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What Challenges Affect Arab Women's Engagement in STEM Fields, Particularly Engineering: A Systematized Literature Review

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Abstract

Arab women confront numerous challenges restricting their engagement in Science, Technology, Engineering, and Mathematics (STEM) fields, particularly in engineering. This study conducted a systematized literature review to identify these challenges, guided by the research question: "What challenges affect Arab women's engagement in STEM fields, particularly engineering?" A search was conducted using databases such as ERIC, Education Source from the EBSCO platform, and Compendex, Inspec from the Engineering Village platform. After applying inclusion and exclusion criteria, a total of twelve peer-reviewed articles were selected and analyzed to examine the challenges that Arab women encounter in these fields. The analysis revealed three main themes: The inherent nature of Arab culture and society and the role of family support in the Engineering field, gender stereotyping in Arab and engineering cultures, and the characteristics of the Arab workplace and employment. Addressing these challenges is crucial for promoting Arab women's engagement in engineering, which benefits women and contributes to the growth and development of the economy and society as a whole. This study offers several recommendations for overcoming these barriers, such as raising awareness, providing mentorship and support, creating flexible work schedules and family-friendly policies, fostering diversity and inclusion, and promoting gender equality in the workplace.

Outline

This paper aims to provide a systematized literature review of the challenges faced by Arab women in STEM fields, with a focus on the field of engineering. The study begins with an introduction to the topic and the research question guiding the study. Next, the Literature Review section examines previous research on the topic, while the Methods section details the process of selecting studies and analyzing results. The Analysis and Results section presents findings in three themes, followed by the Discussion section, which provides an interpretation of the findings, recommendations, and implications for addressing these challenges. Finally, the Conclusion summarizes the key findings of the paper.

Introduction

Despite women comprising 50% of the global workforce, they remain significantly underrepresented in STEM fields, which is a concerning trend that persists worldwide [1]. While women make up an estimated 25%-30% of the STEM workforce globally, their representation varies across regions and disciplines [1]. For instance, U.S. Census Bureau data reveals that women are more highly represented in social sciences than in engineering [2]. Although progress has been made in recent years, the underrepresentation of women in engineering remains a persistent issue, as illustrated in Figure 1.

