Journal of Cybersecurity Education, Research and Practice

Volume 2023 | Number 1 Article 2

July 2023

Sociocultural Barriers for Female Participation in STEM: A Case of Saudi Women in Cybersecurity

Alanoud Aljuaid
Marymount University, a0a44774@marymount.edu

Xiang Michelle Liu
Marymount University, xliu@marymount.edu

Sociocultural Barriers for Female Participation in STEM: A Case of Saudi Women in Cybersecurity

Abstract

The participation of women in Science, Technology, Engineering, and Mathematics (STEM) workforces is overwhelmingly low as compared to their male counterparts. The low uptake of cybersecurity careers has been documented in the previous studies conducted in the contexts of the West and Eastern worlds. However, most of the past studies mainly covered the Western world leaving more knowledge gaps in the context of Middle Eastern countries such as Saudi Arabia. Thus, to fill the existing knowledge gaps, the current study focused on women in Saudi Arabia. The aim of the study was to investigate the factors behind the underrepresentation of Saudi women in the cybersecurity space by specifically targeting the existing socio-cultural barriers. The study used a qualitative design that entailed reliance on both primary interview data and additional evidence from prior literature to evaluate the barriers faced by Saudi women in cybersecurity. A sample of 15 Saudi women aged 18 – 30 years with a college education or still in college pursuing a course in IT (Information Technology) or had basic computer literacy skills was purposefully recruited as the most desirable participants. A thematic analysis process was conducted on the primary data to generate theory from the findings, further compared with and verified based on a critical literature review. The themes that were generated from the interviews include lack of autonomy, family responsibilities, female as the weaker gender, and child bearing and caring duties.

Keywords

STEM education, workforce, Middle East, women, cybersecurity, gender equality

Cover Page Footnote

Acknowledgments: The authors thank the anonymous reviewers for their suggestions and comments that helped improve the earlier versions of this paper.

Sociocultural Barriers for Female Participation in STEM: A Case of Saudi Women in Cybersecurity

Alanoud Aljuaid
School of Technology and Innovation
Marymount University
Arlington, Virginia, USA
a0a44774@marymount.edu
https://orcid.org/0000-0002-6490-7838

Xiang (Michelle) Liu
School of Technology and Innovation
Marymount University
Arlington, Virginia, USA
xliu@marymount.edu
https://orcid.org/0000-0002-1801-3171

***Abstract*— The participation of women in Science, Technology, Engineering, and Mathematics (STEM) workforces is overwhelmingly low as compared to their male counterparts. The low uptake of cybersecurity careers has been documented in the previous studies conducted in the contexts of the West and Eastern worlds. However, most of the past studies mainly covered the Western world leaving more knowledge gaps in the context of Middle Eastern countries such as Saudi Arabia. Thus, to fill the existing knowledge gaps, the current study focused on women in Saudi Arabia. The aim of the study was to investigate the factors behind the underrepresentation of Saudi women in the cybersecurity space by specifically targeting the existing socio-cultural barriers. The study used a qualitative design that entailed reliance on both primary interview data and additional evidence from prior literature to evaluate the barriers faced by Saudi women in cybersecurity. A sample of 15 Saudi women aged 18 – 30 years with a college education or still in college pursuing a course in IT (Information Technology) or had basic computer literacy skills was purposefully recruited as the most desirable participants. A thematic analysis process was conducted on the primary data to generate theory from the findings, further compared with and verified based on a critical literature review. The themes that were generated from the interviews include lack of autonomy, family responsibilities, female as the weaker gender, and child bearing and caring duties.**

Keywords*— STEM education, workforce, Middle East, women, cybersecurity, gender equality

I. Introduction

As women in technology, the authors would want to play a proactive role in empowering other women both in Saudi Arabia and globally to pursue careers in the STEM fields including cybersecurity. It is worrisome that there has been salient underrepresentation of women in the sector and such trend has prevailed over several decades. For example, the number of women in the workplace in 2022 is about the same as in 1988 (Refer to https://nwlc.org/resource/january-jobs-day-2021/). Women are equally capable to compete favorably with men in any field regardless of the imagined or perceived technicality. The world should be more concerned when a proportion of the population is segregated based on different parameters such as gender. Therefore, the authors are more interested in investigating the barriers triggering the underrepresentation of women in cybersecurity, and more specifically, the role of sociocultural barriers. To summarize, the main motivation of this study is to investigate the sociocultural factors that contribute to the underrepresentation of women in cybersecurity in Saudi Arabia, which is an area that has been overlooked due to WEIRD (Western, Educated, Industrialized, Rich, and Democratic) society trends in research studies.

The Cambridge University defines sociocultural as the "differences between groups of people relating to the social class and culture in which they live" [1]. Socio-cultural barriers are man-made constructs arising from cultural values and social norms [2]. This paper covers sociocultural issues as part of the barriers to the participation of Saudi women in the cybersecurity field. The sections of the paper are the background, methodology, results and analysis, discussion and conclusion.

A. Background

According to the Saudi National Cybersecurity Authority [3], cybersecurity is defined as:

"The protection of information technology systems and networks as well as systems and components of operating technologies, including hardware and software, together with services provided thereby and data included therein, against unlawful hacking, obstruction, modification, access, use or exploitation."

Saudi Arabia has been a victim of cyber-attacks in the recent past as compared to the other countries globally. For example, Saudi Aramco was attacked in 2012 by the Shamoon virus that affected at least 30, 000 Windows-based machines within the corporation's network [4]. In 2015 alone, there were at least 160, 000 attacks each day [5]. In 2018, the Ministry of Health was impacted by a Denial of Services (DoS) attack leading to denial of access to the ministry's website [6]. Thus, based on these scenarios, it is essential to protect the digital systems and services from cyber attacks by involving cybersecurity experts.

Unfortunately, there has been relatively low awareness of cybersecurity in Saudi Arabia that makes the citizens vulnerable to cyber-attacks [7,8]. The studies found that poor cultural practices and limited awareness make the citizens more

vulnerable to cyber attacks. Additionally, a prior survey of Saudi citizens suggested that there should be awareness campaigns due to poor maintenance of information safety in society [9]. Efforts have been made to enhance the status of cybersecurity in Saudi Arabia despite there being limited education programs aimed at enhancing cybersecurity awareness [10]. This is also evidenced by the establishment of the National Cybersecurity Authority (NSA) in 2017 to execute both regulatory and operational functions to enhance cybersecurity in the country [3].

