

Article

Challenges to Female Engineers' Employment in the Conservative and Unstable Society of Taiz State, Yemen: A Survey Study

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Abstract: Typically, the underrepresentation of female engineers in education, employment, and leadership is a worldwide social issue. The present study investigates the critical employment challenges and barriers for female engineers in Yemeni's unstable, conservative, and poor society. The quantitative methodology was based on two constructed questionnaires targeting female engineering graduates from 2012 to 2021 at Taiz University and executive HR managers. The results indicated that the ongoing civil war, employability attributes, personal attitudes, low wages, the conservative society, and marriage–family beliefs are the most apparent barriers to female engineers' employment in Yemen. Nearly 40% of female engineers are frustrated with not having a job, almost the same percentage stopped seeking a job, and about two-thirds did not register with government employment offices. This study prompts engineering colleges to frequently update their programs to cope with rapid developments and to include employability courses in their curricula. Furthermore, this study advises female engineers to consult experts before enrolling in engineering programs and to practice training and employability skills immediately after graduation. We want to encourage such social studies in Yemen that are concerned with female issues to underpin their participation in society and to make use of unutilized resources.

Keywords: women engineers; gender discrimination; engineering profession; employability skills; workforce



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1. Introduction

The engineering education-workforce system is a lively system that tightly depends on technological innovations, economic conditions, demographic location, market variation, political stability, and engineering discipline [1–3]. The relationship between an engineering education and the workforce should be constantly evaluated and reviewed to ensure sustainable development for our society. Engineering graduates are job-satisfied and supported with career promotions whatever their occupation type is. In fact, engineering occupations are classified according to the UNESCO classification of sustainable development [4,5] into engineering-related, engineering-proximate, and non-engineering-related positions; for example, in the USA these are 36%, 46%, and 18%, respectively [6].

These motivations, in addition to social value and high wages, push many matriculation holders to enroll in engineering programs without realizing the difficulty of science,

technology, engineering, and mathematics (STEM) courses [7] and the requirements of the accelerated workforce market. Unlike other disciplines, the engineering profession faces unprecedented challenges for male and female engineers, with more peculiar and pronounced difficulties for female engineers [8–10]. In particular, female engineers are at the heart of these challenges in addition to their own social and physiological restrictions. This is plausibly attributed to the additional complex socio-cultural barriers, gender discrimination, severe engineering responsibilities, family constraints, and an unhealthy work environment. The problem is not only finding employment, as it is also complicated; women, to some extent, are not compatible with STEM courses [11–14]. For that, their admission proportion in engineering disciplines is low, while the college dropout of engineering students is ultimately high [15].

The best realistic description of female engineers is “visible as women and invisible as engineers” [16]. Engineering professional practices entail multi-faceted demands for qualifications, experience, and intellectual characteristics. Some engineering work requires the execution of duties, which need overtime work, long travel, sudden maintenance, night shifts, heavy equipment works, field visits, labor supervision, etc. Innately, women are not happy with such duties [9,17–19]. Accordingly, their employment in engineering jobs is lower and relatively unwelcomed by human resource managers.

Constantly, the underrepresentation of female engineers in education, employment, and leadership is a worldwide social issue [9,10]. Globally, female participation in engineering educations, workplaces, and leadership positions is at its lowest level. For further understanding, the engineering career is believed to be a male-dominated discipline, in which female engineers are kept as a minority and assigned only light and office duties; therefore, professional success is challenging. Physiological scientists declare that female engineers are more conservative, less bold, less adventurous, and more organized. Further, it is a huge challenge for female engineers to be easily provided with related engineering jobs. Engineering is such treated as a room full of men where female engineers must compete with men to appear to have more expertise, more experience, better imagination, more curiosity, more creative solutions, and better problem-solving skills.

Female engineers are enrolled in Yemeni universities without discrimination based on their gender. In addition, gender segregation in Yemeni higher education is uncommon. Female engineers complete their studies with men in the same classroom, they participate together, and compete with them in the workforce market. However, the higher education sector in Yemen has witnessed a deep decline during the last decade, plausibly due to the ongoing civil war and the political crisis. All statistics from international organizations related to the work and employment of female engineers in Yemen are unavailable in their lists. This study attempts to realize the challenges and barriers to employment faced by female engineers in Yemen who have graduated in the last ten years. It is a pioneering study in Yemen to explore this problem from all directions and angles. Furthermore, a distinctive recommendation will be drawn based on the outcome of this study.

This study sheds light on the occupational opportunities for female engineers in Yemen who are enrolled in both temporary and permanent engineering-related, engineering-proximate, and non-engineering careers. Also, the impact of economic conditions and political instability on engineering careers is elucidated. Furthermore, the effect of the socio-cultural norms of the local community on female engineers’ work is clarified.

1.1. Literature Review

The transition stage between graduation and obtaining a job is crucial in the lives of female engineers. It requires a series of critical career decisions and expert consultations [20–23]. These decisions certainly determine the future and well-being of individuals. It is well known that success in education does not mean success in a career. Colleges teach students the knowledge, not workplace cultures, employability skills, or multi-dimensional duties [2]. In the long term, employee well-being is a strategic element of achieving good career adaptability and sustainability. For that, vocational development models and

theories are extensively investigated to explore the interrelationship between personal characteristics and the workplace; in other words, the theoretical prediction models are of fundamental importance to manipulating a series of decision-making processes that affect the relationship between individual qualifications, skills, and career features [20,22,24–30].

In this regard, Social Cognitive Career Theory (SCCT), developed by Bandura in 1986, investigates the underrepresentation of female engineers in the workplace [30,31]. Generally, SCCT has been considered a good platform, providing guidelines to specify the interrelationship between complicated social issues, including gender, and the workplace [32,33]. SCCT is an appropriate tool to investigate the characteristics of graduates, particularly female engineers, who are at the college-workforce-transition stage [31]. SCCT theory focuses on the self-efficacy of individuals in terms of their skills, capabilities, qualifications, motivations, and expectations as sources of success in professional life.

SCCT was used to evaluate the adaptability and motivation of engineering students toward career programs [34], to evaluate women's restrictions and gender differences in the engineering career [31,32,35], and to corroborate information about engineering specialization selection [36].

Low employment participation for female engineers has been well described worldwide [2,8–10]. Worldwide, female engineers' enrolment in the occupation showed men's dominance; according to the UNESCO Institute of Statistics 2019, female engineer enrolment is on average, between 15 and 35% [37]. Globally, female engineers make up 10–20% of the engineering workforce, while in disciplines other than engineering, they can make up more than 50% [38]; an exception lies in Jordan, where female engineers (31%) account for higher percentages than other disciplines (19%) [39]. There has been a rise in female participation in engineering higher education in many countries worldwide, including highly conservative societies such as Saudi Arabia [38,40]. The Saudi studies indicated that gender segregation was dominant in the Saudi education system [38,40–42]. However, this system has been broken in the last few years since both men and women have enrolled in engineering colleges and shared the same classes and university campus activities [38,43]. In 2013, Hoda Baytiyah [44] reported the employment opportunities of graduate engineers in Lebanon as a model for the Middle East. The outcomes of Hoda's study are similar to those of Khan, 2021, in Saudi Arabia [41], which found engineers acquire full theoretical knowledge and technical skills but are poor at creativity, innovation, and communication.

Challenges and barriers experienced by female engineers, their career adaptability, as well as their motivation toward the engineering profession, have been investigated [9–15,39,40,45–50]. These challenges are mainly the previously referred to socio-cultural norms and accepted traditions, which vary in different societies. Few studies have reviewed this definitive topic and are limited to stable countries where there is no economic decline or political crisis, such as in Yemen [9,10]. In 2018, Subri reported the employment barriers facing married female engineers; this study reported fourteen challenges: leadership factors, gender discrimination, sexual harassment, work–family interrelation, childcare, safety, support, health, work environment, communication, salary, transportation, leaves, and female mentors. All reported barriers were classified into three fundamental factors: gender discrimination, childcare, and work–life balance conflict [10]. Another study by Longe and Ouahada, in 2019 [9], investigated the behavior of female engineers in the classroom, in professional careers, and in leadership positions; this study concluded that the most challenging elements were gender discrimination, gender stereotypes, socio-cultural limitations, employment discrimination, and sexual harassment. More extensively, employed women faced more challenges than their male counterparts [9]. The involvement of women in education in the Gulf Cooperation Council (GCC) is higher than that of men. However, they are considered an underutilized resources since their participation in workforce markets to enhance the nation's economy is hindered by socio-cultural norms [51]. The Saudi Arabian community is almost like the Yemeni community except for the wealth factor and political stability [51–54]. The socio-cultural norms, Islamic rules, and gender segregation are relatively identical for both communities [38,40–42].

Employers' expectations could contribute to exacerbating the challenges. A study conducted by Khan, 2021 [41] administered a structured questionnaire that targeted female engineering senior students from six Saudi universities; they also conducted another independent questionnaire for more than 80 employers from different industrial backgrounds. The findings of Khan's study suggested there was a significant gap in priorities between graduated engineers' and employers' expectations; employers were interested in good communication, computing, creativity, and problem-solving skills, while engineering graduates had technical capabilities and scientific methods.

In many developed countries, accurate information about the proportion of female engineers and their activities at the workplace is available. On the other hand, there is little, and imprecise, data about the employability skills and employment barriers of female engineers in developing countries, including Yemen.

This study is in line with other research studies that aimed to investigate the role of interpersonal characteristics and the social beliefs of female engineers in their employment choices and job sustainability. This unique study intends to bravely discuss many society-sensitive barriers to women's employment, which have never been discussed before regarding the conservative society of Yemen. The present study investigates many scenarios, such as socio-cultural norms, religious law, and family beliefs, and their effects on job opportunities. The impact of GPA, employability skills, frequent searches for jobs, and continuity in the workplace for female engineering graduates are also addressed. Finally, this research paper investigates how the ongoing war negatively affects job opportunities in Yemen.