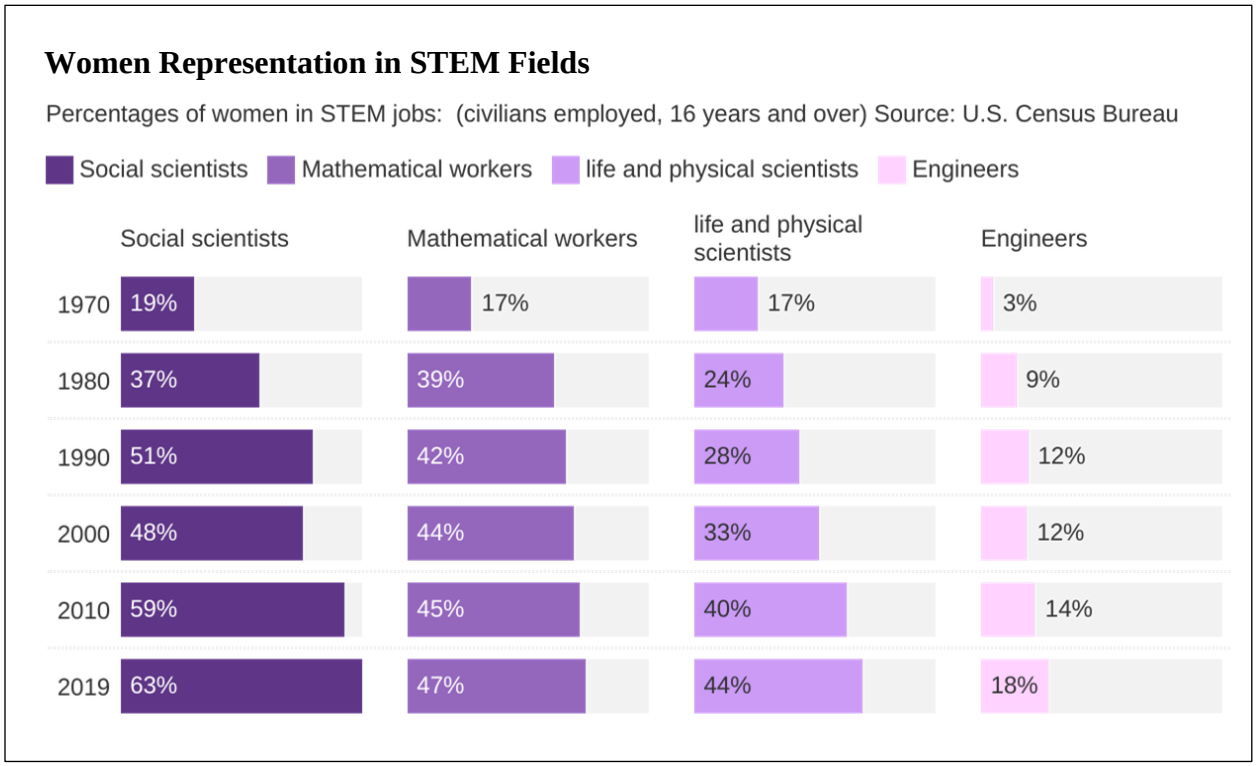

Figure (1) The Percentage of Women in STEM Jobs [2].

Engineering is crucial in improving societies and positively impacting communities [3]. However, despite its significance, the field is often perceived as male-dominated [4], which creates a sense of exclusion for women and discourages their active engagement. To address this issue and make engineering a more inclusive and accessible field for everyone, regardless of gender or background, it is crucial to increase the representation of women in the field and provide them with the necessary support and empowerment to succeed [5].

Generally, women from diverse regions across the globe, particularly those in STEM fields such as engineering, face various challenges, including math anxiety, gender stereotypes, and financial barriers [6]. In addition, students pursuing careers in science also face similar challenges [7]. Thus, math anxiety can be a significant internal obstacle for women in engineering, as it can erode their self-assurance and motivation to pursue careers in this field [6].

In the Arab world, which comprises 22 countries in the Middle East and North Africa and has a population of over 444 million, women make up approximately half of the population [8], [9]. However, Arab women continue encountering challenges in STEM fields, particularly in engineering. According to UNESCO and the World Bank, as well as a study by Islam (2019), Arab women now enroll in STEM fields at high rates, with an average enrollment rate of 34-57% [1], [10], [11]. Figure 2 shows how the percentage of women who graduated from STEM varies among Arab countries. While some countries have high rates in the engineering field, others, such as Saudi Arabia, have low rates.

In contrast to other STEM fields, Arab women are less likely to engage in engineering [1]. Therefore, it is crucial to understand the various factors, including cultural norms, societal expectations, and institutional barriers, that contribute to this underrepresentation [12].

