Can I Be An Engineer? Factors Influencing Women's Decisions to Pursue Undergraduate Engineering Studies in Lebanon (Fundamental)

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Can I Be an Engineer? Factors Influencing Women's Decisions to Pursue Undergraduate Engineering Studies in the Middle East and North Africa (MENA)

ABSTRACT

In Lebanon, an Arab country in the Levant, different institutional and cultural factors seemingly play a significant role in influencing women's decisions to enroll in undergraduate engineering programs. Additionally, there is a persisting discrepancy in the gender-based representation of students in specific engineering fields in the country. In this work, we aim to uncover key influences that affect young women's decisions to pursue undergraduate engineering studies in Lebanon. First, we conducted a survey during a student-led engineering summer program in 2024 at the Maroun Semaan Faculty of Engineering and Architecture (MSFEA) at the American University of Beirut (AUB), which is a large university based in Lebanon. The program aimed to introduce high school students to different engineering majors offered at MSFEA, in an experiential learning environment. The survey participants were 47 high-school female students coming from diverse regions and backgrounds in Lebanon. The survey included open and closed-ended questions addressing gender roles, family expectations, institutional influences, and other factors that may influence young women's decisions to major in engineering. Next, to analyze the collected and cleaned data, we adopted the grounded theory-building approach. We conducted a round of open coding, followed by focused coding. This allowed us to generate our findings inductively and directly from the raw data, and we further analyzed the former in the context of the Social Cognitive Career Theory (SCCT). We also conducted inter-rater reliability checks to bolster the research quality of our work. Our preliminary findings indicate that stereotypes, exposure to women engineers' experiences, and the perception of certain engineering fields as male-dominated influenced women's decisions to pursue engineering studies. Additionally, high schools, universities, the media, and governmental policies were perceived as influential factors by the female survey respondents. These diverse cultural and institutional influences seemed to impact women's decisions to apply for and pursue undergraduate engineering studies both negatively and positively. Moreover, young women seemed to favor a major over another based-on job market prospects and particular encouragement from parents and educators to justify their preferences. Finally, we discuss the implications of our findings on the roles of different stakeholder entities involved in young women's undergraduate education decisions. We also propose recommendations for high schools and university outreach programs to improve the inclusivity and appeal of undergraduate engineering programs to young women applicants in Lebanon specifically, and in the MENA region more broadly.

1. Background

1.1 Related Work / Literature Review

Our research explores the factors influencing women's enrollment in engineering majors, focusing on the impact of institutional and cultural dynamics that vary across global, regional (Middle Eastern), and local (Lebanese) contexts. The engineering majors available at the American University of Beirut (AUB) under the Maroun Semaan Faculty of Engineering and Architecture include Computer and Communications Engineering (CCE), Computer Science Engineering (CSE), Electrical and Computer Engineering (ECE), Industrial Engineering and Management (INDE), Mechanical Engineering (MECH), Chemical Engineering and Advanced Energy (CHEN) and Civil and Environmental Engineering (CIVE). Our study builds on existing research that examines the roles of social norms, governmental policies, high schools, and university influences in changing the perception of high-school women students towards engineering in general.

1.1.1 Global Trends

Globally, women's representation in engineering varied across countries in the Global South and Global North [1], and among developed countries (Eastern Europe, Islamic, Asian) versus undeveloped countries [2], widening the plausible sociocultural and economic factors contributing to the gender gap in engineering. Notably, in 2015, only 30% of the female population across 110 nations in both the Global North and Global South were interested in a STEM undergraduate program, 8% of which were driven towards engineering [3]. In Taiwan, for instance, women constituted about 13% of the engineering workforce [4], while in Canada only 20% of engineering students were women in 2022 [5]. In France, women represented 23% of the engineering student population, compared to 63% in social sciences and law [5]. Similar underrepresentation was observed in the United States and Malaysia in 2019 with engineering being viewed as incompatible with women's identities (personal and professional), and incompatible between family life and work [6]. This underrepresentation of women was further verified within specific engineering majors. A survey conducted on 974 students in Atlanta, United States, revealed that Industrial and Chemical Engineering had the highest female enrollment [7]. In contrast, a survey of 531 women in Taiwan highlighted Mechanical Engineering as having the lowest female representation [4].

Cultural norms, societal expectations, and parents' influence were reported among the main factors shaping women's participation in engineering. The gender segregation of activities, and home chores at an early age initiated a biased mindset urging children to associate technical professions with men [3]. This was further reinforced by the fact that children significantly develop their values and identities based on parental interactions and beliefs [8]. Some parents in American and European cultures provided more support and encouragement for sons rather than daughters to major in engineering [9]. The existence of strict gender norms in engineering domains created an environment where women who deviate from traditional gender duties were criticized, while those abiding by them were objectified [3]. Early marriage and balancing family life with an engineering career were examples of such societal constraints that discourage women from pursuing engineering careers [1, 3].

Educational institutions, such as schools and universities, critically influenced career choices. It was reported in 2015, that the university admission processes in Tunisia and Iran were solely based

on grades, limiting students' personal choices and interests [10, 11]. Research has also noted how teachers' attitudes toward engineering careers and beliefs pertaining to gender and career capabilities greatly impact students' career choices [12]. Moreover, research conducted in New Zealand discussed how some high schools lacked proper and effective career guidance programs that were deemed necessary when students were choosing their college major [6]. Academic communities and international conferences embraced the importance of women's representation in engineering by adopting topics pertaining to women as main session themes [3].

The gender gap in engineering, although shrinking, may extend into the professional sector with some women globally reporting challenges related to gender disparities [13], peer pressure [6], and financial barriers [3]. Some women engineers faced social stigma in the engineering industry [14, 15, 16, 17], including access to male-dominated networks, negative attitudes from male peers [6], and some degree of underestimation of women's skills [6]. Financial barriers were additional challenges that could be still faced by women in engineering in some disciplines and countries, where women reported lower pay in comparison to their male colleagues [18].

Given the above challenges, governmental policies and legislations have been introduced to alleviate gender disparities. For example, in 2019, the Taiwanese and American governments, in cooperation with local non-profits, introduced a new legislation to promote equality in education and in the workplace [15].

1.1.2 Trends in the Middle East and North Africa (MENA)

The Middle East and North Africa (MENA) region, known for its rich cultural heritage and diversity, incorporates numerous interconnected and dynamic factors that influence women's choices of undergraduate majors. Notably, in 2021, the representation of women in engineering varied across MENA countries. Algeria, Tunisia, and Morocco achieved female engineering graduate rates of 48.5%, 44.2%, and 42.2%, respectively [19]. In contrast, several members of the Organization for Economic Co-operation and Development (OECD) reported lower enrollment rates, including France (26.1%), United States (20.4%), and Canada (19.7%) [19]. The results in UNESCO's 2024 Report on women under-representation in scientific studies and professions on G20 countries (Argentina, Australia, Brazil, Canada, China, France, Germany, India, Indonesia, Italy, Japan, Mexico, Russia, Saudi Arabia, South Africa, South Korea, Turkey, United Kingdom, United States and European Union), show a 35% of women representation in STEM, 29% in information and technologies, and 26% in engineering [20]. This representation further varies among different engineering disciplines within the same country as well, where Civil Engineering and Mechanical Engineering were considered by students at Qatar University as male-dominated fields while Chemical Engineering and Industrial Engineering were considered welcoming to all genders [21].