Despite cybersecurity being one of the most desired professions within the STEM career path, it is negatively affected by various socio-cultural barriers. These barriers are perceived in both the developed and developing worlds, however, their impacts on the general population differs. Various findings on the subject are enumerated below. A prior study on the aspect of gender and Information Technology (IT) work found that the rate at which women are being lost in the IT-related work surpasses the rate of recruitment in the U.K. [11]. This is a case of marginalization of women based on the assumption that masculinity is essential in IT. In the U.S., a survey of university students to determine gender stereotypes held by the students found that there was gender stereotyping about IT knowledge and skills even though they were not uniform across the whole gender group [12]. According to the study, male respondents rated all the IT-related skills as masculine as compared to the female respondents [12]. Additionally, a longitudinal study conducted in Ireland to investigate the changes occurring in the factors affecting the participation of women in IT profession from the 1970s to 2010s found that the commonest factors were policy, cultural, infrastructural, motherhood and family against the economic changes occurring in a country over a length of time [13]. Moreover, using the individual differences theory of gender and IT on respondents in four Western countries, [14] found that some of the cultural factors affecting the career of women in IT were maternity, childcare, a woman working outside her home and parental care. More socio-cultural factors impacting women's career choices in IT were economic opportunity, social class, career norms, and gender stereotypes about aptitude [14].

One of the leading sociocultural barriers barring women progression in the IT field is the requirement to balance home and career as outlined in [14]. One assumption of this study is that the same barrier may impact women in cybersecurity because it is an IT-related field. According to [15], professional women are culturally programmed to undertake childcare duties and housework as compared to male counterparts. Thus, with such responsibilities on their shoulders, it becomes difficult for professional women to compete fairly with their male counterparts [16]. In addition to being compelled to balance work and home duties, women also face stereotypes when working in male-dominated workplaces. For instance, according to the findings by [16], women were mistaken for lower cadre employees such as secretary and support staff instead of being recognized as professionals. This is an indication of the low-ranking status attributed to the female gender despite being qualified to compete favorably with men in technical professions such as cybersecurity.

The adoption of the Islamic national culture within institutional and organizational culture is rampant in Saudi Arabia. According to [17], gender roles have been strictly defined in the Arab societies as they purely embrace masculinity. This explains the difficulties that Saudi women face in securing careers outside their homes due to the stereotype that they should retain the roles of mothers, wives and family makers [18]. In this collective society, women who attempt to seek opportunities outside their homes are termed deviants as they are required to shun their career aspirations and adhere to the societal rules, values or norms [19]. According to [20], women advancement in career is limited by the culturally set expectations of what they should do as members of the society.

Despite the government of Saudi Arabia supporting education equality that has seen an increased workplace participation and educational achievements among women, the conservative gender-based culture has led to women pursuing "feminine" areas such as arts, humanities, healthcare and teaching [21,22]. Additionally, women in Saudi Arabia are excluded from decision-making processes because of a deeply established patriarchal organizational cultures that place limits on career progression among professional women [23]. This evidence is supported by the survey of at least 160 Saudi women by [24] that found that centralization of decision-making denied women the opportunity to be empowered or gain authority at the workplace. Thus, based on these findings, a conclusion can be made that Saudi women may be educated and ready to progress in their careers but they face sociocultural barriers supported at the organizational level, societal level and at the national culture level.

B. Knowledge Gaps

There is limited research on the sociocultural factors limiting Saudi women's participation in the workforce as most of the existing studies were conducted on the Western context. Nevertheless, there is very limited evidence on the sociocultural barriers on the progression of Saudi women in the cybersecurity sector despite the government being at the forefront to empower and educate more women. The reviewed literature does not specifically outline the extended aspects of socio-cultural barriers from the perspective of Saudi women in the cybersecurity field. Therefore, there is room for conducting more research to fill the existing knowledge gaps in a way that will lead to recommendations that will positively contribute to the empowerment of Saudi women to pursue careers in cybersecurity.

C. Problem Statement

There is acknowledgement in the literature of the existence of a wide gender disparity in the cybersecurity sector [25]. To enhance women participation in the cybersecurity and technology labor force, there are calls for global economies to implement reforms and establish initiatives that will allow women to pursue such opportunities [26]. It is even more appalling that women made up only 5% of the information security workforce in the Middle East [27,28]. Further, women were even further unrepresented in managerial positions including almost no presence in senior and executive leadership in the Middle East [27]. As argued in the literature, the leading challenges faced by women in cybersecurity include segregation, discrimination, and wage inequality [29]. These are the key pointers to the reasons leading to the workforce

inequality in technology where women are underrepresented. The literature review critically discusses the sociocultural barriers that limit the participation of women in cybersecurity.

Despite the global interests focusing on the improvement of women careers, there is still scarcity of knowledge on women in the Arab world. Scholars and previous publications have always focused on the Western world with limited regard to understanding women careers in the Arab world [19]. Those that come closer to fulfilling this agenda investigate other countries such as the United Arab Emirates [20,30] and Lebanon [31,32]. This then depicts the existence of a knowledge gap in the research area of investigating the place of women in the Saudi technological workforce. However, there exists some knowledge on this issue albeit the need for more research to widen the knowledge base on the challenges women face in Saudi Arabia in pursuing careers in technology and cybersecurity.

However, despite these challenges being clearly elaborated, negligible attention has been directed to sociocultural barriers that negatively influence women participation in cybersecurity. Little concern has been directed on coverage of these barriers in relation to Saudi women since the demographics differ globally. Furthermore, the previous studies that has partly addressed this problem did not fully outline the sociocultural barriers faced by Saudi women in cybersecurity and measurable solutions to these challenges. Hence, there is a need for conducting more robust research to identify the specific sociocultural barriers, which will then inform identification and implementation of solutions.

D. Research Aim

The aim of the study is to determine the sociocultural barriers faced by Saudi women in accessing cybersecurity opportunities. The findings will fill the existing knowledge gaps evidenced by a lack of research on this topic targeting representation of women in cybersecurity in the Saudi context.