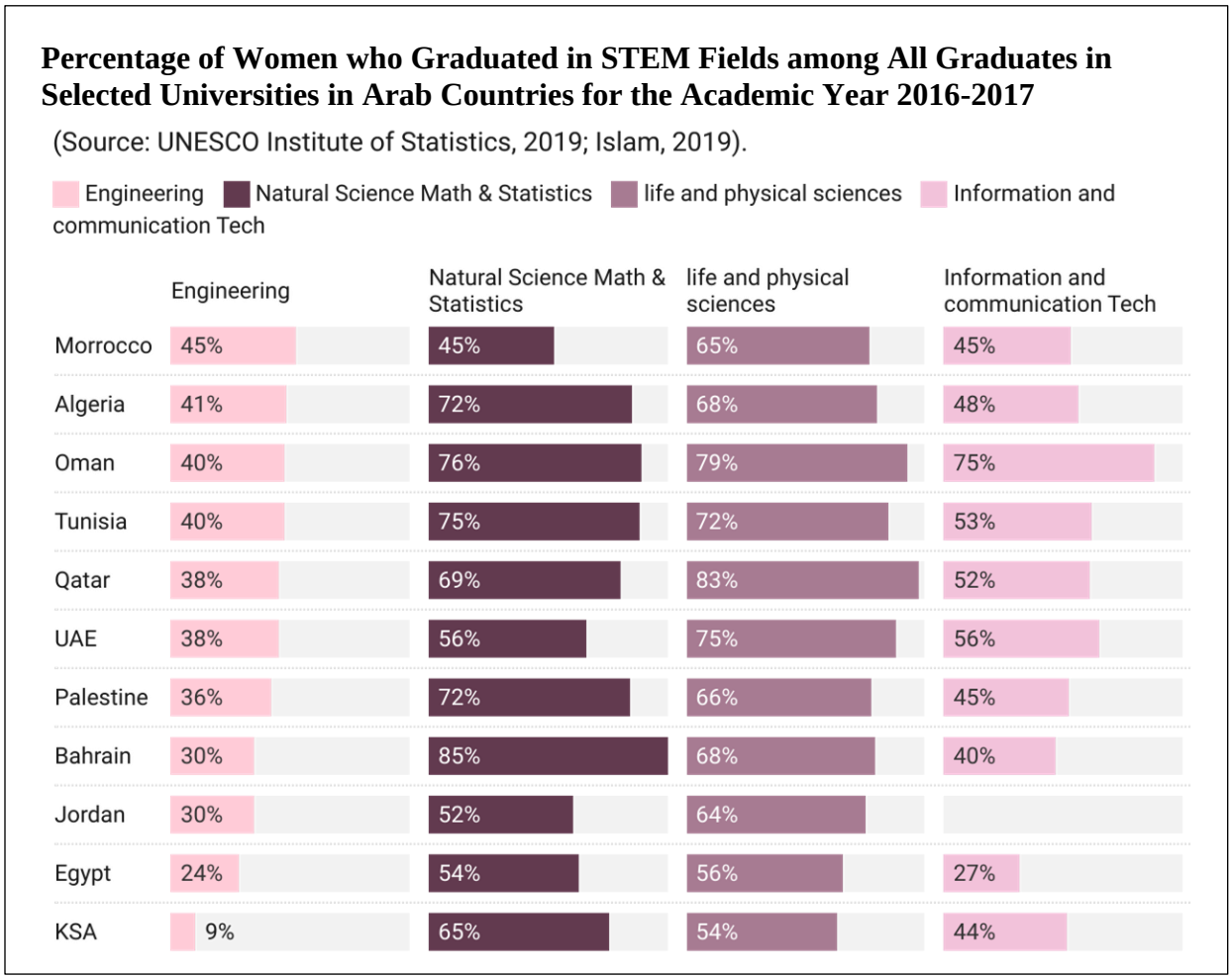

Figure (2) Percentage of Women who Graduated in STEM Fields among All Graduates in Selected Universities in Arab Countries for the Academic Year 2016-2017 [10], [11].

This systematized literature review aims to answer the research question: "What challenges affect Arab women's engagement in STEM fields, particularly engineering?" The study will shed light on the challenges, obstacles, and barriers that Arab women face by reviewing existing literature. The study aims to identify the most critical challenges frequently discussed in peer-reviewed papers and highlight the pressing issues women face in STEM, especially in engineering. Identifying the main themes can lead to informative conclusions and well-grounded recommendations, as well as proposing potential solutions to better support and empower women in engineering.

Literature review

Although progress has been made recently to promote diversity and inclusion in STEM fields, Arab women still encounter significant obstacles, specifically in engineering. Studies have shown that women in STEM face workplace discrimination, recruitment and retention issues, and a lack of supportive and flexible work environments, making it difficult for them to succeed [11], [13]. Additionally, societal bias, misalignment, and a fear of working outside the public sector can

deter women from pursuing STEM careers [13]. The recruitment, retention, and career development challenges further complicate the situation [14]. Women, especially those with families, find it challenging to work in engineering. Some women reported leaving the engineering profession due to the hostile work environment, causing them to switch careers, become entrepreneurs, start businesses, or work for non-governmental organizations [11], [12]. The hostility towards women in the workplace has also been documented in other studies [15], [16]. Addressing these challenges requires ongoing research, implementing favorable employment laws, and ensuring women's voices are heard in decision-making [11].

According to Howe-Walsh et al. [17], women in the United Arab Emirates (UAE) prioritize work prestige in their career choices, regardless of whether they work for a public or private company. This preference for work prestige may challenge women who value balancing their professional and personal goals, as it could limit their career opportunities [17].

Researchers have identified several factors and challenges that affect women's entry, persistence, or departure from STEM fields. For instance, one study found that these factors included the relationship between self-efficacy and competence, religious and personal beliefs, family and cultural issues, and the value of work and social standing [12]. Another study suggested that parental educational background was a significant factor in determining female students' choice of engineering as a major [3].

A study in Brazil found that women were less likely to pursue engineering careers due to disrespectful and unsafe work environments [18]. In contrast, a study in the United States found that women in STEM prioritize workplace amenities, such as infrastructure, and are more satisfied with their careers if these amenities are met. Therefore, failing to meet certain workplace amenities can make it challenging for women to pursue or engage in engineering careers [19]. A systematic literature review identified potential barriers for women pursuing STEM careers, focusing on the UAE. The study concluded that job prospects remain limited despite increasing access for women in STEM [20]. Additionally, another systematic review of women's engagement experiences in STEM fields revealed that these experiences in engineering are influenced by personal characteristics such as self-efficacy, motivation, and passion, as well as the practices of male colleagues, parents, and human resources [21]. Furthermore, Baytiyeh [22] found that women engineers often struggle with communication, self-confidence, and creativity.