Cultural norms, societal expectations, and parental influence play a significant role in shaping women's choices of undergraduate majors in the MENA region [22, 23, 24, 25, 26, 27]. In some MENA countries, women were viewed as dependent on men [28], with their primary duties limited to household chores, childcare, and husband support [29, 30]. Recent work by El Said et al. [29] highlights this gender disparity, quoting a Saudi female Computer Engineering student who was pressured by her fiancé to select a major leading to a more socially acceptable teaching career, under the risk of separation [31].

It is reported that parents have a strong influence on the selection of university majors of Qatari women [32], United Arab Emirates (UAE) high school girls [33], and Palestinian girls [34], which can either hinder or encourage their enrollment in their major of choice. For instance, Eman Martin-Vignerte shared her journey as an Arab electrical engineer born in Qatar, working in the automotive industry. She discussed the pivotal role her father played in supporting her education and encouraging her to study abroad at the University of Paderborn/Ulm in Germany [35]. This support inspired her to help other Arab women aspiring to pursue careers in engineering. Other parents discouraged their daughters from pursuing engineering. Aldossari recounted the stories of young women in Saudi Arabia, including an accounting graduate who was forced by her father to work in a female-only sector despite lower payment, another participant who prioritized her family acceptance over governmental support, and a third participant who emphasized that family satisfaction was more important than legal entitlements, reinforcing that even if engineering was considered a viable option supported by policies and legislations, some students would still prioritize their family's choice and align their decisions with their family's preferences [31].

Apart from parents' influence, educational institutions, such as high schools and universities, play an indispensable role in shaping students' aspirations in the MENA, with teachers exerting key influence in fostering interest in engineering disciplines. In fact, many high schools in Saudi Arabia did not offer courses or introductory programs to inform students about all available undergraduate programs and career prospects [31]. Based on the High School Longitudinal Study (HSLS) implemented in 2021 in the US, students were often given advice on which major to choose based on grades solely, while disregarding students' interests [36]. Teachers, of similar cultural backgrounds to their students, can positively influence students' perception of engineering. For example, some teachers in Saudi Arabia led free pre-university courses to encourage students to consider STEM majors [31], while other teachers in some European countries (Spain, Italy, Austria, Germany, Czech Republic) reinforced gender bias [37] by perceiving engineering as a male-dominated field and advising girls to major in what they described to be female-oriented traditional fields, such as nursing and teaching [38]. Engineering majors in the MENA region have been associated with gender disparity [39], underestimation of women's creative and problem-solving skills [5, 40], and lack of female role models [29]. This gender inequality was worsened by societal obligations, inaccessibility of resources, and lack of women-centric initiatives impacting women's education and future career life [31].

Governmental initiatives and policies to enhance women's representation in engineering remain relatively limited in the MENA region [29]. At the international level, the United Nations have proposed initiatives to shape national policies influencing women's participation in higher education [41]. However, some countries in the MENA region have fallen short in implementing or following through on the effective execution of these policies [42].

The United Arab Emirates (UAE) government, for instance, launched software platforms to promote gender equality in STEM after a collaboration between the UAE's Federal Ministry for Family Affairs, Senior Citizens, Women and Youth and the Federal Ministry for Employment and Social Affairs aiming to alleviate gender stereotypes in all career and study paths for girls and boys from the pre-primary level till university [33].

Lebanon, a country in the MENA, has one of the best educational systems in the Middle East with its graduates being the core of higher education engineering institutions in the Gulf and the region

[5, 40]. Despite this, there still exists a lack of comprehensive studies regarding the representation of women in engineering undergraduate programs, the cultural factors contributing to their underrepresentation, and the variation in female enrollment across the various engineering disciplines in Lebanon. This gap in research highlights the need for further investigation, which aligns with the objectives of our study.

1.2 Related Theories

In this study, we adopted the Social Cognitive Career Theory (SCCT) to examine the factors influencing women's decision-making process when transitioning to engineering studies in higher education. SCCT is a robust framework that analyzes factors influencing individual career decisions and behaviors, while emphasizing the interplay between personal, behavioral, and environmental factors [43, 44].

SCCT targets three dimensions of career development: (i) the development process of basic academic and career interests, (ii) the decision-making process of educational and career choices, and (iii) the path to success in academics and career [45]. The theory incorporates various concepts such as interests, abilities, and values from earlier career theories that are interconnected with career development [45]. SCCT asserts that career choice intentions and behaviors are overseen by three intricately linked variables: self-efficacy beliefs, goals, and outcome expectations [43]. SCCT emphasizes the role of psychological, social, and economic factors [46] as well on individual career decisions. According to SCCT, goals are categorized into two types: choice goals, which focus on selecting activities, and performance goals, which emphasize achieving specific outcomes [45]. We chose SCCT as a systematic framework that combines cognitive, personal, and environmental variables to understand how female high school students choose their majors, ultimately shaping their career paths and professional development.

Several studies that use the SCCT theory on the topic of women-centered research studies in engineering and STEM are available in the literature, such as the work of Kiernan et al., which explored the barriers that deter women from choosing STEM disciplines at the post-primary education level. Ortiz-Martínez et al. identified factors contributing to the retention or abandonment of STEM careers by women in higher education based on SCCT while offering insights into the challenges faced by women students in STEM fields [47]. Moreover, systematic literature review by Verdugo-Castro et al. examined the persistent underrepresentation of women in higher education STEM fields, specifically in Europe, leveraging SCCT as a theoretical lens to provide a comprehensive understanding of the multi-dimensional factors influencing women's decisions in STEM education, including gender stereotypes, social influence, and self-perception [48].

1.3 Our Context

Lebanon is characterized by historical factors, which influenced its political and socio-economic landscape. Internally, Lebanon’s stability is currently affected by regional conflicts, highlighted by the influx of Palestinian and Syrian refugees [49] in millions and the Lebanese infrastructure’s inability to accommodate these large numbers. Moreover, worsening sectarian divisions are threatening the country’s safety and stability [49]. Lebanon’s education system, on the other hand,

reflects the discrepancies in the socio-political structure, where private schools often offer high-quality education, compared to underfunded and struggling public schools [50].

In 2019, Lebanon witnessed an uprising and protests against political corruption and the absence of governmental services. Shortly after, the Beirut explosion in 2020, due to governmental negligence, destroyed a huge portion of the capital and killed, injured, and displaced thousands of Lebanese citizens. Lebanon has also recently witnessed an unprecedented economic crisis, hyperinflation, and drastic electricity cuts. These events are examples of governmental disregard for citizens and of corruption [51].

The Lebanese higher education system still entails significant gender discrepancies in engineering. For instance, the average enrollment of women in the sciences across universities in Lebanon was 54% in 2018, compared to 25% of women enrollment in undergraduate engineering programs at nine major universities (Lebanese University, American University of Beirut, Saint Joseph University, Lebanese American University, Beirut Arab University, Balamand University, Notre Dame University, Holy Spirit University of Kaslik, Lebanese International University) [52]. In remote or more rural communities, cultural factors may further reinforce these discrepancies in representation by instilling traditional gender roles from an early age, with societal expectations sometimes encouraging women to take on primary roles as caretakers. Such beliefs, although becoming less prevalent, were highlighted in a study conducted in 2015 that explored the socialization of Lebanese men's attitudes toward gender equality, revealing that qualities like taking care of the family emerged under the concept of the "ideal" woman, while education and personal achievements were rarely enlisted under this concept [53]. However, it is worth noting that such beliefs are becoming less prevalent.