1.2. Theoretical Framework

Considering the previous studies, structural equation regression modelling was used to investigate the relationship between qualifications, social culture, interpersonal characteristics, and educational performance. It tested the hypotheses corresponding to the research topic; challenges and barriers that affect female engineers' employment chances and sustainability. Figure 1 illustrates the model tested in this study. Women's participation in the labor market is decreasing in Yemen due to significant disparities related to gender, a tribal culture, and the patriarchal social norms. Women's role in paid work has been countered by the widespread beliefs that women's primary roles are domestic, primarily childbearing, and broad family responsibilities, as well as a stigma attached to working outside the home for women.

Female engineers face significant challenges and problems as well. According to the conceptual theoretical framework developed in this study (Figure 1), female engineers seeking employment face challenges in the pre-employment, during-employment, and post-employment stages. Furthermore, personal characteristics, attitudes, behaviors, academic achievement, training, bullying, and social surroundings may increase the influence of the problems. As a result of misperceptions regarding women's roles, female engineers are facing increasing challenges. Therefore, we attempted to identify (1) the difficulties experienced by female engineers in the Yemeni market; (2) the impact of the practical qualifications of female engineers on their future employment prospects; and (3) behavioral issues related to female engineers that limit their employment opportunities in the engineering profession. Additionally, this study was designed to investigate the impact of the Yemeni female engineer's job by identifying obstacles and challenges associated with finding employment in the same specialty. This was completed by finding cases and diagnosing the difficulties, especially in times of crisis, as Yemen has recently experienced.

The research variables and questionnaire questions were constructed from several similar studies. Variables about education, including specialization, English level, using a computer, graduation year, and overall grades were adapted from [1,30,31,38]. Similarly, variables related to employment, such as applying for a job, job opportunities, searching for jobs, and continuing with a job were adapted from [6,9,17,30,31,40,41,44,45,53]. Lastly, variables concerning women's beauty, bullying, and face cover were adapted from [49,55,56].

This diverse set of variables was chosen to facilitate a comprehensive examination of the problem within the context of a conservative and volatile environment.

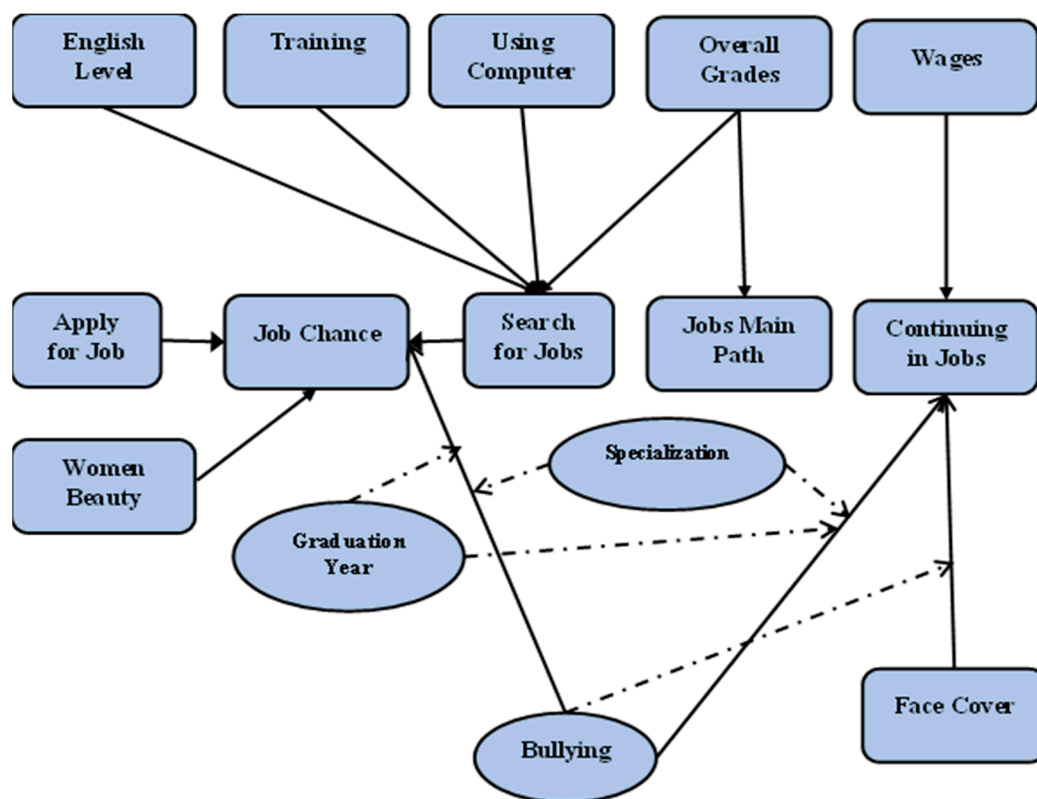


Figure 1. An illustration diagram depicts the theoretical structural framework of research variables and their interrelations. Dashed lines signify the impact of moderating variables on the relationship, while solid lines represent the direct impact of the independent variable on the dependent variable.

The following hypotheses were also tested using this theoretical model derived from the literature review:

- H1.** Searching and applying for a job increases the chance of getting a job.
- H2.** The moderating of “graduation year and “specialization” impact the relationship between “bullying” and “job opportunities”.
- H3.** There is a positive relationship between “women’s beauty” and “job opportunities”.
- H4.** Employability variables (English Level, training, using a computer, and overall grade) are significantly related to “searching for a job”.
- H5.** The “overall grade” of female engineers supports “obtaining engineering-related jobs”.
- H6.** There is a positive relationship between “wages” and “continuing with a job”.
- H7.** The moderating of “graduation year” and “specialization” impacts the relationship between “bullying” and “continuing with a job”.
- H8.** The moderating of “bullying” impacts the relationship between “face cover” and “continuing with a job”.

2. Methodology

2.1. Study Location

This study was conducted in the Republic of Yemen, a country located south of the Arabic peninsula with a population of ~31 million [52]. The country has witnessed a civil

war, political crisis, and economic decline for almost 10 years. Furthermore, the sample of the study was selected from Taiz University; a public university located in Taiz City, 250 km south of the capital, Sana'a, southwest of the country. Over the last 10 years, the average number of students in the university was 22,540 students; ~50% were female. In contrast to the whole university percentage, the female–male rate in the engineering college is 1:6, with a total of ~470 female engineers having graduated in the last ten years, whom we considered a population sample. The socio-cultural diversity of people in Taiz state indicates that the selected sample can, to some extent, represent the whole country. Also, the main causes of the underrepresentation of women in employment are the common causes for all Yemeni society.

2.2. Data Collection, Design, and Tools

The present work is a quantitative study that used data of two types: elementary data, which depends on two constructed electronic questionnaires, and secondary data collected from the engineering college, Taiz University. Particularly, 5-point Likert scale questionnaires were designed and administered by Google online forms and used to evaluate the challenges and obstacles to female engineers' employment during the job-hunting process. During the survey, participants were asked to provide their socio-demographic characteristics (overall grade, specialization, profession, and graduation year) and employers' spheres (commercial, government, educational, and industrial). The online survey links were distributed through email and appropriate social media between November and December 2022 to the respondents, with high-accuracy data.

The first survey targeted female engineers who graduated from the engineering faculty at Taiz University from 2012 to 2021 (see Figure 2a,b). Various questions were arranged in four subtitles, with a response rate of 124 among 470 female engineers of the total population sample. However, data were statistically analyzed from only 114 participants who had completed the questionnaire in its entirety. About 14 meaningful questions from the questionnaire were selected as the main variables corresponding to the problem statement. As depicted in Figure 3a,b, the survey included six engineering disciplines: software engineering (SE), information technology (IT), communication engineering (Com), mechatronics and robotics engineering (MRE), industrial and manufacturing system engineering (IMSE), and computer networking (CND). Most female engineer respondents scored high GPAs grades, as shown in Figure 3c.

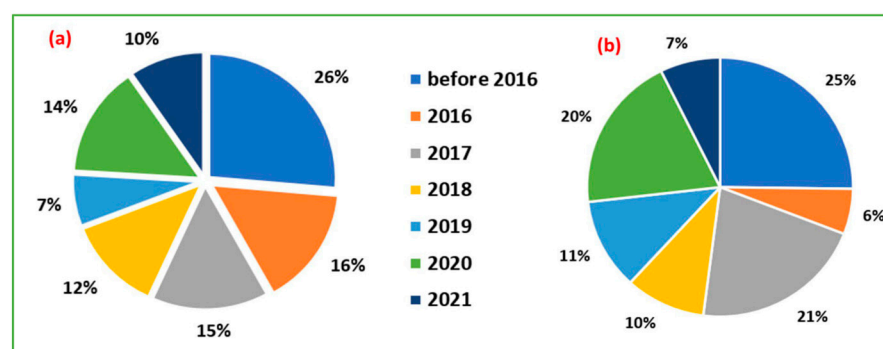


Figure 2. Diagrams of female engineers' statistics based on the graduation year. (a) Graduates (population sample) and (b) respondents of questionnaire samples.

The second constructed questionnaire targeted the executive managers and human resource (HR) managers in different government, commercial, educational, and industrial companies in Yemen. The questionnaire was handed out to the executive and HR managers of industrial (45%), governmental (25%), commercial (15%), and educational (15%) companies and institutions. Many questions were introduced to them to investigate the problem from another viewpoint. The questionnaire link was distributed via social media platforms and through the mail. Thirty-five respondents answered the questions, and the

data were analyzed. A comparison between the data of both questionnaires was correlated for better data analysis.