While the studies reviewed above offer valuable insights, there are still gaps in the literature, such as a lack of research comparing the experiences of Arab women with those of non-Arab women in STEM fields, particularly in the field of engineering. Additionally, most studies that have focused on Arab women were conducted in specific regions and may not represent the experiences of Arab women in other contexts. Therefore, it is essential to address these gaps in the literature and understanding of the experiences of Arab women in order to promote gender equality in STEM fields.

Methods

A Systematized Literature Review (SLR) was utilized in this study to answer the research question. SLR provides a preliminary evaluation of a topic that may be suitable for a systematic review, but with less rigor and criteria [23]. Unlike systematic reviews, SLRs are often performed independently without a thorough quality assessment of the literature. The process of SLR, as described by Grant & Booth [24], involves defining the research question before collecting

literature from relevant databases, filtering it by relevance, categorizing it, assessing its quality, and synthesizing findings.

Searching Strategies and Database Selection Procedure

This SLR utilized the Engineering Village and EBSCO platforms to search for relevant articles. Four databases were selected for this study.

The Engineering Village is an online information platform known for its high-quality search and discovery features in the engineering field [25]. Therefore, this platform was used to access Inspec and Compendex databases. In comparison, the EBSCO platform is an efficient research platform with quality databases and search features [26]. Thus, this platform was used to access Education Source and ERIC databases.

Inspec is a major indexing database of scientific and technical literature, and Compendex is the world's most comprehensive interdisciplinary engineering database. Education Source caters to the needs of education students, policymakers, and professionals, while the ERIC database provides access to extensive educational literature and research.

These databases were selected for their relevance to the research question as they contain numerous peer-reviewed journals on education and science.

Database Search Results

In order to identify the challenges encountered by Arab women in their undergraduate or graduate studies and in the field of engineering, a comprehensive search was conducted using four databases: Education Source and ERIC from the EBSCO platform, as well as Compendex and Inspec from the Engineering Village platform. The search criteria for literature related to Arab women in STEM education for these databases included the following keywords: (woman OR female) AND (engineering education or STEM education) AND (Arab OR Middle East) AND (obstacles OR barriers) for all fields.

Multiple search operators and wildcards were used for all keywords in the search criteria, including variations of each term to ensure a comprehensive search. For instance, 'wom?n' was used to capture both 'woman' and 'women,' and 'educat*' was used for 'education' to include related terms like 'educational,' 'education,' 'educate,' and 'educator.' The wildcard symbols'*' and '?' were used throughout to capture all possible variations of the search terms.

The initial search yielded 545 articles. Next, a filter was applied to exclude books and conference papers to refine the results, and only full-text journal articles were selected. Finally, further refinement was achieved using inclusion and exclusion criteria, which will be detailed in the following paragraph.

Inclusion and Exclusion Criteria

The selection criteria were applied to narrow down the initial pool of articles and identify the most relevant to the research question. The first step involved removing duplicate articles and reducing their number to 496. Subsequently, only peer-reviewed journal articles were included, and books and conference papers were excluded, reducing the number to 254.

The titles and abstracts of the remaining articles were screened, and articles were included if they met the following criteria shown in Table (1).

After applying the inclusion and exclusion criteria, twelve articles were identified for in-depth analysis.

Inclusion Criteria	Exclusion Criteria
• The abstract and title contained the primary keywords or their synonyms. • The article was related to Arab countries or the Arab World. • Women's challenges in STEM were mentioned in the title/abstract.	• Not available in full text. • Not within the Arab World. • Not addressing the challenges faced by women. • Not in a STEM-related context • Not in English.

Table 1: Inclusion and Exclusion Criteria

PRISMA Flow Diagram

The PRISMA flow diagram, which stands for the Preferred Reporting Items for Systematic Reviews and Meta-Analyze, is a valuable tool for charting the progress of the articles' identification, screening, and inclusion process. The diagram maps out the number of records identified, screened, included, and excluded and the reasons for the exclusions at each step, as illustrated in Figure 2.