In this work, we elicit insights from 47 female participants in the summer engineering program at the American University of Beirut to explore the cultural and institutional factors that influence women's decisions to pursue undergraduate degrees in engineering in Lebanon.
We aim to expand the body of literature on women's representation in engineering in the MENA region in general and Lebanon in specific, understanding the factors influencing the discrepancies among various engineering fields, and to suggest interventions that upon implementation would support more gender inclusive engineering education in the region.

2. Research Questions

The decision-making process for women pursuing engineering has been extensively studied in global contexts. However, there is a lack of research focusing on Lebanon and the MENA region, where institutional and cultural factors vary. This gap becomes particularly significant when considering not only the general gender disparity in engineering but also the reasons behind women's tendency to favor certain majors, such as Chemical Engineering, over others. Addressing this gap, the questions that guide our research are the following:

1. What are the primary cultural factors that influence women's decisions to pursue engineering in Lebanon?
2. Which institutional organizations (e.g., media, universities, high schools, government) play a role in shaping women's decisions, and how are their impacts portrayed?

3. What key recommendations and initiatives could be implemented to reduce the gender gap in specific engineering disciplines in Lebanon?

3. Positionality

Our research team is composed of four Lebanese women: the principal investigator, co-investigator, and two research assistants, who all share similar backgrounds and roots at AUB. The team brings forward knowledge and diverse expertise in engineering education, women empowerment, and gender-inclusive mentorship. Elsa Maalouf is an assistant professor in Chemical Engineering at AUB and the lead of the Pipeline and Mentorship initiative that supports women in engineering and offers mentorship to university students until after they graduate. Aya Mouallem is a Computer Engineering alumna of AUB and a current PhD candidate in Electrical Engineering at Stanford University, where she conducts engineering education research. She founded All Girl Code, an award-winning initiative, to support young women in STEM in the MENA via free hands-on programming and mentorship. Rasha Malaeb is an undergraduate research assistant and is pursuing a Computer Engineering undergraduate degree at AUB. Jana Sabra holds a Master's degree in Energy Studies from AUB and is the current director of All Girls Code. As such, the research team brings forward diverse backgrounds, similar connections to AUB and its engineering faculty, and overlapping Lebanese lived experiences.

4. An Overview of Summer Camp Program

The American University of Beirut launched the Pipeline and Mentorship Initiative in 2019 to offer more structured and formal guidance and mentorship to female high school students when choosing their university major. The initiative organized events that equip high school students with foundational skills in engineering disciplines and offer mentorship opportunities for students from all over the country. The initiative also partnered with the Amazon Industry Program for undergraduate female students to learn software development, product design, and machine learning from women engineers at Amazon. Moreover, the initiative offered a four-year scholarship program that has funded ten female engineering students since 2020. The initiative's flagship offering, from 2022, is an annual high school engineering summer program, introducing various engineering disciplines via hands-on activities to high school women. The program was piloted in 2022 with 30 women high school students and grew in 2023 to welcome 300 students over 3 days in the following years. In August 2024, the program welcomed 300 public and private high school students of all genders from different Lebanese regions, to tackle the country's most pressing challenges through engineering and design. This study was conducted during the 2024 summer program.

5. Methods

5.1 Data Collection

With the target sample being the high school participants in the summer program, the data for this study were collected through an online survey disseminated after the program. The survey was thoroughly developed and tested by research team members to cover key aspects of the study. The data was collected over two weeks after the study received the Institutional Review Board (IRB) approval ensuring all ethical standards were met. The consent of participants and their parents was

obtained for voluntary participation. The survey included both qualitative, open-ended short questions, quantitative, and multiple-choice questions focusing on interests in engineering and factors influencing women's decisions to pursue engineering majors. A sample of the survey questions is available in Appendix A.

5.2 Data Analysis

After collecting the data, we utilized the grounded theory approach to generate and analyze our findings. The grounded theory approach is a widely used methodology for qualitative research [54, 55]. It entails iterative and inductive analysis for hypotheses to emerge from the raw data itself [54]. The qualitative data collected from the open-ended questions were coded as the first step of the data analysis. Coding refers to the method of systematically labeling and organizing the collected data after reviewing the survey responses and assigning keywords and codes. Next, we identified patterns, themes, and relationships among the different codes. The codes were initially generated inductively in an open coding approach allowing as many codes as possible to emerge from the responses. Open coding was followed by focused coding, in which the codes were merged, modified, and refined for clearer clustering into emerging themes. An excerpt of the codebook presenting the main codes, sub-codes, definitions, and in-vivo examples from the survey responses is provided in Table B1 in Appendix B.

5.3 Validity

We employed several strategies to improve the validity of our qualitative research. Four researchers on the team completed the interrater reliability (IRR) process, during which they coded several in-vivo examples that were randomly sampled from the collected data. The random sampling strategy was chosen to avoid prioritizing certain themes, thus eliminating potential selection bias [56]. After coding these samples, the researchers gave their feedback on the codebook, including comments on the clarity, repetitiveness, and relevance of certain codes and subcodes. The IRR statistical method adopted was Krippendorff's Alpha, as it is suitable for qualitative data, works for any number of raters, allows for complexity beyond a simple one-to-one code-data mapping, and handles missing data [57]. The Krippendorff Alpha was calculated using the open-source K-Alpha calculator [58] which was introduced and validated by Marzi et al. [58].

The Alpha value obtained for our codebook was 0.845, larger than 0.8 thus indicating a satisfactory level of agreement and demonstrating reliable results. Moreover, feedback from all the authors was integrated in revising the codebook.

In addition to IRR, we adopted "investigator triangulation" by involving four researchers in the survey design, data collection, and data analysis processes. We also used *low-inference descriptors*, preserving participants' use of language and terminology word by word, especially in the discussion of cultural and lived experiences, to avoid any researcher bias in the analysis and writing processes [59, 60].

6. Findings

Cultural and institutional factors significantly influence women's decisions to pursue engineering in Lebanon and their choice of discipline within the field. Cultural norms, stereotypes, exposure to engineers, the perception of engineering as male-dominated discipline, and parental expectations were the factors that seem to influence the high-school girls who participated in the survey when choosing their majors. Institutions, teachers, outreach initiatives, media, and governmental policies also have an impact on their decision. These factors are explored and analyzed in the subsequent sections.

