an unethical behavior that negatively impacted her self-esteem and aspirations to ever work in a practical job within her field. She explicitly highlighted that the rejection she received was solely based on her gender as she was never given a chance to proceed with the hiring process and showcase her qualifications and eligibility for the job. She adds:

> "*it [the rejection] could also be as early as when I send my CV–they would reply apologizing that they only need males; or it would be among the requirements that they want male engineers"(Rana, 28, Chemical Engineering, Teaching Assistant, Single).*

In Rana's case, her rejection by employees adds to her family's earlier rejection of her initial career choice to join petroleum engineering, which negatively impacted her self-esteem and aspiration to ever find a job opportunity outside her academic institution and gain practical experience in her field. Thus, the lack of acceptance and recognition of female engineers on project sites and in male-dominated disciplines created working environments that undermine women's ability to join, perform or succeed in their profession.

Almost all female participants underscore that they always feel the need to prove themselves, their credibility and their right to work in their workplaces. This type of gender-based mistreatment and constant doubt has been defined as "a form of hostile environment harassment that appears to be motivated by hostility toward individuals who violate gender ideals rather than by desire for those who meet them" (Berdahl, 2007 qtd in Dresden et. al, 2018); additionally, they were also identified to primarily consist of "derogatory terms of address, comments about women being ill-suited for management, sexist jokes, and crude behavior" (Fitzgerald, Gelfand, & Drasgow, 1995 qtd.in Dresden et.al, 2018). As outlined throughout this study, female engineers continuously face these gender-based challenges that eventually result in their discouragement and exit from the field. More specifically, the lack of recognition and validation of female engineers was experienced as early as in university, which was underscored by Lara who noted:

> "*You can be studying engineering, but you'll only be recognized as an engineer and given that title by others when you prove yourself. Whereas, men are recognized as engineers from day one; they don't really need to prove themselves."* She also goes on to add: "*There was also an attitude of mockery. That I cannot do my job, since I am female. So, I always proved them wrong, by actually doing my job" - Lara, (27, Environmental-Building (Civil) Engineering, Acoustic Engineer, Single).*

As apparent from her shared experiences, Lara was undermined and treated with a derogatory attitude during her undergraduate education as well as during her employment. Her credibility and ability to perform as a professional engineer was constantly questioned. However, due to her self-confidence and professionality, she would always counter such challenges by doing her job well. Based on the interviewees' testimonies, the pressures, in fact, increase during employment, especially if a female employee experiences a rite of passage such as marriage or pregnancy and is expected to fall short or not fulfill her responsibilities. This expectation is usually communicated in various ways throughout her employment. It is usually the underlying sentiment experienced by female engineers during their daily work and interactions with the majority of fellow male colleagues or superiors.

Although she succeeded in becoming the first licensed drilling engineer in a well-known joint-venture petroleum company in Egypt, Mona stressed:

> "*I always felt pressured to prove myself and that I am serious about the job, especially that they knew I was joining them while I was pregnant. - Mona (35, Chemical Engineering, Drilling Engineer, Married)*.

The fact that the doubt and constant pressure that Mona faced was intensified during her pregnancy validates the gender-based and unethical violations female employees experience in male-dominated workplaces. This toxic work culture resulted in some participants internalizing these dynamics and thus, placing limitations on their abilities and experiences. In Mona's case, she was able to prove her qualifications and rights by fulfilling all her duties in addition to passing an internationally accredited licensing exam, which made her the first female engineer to do so in the history of the company. However, in other cases, female engineers face immense and constant struggles or unacceptance that cripple their ability to work and function normally. An example of this crippling and limiting working environment was experienced by Malak, who is a recent architecture graduate. From her reflections on her site-work experience, she noted:

> *"I go to the site now, with a male partner, but without him I would not be heard. They [the workers] would undermine me because I am a girl and young." - Malak (25 years old, Architecture Engineering, Junior Architect Designer, Engaged).*

Using these words, it becomes clear that Malak, although still in her early career years, has already internalized the gendered working dynamics of on site and field work. Based on her current work dynamics, she believes that she cannot perform her job and that she will not be

respected by male subordinates because of her gender; thus, she relies on her male colleague to fulfill some of her responsibilities. Consequently, such working conditions might eventually limit her career progression and undermine her capabilities as a professional engineer, due to the internalization and acceptance of workplace gender-roles. It is also important to note that the internalization of gendered workplace cultures and the association of 'masculinity' with engineering disciplines is a phenomenon experienced during the early years of education as previously discussed. Nonetheless, the consequences of this internalization differ: while some girls may opt out from enrollment in engineering, others may adopt a range of coping mechanisms including assimilating to their status quo.

5.2.3 *Culture: alienating working environments*

Twelve out of 19 female participants cited the words "culture" and "mentality" in their interviews as reasons behind some of the challenges that either they or other female engineers generally face in the Egyptian labor market. Speaking in both English and Arabic, they alternated between using 'culture,' 'mentality,' '*thaqafa,' and 'fekr'* to label and describe the root causes of the types of challenges they faced. Referencing culture may seem redundant and a traditional way of explaining gender-based policy problems that persist until today; therefore, it will be important to define what culture means in this study and how it unfolds in the target group's individually lived experiences. Traditional perceptions and discourses on culture-- being an impediment to girls' education or employment does not apply to this study's sample. As previously highlighted, all participants in this study are university graduates who are either employed or were previously employed and come from middle-to-high income households. Nonetheless, they still faced various forms of discrimination, alienation and conditioning based on their gender within their educational or employment institutions.