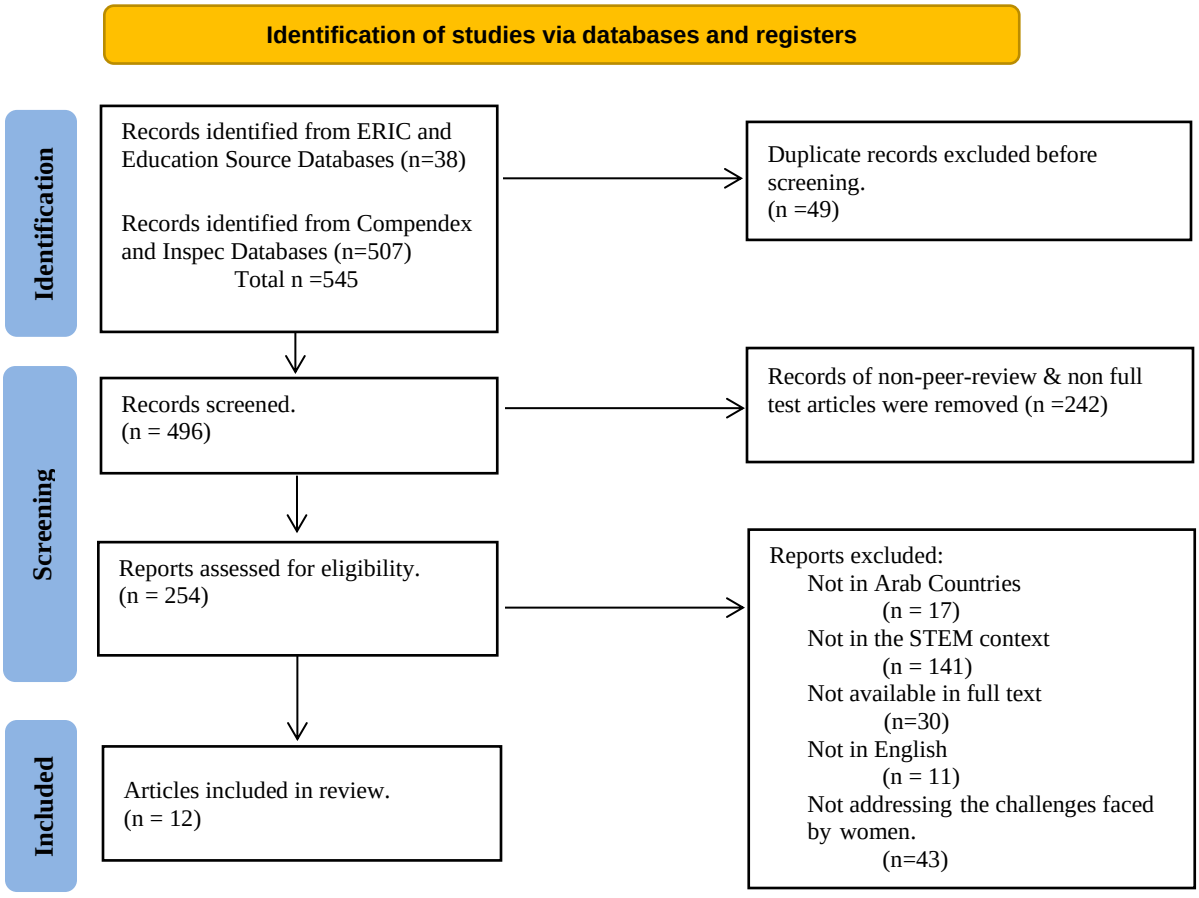

Figure 2: PRISMA 2020 flow diagram of the identification screening and inclusion of studies via databases

Analysis and Results

This systematized literature review aimed to identify the research question: What challenges affect Arab women's engagement in STEM Fields, particularly engineering? Twelve research articles were analyzed using a constructivist approach, which involved categorizing and organizing the findings based on recurring themes. The recurring themes and their frequency of occurrence in the articles were recorded, and the identified themes were then presented in Table 2.

The constructivist approach allowed the identification of three main themes: (1) the inherent nature of Arab culture and society and the role of family support in the engineering field, (2) gender stereotyping in the Arab and engineering culture, and (3) the characteristics of the Arab workplace and employment. A comprehensive overview of the most pressing issues facing Arab women in STEM fields, with a specific focus on engineering, was then provided using high-level codes.

It is important to note that while women in Arab countries face similar challenges, each country has unique regulations and limitations that must be considered when addressing them. Therefore, acknowledging these regional differences is crucial to creating tailored solutions that effectively support Arab women in engineering across different countries.