6.1 Cultural Norms

6.1.1 Stereotypes and their Impact

Stereotypes play a significant role in shaping perceptions of engineering as a viable career choice for women. 64% of participants acknowledged the presence of gender stereotypes in their society influencing their selection of university majors. When asked about the challenges women face compared to men in the engineering field, P40 stated, *"I feel like some people create stereotypes that engineering is mostly for men, I even sometimes think that way."* Some participants highlighted that certain majors are stereotypically seen as gender-specific, as shared by P44, "*Gender roles have steered men toward technical and science-based careers, while women were often encouraged to pursue roles considered more nurturing or artistic,*" and by P11, "*Some women may be influenced by outdated societal beliefs that engineering, (especially civil and mechanical engineering) are more suitable for men.*"

Participants were surveyed about their opinions on the "suitability" of engineering fields based on gender, as reflected in the quantitative survey questions 15–20 in Appendix A. The responses, summarized in Table 1, reveal that while most participants believed all engineering majors are suitable for all genders, a closer examination showed some disparities. For most majors, the percentage of participants who deemed them "men only" exceeded those who considered them "women only," with the exception of Chemical Engineering (CHEN). In contrast, Electrical Engineering (ECE) was the only major that none of the participants identified as exclusively suitable for women. According to Tables 2 and 3, ECE was considered the third least interesting major and the last most interesting major, however, CHEN was the fourth least interesting major and the third most interesting major.

6.1.2 Exposure to Engineers

Exposure to engineers of both genders influences the perception and understanding of different engineering fields among high school female students. However, consistent exposure to male engineers is more common as mentioned by P2, "*We can see nowadays most of the employed people in engineering are males,*" by P29, "*My dad is also an engineer,*" by P16, "*I believe that it is because most of the engineers around me are males,*" and by P28, "*Historically, it was male-dominated because almost every engineering graduate is a man.* "

Other participants commented on their exposure to women engineers compared to men, particularly within their family circles, as highlighted by P11, "*I also see many successful female*

engineers. For example, my cousin studied at AUB and then in Cornell university, graduated top of her class, and received job offers," by P15, "*My family is mostly engineers, so it happened naturally that I followed my family's track in liking engineering,*" and by P18, "*My mother pursued a major in [Computer and Communications Engineering], and her love for what she does has inspired me to stay open to different majors in the future.*"

Table 1. Survey participant's answers (Question 15-20 in Appendix A) when asked about their thoughts on engineering majors being more suitable for men only, women only, or all genders (The total number of responses is N = 47)

Engineering Major	Engineering is for men only (count)	Engineering is for men only (%)	Engineering is for women only (count)	Engineering is for women only (%)	Engineering is for all genders (count)	Engineering is for all genders (%)
Civil Engineering (CIVE)	7	14.89%	2	4.26%	38	80.85%
Mechanical Engineering (MECH)	3	6.38%	2	4.26%	42	89.36%
Electrical and Computer Engineering (ECE)	6	12.77%	0	0.00%	41	87.23%
Computer and Communications Engineering (CCE) / Computer Science Engineering (CSE)	2	4.26%	1	2.13%	44	93.62%
Industrial Engineering (INDE)	2	4.26%	0	0.00%	45	95.74%
Chemical Engineering (CHEN)	0	0.00%	8	17.02%	39	82.98%

The lack of female role models was another significant factor highlighted by participants such as P7, "*All my life I never knew it was an option for me until I saw a female engineer in a TV show 2 years ago,*" by P23, "*When we enter a course for engineering, we see a lot of men, and only like 5 or 10 women,* " and by P44, "*Lack of female role models in engineering and the underrepresentation of women in STEM (Science, Technology, Engineering, and Mathematics) education perpetuated the cycle, making it difficult for women to break into the field.*"

Table 2. Ranking of least interesting engineering majors by survey (Question 12 in Appendix A) participants (N = 47)

Least Interesting Major	Participant (count)	Participant (%)
CCE/CSE	14	29.79%
CIVE	13	27.66%
ECE	7	14.89%
INDE	5	10.64%
CHEN	5	10.64%
MECH	3	6.38%

Table 3. Ranking of most interesting engineering majors by survey (Question 2 in Appendix A) participants (N = 47)

Most Interesting Major	Participant (count)	Participant (%)
CCE/CSE	11	23.40%
CIVE	10	21.28%
CHEN	9	19.15%
MECH	8	17.02%
INDE	6	12.77%
ECE	3	6.38%

Participant 22 pointed out the notable gender gap decrease in engineering through the years while emphasizing the presence of male dominance in the field. She stated, "*I do believe that nowadays the male dominance in this field has decreased significantly but still we can't deny the fact that it is still present at least based on my surrounding community.*"

When asked about the importance of the representation of women in engineering, 63.83% of the participants said it has a significant impact, while 21.28% said it does not have any impact, as shown in Table 4. This result is echoed with a consensus when asked about the influence of the exposure to successful women engineers on the choice of major. All participants agreed that "It can inspire and motivate women to consider engineering". Finally, when asked about the effect of having more female engineering role models on their decision to enroll into an engineering major, 87.23% of the participants agreed that it plays a key role while the rest felt it had no influence.

Table 4. Responses of the survey participants to Question 4 in Appendix A, when asked about the importance of the exposure of participants to women in engineering (N = 47)

Impact Level	Impact of Women's Representation (count)	Impact of Women's Representation (%)
Significant impact	30	63.83%
Impacts but is not significant	5	10.64%
It does not matter	10	21.28%
Uncertain about its importance	2	4.26%

6.1.3 Perception of Engineering as a Male-Dominated Field

Participants were asked whether they believed engineering is a male-dominated field. 36% of participants selected engineering as a male-dominated field, 55% selected it is not, and 9% selected that they are unsure.

The perception of engineering as a male-dominated field was largely attributed to the persistence of an "old mindset," which continues to influence high school students as shared by P19, "*We are literally in 2024, where is the gender equality between women and men, years passed and still people have this mindset,* " and by P12, " *In the past, societal norms dictated that men were more suited for roles involving math, science, and physical labor, while women were encouraged to pursue domestic roles or careers in caregiving and the humanities.*"

Another reason engineering was considered as a male-dominated field was cultural expectations and societal norms as elaborated on by P29, "*Because of social expectations, it is more likely for a male to find a well-paying job than a female,*" by P33, "*Cultural expectations further reinforce the perception of engineering being a male-dominated field,* " by P44, "*Traditionally, societal expectations and gender roles have steered men toward technical and science-based careers,* " and by P23, "*Many people say engineering is just for men, it isn't the work of women. Women should not study in this field. In the past, it was just a male-dominated field."* Other participants touched upon stereotypes and the perception of engineering as a male-dominated field, as mentioned by P5, "*I agree that engineering is a male-dominated field because it has become a stereotype that whenever you mention an engineer, people assume that you're talking about a male,*" and by P15, " *It's known since forever to be male-dominated and since engineering falls between the hands of the stereotype,*" which is further relevant to the findings presented in section 6.1.1.