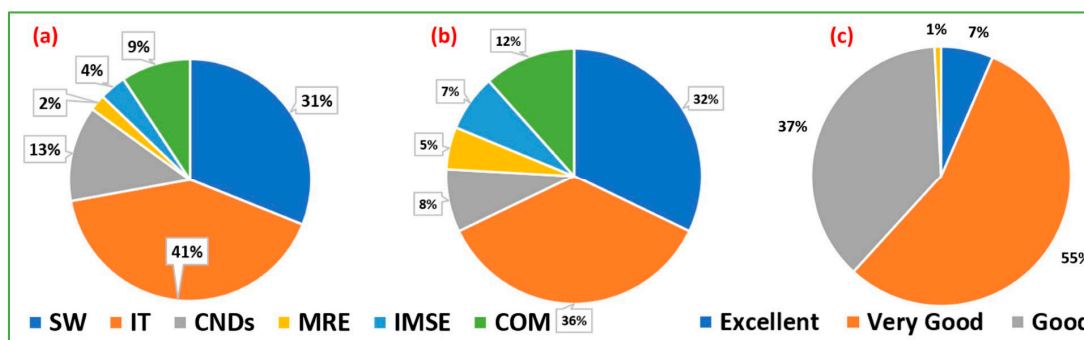


Figure 3. Diagrams of female engineers' statistics based on engineering specialization. (a) Graduates (population sample) and (b) respondents of questionnaire samples. (c) The overall grade (GPA) of female engineers at their colleges: excellent (90–100%), very good (80–90%), and good (65–80%).

Secondary data were officially collected from the engineering faculty at Taiz University throughout the study period. Statistics of total female engineers enrolled and graduated from 2012 to 2021 and the female/male ratios for each year/specialization were precisely recorded and represented in Figures 2 and 3.

The survey questions were non-conventional, in which ~44 questions investigated many raised questions and anticipated real reasons for low female-engineer-participation in jobs in Yemen and their relation to many social issues. The questions were written in the Arabic language, and the responses were officially translated into English. The participants were 23 to 35 years old and had extensive experience in job investigation. All participants had already graduated at least one year before their participation. Statistically, the number of graduated female engineers was high in software engineering (SE) and IT departments, medium in communication and networking departments, and low in industrial and mechatronics engineering departments, as shown in the diagrams of Figure 3a,b.

The research team was careful to send the questionnaire only to the targeted sample to ensure high-accuracy data, while the questionnaire structure did not allow for filling it in twice. Yemeni society is conservative, and women are not used to filling out such questionnaires. Females in conservative and religious communities believe that making statements about their personal, demographic, and social status is shameful behavior. Girls mostly dislike answering questions about marital status, sexual harassment, bullying, incivilities, habits, jobs, etc. Furthermore, the war's consequences created a demographic change for the Yemeni population, making communication with female engineering graduates, in some cases, impossible. Accordingly, many of the females targeted by the questionnaire team were deliberately reluctant to fill it out unless they received repeated reassuring messages. As a social norm, some females needed a spouse or parent's prior permission before they responded to the questionnaire. Accordingly, the response rate was about 25% of the population sample.

The information collected using the online survey was analyzed based on responses from Yemeni female engineers expressed as a percentage and subsequently analyzed using different statistical methods. An analysis of multiple linear regressions was conducted to determine the predictors of employment and employability variables (applying for a job, searching for a job, and continuing with a job). All statistical significance criteria were based on a 0.05 *p*-value. Moreover, an analysis of multiple linear regressions was used to examine linear causal relationships among variables and the effects of the moderation variables (year of graduation, major job path, and bullying). Some 5-point Likert scales were used to construct the body of the questions. The results are presented as a percentage of female engineers' responses, with organization and statistical analysis performed using the Excel spreadsheet and statistical Jamovi 2.2.5 [57].

3. Results

This section divides the results of female engineers' occupations into three main categories: pre-employment, during-employment, and post-employment analysis. Variables related to each step were analyzed and interpreted.

The Jarque–Bera normality test was implemented to examine the adherence of the dataset to a normal distribution, and the results suggest that the data likely conforms to a normal distribution. Also, the Breusch–Pagan/Cook–Weisberg test was conducted to assess heteroskedasticity with the null hypothesis set at constant variance. The outcome of this test implies the absence of significant deviation from the assumption of constant variance (homoskedasticity) within the regression model. Additionally, collinearity testing indicated negligible multicollinearity (VIF 1.01–1.06, mean VIF 1.04), affirming minimal impact on interpretation.

3.1. Pre-Employment Analysis

The behavior and educational attainment analysis of female engineers at the engineering institution and their effects on job opportunities were investigated. Gender discrimination and segregation are not famous phenomena in the education system of Taiz University and other Yemeni universities. Male students conduct all their activities with female students in the same class without gender discrimination.

Figure 4 shows the percentage share of female students at Taiz University in general and the faculty of engineering, in particular, from 2012 to 2022 as 49.18% and 16.77%, respectively. As shown in the plots, the female shares slightly decreased with time, with a steep decline in the last two years (2020 and 2021). This reduction could be attributed to the siege on Taiz City due to the ongoing war and the high poverty level. The high percentage of female participation in Taiz City as students, employees, and academic researchers indicates that the local community provides more respect and appreciation to women, while gender discrimination is at its lowest level. This positive case cannot be generalized for all other Yemeni communities, since many universities are located in tribal communities, where women's participation is at its lowest level.

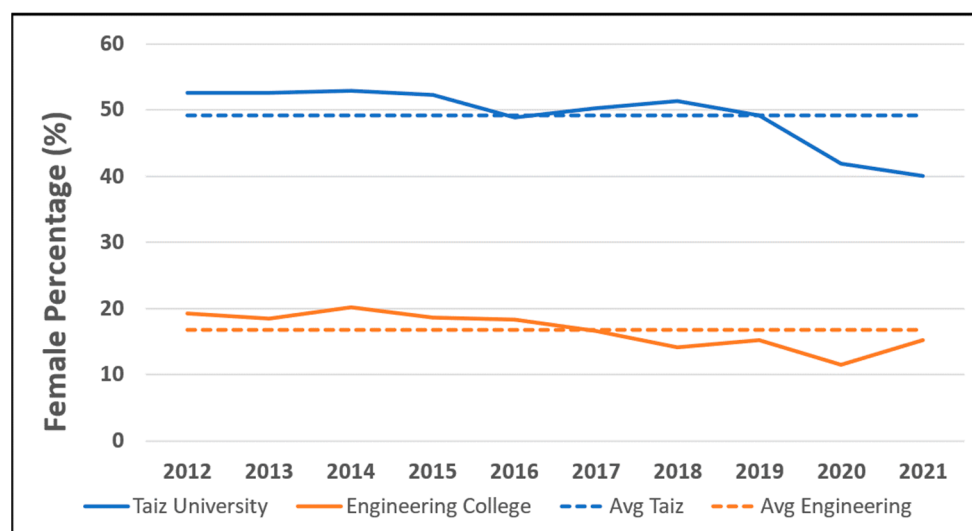


Figure 4. The proportion of female students at Taiz University and at the engineering college.

The scientific attainment of female engineers in university education is more attractive compared to male engineers. They always take their studies seriously and always compete with male engineers. The average default for female engineers who did not complete their studies within the specified five-year period is 12.6%, while for male engineers, it is at 41.34%. Thus, it can be indicated that female engineers are more serious about their studies than male engineers, which is generally the case in many countries [47]. That is plausibly

due to the inability of male engineers to afford the study costs due to financial strain and many other reasons.

Three-quarters of female engineers believe that the non-updated engineering programs are a major factor in their inability to obtain jobs after their graduation. The researchers' investigation discovered the fact that the engineering programs in the targeted college have not been updated for almost two decades, despite the rapid technological development and the significant change in the employment requirements. Because of the war, many academic staff left the establishment and traveled outside the country. Consequently, the lack of specialized academic staff for engineering courses reduced the educational attainment of students, and this forced female engineering graduates to seek an additional qualification after their graduation to obtain a job. This is a reasonable interpretation of the underrepresentation of female engineers in the workforce market. To conclude, there is a divergence in priorities between graduated engineers and the employers' expectations. However, the graduates from engineering colleges are proficient in computer skills and English, which are the most attractive characteristics of female engineering graduates.

3.2. During-Employment and Post-Employment Analysis

Variables related to employability, such as qualification, English level, training, searching for jobs, and applying to jobs were analyzed. The effect of GPA attainment for female engineers on the chance of obtaining jobs was also investigated. Furthermore, a description of the statistics related to the variable and the interrelation between variables were also depicted. Many other variables corresponding to the sustainability of jobs, such as high wages and the bullying phenomenon were also interpreted. Finally, secondary variables that study the influence of external appearance (face cover and beauty) on job opportunities and continuity in jobs for female engineers were also elucidated.

3.2.1. Descriptive Statistics

Table 1 records the calculation of basic statistical analysis of mean, standard deviation, and errors for the variables mentioned briefly in the data structure of Figure 1. The values of means close to the maximum values indicate a high impact of the studied variable. As recorded in Table 1, the means for the variables of employability are statistically determined to be "job opportunities", 2.37; "searching for a job", 2.94; "applying for a job", 1.83; and "major job path", 2.27, which are very low. Accordingly, it can be predicted that the career opportunities for female engineers show a substantial decline, while the employability parameters' mean values indicate little preparation for those jobs from female engineers, affecting their academic, financial, and social life.

Again, the results of mean values indicate that the situation of female engineers after employment is at risk (Table 1). In other words, the mean value of female engineers who enrolled in engineering-related jobs (major job path) is at 2.27, while the mean for continuing in job and wage rates are 1.93 and 1.44, respectively. Female engineers surveyed demonstrated that 78% receive a stipend below USD 100, while only 7% had salaries above USD 300. Fortunately, the results show that female engineers are interested in improving their English level (3.66) and computer use (3.42). Moreover, the participants were concerned that bullying and attention to women's beauty and appearance would negatively affect their future employment (1.97).

3.2.2. Correlation Analysis

Table 2 summarizes the significant positive correlation of variables related to female engineers' employment according to the Pearson correlation coefficient. A total of 14 variables are correlated in the analysis. The outcomes from Table 2 indicate a significant positive correlation between searching for a job (0.417 ***, p -value < 0.001), applying for a job (0.541 ***, p -value < 0.001), major job path (0.498 ***, p -value < 0.001), continuing with a job (0.607 ***, p -value < 0.001), woman's beauty (0.222 *, p -value < 0.05), and English level (0.277 *, p -value < 0.05) and the job opportunities.