Themes	High-level codes
Theme 1: The inherent nature of Arab culture and society & The role of family support in the engineering field	• Role of society. • Role of culture (Patriarchal culture). • Role of Parents. • Role of male siblings. • Conservative regions. • Overprotecting women. • Lack of support.
Theme 2: Gender Stereotyping in the Arab and engineering culture	• Gendered organizational culture. • Gender-role stereotyping. • Discrimination.
Theme 3: The characteristics of the Arab workplace and employment.	• Discrimination. • Role of male colleagues. • Role of company's owner, leaders, HR, and recruiters. • Lack of equity. • Challenges related to maternity.

Table 2: Theme identification

Theme 1: The inherent nature of Arab culture and society and the role of Family Support in the Engineering field

Recent studies [11], [27]–[30] have highlighted the significant impact of Arab culture and society on women's experiences in engineering, where they face various social, cultural, and familial barriers that contribute to their underrepresentation in STEM fields. These obstacles are

reinforced by the dominant patriarchal culture and cultural norms that dictate women's conduct. In particular, Wang et al. [31] found that low-quality STEM education was a prevalent cultural barrier, while other studies have identified additional cultural barriers in the form of limited family and social support, as well as broader societal-related issues. These cultural barriers are rooted in patriarchal cultures with overprotective attitudes towards women that are commonly found in the Arab world. For instance, parents and male siblings often influence women's career choices, which has been emphasized as a significant contributor to the underrepresentation of women in engineering [27]–[30], [32]–[36].

The influence of Arab culture is cited as a main hindrance for women pursuing careers in engineering. Socio-cultural factors and cultural norms in Saudi Arabia, for instance, present unique challenges for women, as they are expected to behave as their male counterparts dictate, which thereby limits their access to technology and ability to participate in fields such as engineering [37]. According to Alhareth [37], women suffer from a lack of authority and empowerment compared to men due to the centralized decision-making process. Similarly, in Oman, societal restrictions prevent women from participating in information and communications technology [32]. In addition, cultural narratives can shape women's experiences and career choices, including the common masculine-related narratives that "math is for boys"[35].

The absence of family support can be a barrier, affecting women's decision to pursue STEM careers [28], [32]. On the other hand, family influences may also play a positive and supportive role in women's participation in engineering. For instance, in some Palestinian families, engineers are viewed as successful and highly respected, thereby encouraging their daughters to pursue engineering as a career. [38].

In conclusion, the first theme emphasizes how cultural and societal factors, such as family and social support, contribute to Arab women's underrepresentation in engineering. These factors can create a hostile environment for those women and make it difficult for them to pursue and succeed in their careers.

Theme 2: Gender Stereotyping in the Arab and Engineering Culture

The second theme examines the issue of gender stereotyping and inequalities in the Arab and engineering culture. According to the Office of the High Commissioner for Human Rights, a gender stereotype is a generalized preconception about the characteristics, attributes, roles, or functions associated with either men or women [39].

Despite the growth in women's educational pursuits, gender bias still prevails, making it challenging for women to achieve their goals in the field of engineering. Studies in the Arab world reveal a strong gender bias against women in engineering, particularly in the form of gender stereotypes [30]. For example, female students in Qatar faced challenges due to gender bias from their professors and male peers, making it challenging to prove their intelligence and abilities [27]. As highlighted in the study, female Arab students reported that their professors held lower expectations for them than their male counterparts and evaluated them more leniently [27].

Several gender-related challenges, such as gender stereotypes and societal expectations of gender roles, can prevent women from pursuing careers in STEM fields [30]. Women who have graduated from university and attempted to pursue careers or postgraduate degrees are often excluded from these opportunities due to their gender, so they are much less likely to gain employment and/or remain in it [29]. This lack of representation in STEM fields results in lower

wages and limited promotion prospects for women [38]. According to Islam [29], prejudice and discrimination determine the type of employment that is most suitable for women and men in Arab countries. That is why women tend to change their work or major while still in college. Gender stereotypes play a role in the Arab world regarding hiring practices in the engineering industry. For example, companies may be unwilling to hire women, and industries may be hesitant to sponsor women for engineering studies due to these stereotypes. The belief that men are better suited for engineering tasks can limit women's career opportunities. Additionally, negative gender stereotypes may result in less social support for women in STEM fields [35].

Discrimination in the form of gender stereotypes is evident when men exploit women's timid nature and pass them over for promotions in favor of more ambitious and assertive males [32].

Theme 3: The Characteristics of the Arab Workplace and Employment.