On the other hand, several participants did not consider engineering to be a male-dominated field, due to a positive shift in mindset. P6 shared, "*The idea that engineering is only a specialty for men has become an old idea that is only recognized by the elderly, and girls in our time have become certain that passion is the only one capable of determining her specialty, and it no longer can influence her decision, especially since awareness of this topic has become widespread."* P38 mentioned, "*Males cannot dominate engineering because there is a large and effective role for women in engineering,*" and P10 added, "*Personally, I don't think that engineering is a male-dominated field. Whether you are a female or a male you can pursue your dreams in any field that you like and specifically engineering. All of us are equals.*"

6.1.4 Family and Social Support Systems

The presence of support systems plays a critical role in influencing students' decision to pursue engineering; 73% of participants in the study rated "support" as being indispensable for their choice of major. The lack of support from families and schools created barriers to pursuing engineering studies as shared by P8, "*Women get a lot of criticism when they choose that field, whether it's from parents, classmates, or their environment in general,* " and by P19, "*We can see that society always has a role in influencing women to never even consider this major which should be a shame.*"

According to the participants, parents can play either supportive or discouraging roles in their daughters' choices to pursue engineering. Supportive parents enroll their daughters in engineering programs during their high-school years as shared by P34, "*They expose their daughters to engineering activities and connect them with female role models,* " and by P8, "*They encourage their children by buying them books on engineering their child is interested in, sending them to camps, and buying them supplies for their kids to experiment at home (ex: computers for aspiring computer engineers).*"

Parents, with prior experience in engineering, tend to encourage their daughters to explore the same fields as elaborated on by P40, "*We all know that most parents think of their child/children as mini versions of themselves and when it comes to their career path, most of the time they would want their child/children to choose the same major,*" by P32, "*Supportive and informed parents can play a key role in helping their daughters overcome challenges and develop a strong interest in engineering studies,* " and by P4, "*Parents believe that they know best so they can advise and guide her into choosing a proper major.*"

Participants further emphasized the role of parents in nurturing their daughters' self-confidence and problem-solving skills as shared by P12, "*Parents' support, encouragement, and the environment they create can shape a young woman's confidence,*" and by P7, "*Parents can help by teaching their daughters to ignore the stereotypes, and by supporting them in their decisions*." P47 additionally mentioned "*Parents can support their daughters' ambitions by fostering a growth mindset, promoting problem-solving skills, and emphasizing the importance of perseverance in achieving their goals*".

When asked to reflect about the influence of parents, participants further highlighted the possibility of societal pressure exerted by parents on their daughters regarding pursuing engineering. P3 shared, "*Parents can tell their daughters that engineering is for men mostly and not for women."* P7 added, "*Sometimes they share their wrong perception of things in engineering and project it onto their child,*" and P40 stated, "*Parents will begin to give them negative feedback on why they shouldn't pick engineering.*"

6.2 Institutional Roles

6.2.1 Workplace Culture, Requirements and Opportunities

Participants believe that workplace conditions influence women's decision to pursue a career in engineering. Some participants expressed that salary discrepancies between men and women continue to be a major barrier, as discussed by P12, "*As a woman engineer I believe I might encounter a handful of challenges just like gender bias, workplace culture, lack of representation, and pay gap,* " and by P23, "*I read that especially in the engineering field, a company would give women work more than men and harder work but they would still give them lower salaries than men.* "

Gender bias in the workplace can further worsen women's experiences especially when women are overlooked for leadership roles. Workplace norms that favor male colleagues were discussed by P33, "*To me, engineering is a male-dominated field due to gender imbalance, which is visible in both educational settings and the workforce, where men outnumber women,*" by P44, "*This*

male-dominated environment also led to the development of workplace cultures and networks that were often less welcoming or inclusive for women," and by P23, "*If an amazing idea for a project or anything that a woman came up with, they would give the credit to men and the woman's hard work would go for nothing.*"

Participants believing that engineering is a demanding career affected their decisions. Some pointed out that the long working hours often associated with jobs in engineering can discourage women (Table 5), particularly those who anticipate balancing family responsibilities with their careers in engineering, as reported by P11, "*Engineering is male dominated in the job market because the working hours are generally long, which is not typically preferred by women.*"

Table 5. Survey responses to Question 10 in Appendix A, regarding the factors that may influence female high school students' choice of major (N = 47)

Factors Influencing Decision Making	Yes (count)	Yes (%)	No (count)	No (%)
Negative feedback from surrounding	6	12.77%	41	87.23%
Culture and social norms	10	21.28%	37	78.72%
Technical and non-technical skills	12	25.53%	35	74.47%
Financial abilities	25	53.19%	22	46.81%
Discouraging atmosphere within the university	4	8.51%	43	91.49%
High school influence during fairs	10	21.28%	37	78.72%
University open days	16	34.04%	31	65.96%
Demanding (long) working hours	8	17.02%	39	82.98%
Lacking information about engineering	14	29.79%	33	70.21%

Others highlighted how engineering is viewed as requiring physical strength and hands-on fieldwork, which could limit female participation. P28 shared, "*Civil Engineering requires building roads and holding heavy equipment. I think that this specific field in engineering is more likely for men than women because they can hold these weights more than women, but I think that by the collaboration of the two of them in this field, they can succeed in it.*" These job requirements align with traditional cultural beliefs that underestimate women's ability to engage in physical, on-site tasks which were further emphasized by P20, "*I might be underestimating, especially since Mechanical Engineering is a very hands-on career and certain people may not find that suitable for a woman,*" and by P34, "*The demands of engineering roles, especially in certain sectors like construction or manufacturing, can be intense, with long hours and on-site requirements.*"

Other participants expressed concerns about limited opportunities for female engineers, particularly in leadership or high-profile positions, as shared by P29, "*My dad is encouraging me to become a lawyer instead of an engineer because women in engineering are not ensured to find a proper job,*" by P5, "*I believe I may face difficulties in being employed because most people tend to trust male engineers more especially in our Eastern communities,*" and by P6, "*There are some companies that prefer to employ men in this field.*"

However, some participants might choose a specific engineering discipline instead of others due to job perspectives and versatility. For example, P44 reported, *"Civil Engineering's versatility and the broad range of career opportunities it presents, from structural to environmental engineering, also played a significant role in my decision.*" P4 wrote, "*Prior to the Engineering Day I didn't know much about Chemical Engineering, but after I got introduced to it, I realized that it is a wide field in which I can get diverse job opportunities which is what I'm looking for.*" P19 referred to Chemical Engineering as "*a useful major, and can be in demand in the future, especially since Petroleum Engineering is part of it.*" P20 leaned towards Mechanical Engineering by stating, "*I chose this major since it opens up many opportunities, especially in the aerospace field,*" and P6 reported that she likes Civil Engineering as there exists an "*increasing demand for this major, especially in the [Arab] Gulf labor market.*"

6.2.2 Universities

Participants mentioned the need for universities to support initiatives such as organizing events and women-focused talks, which provide inspiration and foster a sense of belonging for women. 83% of the participants rated "Organizing online webinars" as a key initiative universities can implement to inform high school women about engineering and expose them to role models as shared by P24, "*Universities can play a noticeable role in influencing students' choices by providing orientation programs and camps to help them learn more about engineering,*" by P31, "*Inviting high school girls to the university and introducing them to all the engineering majors, by bringing experts to explain the reality of the major and its impact on society,*" and by P47, "*Universities can offer workshops and seminars that address gender biases and promote the achievements of women in engineering.*"

Scholarships and financial support were identified as support strategies to alleviate economic barriers, encouraging women to pursue engineering. These strategies were shared by P19, "*They can offer to the women in engineering a full scholarship throughout their study years and that can help them realize their dreams even when facing financial difficulties,*" and by P32, "*They can create a supportive and inclusive environment by offering scholarships, mentorship programs, and outreach initiatives specifically aimed at encouraging women to enter engineering fields.*"

The importance of creating a welcoming and supportive environment to further attract women towards engineering was elaborated on by P12, "*They can create a welcoming and supportive environment, provide resources, and actively encourage women to consider and succeed in engineering fields,*" and by P47, "*By creating an inclusive and supportive environment, universities can encourage more women to enter and succeed in the field*."