Accordingly, this study focuses on the role of institutional culture which is defined as the underlying beliefs and perceptions–largely based on socially accepted gender roles and abilities–that are shared by people of authority within formal establishments. The context of analysis here is limited to formal education and employment establishments and the workplace culture within them, as opposed to the interplay of culture-based perceptions and informal social interactions outside these establishments. It is also important to note that they

were referred to as "culture" or "mentality" by the interviewees since the challenges they encountered were driven by the preferences and/or managing styles of their employers rather than based on laws, policies or written codes of conduct. Underscoring the absence of discriminatory laws or written policies, Dalia, a civil engineer who worked in both the private and public sectors affirmed:

> *"Nothing is written that discriminates against women. If it was written, we can change the regulations. But they are beliefs and culture. They are old-school beliefs that a woman cannot do everything a man can. Yes, there is progress but there is room for improvement." - Dalia, (40 years old, Civil Engineering, Self-employed, Married)*

Dalia's work experience included both public and private companies, so her testimony on the absence of discriminatory written policies is based on her diverse background. Confirming this realization and reality, a younger civil engineer who also had work experience in private companies strongly attested that:

> *"According to the rule-book, there's nothing official that discriminates against women. There's no law that denies female engineers the right to work on-site or that men should be paid more. These are all cultural stereotypes and social beliefs." - Lara, (27, Environmental-Building (Civil) Engineering, Acoustic Engineer, Single).*

As both participants confirmed, the challenges they faced in their workplace was not based on the presence of written discriminatory laws; instead, they were shaped by their institution's specific working culture. In fact, by analyzing the Egyptian Labor Law 2003, this conclusion was further solidified given the absence of any direct or written discriminatory laws or articles. Therefore, based on these participants' awareness and lived experiences, the challenges faced by the female engineers were primarily in the form of: a) discriminatory hiring processes and lack of sufficient employment opportunities for female engineers in male-dominated disciplines such as mechanical, petroleum or construction engineering, b) limiting female employment to office roles and their unacceptance on sites, c) rejection or disliking of female superiority or promotion in the workplace, d) denying legal rights and benefits and e) conditioning female employees to social expectations of women's roles in the private sphere.

Analyzing incidents when female engineers were denied their legal rights and benefits, it became apparent that male superiors played a significant role in enforcing these discriminatory practices in establishments. According to a testimony shared by Fayrouz, who

works in a prestigious multinational private firm, her manager denied her colleague a right that was granted through an official decree. She explains the case saying:

> *"During the first COVID-19 lockdown in 2020, the head of the National Petroleum Authority issued a decree that female employees with children below 12 years of age can work from home 100% of the time; But my colleague, who has an infant daughter, never benefited from that. If I came to the office three times a week, she would come the same number of days because our manager did not allow her to work from home. But when she eventually spoke with the human resources department they told her it's her right and she should ask for it because all departments enforced that law." -Fayrouz, (27 years old, Petroleum Engineering, Accounts Manager, Married).*

While it was her right to work from home since she had a daughter below 12 years of age, she was denied this right by her male superior without any justification. This incident, thus, highlights how power dynamics could further exacerbate the unfavorable positions of female engineers within formal establishments. Moreover, the fact that this breach of official decrees and legal rights occurred within formal and internationally recognized establishments made older incidents that occurred in public institutions unsurprising. Amal, a very outspoken and hardworking electrical communications engineer who retired and started her own business, highlighted how her entire career within a public entity was characterized by an annual conflict with department heads who refused to promote female employees when budgets were insufficient and prioritized male employees. She narrated her experience saying:

> *"There was an annual evaluation of all employees according to which promotions were granted. So, I used to make a problem every year because if, let's say, the number of deserving employees were 10, they would only promote 4 because of the limited budget – so who would he [the manager] choose? He would choose only male employees. On the basis that a man is a family's breadwinner while a woman's work is just on the side, something extra. When, in reality, a lot of women are the family's breadwinner. Until today this is the case–nothing changed." - Amal, (62 years old, Electrical Communications Engineering, Retired & Self-Employed, Divorced*

Amal's yearly struggle with her manager–a male superior–reflects the power dynamics within her working environment and the ultimate authority that rests with only one individual during critical matters such as promotions and bonus distribution, for example. In addition to not granting female engineers their legal and deserved rights and benefits, there were other examples of how institutional culture and personal preferences of authority figures limited women's potential and career progression. Sharing her insight on her company's policy with regard to female presence on sites, Mona said:

> *"Previously, the chairman approved that female engineers go to the field, but I'm not sure what the current chairman's policies would be. It might only be allowed that they go for visits, but not work from the field." -Mona (35, Chemical Engineering, Drilling Engineer, Married)*

Mona's testimony proves how significant decisions and company policies like the presence of female engineers and employees in fields could only be based on the personal preferences or mindsets of one authority figure. The lack of clear and fixed institutional policies to avoid personal bias and unjust working cultures was cited by other participants as an attribute of public entities. Fayrouz, a petroleum engineer working in an international oil and gas service company frustratingly attested that:

> *"There are big petrol companies with bases that do not support female employees. They actually do not allow females on site. So, if I'm in a service company with a solution to their problem I won't go to their base. I will work on the design from the office." - Fayrouz, (27 years old, Petroleum Engineering, Accounts Manager, Married)*

Fayrouz's encounters with different working cultures and discriminatory policies imposed by owner companies also highlights how women within these institutions are perceived and treated with regard to working on sites and in unaccommodating project locations. However, as she shared other challenges faced during her employment, Fayrouz stressed how women could be undermined and constantly placed under tests based on preconceived gender roles and expectations. She explained:

> *"I didn't get married a long time ago but when I came back from my honeymoon– the day right after, I heard that [my manager] was questioning my focus at work. He told my colleague: Do you think Fayrouz is not focused anymore at work? So, she replied: Why wouldn't she be focused? And he replied: "because she will be more occupied with the responsibilities of life-after-marriage." I wasn't even settled in my house so I didn't have any responsibilities." - Fayrouz, (27 years old, Petroleum Engineering, Accounts Manager, Married)*

Thus, her manager's doubts and suspicions are only indicative of his mindset which confines his female 'subordinate's' primary roles and duties to her marriage and household responsibilities. Other examples also validate this gendered power dynamic as Mona, who is now a successful and accomplished drilling engineer shares her training experience saying:

> *"For instance, in one of the training sessions, the manager undermined our presence and thought I would never actually work as an engineer. He even offered to just give me the certificate without any training experience. He had the mentality that*

> *restricted women's roles and capabilities to certain positions." -Mona (35, Chemical Engineering, Drilling Engineer, Married)*

In her case, Mona was immediately assessed based on her gender and judged as someone who will not continue in the profession. While she was not limited by her initial experience, other students or trainees could possibly internalize and accept the gendered roles and perceptions projected on them by authority figures and superior males in the workplace.