II. Methodology

A. Research Design

The study adopted a qualitative design due to the exploratory nature of the research topic and the need to gain a better understanding of the problem [33]. The design was also justified as it enabled the researcher to fully explore an issue from the perspective of the participants leading to an understanding of the real-life issues they experience in their daily interactions. Thus, adopting the qualitative design was the most appropriate for collecting subjective data from the participants on the phenomenon under investigation.

B. Participants

[29] reported that at least four thousand females in Saudi Arabia graduated with qualifications in information technology courses between 2015 and 2016. Fifteen female participants (n = 15) with interest in cybersecurity were purposefully sampled for participation in the study. This sampling technique enabled the researcher to select the participants meeting the desired expectations such as age, IT-related courses, in possession of basic computer skills, located in urban areas, their availability, and willingness to participate in the study.

The volunteering participants were aged 18 – 30 years with a college education or still in college pursuing a course in IT or had basic computer literacy skills. This age bracket was also essential because they have a better understanding of cybersecurity dynamics and have developed a higher awareness of job mobility. They were also selected from urban areas of Saudi Arabia because those in rural areas are more likely to pursue other traditional careers despite having pursued IT-related courses in the university. However, the sampling approach was biased as a section of the sample population (women in rural Saudi Arabia) was deliberately excluded from the study as informed by the researcher's preferences and assumptions.

The researcher believed that this sample was representative of the population of women in STEM in general, and in cybersecurity specifically, due to the depth of information they possess on the subject of investigation. The sample size (n=15) was also justified based on the findings of the previous studies on interview saturation. [34] established that the majority of new information was established at the sixth interview and no new information was generated as the number of interviews approached 20. [35] found that less than 16 interviews were enough to reach data saturation. Thus, the 15 participants were considered enough to establish data saturation on the research questions.

C. Data Collection

The first set of data was collected directly from the participants through online interviews (Zoom). The guiding question was what socio-cultural barriers discourage women from pursuing opportunities in cybersecurity in Saudi Arabia. Each interview session lasted between thirty minutes and one hour and the interviewees were encouraged to provide as detailed responses as possible. The interview responses were audio-taped. Other relevant details from the interviews were also documented through note-taking. All the audio and textual data were then prepared by the researcher for the next step of data analysis.

The second set of data was collected from published literature sources to verify and complement the primary data. Relevant key words were generated and used to search online databases for related evidence in form of journal articles, reports, and published interviews documented in the news or online databases. The key words include "cybersecurity", "women", "Saudi Arabia", "Saudi women", "social factors", "cultural factors", and "sociocultural factors". The key search terms were combined to return the most appropriate evidence.

D. Data Analysis

Thematic analysis was preferred for use in this paper because it is one of the qualitative analysis techniques applicable in the development of theory from a wide range of textual data [36]. Additionally, [37] argued that thematic analysis enables the researcher to generate themes from data making it possible to understand a phenomenon being investigated. The six steps of thematic analysis by [38] were followed in the analysis of the interview questions, as illustrated in Fig. 1.

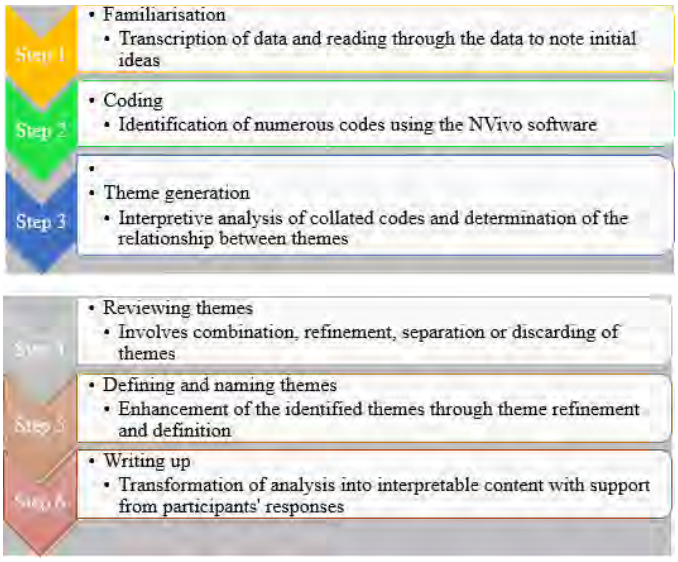

Fig. 1. The six thematic analysis steps

E. *Ethical Considerations*

Participants were informed about the objectives or the research and all the risks likely to arise from their participation in the study. They were then requested to provide informed consent prior to the data collection step. The researcher also assured the participants of their anonymity and confidentiality of the collected data. The collected data was used for research purposes only and not accessible by unauthorized third parties.

III. Results and Analysis

A. *Interview Results*

A total of fifteen participants successfully completed the interviews. All of them were female as earlier indicated in the sampling section. To meet the ethical consideration of anonymity, the participants were identified as P1 – P15 herein. To meet the requirements of thematic analysis, the researcher applied both manual analysis and NVivo version 12 software to aid the process of theme generation. The six steps of thematic analysis are described below.

Step 1: Familiarization

The first approach under this step was to transcribe all the data from audio to text since the interviews were conducted via Zoom. The researcher listened to the recorded audios and then transcribed them to generate text transcripts in readiness for analysis. In the second approach, the researcher read and re-read all the translated transcripts to familiarize with the data while making notes on the codes that were likely to arise from the data. All responses were copied and pasted into a single file for easier analysis.

Step 2: Coding

The file containing the transcribed and translated data was imported into the NVivo software. A total of 15 interview transcripts were analyzed. Each response in the transcript was read while highlighting the relevant codes that are consistent with the interview question. Here, the researcher identified all words within the sentences that depicted different sociocultural themes perceived by the respondents and color-coded them. This process led to the generation of multiple codes from the interview responses. See appendix A.

Step 3: Theme generation

In this step, the researcher categorized the highlighted codes and collapsed the related codes into related themes. The related codes were combined to form a single theme (see appendix). Unlike in cases where several themes are generated from different codes, this study focused mainly on the sociocultural factors impacting women in cybersecurity. The generated themes included lack of autonomy, family responsibilities, female as the weaker gender, child baring and caring duties and family support. See the Fig. 2 for the schematic presentations.