Challenging stereotypes through awareness campaigns and initiatives was another aspect of universities' influence shared by P29, "*They can spread awareness that today, the stereotypes concerning gender and engineering are false,*" and by P15, "*They should probably put more women to talk about engineering and they should raise awareness about the struggles of women in this field*." This was further demonstrated by 73% of participants expressing that universities should offer sessions on financial aid and scholarships to inform students about available opportunities, which in return would reduce the financial burden on their families while pursuing their engineering degree.

6.2.3 High Schools

Instead of nurturing students' interests, schools were perceived by some participants as prioritizing academic performance, advising students solely based on grades rather than their aspirations or potential. This was elaborated on by P3, "*In school they focus on degrees not what the student's loves,*" and by P23, "*They just look at the grades and let the grades define the student, if a student has high grades, they advise the student to go med for the high grades, but they don't really care about what we love and what we want to do or what we are passionate about.*"

Participants were asked about the impact level of their exposure to STEM activities in high school on their decision to study engineering. Table 6 reveals that 45% of participants considered exposure to STEM as "somewhat helpful," 13% of participants believed it had a "significant influence," 19 % of participants believed it had "no influence," and the remaining participants (24%) highlighted the absence of STEM exposure in the school's guidance programs.

Table 6. Participants' survey responses to Question 5 in Appendix A, regarding the role of students' exposure to STEM and schools' career counseling on their (students) choice of university major (N = 47)

Influence Level	Exposure to STEM (count)	Exposure to STEM (%)
Significant influence	6	12.77%
Somewhat helpful	21	44.68%
No influence	9	19.15%
No school guidance	11	23.40%

Women's skills, abilities and performance in high school also seemed to orient their choices and decisions. Participants commented on feeling undervalued by male peers and the community which was elaborated by P7, "*I think schools should work on breaking the stigma, and encourage girls who like math and physics rather than undermining them and not taking them seriously,*" by P39, "*My male classmate thought I was not smart enough to pursue such a major, nor did I have the abilities and skills needed to do so,*" and by P34, "*Women in engineering often encounter gender biases, where their technical skills and leadership abilities may be underestimated compared to men.*"

In our study, participants were asked whether gender affects students' ability to lead jobs with complex and advanced equipment. 40% of participants considered that men were more suitable for such a job, 2% considered that women were more suitable, while 58% considered it to be suitable for both genders.

High school teachers have also impacted students' decision to pursue engineering as shared by P29, "*Teachers should get rid of the mindset where a male is more suited to be an engineer than a woman,*" and by P17, "*If their physics, math, and chemistry teachers make them hate the subjects and demotivate them, they will not put engineering as one of their choices.*"

6.2.4 Governmental Policies

Several participants brought up the Lebanese government's negligence in providing citizens with basic needs, such as stable electricity and a sense of safety to support learning. P43 shared, "*In Lebanon all they can do is provide us electricity and stop the war so we can study for our major peacefully,*" which highlights the dire situation in Lebanon, and the need for a safe place to study and pursue higher education and professional careers.

To increase the government's positive influence on women's inclusion in engineering, some strategies were suggested by P35, "*Governments and policies can influence women's decisions to pursue engineering by funding scholarships, creating STEM initiatives, and promoting gender equality in education,* " and by P37, "*The government can encourage them by giving social norms depending on what major the women should pursue and in this case, they can help them acknowledge their own skills and eventually their ability to enter the engineering field.* "

6.2.5 Media

Showcasing success stories through media has an indispensable role in favoring women's enrollment in engineering as brought up by some participants after being asked about whether highlighting success stories can influence their decision towards engineering. Responses were shared by P11, "*The media can influence women's decisions by showcasing successful female engineers, highlighting the benefits of engineering careers, and providing information about the field,* " by P18, "*They can by always showing posts of women engineers that are always open to inquiries and encourage women to go into engineering,*" and by P19, "*By showing successful women in this field, it can be a positive influence on females in general not only the ones that want to be part of this field but always the young girls that can be watching this media at a young age and saying between themselves that when they grow up they want to become as successful as these women engineering.*"

Participants pointed out the importance of awareness campaigns conducted through social media platforms to educate audiences and address prevalent challenges as elaborated on by P6, "*Now people spend lots of their time on social media so what they hear and see on it can change their decision easily, and many engineers talk about their experience on social media and that helps,*" by P11, "*Media can influence women's decisions by highlighting the benefits of engineering careers and providing information about the field,* "and by P35, "*The rise of technology allows for creative and widespread promotion of women in STEM, inspiring more to consider engineering careers.*"

Furthermore, inclusivity portrayed in the media fostered a sense of belonging and empowerment of women to combat stereotypes as shared by P15, "*Social media lately has been always about inclusivity and empowering women so they can find someone to relate or look up to and they can increase the awareness of women in engineering or female influencers that are engineers,*" and by P47, "*Portraying positive and diverse representations of women in engineering roles, the media can challenge stereotypes and inspire more women to consider engineering as a career.*" Participant P27 mentioned the adverse effects of social media given that different sources may share conflicting information, saying, "*Most teenagers are influenced by the media and hearing any rumors towards engineering would affect their decision.*"

7. Discussion

Our findings resonate with the existing literature while highlighting the cultural and institutional factors shaping women's decisions to pursue engineering. Previous research, conducted in both MENA and non-MENA countries, identified institutional influences, limited exposure to engineering, and the lack of role models as significant barriers to women. To address the gap in the literature, our research focused on Lebanon within the MENA region by resorting to SCCT with the emphasis on the role of self-efficacy, outcome expectations, and personal interests in shaping women's unique view on engineering and providing specific insights on cultural and institutional influence.

7.1 Cultural Influence

Addressing the research question on the cultural factors influencing women's enrollment in engineering, 21.28% of participants indicated that cultural and societal norms influence them as listed in Table 5. Societal stereotypes emerged as key contributors to the perception of engineering as a gender-specific field. This is supported by Patterson et al., who highlighted stereotypes in various engineering fields within the MENA region [39]. Other works explored the influence of home chores perceived as female-friendly, in creating biased mindsets among children [3], reinforcing the idea that women should prioritize domestic duties over professional careers. This, combined with the dependence of women on men in the MENA region [28,29,31], discourages women from pursuing engineering while further limiting their financial independence and career prospects. In Lebanon, the traditional roles of women being limited to households is gradually decreasing as driven by the increasing access of women to education and the rising living costs which urges both couples to work. These continuous advancements come in parallel with younger generations who challenge such traditional gender norms.

36% of participants perceived engineering as a male-dominated field, a belief reinforced by their greater exposure to male engineers. Additionally, 87% of participants acknowledged that female engineering role models play a vital role in shaping students' choice of major. This notion was highlighted by Sulaiman et al., who considered that the underrepresentation of women hinders female's participation in engineering [32]. This underrepresentation affects women's self-efficacy as described in the SCCT theory, limiting young women's ability to envision themselves as successful engineers. In this survey, students commented on the lack of support from their social and educational environment. This was emphasized by Calle et al.'s work exploring how women who divert from traditional roles are criticized [3].