Table 1. Descriptive statistics of the research variables related to female engineering employment in Yemen.

Variable	N	Statistics				
		Missing	Mean	SD	Minimum	Maximum
Job Opportunity	80	34 *	2.37	0.523	1	3.25
Searching for a Job	114	0	2.94	1.099	1	4
Applying for a Job	113	1	1.83	0.925	1	3
Major Job Path	114	0	2.27	1.17	1	4
Continuing with the Job	80	34 *	1.93	0.965	1	4
Overall Grade	114	0	2.68	0.617	1	4
Academic Outcomes	112	2	1.63	0.783	1	4
English Level	114	0	3.66	0.727	2	5
Using a Computer	114	0	3.42	0.797	1	4
Training	114	0	2.03	1.14	1	4
Wages	82	32 *	1.44	0.739	1	4
Bullying	114	0	1.3	0.46	1	2
Face Cover	113	1	1.26	0.459	1	3
Woman's Beauty	112	2	1.97	1	1	3

* Accounted for unemployed females who had no salary and job.

The correlation factor measurements (Table 2) show that job opportunities positively increased with variables such as searching for jobs, applying for jobs, and the job's major path. Furthermore, it enhances the continuity of the job, as well. Again, the response results suggest that job opportunity increases with female beauty, English level, and high wage rates. The findings show that job-searching skills should be accompanied by a good English level, good computer skills, good training, and suitable specialization but are independent of college GPA. However, female graduates who had high GPAs and good computer skills get jobs in their exact specialization more often than low-GPA graduates. Furthermore, high GPAs are associated with a high English level, good computer skills, good training, and good salaries. It can be concluded that high GPA holders get high-quality and sustainable jobs when they are skilled with high employability attributes.

The results elucidated that female graduates who struggle to apply for jobs everywhere continue in their jobs for long periods and are characterized by high English levels; interesting results from the correlation factors indicated that sustainable jobs are negatively affected by bullying practices, low training, and low salaries. Accordingly, correlation findings showed that intelligent females with high GPAs were subjected to lower bullying and sexual harassment. As expected, the woman's beauty and face covering have negligible impacts on educational attainment, employability skills, and job environment.

Table 3 depicts the interrelation between variables. The variables of employability, searching for jobs ($\beta = 0.207^{***}$) and applying for a job ($\beta = 0.112^{***}$) strongly increased job opportunities for female engineers. In other words, the employability patterns ultimately underpin job opportunities, which confirms the correlation in Table 2. Therefore, hypothesis H1 is supported by the findings of this module regression. Nevertheless, in Table 3, module 2 was used between "bullying" and "getting a job", moderated by "graduation year", and the coefficient was reported as bullying $\times$ graduation year ($\beta = -0.758^{***}$). In terms of getting a job, this was a significant contributor to the decline.

According to the regression model, "specialization" did not moderate the relationship between "bullying" and "getting a job", as indicated by the low coefficient (bullying $\times$ specialization, $\beta = 0.199$). Accordingly, H2 is partially supported by the questionnaire results. Consequently, affected by their "graduation years", female engineers are less likely to get jobs, while their chances are relatively unaffected by "specialization". Furthermore, a woman's beauty positively impacts job opportunities ($\beta = 0.116^*$). According to module 3, this relationship is explained using regression and supports hypothesis H3.

Table 2. Correlation matrix of the research variables related to female engineering employment in Yemen.

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1 Job Opportunity	1.000													
2 Searching for a Job	0.417 ***	1.000												
3 Applying for a Job	0.541 ***	0.079	1.000											
4 Major Job Path	0.498 ***	0.158	−0.055	1.000										
5 Continuing with a Job	0.607 ***	−0.13	0.373 ***	0.08	1.000									
6 Bullying	−0.177	0.002	−0.179	−0.103	−0.185	1.000								
7 Face Cover	0.068	0.085	−0.049	0.113	0.072	0.065	1.000							
8 Woman's Beauty	0.222 *	0.08	0.095	0.13	0.13	−0.022	0.348 ***	1.000						
9 Overall Grade	0.064	0.023	−0.095	0.246 **	0.134	−0.186 *	0.11	0.044	1.000					
10 Academic Outcome	0.135	0.095	−0.007	0.164	0.045	−0.089	0.085	0.046	0.064	1.000				
11 English Level	0.277 *	0.35 ***	0.231 *	0.142	0.042	0.017	0	−0.013	0.145	0.055	1.000			
12 Using a Computer	0.182	0.363 ***	0.137	0.208 *	0.064	−0.08	−0.002	−0.054	0.334 ***	−0.006	0.266 **	1.000		
13 Training	0.08	0.397 ***	0.04	0.101	−0.143	0.069	0.068	0.032	−0.038	−0.082	0.096	0.241 **	1.000	
14 Wage Rate	0.21	0.146	0.073	−0.068	0.276 *	−0.137	0.012	0.066	0.124	−0.092	0.002	0.14	−0.102	1.000

Standard errors in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 3. The impact of employment variables on job (pre-employment analysis).

Module	(1)	(2)	(3)	(4)
Variable	Job Opportunities	Job Opportunities	Job Opportunities	Job Opportunities
Searching for a Job	0.207 *** (0.0422)			
Applying for a Job	0.302 *** (0.047)			
Bullying $\times$ Graduation Year		−0.758 *** (0.135)		
Bullying $\times$ Specialization		0.199 (0.171)		
Woman's Beauty			0.116 * (0.057)	
English Level				0.405 ** (0.126)
Training				0.297 *** (0.080)
Using a Computer				0.340 ** (0.124)
Overall Grade				−0.155 (0.153)
Intercept	1.141 *** (0.1647)	2.738 *** (0.104)	2.134 *** (0.1283)	0.107 (0.297)
Observations	80	114	80	114
R ²	0.462	0.294	0.050	0.303

Module 1 tests H1: job opportunity = $\beta_0 + \beta_1 \times$ searching for a job + $\beta_2 \times$ applying for a job + ϵ , module 2 tests H2: job = $\beta_0 + \beta_1 \times$ bullying $\times$ graduation year + $\beta_2 \times$ bullying $\times$ specialization + ϵ , module 3 tests H3: job = $\beta_0 + \beta_1 \times$ woman's beauty + ϵ , module 4 tests H4: searching for a job = $\beta_0 + \beta_1 \times$ English level + $\beta_2 \times$ training + $\beta_3 \times$ using a computer + $\beta_4 \times$ overall grade + ϵ , standard errors in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 3 also describes the interrelation between variables related to female engineering occupations. The employability variables: English level ($\beta = 0.405$ **), training ($\beta = 0.297$ ***), and using a computer ($\beta = 0.340$ **) show strong relation to the “searching for a job” variable. On the other hand, the “overall grade” does not affect “searching for a job” ($\beta = -0.155$). To conclude, except for the “overall grade”, our findings support H4.

Table 4 records the variables related to the post-employment challenges of female engineering graduates. Surprisingly, module 5 explains how “overall grade” substantially affects the “major job path” ($\beta = 0.467$ **), which supports H5. This means that a higher GPA underpins the high opportunity for a female engineer to get an engineering-related job in their exact specialization. As expected in hypothesis H6, high wages have a positive and significant effect ($\beta = 0.358$ *) on continuing with a job and sustainability of jobs.

Furthermore, module 7 was used to test hypothesis H7, which investigates the effect of “graduation year” and external appearance on the “bullying” phenomenon. Our findings indicated statistical significance of the mediation of “graduation year” and its impact on the relationship between bullying and continuing in a job in the future ($\times$ bullying $\times$ graduation year, $\beta = -1.533$ ***). According to the regression model value, specialization did not moderate the relationship between bullying and continuing with a job in the future, as indicated by the coefficient $\times$ for bullying $\times$ specialization ($\beta = -0.0230$). This means that for newly graduated female engineers, even if they get a job, bullying behavior against them increases, limiting their continuity in the job in the future.

Finally, module 8 (Table 4) was established to test H8. The results specified that the “face covering” allows female engineers to still continue in their work in the future (face cover, $\beta = 5.00$ *). Even so, moderating the continued bullying phenomenon had a tremendous negative effect on “face cover” and “continuing with a job” ($\times$ face cover $\times$ bullying, $\beta = -16.81$ *), which supports our hypothesis, H8.

Table 4. The impact of employability variable on job opportunities and continuing with a job (during-employment and post-employment analysis).

Module	(5)	(6)	(7)	(8)
Variable	Major Job Path	Continuing with a Job	Continuing with a Job	Continuing with a Job
Overall Grade	0.467 ** (0.174)			
Wages		0.358 * (0.141)		
Bullying $\times$ Graduation Year			−1.533 *** (0.232)	
Bullying $\times$ Specialization			−0.0230 (0.294)	
Face Cover				5.00 * (2.42)
Face Cover $\times$ Bullying				−16.81 * (8.36)
Intercept	1.023 * (0.477)	1.411 *** (0.228)	2.819 *** (0.179)	−7.96 (4.96)
Observations	114	114	80	80
R ²	0.0606	0.0760	0.375	0.089

Module 5 tests H5: major job path = $\beta_0 + \beta_1 \times \text{overall grade} + \varepsilon$, module 6 tests H6: continuing with a job = $\beta_0 + \beta_1 \times \text{wages} + \varepsilon$, module 7 tests H7: continuing with a job = $\beta_0 + \beta_1 \times \text{bullying} \times \text{graduation year} + \beta_2 \times \text{bullying} \times \text{specialization} + \varepsilon$, module 8 tests H8: continuing with a job = $\beta_0 + \beta_1 \text{fc} + \beta_2 \times \text{face cover} \times \text{bullying} + \varepsilon$. Standard errors in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

3.3. Executive Managers' Responses

Parallel to the results predicted from the female engineers' questionnaire, meaningful results are also obtained from the responses of the executive managers' questionnaire. Table 5 depicts the main outcomes of the executive managers' questionnaire. The evaluation grades are 5.00 as a maximum, 3.00 as an idle, and 1.00 as a minimum.

