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Unveiling the Missing Link: Women in Stem Leadership – A Comprehensive Review

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ABSTRACT

This paper extensively examined the representation of women in Science, Technology, Engineering, and Mathematics (STEM) within Malaysia, contextualized globally and historically. Existing research affirms the growing presence of women in the workforce (Gupta, 2020; National Academies of Sciences & Medicine, 2020), their progress in higher education (Manongsong & Ghosh, 2021; Vietze et al., 2022), their presence in professional and managerial roles (Burton et al., 2020; Evans & Maley, 2021), and their successful elevation to CEO positions (Dadanlar & Abebe, 2020). However, women continue to be significantly underrepresented in leadership positions, particularly within STEM firms (Hideg & Shen, 2019; National Academies of Sciences & Medicine, 2020). Young Malaysian women excel in both academic and extracurricular STEM activities from primary to university. Despite this gender equity achieved in STEM education, with 29% of tertiary engineering graduates and 57% of science degree holders being female, only 6% of women pursue careers as STEM professionals (Looi, 2022). Additionally, slightly over 4% of women hold leadership roles in technology firms in Malaysia (Amin & Tan, 2018). Using social constructivist and feminist theories, this analysis examines how societal and environmental factors affect girls' performance in math and science. Educators and parents play a vital role in providing crucial support. This study also highlights a major research gap, particularly in understanding where qualified women in STEM go, especially within Malaysia.

1. Introduction

A well-known and well-documented societal issue is the underrepresentation of women in STEM jobs at all levels. Women make up roughly 53% of biological scientists, 31% of doctors, 33% of chemists, and only 29% of geoscientists, according to (Gupta, 2020; National Academies of Sciences & Medicine, 2020). In addition,

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according to the aforementioned, women make up only 10% of civil engineers, 8% of electrical engineers, and 10% of aerospace engineers in the most developed countries of the world.

While the causes of this are still being discussed, some have come to the conclusion that they are related to family values (Alfred et al., 2019), gendered socialization (Yavorsky et al., 2022), or stereotypes (Eagly & Koenig, 2021), not to mention lack of support, demeaning comments, and even sexual harassment (Abalkhail, 2017; Ahmed et al., 2020; Cooper & Wilson-Jones, 2023).

Inequity in Pay and Access

Research consistently affirms that women face lower pay and unequal access to the labor market, especially since the 1960s when more women entered the workforce (Bapuji et al., 2020; Hazel & Kleyman, 2020). Commonly cited reasons for this disparity include differences in education, experience, and self-selection (Corneo & Neidhöfer, 2021; Vietze et al., 2022).

Self-Selection

The gender wage gap is often attributed to women's concentration in lower-paying service-based fields and men's focus on higher-paying industries, resulting in occupational segregation. Researchers argue that women's lower earnings stem from systematic exclusion from higher-paying jobs, described as the feminization of certain professions (Henningsen et al., 2022; Ögge et al., 2022).

Women and the Career Ladder

The first decade post-graduation is crucial for women aspiring to attain leadership positions in organizations (Kashyap & Verkroost, 2021). Gender stereotyping remains a major hurdle for female CEOs, backed by data revealing unequal access of women to leadership roles despite appropriate education and experience (Dersch et al., 2022). This division of labor results in a disproportionate allocation of time, with women shouldering more family responsibilities even though they already work longer hours when considering both home and work commitments (Aldossari & Chaudhry, 2021). This perpetuates gender disparities in leadership roles and reinforces the barriers faced by women in their professional journey.

Theories of Social Constructionism

Social constructivist theories posit that the prevailing patriarchal hierarchy, being dominant and influential, plays a crucial role in shaping an artificial perception of the capabilities of men and women, both at conscious and unconscious levels (Alharbi, 2023; Mattila, 2020). This artificial reality is believed to be one of the primary reasons why there is an underrepresentation of women in leadership roles. Gender stereotypes, social role expectations, and challenges related to role congruence further compound the obstacles that impede women's access to leadership positions (Chen et al., 2021). In the subsequent sections, each of these concepts is explored independently.

Stereotypes of Gender

Research highlights how societal meaning construction emphasizes gender stereotypes, shaping expected behaviors for men and women (Jaxon et al., 2019). Stereotypes impact women in leadership roles, perpetuating unfounded beliefs about their emotional capabilities (Dersch et al., 2022; Eagly & Koenig, 2021).