In this context, parents' and teachers' actions significantly influence students' career development through the framework of SCCT. Supportive actions can enhance self-efficacy and inspire students to set future career goals. Conversely, negative influences can discourage students from pursuing engineering and limit their ability to take proactive steps towards achieving their academic and career aspirations. Furthermore, parental beliefs and attitudes towards engineering can be transferred to children. Some participants mentioned that their parents enrolled them in engineering programs to foster learning and engagement. Others mentioned that their parents, with prior experiences in the engineering field, supported their personal interests and choice of major, while boosting their self-confidence. These findings align with the experience of Martin-Vignerte

who shared her journey as a Qatari woman studying engineering in Germany and emphasized the impact of her parents' support on her self-confidence [35].

Despite this positive feedback, other participants highlighted the negative influence of parents, linking their mindset to broader Arab cultural norms. This mindset was discussed by the authors El Said et al. [29] and Aldossari [31] who shared the experiences of Arab women that receive pressure from fiancés and fathers urging them to choose a socially acceptable major and workplace. Participants also noted the role of teachers, that if influenced by cultural and regional mindsets, can negatively shape high school students' subject preferences, and reinforce the idea that engineering is a male-dominated field. This concern is echoed in the works of Lavy et. al [61], Adaya et. al [62], and Dichkauser [63] who considered the influence of teachers on high school students aiming to pursue a STEM major. Other students reported differently, as some teachers were providing their high school students with free pre-college courses to prepare them for university. In this context, the support or discouragement from parents and teachers towards the high schooler's study choices would shape their career development through the SCCT. A supportive approach would bolster self-efficacy and encourage goal-setting for future careers goals and provide resources like workshops and learning camps. Conversely, the negative influence from the surrounding would erode students' self-efficacy, limiting their motivation and actions towards majoring in engineering.

7.2 Institutional Influence

The survey results emphasize the lack of adequate institutional interventions to support women's enrollment in engineering in Lebanon. Participants mentioned that some high schools tend to focus on student's grades and academic performance when guiding major selection instead of broadening student's exposure to diverse career options, which was reinforced by Tan's findings [36]. If high schools overlook the students' personal preferences, students will choose their major based on academic standards instead of personal interests, reducing the likelihood of their long-term success and motivation.

Beyond high schools, universities play a pivotal role in educating students about engineering. Participants emphasized the need to increase the number of events, women-centered talks, and the exposure to STEM, as shown in Table 6, that would provide students with a deeper overview of the various disciplines. Additionally, some participants noted the need for scholarships and financial support to alleviate economic barriers allowing them to pursue their major of interest. In Lebanon, for instance, the cost of engineering credits in private universities is higher than that of other majors, which explains students' perspectives. Job requirements, the lack of opportunities, and workplace culture were considered as discouraging factors for most participants, as they found it challenging to balance long working hours and a limited work-life balance. This aligns with prior research from 2019 which identified balancing family life as "societal constraint" [1, 3]. Furthermore, workplace disparities can perpetuate biases regarding inclusivity, undermining the social and psychological factors central to the SCCT.

While some participants considered majors like Civil Engineering as male-dominated due to their requirement of physical strength, the quantitative results showed different perceptions. 13 participants ranked Civil Engineering as their least interesting major as shown in Table 2, and 10 participants ranked it as the most interesting major as shown in Table 3. This is an important result

that shows that despite the challenges that could be inflicted, students' interests in a major, and social impact can prevail. Moreover, Baytieh's work [5] in Lebanon emphasized the persistence of some systemic barriers, limiting job opportunities for female engineers. This aligns with research by Dos Santos [4] and McGregor [18] who discussed the lack of available job opportunities for women, payment discrepancy, and peer pressure in the workplace [6].

Media is another factor that can play an important role in enhancing the appeal of engineering careers by showcasing the profession's impact and opportunities. Through social media, aspiring female engineers can connect with female professionals and stay informed about engineering career prospects. These platforms can foster a vibrant and supportive community, encouraging high school students to enroll in engineering. However, some participants shared that not all information displayed on social media is reliable, increasing the confusion among students regarding their choice of major. Accordingly, it is important to approach media content critically to avoid its negative influence.

The absence of an active and effective Lebanese government in 2024, along with the economic crisis that started in 2019, and the successive political and regional conflicts were highlighted by a participant reflecting on the inability of the government to provide citizens with their minimal survival needs, minimizing students' focus on their education and future.

8. Recommendations

We propose several recommendations based on our findings and existing literature most of which have been progressively implemented at the American University of Beirut. While our study was centered around Lebanon, we believe that these recommendations can be translated into other settings in the MENA broadly.

8.1 High Schools

1) Host training workshops for educators on gender-inclusive and gender-responsive pedagogy design.
2) Collaborate with universities to host outreach events and campus field trips showcasing engineering programs.
3) Encourage collaborative, project-based, hands-on/experiential learning with opportunities for qualitative feedback rather than grade-based performance evaluation.
4) Integrate culturally-responsive scenarios and examples in the curricular design. For example, use women's names for characters in engineering problems and highlight the stories of trailblazing Lebanese women in engineering during breaks.
5) Integrate standardized STEM courses into the high school curriculum to enhance exposure to STEM, fostering students' critical thinking, problem-solving and hands-on learning. This may require the Ministry of Education's approval and extensive curricular development efforts.

8.2 Universities

1) Offer inclusive career guidance events to inform students of the different engineering fields and the impact of engineering on society.

2) Host Ask-Me-Anything sessions to answer students' questions about the field and address stereotypes.
3) Offer additional financial aid and scholarships to students of low-income backgrounds and refugees.
4) Address the hidden curriculum in engineering by hosting workshops on introductory engineering topics.
5) Invite women professors and engineers to give talks on their experiences in engineering.
6) Feature female engineering students and alumni and spotlight their success stories on the university's social media outlets.

9. Limitations and Opportunities

While we aimed to recruit a diverse cohort of participants for the summer program, most of the attending students were private school students with means to commute to campus for the program duration. Recruitment seemed Beirut-centric, as it was difficult for participants, especially those in South Lebanon, to commute during times of conflict and war, when roads were unsafe. Additionally, the camp was held for one day and repeated over three consecutive days for different batches of students to accommodate more participants. However, a single day was insufficient to address all misconceptions and provide comprehensive insights into the various engineering majors.

This work opens up pathways to future research exploring more factors that influence students' experiences in engineering and evaluating interventions to increase the sense of belonging among women in engineering majors. We are currently analyzing data provided by parents and male participants on their perceptions of women's experiences in engineering, and we are exploring longitudinal data on women's enrollment in engineering at AUB to further elicit insight on enrollment trends. We hope to pilot innovative, responsive interventions accordingly to support the further inclusion of women in engineering at MSFEA.

10. Conclusion

In this study, we adopted the grounded theory approach to analyze the responses of 47 female high school students to a survey conducted during a summer outreach program focused on engineering pathways in Lebanon. The analysis results highlighted different institutional and cultural factors that influence women's enrollment in engineering in Lebanon. Culturally, exposure to female engineers, stereotypes, and the perception of some engineering disciplines as male-dominated were identified as key factors influencing women's enrollment in engineering. Institutionally, universities, high schools, media, and governmental policies were identified as relevant factors. We then presented recommendations for high schools and universities to integrate more inclusive and responsive practices to encourage women to pursue undergraduate engineering programs.