Table 5. Response outcomes of executive and HR managers were manipulated based on the questionnaire respondents.

	Statement	Executive Managers	Response Rating
1	An engineering specialization affects my chance of getting a job	3.9	++ve
2	Engineering programs' contents match well with employment requirements	3.14	+ve
3	My overall university grade is important in getting a job	3.4	+ve
4	English proficiency is an important parameter for getting a job	4.13	++ve
5	Wearing a niqab (face cover) affects my chance of getting a job	2.68	−ve
6	A woman's beauty affects her chance of getting a job	2.17	−−ve
7	Female engineers are proficient with computer applications	4.77	+++ve
8	Employed female engineers often do not receive job promotions	3.04	+ve
9	A job is essential for a woman, and she should not stay at home	4.15	+++ve
10	Engineering is a suitable profession for females	3.93	++ve
11	The overall evaluation for female engineers in the workplace is high	3.55	+ve

There is a complete consensus from all managers that mastering computers and having problem-solving skills are the essential characteristics that distinguish engineers from other disciplines. Managers agree that job opportunities are generally at their lowest levels due to the economic and political conditions that Yemen is experiencing now. Unexpectedly, managers indicated that the university's "overall grade" has a minor effect on their selection for the engineering profession, which matches the results of the female engineers' questionnaire. This finding is in line with the results of higher unemployment proportions for female engineers who scored a high "overall grade".

Managers also suggested that employability requirements and post-university qualifications such as English language proficiency, training, and developing self-skills are essential parameters to underpin job opportunities for female engineers. They believed that following job advertisements continuously is fundamental to obtaining a job.

Like female engineers' beliefs, employers emphasize that external appearance does not affect job opportunities. Wearing a "niqab" (face cover) and a beautiful appearance are insignificant factors in selecting female employees, which is a healthy parameter for female engineers to get a job, whatever their external appearance is. Similarly, managers believe that the engineering programs' syllabus match relatively well with the requirement of the workforce and confirm that there is no gender discrimination when selecting an employee for an engineering position.

Female engineers in Yemen live below the poverty level. The survey results revealed that 42% of Yemeni female engineers from different engineering disciplines and graduation years did not have any chance of employment, whether related, proximate, or unrelated to their exact specialization, temporary or permanent work. Of the remaining 58% who had permanent and temporary occupation opportunities, about 78% received less than USD 100, and only 7% of those had jobs with a salary of more than USD 300. As a result, most female engineers stated that "low salaries" tops the list of challenges in their profession.

Because of the civil war, siege, and political crisis in Yemen, most graduated engineers did not have job opportunities related to their specialization; thus, they seek temporary jobs in relief organizations operating in the country. Almost 23% of female engineers worked temporary jobs at relief agencies, both part-time and full-time, and among them, 10.2% are still working there now. Furthermore, 35% of female engineers in Yemen have tried to obtain permanent or temporary online work. Unfortunately, most female engineers working online receive low salaries of an average of less than USD 100 per month. Our survey investigated the barriers for female engineers who operate online into these points: (1) lack of internet access, (2) slow and intermittent internet, and (3) lack of secure access to electricity.

For a deeper understanding of the behavior of female engineers after graduation, the questionnaire results announced that only 12.9% of them live outside the country, either accompanying their husbands or in postgraduate studies. Furthermore, ~18% of female engineers have access to postgraduate studies inside and outside the country, while 9.3% of female engineers live in rural places. Shocking results confirmed that only 4.5% of female engineers are government employees, while less than 4.6% receive salaries above USD 500 per month.

The analysis of female engineers' occupancy in Yemen has come with the following statistical outcomes: 42% are without jobs and 26% are in temporary and part-time jobs (the payment is per hour of work without insurance). The percentage of unemployed female engineers is 58%, which is much greater than that in Saudi Arabia (35%), for example [36,54]. In particular, 26% of female engineers have temporary and part-time occupations in the academic field as teachers, at both schools and colleges.

The percentage of those who have employment opportunities in Yemen is 32%; it is classified as 6% engineering-related, 8% engineering-proximate, and 18% non-engineering-related jobs. The percentages for engineering-related, engineering-proximate, and non-engineering-related occupations in the USA are 36%, 46%, and 18%, respectively [6]. The results show that the job opportunities are independent of graduation year and university GPA but dependent on the engineering discipline. Female engineering graduates in communications and mechatronics are the lowest-level female engineers with few job opportunities. On the contrary, female engineers who graduated from industrial and software engineering programs had higher chances. Finally, female engineers who graduated from information technology had higher proportions for engineering-proximate and non-engineering careers. The employment proportions of Yemeni female engineers are much less than the reported ratios in the USA, for example. To conclude, Yemeni female engineers

are not practicing employability skills which is considered among the most critical barriers to employment [58].

4. Discussion

The discussion considers occupational challenges to Yemeni female engineers in terms of education performance, economic growth, wealth, religious practices, social structures, and cultural norms. It demonstrates the reasons behind female engineers' underrepresentation in jobs. In particular, the lack of involvement of women engineers in the public and private workforce represents an underutilized resource that deprives society of benefiting from them in the economic, industrial, and social spheres. The following points represent the biggest barriers for female engineers after graduation in Yemen:

4.1. Education Performance

Female engineers in Yemen strive to enroll in the education system and overcome tough STEM topics in the classroom. In general, students successful in STEM courses facilitate their enrollment to engineering programs [7]. Our investigation indicates that the performance of female engineers in education is much better than that of their male counterparts. Yemeni women have shown increased educational realization and employee involvement during the last few decades. Of course, the Yemeni society has become aware of the importance of involving women in education. Paradoxically, female employment participation remains modest and requires enhancement and support, especially in the engineering sector. Of course, the education system plays a prominent role in limiting women's career advancements.

Curricula reform and development to include employability attributes is essential to an engineering education's ability to follow the growing demands of employers [2]. Engineering graduates need the skills of continuous learning, time management, and leadership skills after obtaining their graduation certificates to enhance their job opportunities. Engineering curricula must be dynamic enough to efficiently link to modern engineering's professional requirements to create successful graduates [2].

The nature of the work-related specialization of some engineering disciplines influences the chances of getting a job. These specializations are, for example, mechatronics, communications, and industrial engineering. These specializations, provide job opportunities with extensive duties and long hours outside the home, forcing female engineers to leave their comfort zones and struggle in their careers in a male-dominated environment [8,9,16,44,59]. The length of time female engineers are unemployed following the graduation year makes them frustrated and stop searching and following job advertisements. Female engineers believe that high graduation grades increase their chances of obtaining a wide variety of jobs opportunities. However, this belief, to some extent, is incorrect. The results of this study inferred that a high GPA has a negligible effect on job opportunities, and female engineering graduates should focus on employability skills to bridge the gap between education outcomes and employers' expectations, which correlates with other studies [2,41,44]. To conclude, high GPAs, good employability skills, and good training are essential for female graduates to get sustainable jobs.

4.2. Interpersonal Characteristics

The outcomes of this survey study and, particularly, the interface between variables infers that a high chance of getting a job in this workforce's market is relatively independent of specialization and the long period after graduation. Surprisingly, university GPA has a minor effect in increasing the probability of getting a job, which matches well with other studies in the literature that came up with the same findings [41,44]. That is plausibly due to the large gap between the university's outcomes and the employer's expectations. The prime factor, which we consider the number-one critical outcome hindering female engineers from enrolling in public and private jobs, is the interpersonal characteristics of the female engineer herself. In other words, self-confidence, improving their own skills

and experiences, contentious training, self-rehabilitation, and personality development are critical points for rapid and sustainable careers [60]. These valued predictions are consistent with the theoretical context of Social Cognitive Career Theory (SCCT), which emphasizes the interpersonal characteristics of individuals that influence their career choice and career adaptability [20–30].

A graduated female engineer who does not register her graduation documents at government employment offices and renews them every year has zero chances of obtaining a government job. In this regard, the outcomes conclude that 52% of female engineers have never enrolled for government jobs and 14% have registered without renewal. In other words, only one-third of female engineers have enrolled in governmental employment offices and renewed their registration annually. As a result, only 4.5% of the whole population of this study had a government job, which is almost the lowest percentage worldwide.

Female engineers did not prepare themselves for good jobs in their specializations; more than 50% of female engineers did not study any training course during the last twelve months, including English language and other training courses. Additionally, above one-third of female engineering graduates did not track jobs or follow employment websites. Of course, scoring a high university GPA is not enough to get a job, but it is the first step to success. The submission of female engineers to their surrounding circumstances is unhealthy behavior, and they should not surrender. Unfortunately, about one-third of female engineers have stated that they hate the engineering field and provided advice to young females to leave engineering programs. In fact, graduates' satisfaction is a measure of educational quality [61]. High-satisfaction rates motivate graduates to search and apply for employment in their engineering-related fields.

Indeed, frustrated female engineers waste years of study, causing the loss of great, qualified human resources to the national and familial economy. The frustration, surrender, and despair of female engineers are bad characteristics that kill their motivation and creativity. Accordingly, female engineers should always be motivated and optimistic.

4.3. Socio-Cultural Norms

This subsection discusses the effect of customs, traditions, social norms, and Islamic laws of a multicultural Yemeni community on the underrepresentation of female engineers in the workforce. The consequence of war precipitated many family customs to the stagnation stage and made the family more dynamic. Customs suggest that females are prepared to be housewives and they enroll in education only to study courses that enable them to teach children in elementary education. Many tribal communities in Yemen believe that female work is shameful. Under the pressure of current circumstances, many families in urban areas allow their women to work secretly to avoid social shame [37].

The employment of female engineers in a conservative society suggests that female work is shameful and that a woman was created to be a mother, homemaker, or wife. This social culture should be fought and curtailed. It is a huge challenge for women to practice an engineering career in a conservative and gender-segregated society. Those who challenge cultural traditions are often distinguished as socially perverse and are then deprived of marriage and respect. Also, engineering cultures implement masculine norms. Therefore, female engineering employment is a complicated issue in a Yemeni society that supports men's preferences and dominance. To conclude, marriage and family responsibilities heavily and negatively impact female engineers' work engagement, adaptability, and sustainability. These outcomes are in line with other studies conducted in various environments [55,62].