5.2.4 *Navigating public and private sector experiences*

All interviewees also touched on a very important topic and challenge that faces the majority of working women: the ability of achieving work-life balance. Essentially, almost all women stated that striding towards achieving work-life balance is a matter of choice and being able to set boundaries based on one's priorities. Nonetheless, it was also made clear that women who joined the public sector during their early careers were able to achieve work-life balance and fulfill their familial duties after marriage. This was primarily due to the strict implementation of labor laws allowing women sufficient maternity leave (3-months), nursing hour (1 hour), shorter working hours during pregnancy, and insurance. Generally, benefits of working in the public sector ensure strict working hours, job security, and female-friendly working environments that impact a woman's choices and career paths. Magda, a retired Deputy Minister, stated that her work in the public sector at an early age allowed her to fulfill her duties towards her family, which she had prioritized early on.

> *"I have to say that my home was my priority and this was something that I never compromised. I got married after I had started working and I was still a junior engineer so our working hours were convenient and fixed. Even when I resumed work after taking my maternity leave, the children's bus would pick them up before I left for work and would drop them after I was home. I used to also take my days off during the time when they were undergoing their exams to study and be with them. So, I did not fall short in this regard." - Magda, (61 years old, Electrical Engineer, Retired Deputy Minister, Married)*

Magda's keenness to maintain balance between her work and personal life was very apparent in her narration and description of her milestones and choices in life. As she described above, all her career choices were made in recognition of her family's needs. However, it was also made possible by the availability of decent public employment opportunities and her excellence at work. Similarly, Fadwa, a Professor and Director of a research center at a public

university also shared that her career choice to work in an academic institution by specializing in the field of engineering allowed her to prioritize caring for and raising her children during the first ten or 15 years of her career. Only after then did she start focusing on her career progression and was able to travel and participate in international conferences or stay late at work. She proudly shares:

> *"My priorities for the first 10 or 15 years were my kids. My career was going along, as long as it was okay. It was a fulfilling life for me. Then, when they got older, I started working and realizing my dreams. But first, it was my kids. If I were to repeat it, I would do it the same way. You have to have your priorities, goals and to-do-list." - Fadwa, (64 years old, Chemical Engineering, Professor, Divorced)*

It has to be noted, however, that working in an academic institution plays a significant role in enabling female employees to achieve their desired work-life balance. More so, Fadwa's understanding and acknowledgement of her priorities made her career progression and growth a smooth process. Nonetheless, the ability to balance between work and personal life, especially once a female employee has children, is more challenging in the private sector. This is due to the fact that the private sector is profit-oriented and requires longer working hours and higher efficiency and productivity; thus, while it provides greater incentives–especially in large multinational firms–it also expects greater input and dedication to the job by employees. As Amal, a currently self-employed electrical communications engineer noted:

> *"In the private sector if they give you one pound they will take from you ten pounds in return." - Amal, (62 years old, Electrical Communications Engineering, Retired & Self-Employed, Divorced).*

Amal's experience in both the public and private sectors allowed her to reach this conclusion. Understanding the difficulties of the private market as a business owner and engineer, she was able to identify the advantages and disadvantages of both experiences. Therefore, when asked if they could go back in time and switch to the private sector for its career-oriented benefits, both Magda and Fadwa acknowledged these benefits; yet, they both stood their ground and confirmed that they chose what allowed them to achieve their own personal goals based on their priorities in life. Magda shared her reflections on her career journey and choices, saying:

> *"If I go back in time, I might want to work in the private sector; however, I will lose something that is very important and I think that the National Council for Women in addition to the Labor Law should ensure this right to all female employees: that they*

> *are able to raise their children. But I have to confess that working in the public sector helped me achieve the balance between doing my job at work and at home. The law gives you the right to take paid maternity leave and nursing leaves and I benefited from that." -Magda, (61 years old, Electrical Engineer, Retired Deputy Minister, Married)*

The importance of maintaining work-life balance and prioritizing her family was vivid throughout her interview and stemmed from a place of confidence and understanding one's priorities and values in life. Sharing her perspective and similar career choices, Fadwa also highlighted her motherly instincts that were her driving force in balancing her work and personal responsibilities.

> *"Yes, the private firms offer better pay but at least I get to spend time with my children and watch them graduate. Maybe this is because I am a mother, I don't know. So, I was honest with myself, I wanted a job that I can continue in." - Fadwa, (64 years old, Chemical Engineering, Professor, Divorced)*

While the previous examples were of female engineers from the 55-65 age group who only worked in or preferred working in the public sector during their time when private sector employment was still uncommon, Dalia, a 40-year old civil engineer, worked in both public and several private sector companies until she decided to quit her career in engineering altogether. After progressing in her career and gaining a prestigious job in a renowned multinational private company, which she described as 'top notch' due to the benefits and abundant services provided such as: *"transportation, daily hot meals, medical insurance, abides by labor law, pays for all delivery expenses, [and] continuous professional development and team building activities,"* Dalia decided to quit her job during her pregnancy and to be self-employed as an online teacher and a parenting coach. She elaborates saying:

> *"Thank God, I am very satisfied because I am totally in control–whether with teaching or freelance coaching sessions. So, it is very convenient, in comparison to my previous 9-5 job. Especially if you are someone who gives your all to work and in engineering, there is work all the time. It is very time and energy consuming–you have to work till late at night and receive calls all the time. I moved to corporate work after that and it is even more hectic and I like to do other things–self-development or to play sports and take care of my son." -Dalia, (40 years old, Civil Engineering, Self-employed outside engineering, Married)*

Accordingly, Dalia first wanted a long maternity leave to take care of her son, yet, she quickly realized that she actually wants to change her career to achieve better work-life

balance. Therefore, when she decided to re-enter the market, Dalia chose to be self-employed and navigate a new career path that grants her time and flexibility. Despite the identified differences in age, marital status or sector of employment, female engineers experience similar challenges due to their shared gender which dictates their double-burden of managing work and personal life. Based on these shared examples of testimonies, the pool of participants is primarily represented by educated and employed female engineers who started their careers in the public sector and either continued due to its convenience or quit their engineering career due to its inconvenience. However, the interview sample also included female engineers who more recently started their careers in the private sector and had a different perspective.