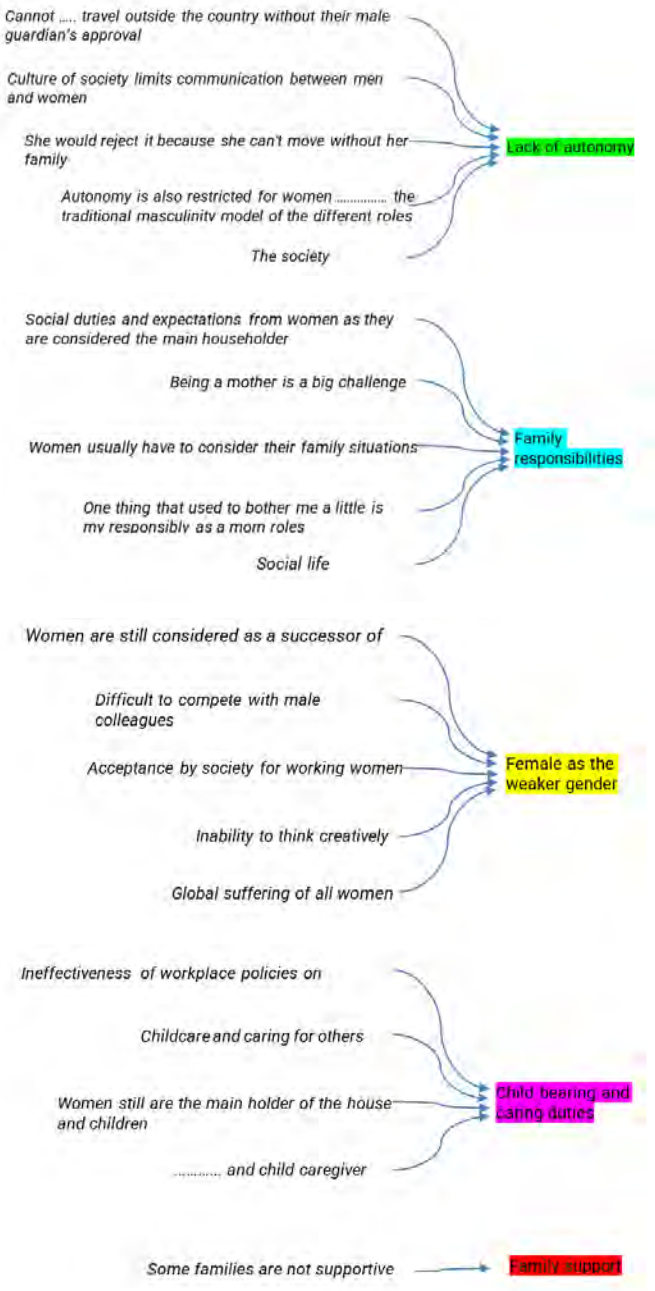

Fig. 2. The schematic presentations of theme generation process

Step 4: Reviewing themes

There was no need of identifying distinctions among themes because they were characterized by sociocultural factors. Furthermore, no changes were made to the theme as they were consistent with each, and thus, they were neither merged nor split. The retained themes were as follows; lack of autonomy, family responsibilities, female as the weaker gender, child bearing and caring duties, and family support.

Step 5:Defining and naming themes

This step requires the researcher to define and name the arising themes for a better understanding. The themes generated from the coding are defined as follows.

- Lack of autonomy – Saudi women face the restrictions of making independent decisions for their own benefit without seeking permission from the male members of their society.
- Family responsibilities – Saudi women face the challenge of pursuing career progression because of the gendered roles in the society requiring them to stay home and take care of their families.
- Female as the weaker gender – There is the belief that some careers are only a preserve for the male gender and that women cannot perform optimally if they pursue them.
- Child bearing and caring duties – The society's culture and beliefs prefer women staying at home and taking care of children as one of the most important gendered roles.
- Family support – Some families do not support females in their quest to pursue careers in cybersecurity.

Step 6:Writing up

This is the last step in the thematic analysis process. It outlines the sociocultural barriers that negatively impact the Saudi women's pursuit for career progression in cybersecurity.

The participants cited a lack of autonomy as one of the sociocultural barriers they face in pursuing careers in cybersecurity. P13 stated that, "*Women usually tend to work in occupations with more structured and reliable hours of work and this often means the work is part-time and low paid. Autonomy is also restricted for women who progress to the highest occupational levels due to the traditional masculinity model of the different roles*." Traditional masculinity, as indicated in the quote, implies that men are traditionally considered the sole decision makers in the Kingdom. Their voices are not hard as stated by P8, "*Less women in top level jobs (our voices are not heard).*" Thus, as indicated in these quotes, women are not allowed to make unilateral decisions to progress in their social and economic life course. P15 added, "*the society traditions. Yes, it effected my decisions in my studies and my career*".

Women are negatively affected by the immense family responsibilities that have to accomplish in accordance with Islam and the Saudi national culture. On this issue, P14 identified "*family obligations*" and P15 identified "*social life obligations and family responsibilities*" as barriers in their careers.

Females are also believed to be the weaker gender in such a way they are required to perform home duties only and not pursue technical careers. This is evidenced by the quotes, "*Gender inequality in the workplace*" as stated by P8, "*I guess the wrong ideas about women not being able to be productive under pressure*" by P6, and "*working harder than men to prove themselves capable*" as stated by P7. These quotes indicate that women have to work harder to prove their performance in technical workplaces. These stereotypes are anchored in the Saudi culture where women are perceived to be the weaker gender.

Child bearing and caring are the other gendered roles that dominate the Saudi culture. According to the responses, women are supposed to avoid pursuing their careers and focus on taking care of their children and families. As a result, they are destructed from pursuing their careers. Some of the quotes presented to support this assertion are, "*Cultural aspects are a main challenge. There are many social duties and expectations from women as they are considered the main householder and childcare giver. These responsibilities could be as an obstacle to pursuit a technical career for women in the Saudi culture*" by P4, and "*one of them the time for maternity*" by P2. Additionally, P3 stated that, "*gender is therefore still a major issue in the work place because of the impact that gender stereotypes have on the attitudes and decision-making of employers and employees alike. Childcare and caring for others featured strongly in the lives of women and their perceptions of these issues as barriers to their employment or progression were multifaceted and influenced decisions regarding work. So it depends on the community and its acceptance.*" All these responses are indicative of a society where caring for children and family take an important precedence than women pursuing their careers.