Further, Islamic law does not prohibit women from working in general. However, it sets many controls that regulate female participation in work, such as modesty, morals, and good behavior [53]. Furthermore, many Islamic schools require the approval of the female guardian (father or husband) for women to travel and work outside the home. The social norms imposed on the husband to take care of all his family requirements has made

the woman dependent on others and reduced her efforts in seeking job vacancies. Many families allow women to leave their homes or travel only if they are accompanied by a male guardian, which reduces their chances of getting jobs, especially those associated with night shifts, sudden maintenance, and frequent workplace visits. This behavior is limited to the conservative society of Yemen and is uncommon in other nations [53].

The external appearance of Yemeni female engineers impacts their occupation chances and workplace activities. In this regard, almost half of the targeted female engineers in the survey believe that a female appearance affects their chances of getting a job. In this regard, about one-fourth of female participants believe that wearing the “niqab” (a dress that covers a female face) negatively affects their job opportunities, activities, and participation in the job. Furthermore, almost a quarter of the participants believe that female beauty slightly increases their chances of getting a job. These findings are statistically proven in Tables 2 and 4 and are compatible with other studies that suggest that women’s beauty slightly increases their job opportunities and increases bullying and harassment practices at work [56,63].

All in all, socio-cultural norms and accepted traditions provide structural barriers to female participation in community work [53]. What is special about Yemeni female engineers is the high poverty level, the ongoing civil war, the economic collapse, and the political crisis, which all together seriously contribute to the reduction in job opportunities and low workforce share. The barriers made by families to the mobility of female engineers substantially reduces their chances of getting a job. Furthermore, physical constraints and sieges were constructed due to the ongoing war, which restricted families movements between large cities and industrial districts.

4.4. Political and Economic Stability

Historically, Yemen’s economy has collapsed twice during the last few decades. The first collapse was a consequence of the Gulf Crisis in 1990, which left the majority of Yemeni people at the poverty level, reaching famine-like conditions [64]. The other collapse was in 2014 when Houthi rebellions took control over the capital city and other large cities in the country [37,42,64]. Indeed, Yemen has been classified by World Bank in the low–middle-income category, and there are no real indicators of reaching the Sustainable Development Goals (SDGs) by 2030, even in the absence of conflict [64]. Furthermore, Yemen ranked 153rd on the Human Development Index (HDI), 138th in extreme poverty, and 172nd in educational attainment [64]. The ongoing war in Yemen has been considered the most disastrous war for decades. The GDP per capita has decreased from USD 3800 in 2014 to USD 1700 in 2022. The extreme poverty index has increased from 18.8% in 2014 to 64.7% in 2022 and expected to reach 78% in 2030 [65].

Economic collapse, salary suspension, rapid inflation, and depletion of foreign currency are prominent indications of Yemen’s condition due to the ongoing war, these factors have caused diverted effects on the employment market and private-sector businesses have cut off 50% of working hours and laid off about 55% of the workforce [37]. Furthermore, more than two-thirds of Yemeni businessmen have left the country, trade exchange to and from Yemen has drastically decreased, and many companies have gone bankrupt. Accordingly, job advertisements have dramatically decreased, and a large portion of Yemeni male engineering graduates have immigrated outside the country to get jobs. However, female engineers cannot afford such a move without male accompaniment. In exact reporting values, two-thirds of female engineering participants claimed that the ongoing civil war represents the most critical reason restricting their occupational opportunities.

To shed light on the worst ongoing conflict in Yemen, it is to be noted that more than 40% of Yemeni people have insecure food, while 50% are at the poverty level. According to the International Labor Organization report in 2013, only 7% of Yemeni females had jobs, and the report considered Yemen to have one of the lowest female-labor-force participations worldwide. Indeed, the low percentage was counted excluding the females working in agricultural activities. Furthermore, this ratio decreased by more than one-quarter,

plausibly due to the ongoing civil war [37]. Salary suspension for many years destroyed the remaining aspirations of Yemeni employees. Of course, the consequences of war on the security and family economy have magnified the problems of female education and their professional careers. In particular, Yemeni families have been forced to choose between obtaining food or tertiary education requirements for their family members, and many chose the former.

On the contrary, frequent reports have revealed that the long-ongoing war had increased the proportion of women participating in the workforce market at the expense of men, enhancing their decision-making power in the family and their contribution to the household budget. However, their domestic chores, such as childcare, cooking, and cleaning, are still female responsibilities. Because of the war, female engineers have new roles in the workforce, starting their own businesses, seeking online work, and operating in nontraditional sectors such as relief organizations and temporary academic teaching.

4.5. Female Engineers' Viewpoint

Figure 5 is a cause–effect diagram (fishbone diagram) that summarizes all the challenges and barriers to female engineers' employment in Yemen. It divides the challenges into four categories: education performance, socio-cultural norms, employability skills, and community stability. In particular, education performance, socio-cultural norms, and employability attributes are common barriers for female engineering graduates in many societies. However, community instability is a unique barrier in the Yemeni society that drastically affects job opportunities.

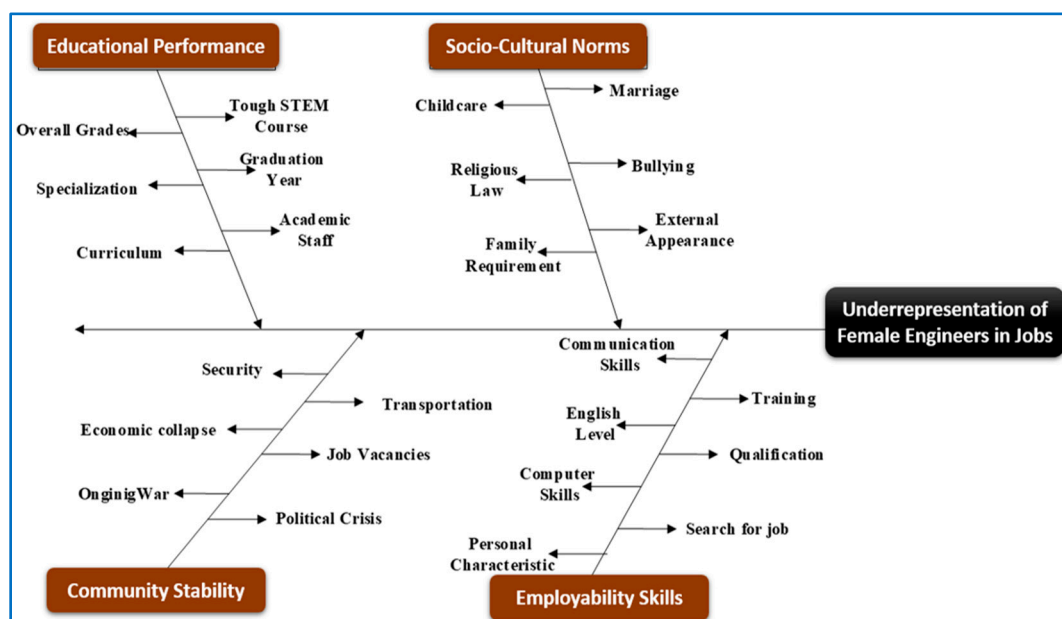


Figure 5. Cause and effect (fishbone) diagram encapsulates the underrepresentation causes of female engineers in the workforce in Yemen.

The main reasons for the low representation of women in the workforce are arranged in the Pareto chart in Figure 6, as per the respondents' opinions. The diagram portrays that the ongoing civil war in Yemen, political instability, and marriage and family requirements represent about 50% of the barriers to the female engineering workforce. Furthermore, the socio-cultural practices and religious law come into the next step as barriers for female engineers' job occupancy.

Interpersonal characteristics are among the most pressing reasons for the underrepresentation of female engineers in employment. In detail, self-confidence, determination, and perseverance are critical elements in the character of an engineer to obtain a career

opportunity. Furthermore, not surrendering to the frustrating circumstances represents a core point in this issue. Many female engineers do not study supporting courses after graduation that would help prompt their qualifications and increase their chances of getting jobs. Many other graduated engineers do not track and follow vacancy announcements and are frustrated with rejection after the first attempt. This depressing behavior reduces their opportunities in the workforce market.

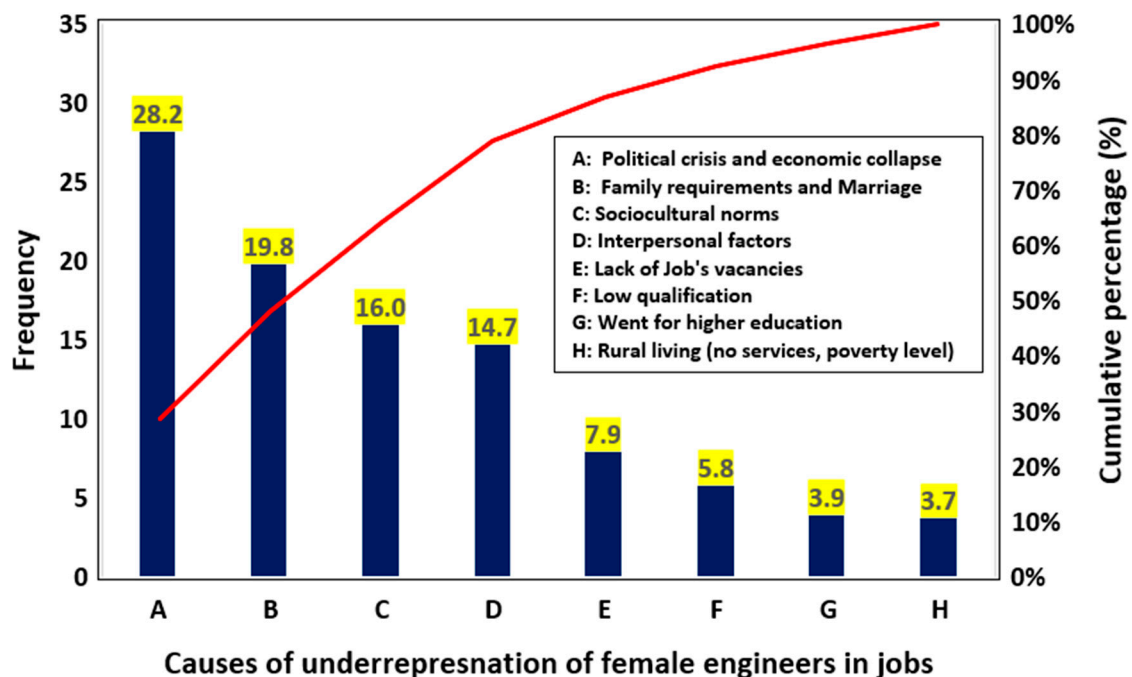


Figure 6. Pareto chart explaining the main factors of low participation of female engineers in employment based on the female respondents in the survey.