First of all, due to the halt on public sector employment, women are now only presented with employment in the private or informal sectors in Egypt; thus, due to the lack of regulation on the latter, the educated female labor force prefers formal employment in the private sector to secure their legal work benefits. Secondly, large multinational private firms are obliged to adopt gender equality agendas and apply a gender quota within their establishments. Therefore, young female engineers, especially those who graduated from commonly perceived 'masculine' disciplines, were able to find employment opportunities in large multinational companies. While she could not secure a job right after graduation, Fayrouz was able to eventually get hired in one of the renowned multinational petroleum service companies in Egypt. After receiving training by them during her undergraduate degree, Fayrouz was targeting to get employed in a specific company and department. She underscores that this was only possible because

> "*it's an international employer [so] they actually try to increase the percentage of female employees [and] one of the KPIs [Key Performance Indicators] of every country manager is to have a certain female-male ratio." -Fayrouz, (27 years old, Petroleum Engineering, Accounts Manager, Married).*

In comparison to her company's policies and institutional culture, Fayrouz angrily added that other public sector companies do not even allow female engineers on their project sites. While she works from the office, other female engineers in their company were rejected from entering the project base of owner companies. She explains:

> *"There is no problem in the private sector, but the public sector is a disaster…There are big petrol companies with bases that do not support female employees. So, if I'm in a [multinational] service company with a solution to their problem I won't go to*

> *their base. I will work on the design from the office." - Fayrouz, (27 years old, Petroleum Engineering, Accounts Manager, Married)*

Fayrouz, thus, underscores the stark differences in workplace culture and employment policies in public and private institutions especially concerning female engineers on site. From her perspective, the hindering policies of owner public institutions negatively impact her ability to professionally perform her job. Consequently, the variation in institutional cultures and policies creates further obstacles and impediments to women's work–especially in already difficult and male-dominated fields such as the oil and gas industry. The adoption and enforcement of agendas and policies promoting gender equity by individual organizations will not be enough if the hegemonic working culture and institutionalized structures within the vast majority of establishments do not support female employment and active representation in all professions.

Findings III: Women's Recommendations

In addition to sharing their lived experiences and challenges as female engineers, the interviewees also suggested solutions and recommendations to improve their current status quo and promote more female-friendly educational and working cultures for future generations. The recommendations briefly highlighted by the interviewees below provide the basis for the policy recommendations suggested in the following chapter, in addition to best practices from existing literature. However, it is important to note that not all interviewees provided specific recommendations and even fewer experienced the implementation of these recommendations in their work or educational settings.

5.3.1 *Managerial-level support and acceptance*

During the entire interview, Sara, a civil engineer working as an Assistant General Manager, underscored the importance of managerial-level support of female engineers and female employment in general, especially in the oil and gas industry. Recalling the difficulties she faced, especially with working on projects that require field visits, she concluded that:

> *"The most important factor is managerial-level support. If the management is supportive of the idea and allows female engineers to handle projects and have access to resources and labor then this facilitates the entire process and encourages women to work." - Sara, (Civil Engineer, Assistant General Manager, Married).*

Sara's emphasis on the importance of managerial-level support was based on her personal experience, since she was only able to secure a position and get promoted in her workplace with the support and approval of her manager. She also mentioned that when she was first hired, there were very few female engineers in the entire company, however, when senior managers (who were all male) started accepting their presence and acknowledging their hard work, more female engineers were hired in several departments.

Similarly, the presence of an understanding and supportive manager was the reason behind the availability of employment opportunities for female engineers or the progression of a female engineer's career in other participants' experiences. Describing her first employment opportunity in a public sector company, Dalia explained that she was actually mistakenly contacted without applying to the company, but was later selected due to the efforts and inclusive mindset of the new department manager.

> *"It was a new department–central procurement department–opening in the company and it was opening with new blood and thinking different than the old-school thinking. He [the manager] was choosing skillful candidates and so he selected me, another girl and 2 boys from Cairo University, which also shows equal opportunity. I stayed with them for 3.5 years." - Dalia, (40 years old, Civil Engineering, Self-employed, Married)*

Although she was not among the top academic achievers who were targeted by the selection committee and was contacted by mistake, Dalia was still selected by the department manager responsible for hiring his subordinate engineers based on her skill sets and qualifications. The manager's approach towards providing all candidates with equal opportunities countered the company's traditional hiring criteria which prioritizes academic achievement. Choosing to start a new department with fresh graduates and ensuring equal representation of gender is a deliberate decision made by the manager, even if it was not in alignment with the company's norms.

Another example also emphasized the power of people with authority and how they can play a transformational role in promoting a cooperative and inclusive working culture for all. In her interview, Mona underscored a point of transition in her career when she wanted to shift to another department within her company and was faced with two types of managers and working cultures within the same entity. Initially, Mona, a chemical engineering graduate, was first employed as a process engineer in the production and processing

department in a large joint-venture oil and gas company. Reaching her full potential within her department after seven years, Mona wanted to gain new experience in another department. Accordingly, she applied to vacancies in both the project management and drilling departments at her company. Although she passed both interviewing processes and was accepted in both departments, when Mona informed the general managers of both departments that she was pregnant in her early days, she received two opposite reactions. On the one hand, she shared that the project manager:

> *"took a step back and told me to wait until I gave birth and then we could reconsider–he was afraid to teach someone new and then they would leave." -Mona (35, Chemical Engineering, Drilling Engineer, Married)*

On the other hand, the drilling manager was very encouraging and supportive, as she quoted him saying:

> "*Even if you are pregnant, you are more than welcome. You can start, learn and take the experience–give birth and come back and continue." -Mona (35, Chemical Engineering, Drilling Engineer, Married)*

The director of the project management department immediately changed his perspective and saw Mona as a pregnant female instead of a professional and qualified engineer. He feared that her pregnancy would be a burden and would impact her productivity and functionality. On the contrary, the drilling department manager accepted Mona's transition and welcomed her addition to the team based on her qualifications. In fact, the support and acceptance that she received from the entire drilling department, which was composed of all-male engineers, encouraged Mona to prove her ability and dedication to her work. She elaborates:

> *"I worked during the entire 9 months and they were supportive because I was fulfilling my job responsibilities. I took my paid maternity leave (3 months) and even elongated and took 9 unpaid months. They were still very supportive and never made me feel that I was pregnant or unable to do anything. When I came back I was in the same position and continued taking more courses. I then established myself and did work that no one was doing." -Mona (35, Chemical Engineering, Drilling Engineer, Married)*

In fact, when she resumed work after her maternity leave, Mona became the first internationally licensed drilling engineer in her department and in the history of the company. She now continues to work with all male colleagues, yet affirms their continuous support and fairness in work. Based on her experience with several male authority figures in male-dominated working environments, Mona underscores that the progress and

improvement in the overall work culture exists; nonetheless, it largely depends on individual mentality.