Lastly, women are not supported by families and society to pursue their career interests due to the factors discussed above. P14 echoes this sentiment by saying, "*I think it depend on the family in the first place, if they are supportive nothing can stop any woman from doing anything she desires. On the other hand, some families are the opposite.*" "The implication is that Saudi women in IT can only progress in their careers if their families and societies delink them from the socio-cultural traditions and stereotypes and support them.

B. Additional Data

Additional data that was systematically retrieved from the published literature was justified to corroborate the primary data. Additional corroborative evidence was necessary due to the selection bias that occurred during the recruitment of the 15 participants and the need to determine whether women in the other STEM fields around the world faced the same sociocultural barriers. This was particularly relevant to determine whether similar challenges are faced by women in developed world. The findings and insights extracted from the relevant literature were integrated and summarized in Table 1.

TABLE I. SUMMARY OF ADDITIONAL FINDINGS FROM PUBLISHED ARTICLES

Literature	Design	Findings
[19]	A phenomenological qualitative approach in this study drawing on 12 in-depth semi-structured interviews with Saudi female	The societal, organizational structural and attitudinal barriers include: Lack of mobility Salience of gender stereotypes Gender-based challenges related to dealing with pregnancy Gender discrimination in the workplace; limited opportunities for growth, development, and career advancement Excessive workload caused by a lack of family–work balance
[39]	Review	Women contribute approximately 39% of the overall workforce. Women contribute up to 38% of workers in STEM job but with only 25% in cybersecurity workforce Women in cybersecurity face gender-based discrimination Unexplained delays in career advancement
[40]	A survey involving 126 Saudi university students	There were no significant differences in cybersecurity awareness among male and female students. The awareness was higher among students in computer and IT departments as compared to others. Cybersecurity awareness was higher in urban students as compared to those in remote areas

The additional evidence corroborates the interview results to a greater extent. The interview results indicate that Saudi women in cybersecurity faced gender discrimination at the workplace in terms of career mobility, inadequate family-work balance, gender stereotypes and limited opportunities, which are consisted with the findings from [19, 39] as listed in Table 1. The findings by [39] are also in agreement that the participation of women in STEM-related careers is marginally low as compared to men. Finally, [40] contributed to the current study's methodology and aims through the findings on the level of awareness of cybersecurity among male and female students, and how it also compares between urban and rural areas. The current research mainly recruited female participants from the urban areas with the assumption that those in rural Saudi Arabia lacked cybersecurity awareness. This assumption has been demystified by [40]. However, the additional evidence does not indicate the extent to which the impacts differ between Saudi subjects and those in the WEIRD countries.

IV. DISCUSSION

The aim of the study was to determine the socio-cultural barriers that affect the participation of Saudi women in the cybersecurity sector. This entails pursuing courses in IT and pursuing careers in the cybersecurity field, which are representative of the overall STEM space.

The arising barriers (themes) include lack of autonomy as women cannot make personal decisions to travel and pursue education or careers in cybersecurity, family responsibilities as primary carers, the perception that women are weaker than men and cannot compete favorably in cybersecurity, mandatory child bearing and caring duties, and lack of support from family and community. All these barriers arise from gendered roles that are enshrined in the Islamic culture within which Saudis operate. Thus, as a result of the socio- cultural barriers, it becomes difficult for women in Saudi Arabia to compete fairly with their male counterparts [16]. Additionally, the findings are indicative of gendered roles that are consistent with the Islamic national culture that is heavily enshrined in Saudi Arabia [17]. This may not be the case for women in the Western countries.

The challenges of low participation by Saudi women in cybersecurity are relatively different from those faced by their counterparts in the developed countries such as the U.K. where there have been reports of a high turnover of women as compared to the rate of recruitment in IT [11]. Despite this observation being relevant to the current context, there is no confirmation that the challenges faced by women in IT can be contextualized to the cybersecurity sector alone. However, a comparison of the two cases – IT in the U.K. and cybersecurity in Saudi Arabia – shows that masculinity plays a significant role in the segregation against women in the technical world. The issue of masculinity and male dominance in the technical field is also a problem in the U.S. where there have been reports of gender stereotyping about IT knowledge and skills [12]. Moreover, [16] reported a high rate of gender stereotyping in male-dominated workplaces, which is true for IT-related courses and cybersecurity as evidenced by the findings. However, despite masculinity being a challenge in the U.S and U.K., the primary triggers of the vice may not be same when compared to Saudi Arabia. In Saudi Arabia, masculinity is more likely to arise as a result of social and cultural nature of the Saudi society than it is in the Western world where sociocultural factors are not wired in the population. For example, the issues in the Western countries may be as a result of mere competition in the STEM field while in Saudi Arabia, it may be an issue of gendered roles.

The other dominant themes generated from the primary data revolve around work-family balance where women's roles radiate around family obligations of caring for their families, giving birth, and caring for the children. This primary finding is corroborated by the literature indicating that societal factors including gender discrimination in the workplace and the challenges associated with child bearing [19]. This aspect of gender-based discrimination was also found to be common by a review conducted by [39]. According to the past literature, the challenge of motherhood and caring for the family is evident in the Western world as observed by [13] that women in IT are overwhelmed with cultural, motherhood and family challenges. More findings from the Western countries indicate that women in IT faced challenges associated with maternity, childcare, working outside her home and parental care [14]. The challenges faced in the Western world are similar to those faced by Saudi women in cybersecurity. However, as already noted above, whether they are remarkably different when comparing IT and cybersecurity cannot be established at the moment. Nevertheless, the novelty of the current study lies in the findings that the patriarchal culture is more impactful on Saudi women in cybersecurity than it is on women in the Western world. This is a positive contribution to the literature base.