Female engineers believe that the “high GPA grade” variable was less important in their selection, owing to the high overall grades they scored in their colleges without enhancing job opportunities. In addition, female engineers who preferred to go for post-graduate studies immediately after graduation represent a proportion of unemployed female engineers. Finally, a few proportions of female engineers live in rural areas, where there is no internet and electricity, and therefore, they cannot apply for job vacancies. These are the main reasons for the low participation of female engineers in employment.

5. Conclusions and Recommendations

This study provides a new investigation into female engineering graduates and their integration into the labor market in a populated country, Yemen, that has never been studied. It is the first study to investigate the effects of socio-cultural norms and economic conditions as substantial barriers to female engineers’ underrepresentation in their careers.

The outcome of this study matches well with other studies conducted of female engineering graduates in which graduates have good qualifications and knowledge but lack employability skills and self-motivation. Female engineering graduates have surrendered to the current situation and the lack of employment opportunities while frustration has got to them. As a special feature of Yemen, the overall condition of the country has steeply decreased job opportunities and increased the frustration rates among female graduates, switching them to unutilized resources for family development. State government and the private sector should seriously and positively provide realistic steps towards the employment of female engineers.

Unlike other nations, female engineering careers in Yemen are associated with extremely low wages, low work opportunities, unfair socio-cultural norms, and unhealthy

work environments. Female engineers need more mobility and freedom, which are restricted by families and society, to increase their occupancy chances. It is preferred for Yemeni female engineers to look for an engineering-related job outside the country, where the job opportunities are ultimately high, and for their family to accept their traveling with/without accompanying family members. The barriers made by families to the mobility of female engineers substantially reduce their chances of getting a job. Furthermore, physical constraints and sieges have restricted family movements between large cities and industrial districts.

This study recommends engineering colleges frequently update their programs' curricula to cope with the rapid development and employers' expectations. Furthermore, the curricula should include courses for improving employability agenda and communication skills. The results of statistically analyzed data indicated that gender bias in the Yemeni education system is uncommon. However, gender discrimination in obtaining a job and at the workplace is frequently prevalent, especially in engineering professions.

The present study strongly recommends female engineers improve their employability attributes along with their high levels of knowledge to compete for engineering-related jobs. Before entering undergraduate studies, females should consult well-experienced seniors to guide them in selecting suitable specializations with high-future-employment chances. Female engineers need self-assessments of the likelihood of obtaining future satisfying employment before college enrolment. More studies are required to explore this problem in other states of Yemen and for disciplines other than engineering where females are minorities.

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References

1. Naja, H.B.M. Identifying the challenging factors in the transition from colleges of engineering to employment. *Eur. J. Eng. Edu.* **2012**, *37*, 3–14.
2. Ramadi, E.; Ramadi, S.; Nasr, K. Engineering graduates' skill sets in the MENA region: A gap analysis of industry expectations and satisfaction. *Eur. J. Eng. Educ.* **2016**, *41*, 34–53. [[CrossRef](#)]
3. UNESCO ICEE. *Engineering for sustainable development: Delivering on the Sustainable Development Goals*; International Centre for Engineering Education: Paris, France, 2021; pp. 1–185.
4. National Academy of Engineering. *Understanding the Educational and Career Pathways of Engineers*; National Academy of Engineering, Academic Press: Washington, DC, USA, 2018.
5. Rowston, K.; Bower, M.; Woodcock, S. Career-changers' technology integration beliefs and practice in initial teacher education: A summative cross-case analysis. *Int. J. Educ. Res.* **2022**, *116*, 102079. [[CrossRef](#)]
6. Balakrishnan, B.; Low, F.S. Learning Experience and Socio-Cultural Influences on Female Engineering Students' Perspectives on Engineering Courses and Careers. *Minerva* **2016**, *54*, 219–239. [[CrossRef](#)]
7. Kutnick, P.; Lee, B.P.-Y.; Chan, R.Y.-Y.; Chan Ka, Y. Students' engineering experience and aspirations within STEM education in Hong Kong secondary schools. *Int. J. Educ. Res.* **2020**, *103*, 101610. [[CrossRef](#)]
8. Panda, S. Constraints faced by women entrepreneurs in developing countries: Review and ranking. *Gend. Manag.* **2018**, *33*, 315–331. [[CrossRef](#)]

9. Longe, A.M.; Ouahada, K. A Literature Review on Challenges and Opportunities for Women in Engineering. In Proceedings of the 2019 IEEE AFRICON, Accra, Ghana, 25–27 September 2019; pp. 1–6.
10. Subri, U.S. A Review of Job Challenges Factors for Women Engineer. *Int. J. Acad. Res. Bus. Soc. Sci.* **2018**, *8*, 1450–1455. [\[CrossRef\]](#)
11. Christie, M.; O'Neill, M.; Rutter, K.; Young, G.; Medland, A. Understanding why women are under-represented in Science, Technology, Engineering and Mathematics (STEM) within Higher Education: A regional case study. *Production* **2017**, *27*, e20162205. [\[CrossRef\]](#)
12. Marco-Bujosa, L.M.; Joy, L.; Sorrentino, R. Nevertheless, She Persisted: A Comparison of Male and Female Experiences in Community College STEM Programs. *Community Coll. J. Res. Pract.* **2020**, *45*, 541–559. [\[CrossRef\]](#)
13. Sellami, A.L.; Al-Ali, A.; Allouh, A.; Alhazbi, S. Student Attitudes and Interests in STEM in Qatar through the Lens of the Social Cognitive Theory. *Sustainability* **2023**, *15*, 7504. [\[CrossRef\]](#)
14. Paucar-Curasma, R.; Cerna-Ruiz, L.P.; Acra-Despradel, C.; Villalba-Condori, K.O.; Massa-Palacios, L.A.; Olivera-Chura, A.; Esteban-Robladillo, I. Development of Computational Thinking through STEM Activities for the Promotion of Gender Equality. *Sustainability* **2023**, *15*, 12335. [\[CrossRef\]](#)
15. Wild, S.; Heuling, L.S. Student dropout and retention: An event history analysis among students in cooperative higher education. *Int. J. Educ. Res.* **2020**, *104*, 101687. [\[CrossRef\]](#)
16. Saavedra, L.; Araujo, A.M.; de Oliveira, J.M.; Stephens, C. Looking through glass walls: Women engineers in Portugal. *Women's Stud. Int. Forum* **2014**, *45*, 27–33. [\[CrossRef\]](#)
17. Male, S.A.; Gardner, A.; Figueroa, E.; Bennett, D. Investigation of students' experiences of gendered cultures in engineering workplaces. *Eur. J. Eng. Educ.* **2017**, *43*, 360–377. [\[CrossRef\]](#)
18. Akinlolu, M.; Haupt, T.C. Investigating a Male-Dominated Space: Female Students' Perceptions of Gendered Cultures in Construction Workplaces. In *The Construction Industry in the Fourth Industrial Revolution, Proceedings of the The Construction Industry in the Fourth Industrial Revolution*. CIDB 2020; Aigbavboa, C., Thwala, W., Eds.; Springer: Cham, Switzerland, 2020.
19. Ballakrishnen, S.; Fielding-Singh, P.; Magliozzi, D. Intentional Invisibility: Professional Women and the Navigation of Workplace Constraints. *Sociol. Perspect.* **2018**, *62*, 23–41. [\[CrossRef\]](#)
20. Gati, I.; Kulcsár, V. Making better career decisions: From challenges to opportunities. *J. Vocat. Behavior.* **2021**, *126*, 103545. [\[CrossRef\]](#)
21. Lent, R.W.; Brown, S.D. Career decision making, fast and slow: Toward an integrative model of intervention for sustainable career choice. *J. Vocat. Behav.* **2020**, *120*, 103448. [\[CrossRef\]](#)
22. Stead, G.B.; LaVeck, L.M.; Hurtado Rúa, S.M. Career Adaptability and Career Decision Self-Efficacy: Meta-Analysis. *J. Career Dev.* **2021**, *49*, 952–964. [\[CrossRef\]](#)
23. Xin, L.; Tang, F.; Li, M.; Zhou, W. From School to Work: Improving Graduates' Career Decision-Making Self-Efficacy. *Sustainability* **2020**, *12*, 804. [\[CrossRef\]](#)
24. Brown, S.D.; Lent, R.W. *Career Development and Counseling: Putting Theory and Research to Work*; eBook; John Wiley & Sons: Hoboken, NJ, USA, 2021.
25. Walker-Donnelly, K.; Scott, D.A.; Cawthon, T.W. Introduction: Overview and Application of Career Development Theories. *New Dir. Stud. Serv.* **2019**, *166*, 9–17. [\[CrossRef\]](#)
26. Rogers, S.E.; Miller, C.D.; Flinchbaugh, C.; Giddarie, M.; Barker, B. All internships are not created equal: Job design, satisfaction, and vocational development in paid and unpaid internships. *Hum. Resour. Manag. Rev.* **2019**, *31*, 100723. [\[CrossRef\]](#)
27. Wang, X.-H.; Wang, H.-P.; Lai, W.-Y. Sustainable Career Development for College Students: An Inquiry into SCCT-Based Career Decision-Making. *Sustainability* **2023**, *15*, 426. [\[CrossRef\]](#)
28. Dos Santos, L.M. The Relationship between Workforce Sustainability, Stress, and Career Decision: A Study of Kindergarten Teachers during the COVID-19 Pandemic. *Sustainability* **2021**, *13*, 11521. [\[CrossRef\]](#)
29. Wang, C.-J. Should I Stay or Should I Go? Linking Career Decision-Making Self-Efficacy to Intention to Stay in the Hospitality Industry Based on Internship Experience. *Sustainability* **2021**, *13*, 10571. [\[CrossRef\]](#)
30. Jung, E.; Eunice Kim, J.Y. Women in Engineering: Almost No Gap at University but a Long Way to Go for Sustaining Careers. *Sustainability* **2020**, *12*, 8299. [\[CrossRef\]](#)
31. Mozahem, N.A.; Ghanem, C.M.; Hamieh, F.K.; Shoujaa, R.E. Women in engineering: A qualitative investigation of the contextual support and barriers to their career choice. *Women's Stud. Int. Forum* **2019**, *74*, 127–136. [\[CrossRef\]](#)
32. Byars-Winston, A.; Rogers, J.G. Testing intersectionality of race/ethnicity $\times$ gender in a social-cognitive career theory model with science identity. *J. Couns. Psychol.* **2019**, *66*, 30–44. [\[CrossRef\]](#) [\[PubMed\]](#)
33. Wu, J.R.; Kundu, M.; Iwanaga, K.; Chan, F.; Chen, X.; Rumrill, P.; Wehman, P. Social Cognitive Career Theory Predictors of Goal Persistence in African American College Students with Disabilities. *Rehabil. Couns. Bull.* **2022**, *14*, 00343552221108407. [\[CrossRef\]](#)
34. Carrico, P.E.C.; Tendhar, C. The Use of the Social Cognitive Career Theory to Predict Engineering Students' Motivation in the PRODUCED Program. In Proceedings of the 2012 ASEE Annual Conference & Exposition, San Antonio, TX, USA, 10 June 2012; pp. 25–1354. [\[CrossRef\]](#)
35. Inda, M.; Rodríguez, C.; José Vicente, P. Gender differences in applying social cognitive career theory in engineering students. *J. Vocat. Behav.* **2013**, *83*, 346–355. [\[CrossRef\]](#)