The third theme focuses on the characteristics of the Arab workplace and employment that contribute to the underrepresentation of women in engineering. Despite the limited job prospects for women in the region [11], [28], [29], [31], they face numerous challenges in the workplace. That includes uncomfortable work environments, unfair treatment by company owners, limited job and career advancement opportunities, maternity-related difficulties, gender discrimination, negative perceptions of their professional capabilities and commitment, and a lack of mentoring and coaching support [11], [28], [29], [31], [38]. In addition, discriminatory organizational policies and practices, including employer bias and stereotypical gender discrimination, also contribute to these challenges [30], [31].

One of the studies mentioned that the directors of contracting in the Arab world are often unwilling to hire women engineers, as they perceive them as unqualified and incapable of enduring the same hard work as men [38]. In addition, those directors believe that maternity leave may delay company projects and negatively affect firm operations [30], [38]. Furthermore, women engineers in the Arab world are also limited in their job opportunities because cultural norms prevent them from traveling offshore alone [30]. As a result, companies prefer to hire men over women [30].

In Palestine, women engineers face similar limitations due to cultural norms, including feeling disrespected and unsafe in the workplace and having limited access to site experience [38]. Moreover, despite engineering firms in Palestine being willing to hire women, the majority still prefer men, highlighting the role of gender bias as a significant barrier for Arab women [38].

Discussion

Women in STEM fields, particularly engineering, face various challenges worldwide before, during, and after graduation. These challenges may include financial constraints, math anxiety, gender stereotypes, and the pursuit of career prestige, quality infrastructure, and amenities [20]. However, Arab women encounter additional obstacles that are predominantly rooted in social and cultural norms, including patriarchal cultures, gender stereotypes, and workplace discrimination, which lead to limiting their education and career growth and hindering their professional development. The social and cultural norms that prevail in Arab societies discourage women from pursuing careers in engineering. Women are expected to prioritize their families over their careers and are often viewed as incapable of handling the technical and physical demands of engineering. Additionally, gender stereotypes and discrimination in the workplace limit women's access to education, employment, and career advancement opportunities.

Implications:

The underrepresentation of Arab women in engineering is a complex issue that contributes to a significant gender gap in the field. To address this issue, it is necessary to take a multifaceted approach that recognizes and addresses various cultural and workplace barriers. For instance, cultural norms, beliefs, and practices can limit women's access to education, employment opportunities, and career advancement. In addition, workplace issues, such as gender bias and a lack of work-life balance support, can impede women's progress in engineering. By acknowledging and addressing these barriers, we can create a more inclusive and supportive environment that facilitates equal opportunities for women in engineering and fosters a more diverse and innovative workforce.

This systematized review highlights the significant challenges faced by Arab women in engineering. Furthermore, it emphasizes the importance of addressing these challenges to promote gender equality and encourage women to pursue and remain in STEM careers.

Strategies for Promoting Women's Participation in Engineering in the Arab World:

Achieving gender parity in engineering is crucial for creating a more inclusive and diverse engineering workforce that reflects the full range of talent and perspectives in Arab societies. To promote gender equality, a collaborative effort is necessary among various stakeholders, including industry, government, civil society organizations, communities, universities, and individuals. In addition, systemic change in organizational policies and societal attitudes towards women in STEM fields is necessary for sustainable progress.

Policymakers have a significant role to play in promoting gender equality. They can achieve this by creating laws and regulations that support gender equality, offering incentives for companies that promote diversity and inclusion, and investing in education and awareness campaigns that challenge negative stereotypes and promote positive role models of women in different fields, including engineering. However, changing cultural norms is a complex and challenging process that requires sustained effort and collaboration among various stakeholders. For example, policymakers can collaborate with community leaders, religious figures, and other influencers to encourage inclusive cultural norms and promote positive change from within. In addition, addressing the structural barriers that prevent women from accessing education and employment opportunities in STEM fields is crucial. This includes implementing mentorship programs, networking opportunities, and creating a supportive environment fostering diversity and inclusion.

Gender parity in STEM benefits women and contributes to the growth and development of the economy and society [13]. By working together, stakeholders can create a more inclusive and equitable world where all individuals, regardless of gender, have equal opportunities to contribute their skills and talents to society. The following section will provide recommendations that can help support women's participation in STEM fields, including engineering.

Future research should investigate the role of education, cultural and religious beliefs, and societal norms in shaping perceptions of STEM careers for Arab women and explore the experiences of those who have successfully navigated these barriers and achieved success in STEM fields. Such studies can provide insights into effective strategies and interventions to promote gender equality in STEM for Arab women. In addition, they can inform the development of policies and programs that offer equal opportunities for women worldwide.