Whether there are statistically significant differences in cybersecurity awareness based on the variables of gender, course type, and location of students has been researched by [40]. The findings of the study show a lack of significant differences among male and female students, a higher awareness

of cybersecurity awareness among students in IT and computer departments as compared to other courses [40]. Of great interest to the current study, [40] also found that cybersecurity awareness was much higher in urban students as compared to those in remote areas. The current study recruited only urban students, therefore, one limitation of the study is lack of primary evidence to show the differences among urban and rural groups in terms of their perceptions of the impact of sociocultural barriers on cybersecurity participation. Nevertheless, relying on the background information that urban students are more aware of cybersecurity than their rural counterparts made it possible to have a vivid overview of the characteristics of the participants based on where they come from.

The future research should adopt additional methodological approaches to enhance the reliability of methods and credibility of the results. Moreover, the future research should recruit a larger sample size of diverse participants to enhance the generalizability of the findings to the bigger population. For instance, they may recruit officials from government's social services and gender departments, policy makers, government representatives, community leaders, and women from rural areas. The future research should also obtain the perspective of Saudi women in both urban and rural areas to establish solutions or interventions to counter the identified sociocultural barriers.

V. Conclusion

The purpose of this paper was to fill the existing knowledge gaps by investigating the sociocultural barriers negatively impairing Saudi women's pursuit for career progression in cybersecurity. Fifteen young Saudi women aged 18 – 30 years were interviewed via Zoom. Thematic analysis using Nvivo found that sociocultural factors retrogressively affected their career progression in cybersecurity. They cited traditional stereotype of women being the weaker gender, mandatory childbearing and caring roles, social and family responsibilities, and lack of autonomy to make own decisions or move out of their homes to work without going with families. Despite these barriers also being dominant in the Western world and in the other STEM-related fields, they are more impactful on Saudi women in cybersecurity mainly due to the patriarchal culture that is practiced in the Kingdom. Thus, based on these findings, a conclusion can be made that Saudi women may be educated and ready to progress in their careers but they face sociocultural barriers prevalent at the organizational level, societal level and at the national culture level. In spite of these challenges being clearly elaborated, negligible attention has been directed to support women in this regard. It is paramount that the government develops and implements policies to cushion women from the identified socio-cultural barriers. Equally relevant, the Saudi society should change their socially and culturally motivated stereotypes against women in STEM, and any other career traditionally reserved for the masculine gender. Initiation of mentorship programs are highly encouraged to create awareness and provide the required career progression assistance to uplift women and maintain parity with men in the same career path. It is mainly through these initiatives that the future of Saudi women in cybersecurity will be assured.

References

[1] Cambridge University Press, "Sociocultural," https://dictionary.cambridge.org/dictionary/english/sociocultural.

[2] R. Savolainen, "Approaches to socio-cultural barriers to information seeking," *Library & Information Science Research,* vol. 38, no. 1, pp. 52-59, 2016/01/01/ 2016, doi: 10.1016/j.lisr.2016.01.007. [Online]. Available: https://www.sciencedirect.com/science/article/pii/S0740818816300330.

[3] National Cybersecurity Authority, " About NCA," 2022, https://nca.gov.sa/en/about.

[4] S. Jewkes, "Saipem says Shamoon variant crippled hundreds of computers," 2018, https://www.reuters.com/article/us-cyber-shamoon/saipem-says-shamoon-variant-crippled-hundreds-of-computers-idUSKBN1OB2FA.

[5] A. Olech and K. Siekierka, "Cybersecurity in Saudi Arabia," https://www.cyber-insights.org/cybersecurity-in-saudi-arabia/.

[6] M. Dawson, "An Argument for Cybersecurity in Saudi Arabia," *Land Forces Academy Review,* vol. 27, no. 1, pp. 78-83, 2022, doi: doi:10.2478/raft-2022-0011. [Online]. Available: https://doi.org/10.2478/raft-2022-0011.

[7] A. Alarifi, H. Tootell, and P. Hyland, "A study of information security awareness and practices in Saudi Arabia," in *2012 International Conference on Communications and Information Technology (ICCIT)*, 26-28 June 2012 2012, pp. 6-12, doi: 10.1109/ICCITechnol.2012.6285845.

[8] I. Alseadoon, T. Chan, E. Foo, and J. Gonzales Nieto, "Who is more susceptible to phishing emails? A Saudi Arabian study," in *ACIS 2012: Location, location, location: Proceedings of the 23rd Australasian Conference on Information Systems*, 2012.[Online]. Available: https://aisel.aisnet.org/acis2012/21.

[9] F. Alotaibi, S. Furnell, I. Stengel, and M. Papadaki, "A survey of cyber-security awareness in Saudi Arabia," in *2016 11th International Conference for Internet Technology and Secured Transactions (ICITST)*, 5-7 Dec. 2016 2016, pp. 154-158, doi: 10.1109/ICITST.2016.7856687.

[10] M. Zarour, M. Alenezi, M. Dawson, and I. Alsmadi, "Toward Effective Cybersecurity Education in Saudi Arabia," Cham, 2020: Springer International Publishing, in 17th International Conference on Information Technology–New Generations (ITNG 2020), pp. 79-85, doi: 10.1007/978-3-030-43020-7_12.

[11] A. Adam, M. Griffiths, C. Keogh, K. Moore, H. Richardson, and A. Tattersall, "Being an 'it' in IT: gendered identities in IT work," *European Journal of Information Systems,* vol. 15, no. 4, pp. 368-378, 2006/08/01 2006, doi: 10.1057/palgrave.ejis.3000631. [Online]. Available: https://doi.org/10.1057/palgrave.ejis.3000631.

[12] E. M. Trauth, C. C. Cain, K. D. Joshi, L. Kvasny, and K. M. Booth, "The Influence of Gender-Ethnic Intersectionality on Gender Stereotypes about IT Skills and Knowledge," *Data Base for Advances in Information Systems,* vol. 47, no. 3, pp. 9–39, 2016, doi: 10.1145/2980783.2980785.

[13] E. M. Trauth and R. Connolly, "Investigating the Nature of Change in Factors Affecting Gender Equity in the IT Sector: A Longitudinal Study of Women in Ireland," *MIS Quarterly,* vol. 45, no. 4, pp. 2055–2100, 2021, doi: 10.25300/misq/2022/15964.

[14] E. M. Trauth, J. L. Quesenberry, and H. Huang, "A Multicultural Analysis of Factors Influencing Career Choice for Women in the Information Technology Workforce," *Journal of Global Information Management,* vol. 16, no. 4, 2008, doi: 10.4018/jgim.2008100101.