36. Alshahrani, A.; Ross, I.; Wood, M. Using Social Cognitive Career Theory to Understand Why Students Choose to Study Computer Science. In Proceedings of the 2018 ACM Conference on International Computing Education Research (ICER '18), Espoo, Finland, 8 August 2018; pp. 205–214.
37. Al-Ammar, F.; Patchett, H.; Shamsan, S. *A Gendered Crisis: Understanding the Experiences of Yemen's War*; Sana'a Center for Strategic Studies: Sana'a, Yemen, 2019.
38. El-Sherbeeney, A.M. Assessing Engineering Disciplines with Expected Success for Females in Saudi Arabia. In Proceedings of the 2018 ASEE Annual Conference & Exposition, Salt Lake City, UT, USA, 23–27 June 2018.
39. Abu-lail, N.I.; Phang, F.A.; Kranov, A.M.A.; Mohd-Yusof, K.; Olsen, R.G.; Williams, R.L.; Abidin, A.Z. Persistent gender inequity in U.S. undergraduate engineering: Looking to Jordan and Malaysia for factors to their success in achieving gender parity. In Proceedings of the 2012 ASEE Annual Conference & Exposition, San Antonio, TX, USA, 10 June 2012.
40. Nayeemuddin, M.; Chowdhury, S.R.; Ayadat, T.; Ahmed, D.; Asiz, A. A comparative analysis between female and male motivations to study engineering: A case study in Saudi Arabia. *Glob. J. Eng. Educ.* **2022**, *24*, 122–133.
41. Khan, A.; Alsulami, H.; Shahzad, A.; Elnahas, N.; Almalki, S.; Alshehri, R.; Alamoudi, M.; Alshoaibi, H. Perception Gap of Employability Skills between Employers' and Female Engineering Graduates in Saudi Arabia. *Int. J. Eng. Educ.* **2021**, *37*, 341–350.
42. El-Sherbeeney, A.M. Highlighting the Need for Engineering Education for Females in Saudi Arabia. In Proceedings of the 2014 ASEE Annual Conference & Exposition, Indianapolis, IN, USA, 15–18 June 2014.
43. Almathami, R.; Khoo-Lattimore, C.; Yang, E.C.L. Exploring the challenges for women working in the event and festival sector in the Kingdom of Saudi Arabia. *Tour. Recreat. Res.* **2022**, *47*, 47–61. [\[CrossRef\]](#)
44. Baytiyeh, H. Are women engineers in Lebanon prepared for the challenges of an engineering profession. *Eur. J. Eng. Educ.* **2013**, *38*, 394–407. [\[CrossRef\]](#)
45. Alharazi, S.; Batool, N. Factors Affecting Female Students in Choosing Engineering as an Academic Degree and Profession in Gender-Segregated Society in Saudi Arabia. *PalArch's J. Archaeol. Egypt Egyptol.* **2021**, *18*, 462–470.
46. Alfarran, A.; Pyke, J.; Stanton, P. Institutional barriers to women's employment in Saudi Arabia. *Equal. Divers. Incl. Int. J.* **2018**, *37*, 713–727. [\[CrossRef\]](#)
47. Orr, M.K.; Hazari, Z.; Sadler, P.M.; Sonnert, G. Career motivations of freshman engineering and non-engineering students: A gender study. In Proceedings of the 2009 Annual Conference & Exposition, Austin, TX, USA, 14–17 June 2009.
48. Rosser, S.V. Breaking into the Lab: Engineering Progress for Women in Science and Technology. *Int. J. Gend. Sci. Technol.* **2012**, *10*, 213–232.
49. Fouad, N.A.; Chang, W.-H.; Wan, M.; Singh, R. Women's Reasons for Leaving the Engineering Field. *Front. Psychol.* **2017**, *8*, 875. [\[CrossRef\]](#) [\[PubMed\]](#)
50. Smith, K.N.; Gayles, J.G. Girl Power: Gendered Academic and Workplace Experiences of College Women in Engineering. *Soc. Sci.* **2018**, *7*, 11. [\[CrossRef\]](#)
51. DeBoer, J.; Kranov, A.A. *Key Factors in the Tertiary Educational Trajectories of Women in Engineering: Trends and Opportunities in Saudi Arabia, the GCC, and Comparative National Settings in Science and Technology Development in the Gulf States*; Gerlach Press: London, UK, 2017; pp. 56–88.
52. Ahmad, A.A.; Hanafi, I. The Yemeni Civil War's Impact on The Socio-Cultural Conditions of the People in Yemen. *J. Tapis Teropong Aspir. Polit. Islam* **2023**, *19*, 145–158.
53. Al-Asfour, A.; Tlaiss, H.A.; Khan, S.A.; Rajasekar, J. Saudi women's work challenges and barriers to career advancement. *Career Dev. Int.* **2017**, *22*, 184–199. [\[CrossRef\]](#)
54. Hattab, H. Towards understanding female entrepreneurship in Middle Eastern and North African countries: A cross-country comparison of female entrepreneurship. *Educ. Bus. Soc. Contemp. Middle East. Issues* **2012**, *5*, 171–186. [\[CrossRef\]](#)
55. Çemberci, M.; Civelek, M.E.; Ertemel, A.V.; Cömert, P.N. The relationship of work engagement with job experience, marital status and having children among flexible workers after the COVID-19 pandemic. *PLoS ONE* **2022**, *17*, e0276784. [\[CrossRef\]](#) [\[PubMed\]](#)
56. Desrumaux, P.; De Bosscher, S.; Léoni, V. Effects of Facial Attractiveness, Gender, and Competence of Applicants on Job Recruitment. *Swiss J. Psychol.* **2009**, *68*, 33–42. [\[CrossRef\]](#)
57. The Jamovi Project. Computer Software. 2021. Available online: <https://www.jamovi.org/about.html> (accessed on 3 June 2023).
58. Shafie, L.A.; Nayan, S. Employability awareness among Malaysian undergraduates. *Int. J. Bus. Manag.* **2010**, *5*, 119–123.
59. Schmitt, M. Women Engineers on Their Way to Leadership: The Role of Social Support Within Engineering Work Cultures. *Eng. Stud.* **2021**, *13*, 30–52. [\[CrossRef\]](#)
60. Colton, N.A. Yemen: A Collapsed Economy. *Middle East J.* **2010**, *64*, 410–426. [\[CrossRef\]](#)
61. Espinoza, O.; McGinn, N.O. Graduates' satisfaction as a measure of quality: Evidence from two programs in three Chilean universities. *Int. J. Educ. Res.* **2018**, *90*, 133–143. [\[CrossRef\]](#)
62. Tijani, B.; Osei-Kyei, R.; Feng, Y. A review of work-life balance in the construction industry. *Int. J. Constr. Manag.* **2022**, *22*, 2671–2686. [\[CrossRef\]](#)
63. Busetta, G.; Fiorillo, F.; Palomba, G. The impact of attractiveness on job opportunities in Italy: A gender field experiment. *Econ. Polit.* **2021**, *38*, 171–201. [\[CrossRef\]](#)

64. Moyer, J.D.; Bohl, D.; Thanna, T.; Mapes, B.R.; Rafa, M. Assessing the Impact of War on Development in Yemen. United Nations Development Programme (UNDP). 2019. Available online: <https://www.undp.org/sites/g/files/zskgke326/files/migration/ye/Impact-of-War-Report-3---QR.pdf> (accessed on 3 June 2023).
65. World Bank. The Republic of Yemen Unlocking the Potential for Economic Growth: A Country Economic Memorandum. World Bank 2015, 102151-YE. Available online: <https://openknowledge.worldbank.org/handle/10986/23660> (accessed on 3 June 2023).

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