5.3.2 *Labor law enforcement and regulation*

The second most recommended policy by the interviewees was the enforcement of employee rights and benefits as outlined by the 2003 Egyptian Labor Law. Based on their experiences, the majority of female engineers experienced varying degrees of law enforcement and regulation policies in their workplaces that impacted their sense of job security and work-life balance. For instance, Dalia underscored that variation in law application could create toxic working environments where employees are not granted their basic rights to the point of even finding difficulty in quitting their jobs and acquiring their deserved benefits. She, thus, believes that :

> "*Abiding by the labor law should not be a matter of choice especially if it is a large entity... but there are no regulations on small companies or firms [that] sometimes resort to other unethical practices that would lead people to leave their jobs." -Dalia, (40 years old, Civil Engineering, Self-employed, Married)*

Dalia, personally, was not subjected to the 'unethical practices' that she hinted at, yet, she was keen on mentioning that several of her friends were exposed to situations when they were cornered to quit their jobs and give up their deserved rights. Such cases expose companies that refuse to abide by the labor law and prioritize other objectives such as maximizing profit by saving costs and overworking employees. On the contrary, other examples portrayed how when regulations are in place, individuals are not left to their own liking. Referring to another case, Mona shared that one of her managers refused to allow her to leave early when she was pregnant; however, when she reported the issue it became clear that the company was abiding by the law. She explains:

> *"For instance, when my manager reported the issue to his senior, he did not approve his complaint and told him that it was my right to leave early and that I was not the first or last to do this." -Mona (35, Chemical Engineering, Drilling Engineer, Married)*

Without the presence of a hierarchical and regulatory system in place, Mona would not have been able to claim her rights and would have continued to be managed by an individual's personal preferences and gendered managing style. Accordingly, in the presence of a

regulatory system and hierarchy of authority that conforms to written laws and policies, individuals with supremacy will not be allowed to dictate the working culture or enforce their own mentality on their subordinates.

Another successful example of when this happens is when registered companies are forced to provide insurance to all employees and not just a selected few. Experiencing this in one of the private companies she worked at, Lara recounts:

> "*When there are strict laws or procedures that are placed from above, the management tends to take it seriously. Since my company has a tax card and is licensed, it's mandatory that it provides medical insurance. In previous companies, that was not present. They used to provide insurance to engineers, but not other laborers. But when it becomes mandatory, they have no option but to provide the insurance to all - Lara, (27, Environmental-Building (Civil) Engineering, Acoustic Engineer, Single).*"

Experiencing the different types of companies and their enforcement of the labor law enabled Lara to detect when a form of injustice and violation of the law such as discrimination between employees was performed. Therefore, applying the law to all employees is a step that will encourage women to seek employment and retain their jobs even after marriage, which is usually the point of departure of many working women in Egypt. Due to the fact that many women leave their jobs after marriage as a result of the double burden of responsibilities and conflicts between work and personal life, senior female employees like Magda, who is now retired, argue that:

> "*If the law ensures that all female employees get their rights and deserved leaves before and after bearing children, they will be able to resume their work and give it their all. -Magda, (61 years old, Electrical Engineer, Retired Deputy Minister, Married).*"

Magda benefited from all her legal rights and was able to balance between her career and personal life; thus, she recommends that the strict implementation of labor laws and policies on all formal establishments will provide the necessary job security and deserved rights to all female employees while minimizing any risks and gender-based hindrances to their career.

5.3.3 *Diversifying Support Systems*

In addition to the managerial-level support and acceptance of female engineers highlighted above, several participants emphasized the importance of other forms of support

systems. The need to diversify sources of support stems from their significant, yet varying degree of influence for each individual. For example, Fayrouz, a 27-year old petroleum engineer noted how career advising, whether undergone in school or in university helped her to better navigate towards the right discipline and career path for her based on her academic interests and areas of strength. She explains:

> *"During advising in school, they told me that taking AL [Advanced Level] math and chemistry makes me eligible for engineering, so why do I want to enroll in pharmacy when I don't like AL biology –it doesn't make sense. I found myself shifting my path and going towards engineering more. [In university] I was intending to study architecture, but when I went to a career advising session offered by the university, I found out that I like chemistry, math and science. Initially, I thought I wanted architecture because I like drawing and thought it was all about that. But when I saw the courses I didn't feel this way. So, I started with elimination and chose petroleum as the most suitable major without thinking of where I was going to work." - Fayrouz, (27 years old, Petroleum Engineering, Accounts Manager, Married)*

The availability of career advising and counseling services offered by both her school and university provided the support and guidance that Fayrouz needed to make more informed decisions regarding her career. Without them, Fayrouz, like many other students, would not have been able to choose the specific college or discipline that nurtures her interests. When asked about the different support systems that influenced their employment experiences, participants' responses varied to include the support of colleagues, spouses and parents. For example, when Mona experienced the greatest challenge in her career by shifting to the drilling department, she underscored the role played by her colleagues, by sharing:

> *"But honestly, they really encouraged me in the drilling department, especially that I was the only female engineer in the entire department. It was a company policy to achieve diversity across all departments and they only needed a courageous female engineer to take this step and join an all-male department (in the office there are about 30 male engineers). They were basically haunting unique and capable female engineers from other departments and were ready to teach and prepare her for the job." - Mona (35, Chemical Engineering, Drilling Engineer, Married)*

The support and encouragement she received were key in motivating her to take this leap of faith and join the department as the only female engineer. Without this support system, Mona might have not had the opportunity to shift from her department and achieve a significant milestone in her life. In another example, the role of the family unit played an integral role in helping a hardworking female engineer retain her job. As previously mentioned, Magda first

prioritized her family and children during her early career years. She later acknowledged that her nuclear family played a very supportive role when her children grew older and were able to assist with household responsibilities. In comparison to other cases when spouses are undermining female employment and unsupportive in household responsibilities, Magda affirmed that:

> *"The family plays a huge role in supporting women, including the children when they grow older–I used to give them responsibilities in the house when I was at work. My husband was in a ranking position in the police and he was very understanding. My job required that I travel sometimes or stay out late and he never minded. On the contrary, he would encourage me to succeed and do this for myself."* - *Magda, (61 years old, Electrical Engineer, Retired Deputy Minister, Married).*

Each member of Magda's nuclear family played a supportive role during different phases of her life. During her early career years, Magda's husband was constantly encouraging and supportive of her career progression. After raising and caring for her children during their childhood, they, in turn, took responsibility and assisted in household chores to sustain the support needed by their working mother. Hence, regardless of the magnitude of the support service or action provided, women's testimonials underscored that all kinds of acknowledgment of their effort and work leaves a positive imprint on their experiences and has a motivational impact. The smallest gestures, such as giving engineering students the title of 'engineer' (*bashmohandes* in Arabic) before they graduate and practice could boost their confidence and sense of belonging to the profession, in addition to making them feel *'important and responsible* as commonly noted by participants.