[15] D. J. Armstrong, C. K. Riemenschneider, M. W. Allen, and M. F. Reid, "Advancement, voluntary turnover and women in IT: A cognitive study of work–family conflict," *Information & Management,* vol. 44, no. 2, pp. 142-153, 2007/03/01/ 2007, doi: https://doi.org/10.1016/j.im.2006.11.005. [Online]. Available: https://www.sciencedirect.com/science/article/pii/S0378720606001224.

[16] S. Bagchi-Sen, H. R. Rao, S. J. Upadhyaya, and S. Chai, "Women in Cybersecurity: A Study of Career Advancement," *IT Professional,* vol. 12, no. 1, pp. 24-31, 2010, doi: 10.1109/MITP.2010.39.

[17] G. Hofstede, *Culture's Consequences: Comparing Values, Behaviors, Institutions, and Organizations Across Nations*, 2nd ed. Thousand Oaks, CA.: Sage, 2001.

[18] A. Al-Asfour and S. A. Khan, "Workforce localization in the Kingdom of Saudi Arabia: issues and challenges," *Human Resource Development International,* vol. 17, no. 2, pp. 243-253, 2014/03/15 2014, doi: 10.1080/13678868.2013.836783. [Online]. Available: https://doi.org/10.1080/13678868.2013.836783.

[19] A. Al-Asfour, H. A. Tlaiss, S. A. Khan, and J. Rajasekar, "Saudi women's work challenges and barriers to career advancement," *Career Development International,* vol. 22, no. 2, pp. 184-199, 2017, doi: 10.1108/CDI-11-2016-0200. [Online]. Available: https://doi.org/10.1108/CDI-11-2016-0200.

[20] H. A. Tlaiss, "Entrepreneurial motivations of women: Evidence from the United Arab Emirates," *International Small Business Journal,* vol. 33, no. 5, pp. 562-581, 2015, doi: 10.1177/0266242613496662. [Online]. Available: https://journals.sagepub.com/doi/abs/10.1177/0266242613496662.

[21] R. Alselaimi and L. Lord, "Female Participation in the Saudi Workforce: A Saudi Perspective of Key Barriers," in *Australian and New Zealand Academy of Management Conference*, Perth, Australia:ANZAM, R. Pillai, M. Ozbilgin, B. Harley, and C. Hartel, Eds., Dec 5-7 2012.[Online]. Available: https://espace.curtin.edu.au/handle/20.500.11937/42746.

[22] H. A. Tlaiss and A. Elamin, "Human Resource Management in Saudi Arabia," in *Handbook of Human Resource Management in the Middle East*, P. Budhwar and M. Mellahi Eds.: Edward Elgar Publishing Ltd, 2016, pp. 141-160. https://www.e-elgar.com/shop/usd/handbook-of-human-resource-management-in-the-middle-east-9781784719517.html.

[23] A. M. Elamin and K. Omair, "Males' attitudes towards working females in Saudi Arabia," *Personnel Review,* vol. 39, no. 6, pp. 746-766, 2010, doi: 10.1108/00483481011075594.

[24] H. Al-Ahmadi, "Challenges facing women leaders in Saudi Arabia," *Human Resource Development International,* vol. 14, no. 2, pp. 149-166, 2011/04/01 2011, doi: 10.1080/13678868.2011.558311. [Online]. Available: https://doi.org/10.1080/13678868.2011.558311.

[25] D. N. Burrell, "An exploration of the cybersecurity workforce shortage," in *Cyber Warfare and Terrorism: Concepts, Methodologies, Tools, and Applications*: IGI Global, 2020, pp. 1072-1081. doi: 10.4018/978-1-7998-2466-4.ch063.

[26] M. K. Khan, "Overcoming Gender Disparity in Cybersecurity Profession," 2020, https://www.g20-insights.org/policy_briefs/overcoming-gender-disparity-in-cybersecurity-profession/.

[27] Frost & Sullivan, "2017 Global Information Security Workforce Study: Benchmarking Workforce Capacity and Response to Cyber Risk," 2017, https://iamcybersafe.org/wp-content/uploads/2017/06/europe-gisws-report.pdf.

[28] D. Peacock and A. Irons, "Gender Inequality in Cybersecurity: Exploring the Gender Gap in Opportunities and Progression," *International Journal of Gender, Science, and Technology,* vol. 9, pp. 25-44, 2017. [Online]. Available: https://genderandset.open.ac.uk/index.php/genderandset/article/view/449.

[29] Z. Iqbal and M. K. Khan, "Saudi Women in Cybersecurity Narrowing the Gap of Human Capital Crisis," 2019, https://www.gfcyber.org/saudi-women-in-cybersecurity-narrowing-the-gap-of-human-capital-crisis/.

[30] H. A. Tlaiss, "Conformers, fighters and rebels: the unfolding of the careers of women in the United Arab Emirates," *Human Resource Development International,* vol. 17, no. 3, pp. 339-357, 2014/05/27 2014, doi: 10.1080/13678868.2014.896128. [Online]. Available: https://doi.org/10.1080/13678868.2014.896128.

[31] H. A. Tlaiss and K. M. Dirani, "Women and training: an empirical investigation in the Arab Middle East," *Human Resource Development International,* vol. 18, no. 4, pp. 366-386, 2015/08/08 2015, doi: 10.1080/13678868.2015.1050315. [Online]. Available: https://doi.org/10.1080/13678868.2015.1050315.

[32] H. A. Tlaiss, "Between the traditional and the contemporary: careers of women managers from a developing Middle Eastern country perspective," *The International Journal of Human Resource Management,* vol. 25, no. 20, pp. 2858-2880, 2014/11/13 2014, doi: 10.1080/09585192.2014.914054. [Online]. Available: https://doi.org/10.1080/09585192.2014.914054.

[33] J. Creswell, W. , *Research Design: Qualitative, Quantitative and Mixed Methods*, 5th ed. London: Sage, 2017.

[34] M. Morgan, B. Fischoff, A. Bostrom, and C. N. Y. Atman, NY: Cambridge University Press., *Risk Communication: A Mental Models Approach*. Cambridge/New York: Cambridge University Press, 2002.