Social Positions

Societal expectations based on biological sex delineate labor division and gender norms (Schneider & Bos, 2019). In domains like politics and business, these roles favor men in leadership due to perceived agentic traits (Ma et al., 2022).

Role Congruity Theory

Role congruity theory posits societal biases viewing women as less suitable for leadership roles, associating them with less desirable behaviors (Eagly & Koenig, 2021). This dichotomy creates a conflict for women, shaping perceptions of leadership and femininity.

Attitudes Towards Women in Leadership Positions

Leadership historically linked to masculine traits shapes societal expectations, hindering women's success (Garr-Schultz et al., 2023). Women adhering to gender role expectations face reduced acceptability for leadership positions (Arora, 2022).

Symptoms of Systemic Incongruence

Female leaders displaying typical leadership traits often face unfair portrayal compared to male counterparts (Ma et al., 2022). Gender bias is evident in performance evaluations favoring men (Schneider & Bos, 2019). Addressing these biases is crucial for an equitable workplace.

Limitations of the Social Roles Theories

Using this lens overlooks progress in gender equality in developed countries (Shannon et al., 2019). Institutionalized patriarchy and social policy influence women's access to leadership roles (Knox-Bell, 2022). Gendered occupational segregation is challenged by women's increasing presence in diverse fields (Churchill & Craig, 2019). The theory assumes women lack agency to overcome barriers, despite evidence of progress in women accessing higher-status roles (Megarry, 2020; Schneider & Bos, 2019). Social roles research, relying mainly on quantitative metrics, fails to capture the complexity of gender disparity (Eagly & Koenig, 2021). Beyond the male-female binary, other contributors to gender equality are overlooked (Meltzer et al., 2020).

Women in Science, Technology, Engineering and Mathematics (STEM)

The representation of women in STEM has increased, but men maintain a numerical advantage, especially in higher echelons. In primary, middle, and secondary education, both genders show similar enrollment rates in math and science, especially in Southeast Asia (Eaton et al., 2020; Freeman et al., 2019; Kang et al., 2023). The proportion of female high school graduates eligible for STEM studies is comparable to males (Kärkkäinen & Joo, 2019; Master et al., 2021). However, fewer women choose STEM disciplines in higher education. At graduation, men significantly outnumber women, especially in physics, engineering, and computer science (Adams et al., 2022; Eaton et al., 2020; Freeman et al., 2019). This gender gap persists in graduate education and the professional workplace (Cordeiro et al., 2020; García-Peñalvo et al., 2022). Cultural factors, not just inherent aptitude, contribute to girls' improved math scores (Cordeiro et al., 2020; Kärkkäinen & Joo, 2019).

Studies show that emphasizing intellectual development through education boosts math performance and interest in further studies (Leaper & Starr, 2019; Şahin Timar & Misirli, 2023). Cultivating a growth mindset is especially beneficial for girls facing enduring math-related stereotypes, improving academic engagement and achievements (Leaper & Starr, 2019). Addressing stereotypes by emphasizing equal capabilities diminishes the observed performance gap (Dersch et al., 2022). Encouraging equitable academic performance can foster more accurate self-assessment among girls (Eagly & Koenig, 2021). Negative stereotypes regarding girls' math abilities can notably affect their performance and potential long-term career aspirations in science and engineering (Tabassum & Nayak, 2021). Training programs demonstrate significant improvement in spatial skills, suggesting potential for enhancing girls' spatial abilities and fostering interest in STEM disciplines (Kelly & Beltz, 2022; Yang et al., 2020).

In STEM, a strong foundation for a career is established in higher education like universities (Blackburn, 2023). Physics and computer science departments can significantly boost female student recruitment and retention by broadening the introductory course perspective (Bowman et al., 2022). Fostering an inclusive culture in departments can also improve the recruitment of female science and engineering faculty (Bowman et al., 2022). Studies show that women in academia often experience lower job satisfaction and higher rates of premature departure. Implementing mentoring programs and equitable work-life policies can enhance female faculty recruitment and retention (Blackburn, 2023; Domingo et al., 2022).