Summary of Findings

Analyzing female engineers' shared experiences in the Egyptian labor market, it becomes clear they walk a very difficult and challenging path. This is due to the fact that female engineers encounter continuous challenges and hardships during both their educational and employment experiences. As highlighted throughout this study, girls' decision to join the engineering profession is influenced by a myriad of factors, many of which are external and beyond their individual preferences and control. While 70% of the participants' chose engineering as their profession from a young age, other factors influenced their opportunities and choices along the way. These external influences took place during a)

secondary high-school education, b) university education, and c) post-graduation employment. In the first phase, before employment, girls who were interested in an engineering career faced four main challenges: 1) score-based allocation systems, 2) family influence, 3) undergraduate discrimination and 4) lack of training opportunities.

Consequently, girls' personal interests in mathematics and science subjects, in addition to skills such as problem solving and trouble-shooting, are not the only determinants of their career choice. Instead, features of specific education systems, such as the tracking system in Egyptian *thanaweya amma* or the public university allocation system (*tanseeq*) dictate that students' scores are more important than their interests and aspirations. In fact, even when students are able to enroll in an engineering college, they are still subjected to an undergraduate score-based allocation system to qualify them for their desired engineering major. Due to this, only seven participants were able to successfully enroll in the specific engineering discipline they targeted. The remaining 12 participants were influenced by rigid score-based allocation systems in addition to the absence of advising services.

Family influence also played a significant role in girls' choices before and during engineering education. Nine participants specifically cited their father's role (in addition to other members) in influencing their decision to join engineering, in general, or a specific discipline, in particular. Fathers stood out in participants' narratives due to the fact that they were engineering professionals who shared their experiences and passion with their daughters; thus, nurturing their skills and interests. However, family influence included neutral encounters when parents did not interfere in their daughter's academic and career choices, as well as negative interventions that hindered their daughter's ability to join her desired discipline. The grounds for family disapproval included fears regarding gender discrimination and lack of acceptance of female engineers in professional employment.

Validating these fears, the majority of participants underscored that their gender impacted their education experiences. During their undergraduate learning journey, they experienced gender-based discrimination in various forms including prejudice, bullying and marginalization. The perpetrators also included male professors, classmates and mentors alike. The specific encounters mentioned by the participants emphasized that differences in age, time, discipline or type of university did not prevent them from experiencing verbal harassment, alienation, or lack of quality practical experience. The consequence of these

encounters caused eight participating female engineers to feel unprepared for the labor market.

Moving on to the labor market experiences of female engineers in Egypt, it became apparent that engineering is a gendered and male-dominated field. A few engineering disciplines, such as architecture, challenge male hegemony of the profession however by accepting and demanding female engineers. Nonetheless, 13 out of the 19 participants were in so-called 'masculine' disciplines such as petroleum, petrochemical, mechanical power, mechatronics, civil and construction engineering. Their employment experiences within these fields included challenges such as: a) gender-based harassment, b) denial of legal rights and benefits, c) the conditioning of female employees to women's socially accepted roles in the private sphere and d) difficulty in navigating changes between public and private sector employment.

Gender-based harassment in formal workplaces included job advertisements and hiring processes rejecting eligible female candidates on the basis of their gender. It also manifested in the form of male superiors and persons of authority continuously undermining female employees' ability to perform, skills and relevance on the team. Instead, male employees could be prioritized in annual promotion assessments, on-site positions and with regard to the provision of services and facilities (i.e. lack of segregated bathrooms, caravans, among others). The resulting alienating working environments cause female engineers to either internalize these gendered dynamics or develop coping mechanisms to retain their positions. The fact that 13 participants cited 'culture' and 'mentality' and their Arabic translations: '*fekr*' and '*thaqafa'* emphasizes their serious influence on women's professional lives and ability to achieve work-life balance.

According to participants' input, their ability to achieve work-life balance was in some cases correlated to their employment sector. Female engineers from the older age group (40-65 years) represented the majority of participant examples of employment in the public sector and in academia. Based on their narratives, public sector employment is convenient for female employees, especially within the engineering field, due to shorter working hours, transportation services, sufficient maternity leaves, medical insurance, job security, and overall implementation of the labor law. Thus, female engineers from this age group were keen on highlighting the importance of maintaining work-life balance and their ability to do

so as a result of their public sector career. On the other hand, female engineers from the younger generations (25-35 years) represented participant examples within the private sector. Based on their experiences, the private sector represents more progressive employment with regard to the introduction of gender quotas and equality agendas. Although female engineers within the private sector still experienced many of the previously discussed labor market challenges, they were still keen to mention the advantages and benefits of working within this sector. Due to the halt on public sector employment, the private sector represents the alternative to formal, active and productive employment when gender inequality is addressed.

Aiming to find solutions to these aforementioned challenges, female engineers also suggested a few recommendations based on their personal experiences. These recommendations provided the basis for the overarching policy recommendations outlined in the final chapter below. Based on their encounters, female participants in this study highlighted the following recommendations to improve their status quo and promote more female-friendly working cultures for future generations: a) managerial level-support and acceptance, b) labor law enforcement and regulation and c) diversifying support systems. These specific recommendations were triggered by challenges they faced and arising solutions that improved their employment conditions. For example, managerial level-support and the acceptance of female engineers in male-dominated workplaces provided several participants with their first employment opportunity and the experience needed to continue in an engineering career with confidence and interest. Moreover, the majority of female engineers experienced varying degrees of law enforcement and regulation policies in their workplaces that impacted their sense of job security and work-life balance; hence, the need to enforce laws and regulations became an essential part of problematizing gendered employment and the persistence of gender-based harassment and discrimination. Lastly, due to the merge between different cultural and structural impediments, participants stressed on the need to diversify support systems and incorporate: career advisors, parents, spouses, children, colleagues and mentors to tackle all aspects and enablers of female marginalization and underrepresentation in the engineering profession in Egypt.