Recommendations:

Improving the representation of Arab women in engineering is crucial for achieving a more diverse and inclusive STEM workforce. To achieve this goal, we recommend the following strategies:

1. Education and Awareness:
    - Raise society's awareness about the vital role of women in engineering and educate the next generation about it.
    - Offer quality education and training programs that challenge negative gender stereotypes.

2. Encouragement, Support, and Mentorship:
    - Assist women in pursuing engineering careers by receiving support from their families, friends, and communities.
    - Offer mentorship and career advancement opportunities.
    - Promote women's involvement in professional societies by offering more encouragement and training for women to take on leadership roles and develop networking skills. In addition, such involvement can help them connect with other professionals, access new opportunities, and highlight their skills and knowledge.

3. Flexibility and Family-Friendly Policies:
    - Promote business decision-makers to offer flexible work schedules and family-friendly policies to help women balance their work and family obligations.
    - Provide childcare facilities, parental leave, and caregiver support to make it easier for women to pursue their careers while fulfilling their caregiving responsibilities.

4. Inclusion and Diversity and Gender Equality
    - Improve women's representation through affirmative action and diversity initiatives, establishing diversity committees, conducting diversity training, and implementing diversity goals.
    - Promote gender equality among human resource professionals, eliminate workplace gender bias, and ensure equal pay for equal work.
    - Recruit and promote individuals based on their skills rather than gender and establish gender equality policies in the workplace.
    - Promote women to leadership positions through leadership and training programs.

5. Inspiration through Role Models:
    - Use role models to motivate and inspire young girls to pursue careers in engineering.
    - Highlight success stories of women in engineering.

6. Entrepreneurship:
    - Explore the feasibility of Arab women forming their own companies.
    - Provide women with more autonomy and control over their careers to help them bridge the gender gap in the engineering profession.
    - Address challenges such as lack of funding and limited access to resources.

7. Visibility, Assertiveness, Collaboration, and Networking:
    - Offering encouragement and training for women to take on leadership roles and develop networking skills in professional societies can promote their involvement and visibility, particularly in entrepreneurship and engineering. This can increase their representation and help break down barriers to success.
    - Encourage women to present their research or participate in panel discussions at professional conferences.
    - Create opportunities for women to connect, share resources, and support each other's career goals.

The strategies proposed in this paper aim to foster a more diverse and inclusive STEM workforce that benefits everyone. These strategies draw from various sources, including existing literature, citations within this paper, and the author's insights and experiences. By synthesizing these sources, a comprehensive approach is offered to addressing the barriers faced by Arab women in engineering and promoting their participation in the field.

Conclusion

In summary, the underrepresentation of Arab women in engineering is a complex issue that requires a multifaceted approach. This systematized literature review has identified obstacles that Arab women face in pursuing engineering, such as cultural attitudes, gender stereotyping, and workplace discrimination. Various initiatives can be implemented to address these challenges, including those recommended in this paper. By improving the representation of Arab women in engineering, a more diverse and inclusive workforce can be created, leading to broader social and economic benefits. This is not just a matter of equity but also a necessity to bring diverse perspectives and ideas to the table and drive innovation forward.

Achieving these goals requires a collaborative and comprehensive strategy from various stakeholders, including educators, industry leaders, public officials, and society. Together, they can create a more supportive environment that facilitates equal opportunities for women in engineering, promotes diverse female role models, and advocates for cultural and societal change. With concerted efforts, we can achieve a more inclusive and equitable future for Arab women in engineering and beyond.

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Appendix

Table 3: Summary of the Final Articles Analyzed for Emergent Themes

Title	**Citation**
E-learning accessibility for Saudi women: A literature review	[37]
Are women engineers in Lebanon prepared for the challenges of an engineering profession?	[28]
Towards gender equal access to ICT	[32]
International Partnerships for the Development of Science, Technology, Engineering, Mathematics, and Medical Education of Middle Eastern Women	[31]
Arab Women in Science, Technology, Engineering and Mathematics Fields: The Way Forward	[29]
Israel's Arab Sector High Schools: An Island of Gender Dominance in STEM Subjects.	[33]
Gender, Education, and Career in the Arab World: A Literature Review	[30]
Integration of Arab Female Students at a Technological University--Narratives of Identity in Figured Worlds	[35]
Transforming Higher Education in the United Arab Emirates (UAE).	[36]
The perception of women engineers in the construction industry in Palestine	[38]
Science, Technology, Engineering and Mathematics (STEM): Liberating Women in the Middle East	[11]
A Qatari perspective on women in the engineering pipeline: an exploratory study.	[27]

Note: This Table includes only the final twelve articles. Articles are arranged randomly.