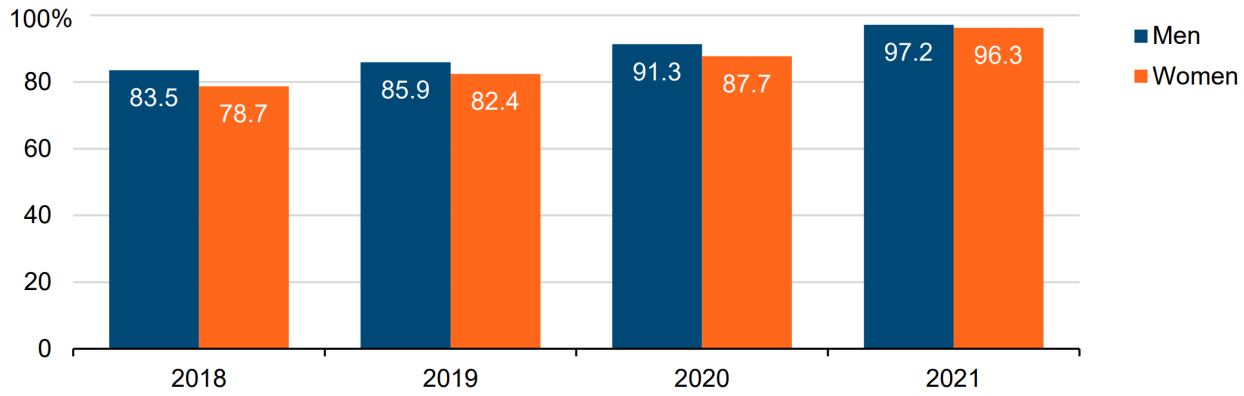
STEM and Women in Malaysia

The Graduate Tracer Study (GTS), an annual survey of local graduates about their post-graduation status, is carried out in Malaysia by the Ministry of Higher Education (MOHE). According to the survey, women made up a higher percentage of STEM graduates from local tertiary education institutions than global trends (53 per cent in 2021). However, men who major in STEM are hired at higher rates than women.

The Gender Digital Divide in Malaysia

The gender digital divide in Malaysia is more a function of digital skills than of internet access. Overall, Internet use has increased over time for both sexes, with the gender gap closing in the last four years (Figure 1). The gender disparity in Internet use was 4.8 percentage points in 2018 and 0.9 percentage points in 2021 (Gong, 2023).

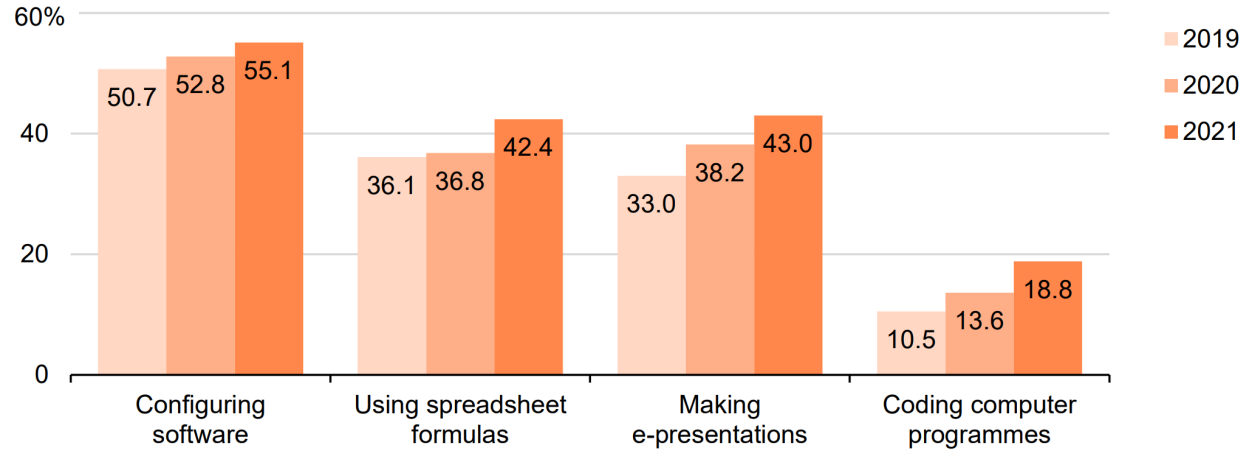
Figure 1 – Internet Use Rates by Gender 2018-2021[1]



Source: DOSM ICT Use and Access by Individuals and Households Survey Report, 2018–2021

Figure 2 illustrates specific digital competencies. It is evident that women's digital competencies are growing. Advanced information and communications technology (ICT) tasks like downloading, installing, and configuring software, using simple math formulas in a spreadsheet, creating electronic presentations with computer software, and writing computer programs using a specialized language are all becoming easier for women to master.