Chapter VI: Conclusion and Policy Recommendations

According to the findings of this study, female engineers in the Egyptian labor market experience a range of challenges and impediments to their career that are independent of their personal preferences. The externality of these challenges dictates the need to investigate their root causes and possible solutions to increase female labor participation in Egypt. Analyzing the individual cases of 19 female engineers, it becomes apparent that personal differences such as age, marital status, social background, type of university education or number of children do not play a crucial or determining role in women's education and employment experiences in the field of engineering. Instead, their gender commonality is the primary denominator impacting their lived encounters and dynamics throughout the three main stages of their career. Although progress is witnessed by the slight increases in female enrollment in engineering colleges and their employment in a range of private sector companies, as opposed to being limited to the public and academic sectors, they are still underrepresented in the vast majority of engineering disciplines and are marginalized in male-dominated and alienating work environments. Thus, the policy problem continues to exist due to the persistence and deep embedding of the cultural and structural factors discussed.

Building on the participants' suggested recommendations in the previous chapter, the overarching policy recommendations outlined below address the most recurring challenges experienced by all female engineers interviewed. As explained throughout this study, the challenges faced by female engineers took place in formal educational and employment establishments and could be divided into external influences impacting women's career choices and progression and existing gender-biased institutional structures that are embedded within engineering workplaces. Accordingly, in order to increase female engineers' participation in the formal and private sector, policy recommendations must address the merge between structural and cultural institutional factors at play.

6.1 *Start early: promote practical training and career advising*

To feel prepared for the labor market, female engineers need to be well educated and trained during their undergraduate learning journeys in engineering schools. Accordingly, a review and adjustment of engineering curricula is recommended to take place in private and

public universities to ensure the preparedness of engineering students before their release into the labor market. Since this study does not focus on the effectiveness of the educational material and pedagogy of teaching in engineering schools, the recommendation only relates to necessitating practical experience for every student and regulation of group projects, especially in disciplines with disproportionate male-female student ratios. Simply including a requirement that all students undergo a training/internship before graduating is not enough; instead, this training/internship could be facilitated by the university alongside the training entity.

However, this degree of coordination and supervision might not always be feasible for all universities, especially with budget constraints and large numbers of students in both private and public universities. Therefore, another *regulatory system* should be in place to ensure that students receive the necessary practical experience they need. This could be applied by requiring that students submit a mid-training report or presentation on key learning points, an end-of-training evaluation and the signed certificate with the number of training hours. Moreover, all universities could formulate collaborations and partnerships with a range of credible companies, authorities and establishments that include engineering work. Diversifying these collaborations will also be important to ensure students have access to internships, career fairs or trainee job shadowing opportunities.

Career guidance and counseling is also very important to help students identify their majors during their educational journey, rather than relying on a fixed scoring system to assess student's cognitive abilities. Including such services towards the end of the first year or beginning of the second year of education will facilitate the learning experience and help students identify the engineering discipline that is most suitable for their interests, goals and abilities. This advising process could also be repeated towards the end of their third year to underscore students' area of specialization and help them target employment opportunities through labor market mapping.

Starting with this policy might facilitate the transition to the labor market upon graduation and decrease the skills-mismatch commonly cited as a cause of unemployment or underemployment in the labor market. The mismatch is usually due to low quality education and lack of skilled labor; however, as apparent from this study's sample, the primary problem with the education system was the lack of practical experience and outdated theoretical

knowledge. Therefore, regulating a student's training/internship experience would be integral to improving their overall educational experience.

6.2 *Improving management and regulation systems*

Revolutionizing labor dynamics to increase female participation and retention in private engineering firms will require a multi-tiered approach that includes: a) improving management systems, b) promoting female-friendly policies and c) enforcing and regulating the application of labor rights and benefits. Starting with the improvement of management systems is integral as it determines the success or failure of other kinds of reform. Accordingly, the recommendation is to follow a top-down approach of policy implementation to ensure its success through the interconnection of all three pillars of reform.

To begin with, the improvement of managing systems is the first step because it is the most vital to the success of following steps. Without an updated, fair and transparent management system, all other recommendations will not be sustainable. However, due to the limited scope of this study, only one element will be addressed, which is the regulation of the roles, responsibilities and powers of authoritative management figures. This is due to the fact that almost all interviewees mentioned the role played by their manager in either facilitating and improving their employment experience or negatively impacting it by being the enabler or enforcer of their challenges and obstacles. The latter example was the most common as 13 out of 19 participants identified their manager as the source of challenges in addition to the overall working culture which is greatly influenced by the mindsets and preferences of authority figures.

The second step is to ensure that there is a regulation system in place to oversee and ensure that laws and policies are implemented and abided by. The presence of such a system will regulate the authorities of all management-level employees and create a system of checks-and-balances. This is to avoid the individual application of policies and lack of uniformity. This recommendation was also highlighted by several interviewees who experienced variation in their workplaces due to the lack of regulation and strict policy implementation.

6.3 *Promoting female-friendly policies*

Based on women's recommendations and the literature addressing low female participation, female-friendly (in some studies identified as 'family-friendly') policies are introduced to facilitate and ease women's employment experiences in the formal labor market. The point is not to widen the gender gap but to accommodate the needs and differences necessary to retain female employment in difficult working environments, especially in engineering sectors. The introduction of such policies is a way to either ensure the implementation of already existing gender-neutral law that are largely ignored or violated in workplaces or to introduce new policies targeting female employment and retention in gendered or discriminatory environments. Therefore, they are intended to fix or improve the current status quo identified by women's low rates of participation, especially among the educated groups.

The examples of female-friendly policies vary and they could include transportation services for all employees, to avoid the discouragement of female presence in far and remote working sites which is common in many engineering disciplines. The importance of introducing these policies as opposed to gender-neutral policies is that the latter could have unintended adverse effects on women's active participation. For instance, Assaad and Arntz (2005) discuss the impact of urban planning policies that incentivize the location of new industries in special economic zones located far away from populated areas in order to reduce urban congestion. They argue that, in reality, such policies could end up placing female employees who are less able to commute long distances to work in far or remote areas without the necessary supporting transportation services at a disadvantage. The problem here is not in women's inability to drive or the fear of remote areas, but in the additional burdens and financial costs associated with their safety, commute time, energy and work-life balance.