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Appendix A - Survey Questions

1. Your school is a:
- Private school
- Public school

2. Which of the following engineering majors are you most interested in?
- Electrical and Computer Engineering
- Computer and Communications Engineering / Computer Science and Engineering
- Civil Engineering
- Industrial Engineering
- Chemical Engineering
- Mechanical Engineering

3. Why did you choose this engineering major over other available options? Please elaborate. _____

4. How important is the representation of women in engineering to you?
- It's crucial to encourage more women to pursue engineering, and it significantly impacts
- my choice
- Gender representation impacts my choice, but not significantly
- Representation doesn't matter as long as I'm interested in the engineering field. I'm
- uncertain about the importance of representation to me

5. What role does your school's career counseling or exposure to Science, Technology, Engineering, and Math (STEM) activities play in your consideration of engineering fields?
- It's a significant influence on my choices
- It's somewhat helpful in my decision-making
- It does not influence my choices
- My school doesn't provide career guidance

6. How might showcasing successful women engineers impact women applicants, to engineering?
- It has no impact on women applicants' decisions
- It can inspire and motivate women to consider engineering
- Showcasing success is only relevant to male applicants
- Showcasing success can discourage women from pursuing engineering

7. Do you think that engineering is a male-dominated field?
- Yes
- No
- I'm unsure

8. Please elaborate on your answer to the previous question:_____

9. Fill in the blanks: _____ are likely to be employed in positions that involve complex and advanced equipment in engineering fields.
- Women
- Men
- All genders

10. Do any of the following influence your decision in choosing engineering as a major? Please select all that apply.
- Negative feedback from parents and the surrounding community
- Culture and social norms dictating that engineering is for men
- Technical and non-technical skills needed in the engineering profession
- Financial abilities
- Discouraging atmosphere within the university
- High school influence during job and career fairs
- University open days and orientation programs
- Concerns about working long-term in engineering (e.g., demanding hours)
- Lacking adequate knowledge about what engineering entails
- None of the above. I am excited to be a future engineer!
- Other: _____

11. Are there obstacles or challenges that you believe women may face as engineers in comparison to men in the field? Please elaborate. If none, please write "none."

12. Which of the following engineering majors are you least interested in?
- Electrical and Computer Engineering
- Computer and Communications Engineering/ Computer Science and Engineering
- Civil Engineering
- Industrial Engineering
- Chemical Engineering
- Mechanical Engineering

13. Please elaborate on your answer to the previous question: _____

14. What can universities do to support you in making your decision to select engineering as a major?
- Visit my high school and provide orientation and guidance
- Organize events at the university where we can visit labs and interact with students and professors to learn about engineering
- Organize online webinars about engineering
- Provide information about the different engineering majors via social media posts
- Hold events for parents to explain what the available engineering majors entail
- Provide testimonials from women students and engineers about their careers
- Provide information about financing my studies (scholarships, loans, work-study

programs, etc.)
- Universities cannot support me in making my decision
- Other: _____

15. Do you think pursuing civil engineering as a major is more suitable for:
- Men
- Women
- All genders

16. Do you think pursuing mechanical engineering as a major is more suitable for:
- Men
- Women
- All genders

17. Do you think majoring in Electrical and Computer Engineering is more suitable for:
- Men
- Women
- All genders

18. Do you think majoring in Computer and Communications Engineering/ Computer Science Engineering is more suitable for:
- Men
- Women
- All genders

19. Do you think majoring in industrial engineering is more suitable for:
- Men
- Women
- All genders

20. Do you think majoring in chemical engineering is more suitable for:
- Men
- Women
- All genders

21. Do you think parents can influence women's decisions to pursue engineering studies? If Yes, what can they do? Please elaborate. If not, respond with No, and please explain your answer. _____

22. Do you think universities can influence women's decisions to pursue engineering studies? If yes, what can they do? Please elaborate. If not, respond with No, and please explain your answer.

23. Do you think high schools can influence women's decisions to pursue engineering studies? If yes, what can they do? Please elaborate. If not, respond with No, and please explain your answer.

24. Do you think governments or policies can influence women's decisions to pursue Engineering studies? If yes, what can they do? Please elaborate. If not, respond with No, and please explain your answer.

25. Do you think the media can influence women's decisions to pursue engineering studies? If yes, what can they do? Please elaborate. If not, respond with No, and please explain your answer.

Appendix B - Excerpt of the Data Analysis Codebook

Table B1: Excerpt of codebook showing the code, definition, subcode, and in-vivo example of three codes.

Codebook			
Code	**Definition**	**Sub-Code**	**In-Vivo Example**
Exposure to Representation in Engineering	Engineers' exposure can influence perceptions of the profession, challenge gender stereotypes, and encourage more balanced representation by showing diverse role models in engineering.	Representation of Male Engineers	"Yes, as we can see nowadays most of the employed people in engineering are males."
		Representation of Female Engineers	"Males cannot dominate engineering because there is a large and effective role for women in engineering."
		Need for More Equal Representation	"I believe that both women and men are needed in the diverse fields of engineering."
		Lack of Female Role Models	"All my life I never knew it was an option for me until I saw a female engineer in a TV show 2 years ago."
		Females previously enrolling in engineering without informing their family /surrounding	"A century ago, if a woman wanted to study engineering, she would do it in secret."

Male-Dominated Field	An area of study or profession where men significantly outnumber women	Traditional Mindsets	“We are literally in 2024 , where there is gender equality between women and men, years passed and still people have this mindset.”
		Cultural Expectations	“Cultural expectations and a lack of female role models further reinforce this perception.”
		Societal Expectations	“Because of social expectations, it is more likely for a male to find a well-paying job than a female.”
		Gender Imbalance among Professors (historically predominating the field)	“The professors were mainly men, which indicates that they’ve been longer in the field.”
Gender Bias in the Workplace	A workplace environment where a certain gender is unequally favored	Payment Discrepancy	“I read that especially in the engineering field, a company would give women work more than men and harder work, but they would still give them lower salary than men.”
		Gender Bias in the Culture	“Women in engineering often encounter gender biases, where their technical skills and leadership abilities may be underestimated compared to men. These biases can lead to fewer opportunities for career advancement and recognition”
University's Influence	University's role in shaping students' perceptions and interests in opportunities in engineering	Organizing Women's Events and Talks	“They can organize events or feature on their social media women pursuing their engineering career or students.”

		Scholarships and Financial Support	“By presenting scholarships and by showing some of their female students who are now successful in this major.”
		Creating a Supportive and Inclusive Environment	“They can create a welcoming and supportive environment, provide resources, and actively encourage women to consider and succeed in engineering fields.”
		Awareness of and Challenging Stereotypes	“If universities can give women the recognition that they need and raise awareness about this topic by holding events or doing other things, there won't be a problem anymore with women not entering engineering.”
		Creating and Sharing content about engineering and its work aspects using available and accessible platforms	“Universities can raise awareness about women's importance in taking part in the engineering field by using social media platforms and orientation sessions and days.”