Figure 2 – Share of Women's ICT Skills, 2019-2021



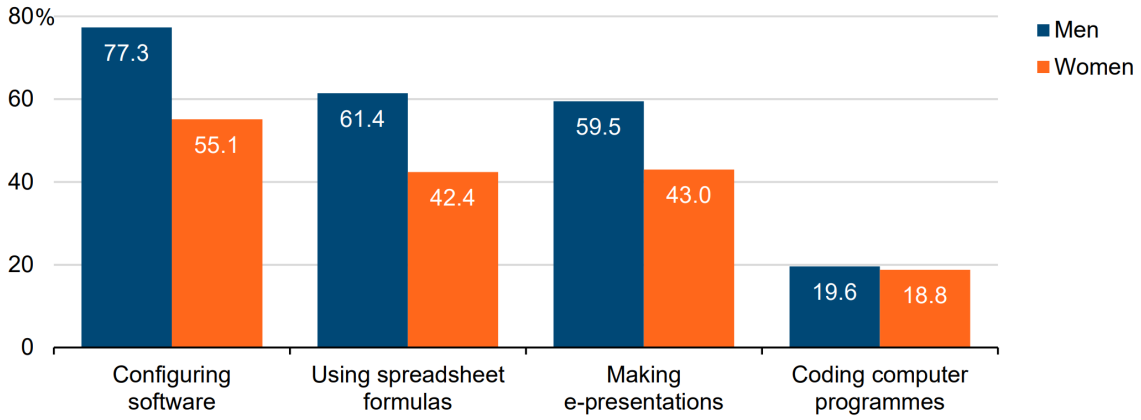
Source: DOSM ICT Use and Access by Individuals and Households Survey Report, 2019–2021

Despite these advancements, Figure 3 demonstrates that gender differences in these advanced abilities are substantially wider than those in Internet use. In 2021, 42 per cent of female computer users said they had used spreadsheet formulas, and 43 per cent said they had made digital presentations. In the same year, 59.5 per cent of men reported doing electronic presentations, and 61.4% said they used spreadsheet formulas. These two abilities are getting increasingly in-demand for professional positions. Regarding technical proficiency, 55.1 per cent of female computer users said they could download, install, and configure software, while about 19 per cent said they could code computer programs. Comparatively, 77 per cent and about 20 per cent of men

[1] The tables used in this section have been taken from KRI (2023), which have themselves been taken from the sources given.

reported having comparable talents. The gap in coding is substantially less (almost 1 percentage point), despite the seeming size of the gap in systems administration duties like installing software (22 percentage points).

Figure 3 – ICT Skills by Gender 2021



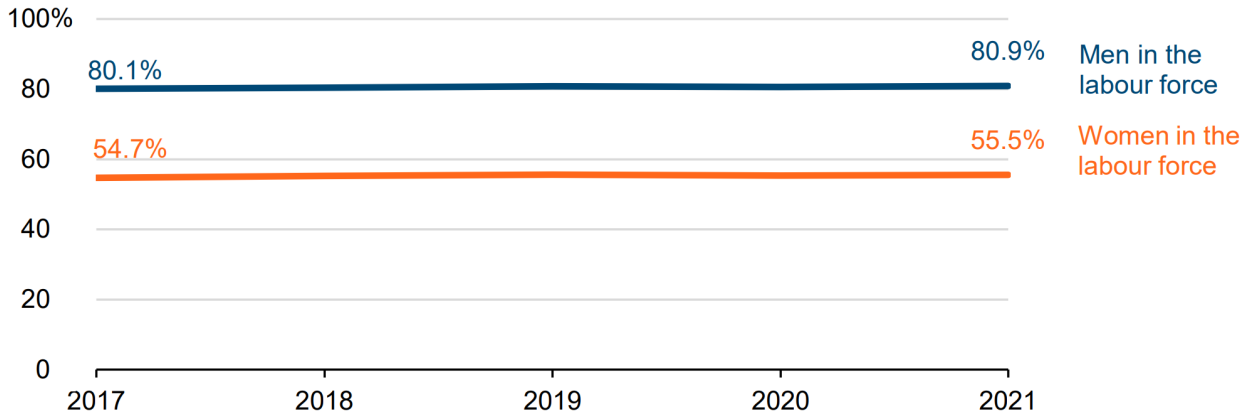
Source: DOSM ICT Use and Access by Individuals and Households Survey Report, 2021

These ability gaps vary, presumably because of experience rather than schooling. System administration duties, such as managing and playing online computer games in the house or fixing networking errors at home, are arguably more likely to be carried out by men (Garr-Schultz et al., 2023). On the other hand, learning how to code might be a talent that is better studied in a class where there may be more opportunities for both men and women (Cordeiro et al., 2020).