[35] A. K. Hagaman and A. Wutich, "How Many Interviews Are Enough to Identify Metathemes in Multisited and Cross-cultural Research? Another Perspective on Guest, Bunce, and Johnson's (2006) Landmark Study," *Field Methods,* vol. 29, no. 1, pp. 23-41, 2017, doi: 10.1177/1525822x16640447. [Online]. Available: https://journals.sagepub.com/doi/abs/10.1177/1525822X16640447.

[36] J. Creswell, W. , *Research Design: Qualitative, Quantitative and Mixed Methods*, 4th ed. London: Sage, 2014.

[37] J. Fereday and E. Muir-Cochrane, "Demonstrating Rigor Using Thematic Analysis: A Hybrid Approach of Inductive and Deductive Coding and Theme Development," *International Journal of Qualitative Methods,* vol. 5, no. 1, pp. 80-92, 2006, doi: 10.1177/160940690600500107. [Online]. Available: https://journals.sagepub.com/doi/abs/10.1177/160940690600500107.

[38] V. Braun and V. Clarke, "Using thematic analysis in psychology," *Qualitative Research in Psychology,* vol. 3, no. 2, pp. 77-101, 2006/01/01 2006, doi: 10.1191/1478088706qp063oa. [Online]. Available: https://www.tandfonline.com/doi/abs/10.1191/1478088706qp063oa.

[39] D. Panhans *et al.*, "Empowering Women to Work in Cybersecurity Is a Win-Win," *BCG Global,* https://www.bcg.com/publications/2022/empowering-women-to-work-in-cybersecurity-is-a-win-win.

[40] W. Aljohni, N. Elfadil, M. Jarajreh, and M. Gasmelsied, "Cybersecurity Awareness Level: The Case of Saudi Arabia University Students," *International Journal of Advanced Computer Science and Applications,* vol. 12, no. 3, 2021, doi: 10.14569/ijacsa.2021.0120334

APPENDIX. INTERVIEW TRANSCRIPTS AND POSTERIORI CODES

Question: What barriers do you think hinder the participation of Saudi Women in the cybersecurity sector?

	Responses	Posteriori codes
P1	Women cannot apply for a passport or travel outside the country without their male guardian's approval.	*Cannot ..... travel outside the country without their male guardian's approval* [Lack of autonomy]
P2	One of the challenges faced is the ineffectiveness of workplace policies on maternity and paternity packages to advancement processes.	*Ineffectiveness of workplace policies on maternity* [Child caring and bearing duties].
P3	Gender is therefore still a major issue in the work place because of the impact that gender stereotypes have on the attitudes and decision-making of employers and employees alike. Childcare and caring for others featured strongly in the lives of women and their perceptions of these issues as barriers to their employment or progression were multifaceted and influenced decisions regarding work. So it depends on the community and its acceptance	*Childcare and caring for others* [Child caring and bearing duties].
P4	It could be personal preferences, lack of announced opportunities/jobs for women in the field, or difficulty to manage such a hard field with the expected role of women in the Saudi culture. The society yes in terms of duties and roles (women still are the main holder of the house and children, while men are expected to be the financial provider in the household). In terms of salary, I know in government sector it is the same, I do not know if there is a different in salary between women and men in the private sector in Saudi Arabia. Cultural aspects are a main challenge. There are many social duties and expectations from women as they are considered the main householder and child caregiver. These responsibilities could be as an obstacle to pursue a technical career for women in the Saudi culture.	*Women still are the main holder of the house and children* [Child caring and bearing duties]. *Social duties and expectations from women as they are considered the main householder* [Family responsibilities] *and childcare giver* [child caring and bearing duties].
P5	Being a mother is a big challenge because of the responsibilities. Sometimes yes it could influence life and decisions	*Being a mother is a big challenge* [Family responsibilities]

P6	Women are still considered as a successor of men. They still struggle to find a way to make a difference in the society. It shaped me to work harder and try and push the wheel of women involvement forward.	*Women are still considered as a successor of men* [Female as the weaker gender]
P7	It made it difficult to compete with male colleagues sometimes. I get frustrated sometimes and discouraged. However, it doesn't stop me from trying to be as skilled and qualified as I possibly can.	*Difficult to compete with male colleagues* [Female as the weaker gender]
P8	Many reasons, some of them social such as acceptance of society for working women and others related to gender or accessibility. Limited opportunities for training and networking (how women can find training especially when men dominate the job market and the culture of society limits communication between men and women). The perception that women are not good enough and that they have to work twice as hard to proof that they are capable. Not having work life balance.	*Acceptance of society for working women* [Female as the weaker gender] *Culture of society limits communication between men and women* [Lack of autonomy] *Not having work life balance* [Family responsibilities]
P9	I think the main challenge is that women usually have to consider their family situations. For example, if a woman got a better job opportunity in the field in a different city, usually she would reject it because she can't move without her family and it is a hard decision to move them all.	*Women usually have to consider their family situations* [Family responsibilities] *She would reject it because she can't move without her family* [Lack of autonomy]
P10	The fear that men might handle this type of work better than them. Or security and its related jobs are not for women. Regarding me feeling capable one thing that used to bother me a little is my responsibly as a mom. Most of my colleague (men and women) were single or have no kids, so for me being a single mom with four kids and being able to work as hard as them and show myself as capable to do what they do was sometimes challenging	*One thing that used to bother me a little is my responsibly as a mom* [Family responsibilities]
P11	On inability to think creatively	*Inability to think creatively* [Female as the weaker gender]
P12	The challenge is the global suffering of all women all over the world	*Global suffering of all women* [Female as the weaker gender]
P13	Women usually tend to work in occupations with more structured and reliable hours of work and this often means the work is part-time and low paid. Autonomy is also restricted for women who progress to the highest occupational levels due to the traditional masculinity model of the different roles.	*Autonomy is also restricted for women …… the traditional masculinity model of the different roles* [Lack of autonomy]

P14	I think it depend on the family in the first place, if they are supportive nothing can stop any woman from doing anything she desires. On the other hand, some families are not supportive.	*Some families are not supportive* [Family support]
P15	The society traditions. Yes, it effected my decisions in my studies and my career. Social life obligations and family responsibilities.	*The society traditions* [Lack of autonomy] *Social life obligations and family responsibilities* [Family responsibilities]