Another widely discussed female-friendly policy recommends shorter and/or flexible working hours and shifts. To avoid opposition which would mainly be driven by profit maximization efforts, other types of employment contracts could be introduced to increase employment opportunities and accommodate different needs (i.e.., part-time, job-sharing). Considering adjusting working hours in order to include more females in factories or on-site projects, morning and night shifts could be divided between employees with female engineers

occupying the former and male engineers alternating between morning and night shifts in teams of three or more engineers (to ensure that male engineers also have the opportunity to work during the morning shift and balance work-life). Due to carrying the double burden of work and family responsibilities, greater flexibility in working hours and contract types could be helpful policies implemented during times of emergency when female employees undertake multiple caretaking roles.

When adopted, this policy could also be universal and applicable to all employees when greater sympathy and consideration are required to promote better work-life balance. Universalizing the benefits of such policies to promote work-life balance and family-friendly working cultures would allow policy-makers to socialize the cost of female-friendly labor policies and spread the benefits to all. However, in current male-dominated and highly discriminatory workplaces, the introduction and application of these policies should initially focus on facilitating the employment of females.

6.4 *Fighting gender-based discrimination in the workplace*

As previously identified in the literature and from women's lived experiences in their education and employment institutions, gender-based discrimination takes several forms, with some more subtle and indirect than others. It could be in the form of asking personal and gender-specific questions during the interview process such as: *"are you planning to get married soon or are you planning to get pregnant soon?"* as encountered by colleagues of one of the interviewees. Or it could also be directly specified in a job advertisement. The fact that such hiring policies take place and are common in the engineering sector discourages many females from either enrolling in engineering or applying to jobs after graduation. This is due to the fact that such institutional culture and gender-bias is exported to female students as early as when they are in university. Therefore, job vacancy advertisements should only be accepted and marketed on career websites and job search engines if they do not include gender-specifications, especially when based on cultural stereotypes and accepted gender roles.

Changing the status quo involves both structural and cultural changes and adjustments to let go of traditional mindsets and working conditions that disable women from working in their field of study or balancing between work and life after marriage. The presence of

support systems is necessary to provide the assistance, guidance and validation needed to manage multiple responsibilities. Support systems are integral to sustain all other efforts and policies that are implemented to promote female participation. Without the support from within professional and private spheres, policies alone will not be sufficient to ensure the sustainability of gender-mainstreaming efforts.

6.5 Conclusion

In conclusion, this study aims to address the persistent policy problem of low female labor participation in productive employment sectors that require highly educated and skilled labor. The main purpose of the study is to investigate how national and international development goals such as: gender equity and achieving sustainable, inclusive, and knowledge-based economic growth necessitate the reliance on the full potential of the Egyptian labor force. In turn, the endorsement of female-friendly employment policies to increase women's active labor market participation is also addressed. More specifically, the focus is on one specific group of educated and employed or ever-employed women: female engineers. The focus on female engineers is to underscore that girls are interested, skilled and academically excelling in all subjects and areas of knowledge necessary to enroll in an engineering field of study but are limited by external factors. More importantly, after challenging existing systems and hindrances to their career choices, female engineering graduates are also interested and ready to commence their professional career within their discipline but are once again limited, marginalized and underrepresented within formal employment institutions on the basis of their gender.

As a qualitative study, the research methodology was centered on collecting data on the lived experiences of female engineers by conducting in-depth interviews with a sample of 19 female engineers from 10 different engineering disciplines (mechanical–mechanical power and mechatronics major–architecture, construction, civil, chemical, electrical, petroleum and petrochemical undergraduate programs). The sampling approach was first reliant on reaching out to personal and professional circles and then followed the snowballing technique to diversify the pool of participants. The utilization of qualitative tools is to underscore women's actual lived experiences through the presentation of raw data and commonly cited challenges experienced by the target group, in comparison to analyzing pure quantitative data to deduce

conclusions. Moreover, the data collection process was conducted in several phases, representing an evolutionary, semi-structured approach.

Using content analysis and coding to pinpoint the similarities and differences in participants' stories, the findings conclude that labor-market challenges are a result of gender-discriminatory education and working cultures that are embedded within institutional structures and their ensuing alienation of female employment. Relying on the chronological order of events was also utilized to underscore that female engineers experience challenges during three main stages in life: pre-university education, university education and employment. As the primary concern of this study is women's employment experiences, the findings show that engineering working cultures are characterized by: 1) hegemonic gender stereotypes and biases against female engineers in male-dominated disciplines, 2) a lack of assessment measures of gendered power dynamics in formal educational and employment establishments, 3) inconsistent enforcement of labor law and employment benefits, and the 4) absence of female-friendly policies and inclusive working cultures.

In order to tackle these persistent impediments, the following policy recommendations were highlighted: 1) promoting practical experience and career advising in undergraduate educational programs, 2) improving management systems in formal establishments to regulate power dynamics and the influence of authority figures, 3) granting rights and benefits in accordance to the 2003 Labor Law, 4) promoting female-friendly policies in workplaces, 5) banning gender-bias and discrimination and 6) strengthening support systems and services. Accordingly, it becomes apparent that the road to achieving gender equity and promoting gender-inclusive economic sectors in the formal Egyptian labor market will necessitate the continuation of state-led reform initiatives and introducing female and family-friendly employment policies in private establishments while abiding by labor regulations and national strategic goals. Adopting a sectoral approach and starting early will facilitate the process and unify individual efforts. In the end, the goal is to decrease gender imbalances in the Egyptian labor market, especially when females are interested, capable and aspiring to join vital economic sectors like engineering.

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Appendix: Interview Guide

1. Could you kindly introduce yourself (name, age, employment status, educational background, marital status, anything else you would like to share?
2. So, why did you choose to study engineering and your specific major?
3. How did you find the education system and your experience in college?
4. What was the female-male student and professor ratio?
5. Was there any kind of training/internship that you had to do to graduate?
6. Did you want to work right after you graduated?
7. If yes, did you feel prepared? If not, why?
8. How was your first employment experience?
9. Could you please describe the hiring process?
10. Where are you now and how satisfied are you with your career?
11. What are some of the challenges that you faced as a female engineer, if any?
12. Generally speaking, how would you describe the labor market from the point-of-view of a female engineer? Does it differ depending on the specialty/sector?
13. Personally, do you support female engineers to work in Egypt? Why or why not?
14. What do you think needs to change (policies, laws, habits) to encourage more women to study engineering or to find jobs upon graduation?
15. Are you able to balance between work and personal life? How so?