Gender Gaps in STEM Education and Employment

The gender disparity in Malaysia's labor force participation has remained largely stable over the previous five years, with roughly 80 per cent of men working or searching for employment compared to about 55 per cent of women (Figure 4). This shifts the focus from gender differences in ICT use to the workforce.

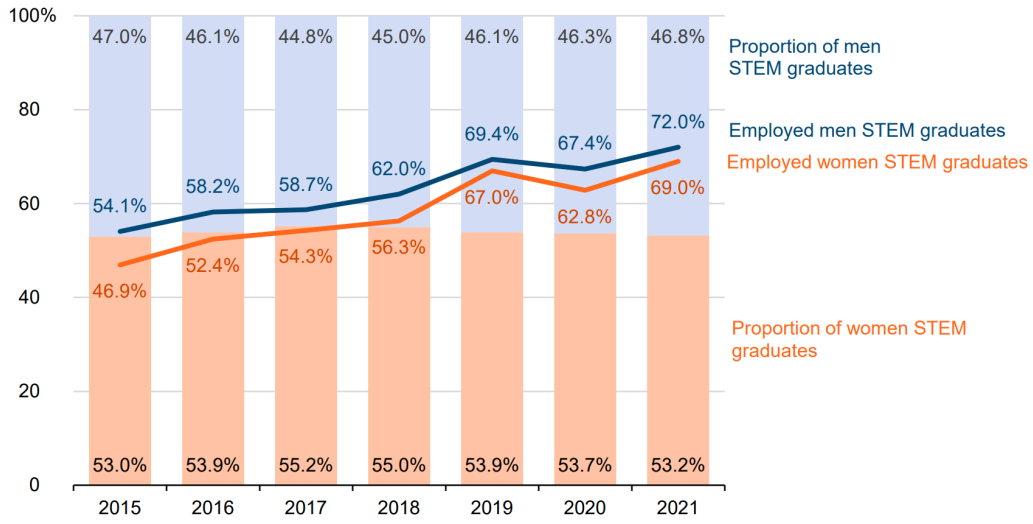
Figure 4 – Labor Force Participation by Gender



Source: DOSM Labour Force Survey Report 2022

Data from MOHE's GTS suggest that Malaysia defies international trends in STEM education and employment, but not in terms of the employment of women. In Figure 5, the lines represent the rates at which men and women with STEM degrees were employed at the time the GTS survey was conducted, and the bars represent the proportion of STEM graduates (bachelor's degree and above) from 2015 to 2021. Women typically graduate in greater numbers than men in STEM fields, but they are hired at lower rates than men.

Figure 5 – Proportion of STEM graduates and employment rate, by gender, 2015–2021



Source: MOHE Graduate Tracer Study, 2015–2021

The gender pay gap, career advancement, or other, related employment sectors (STEM or non-STEM) are not discussed in this report. Nevertheless, the results imply that, despite the shrinking gender gap in STEM graduate employment, employers' preference for hiring males over women may be one of the factors affecting Malaysian women's labor market participation rate as is also corroborated by the literature (Alam et al., 2021; Gong, 2023.

According to a recent study by the Associated Chinese Chambers of Commerce of Malaysia (ACCCIM), about 41 per cent of the research participants believe that increased maternity leave policies will make women less employable. In order to offset the additional costs of a change to the Employment Act that increased maternity leave from 60 to 98 days, employers said they would hire more men than women. There are at least two ways in which this response to maternity leave might be detrimental to society which is also corroborated by research (Fagan & Norman, 2012; Ögge et al., 2022).

Businesses' unwillingness to recruit women could lower women's involvement in the labor force. According to research, greater employment of women is linked to improved socioeconomic development, labor productivity, and gross domestic product (GDP) (Alon et al., 2022; Strauss et al., 2021; Voumik et al., 2023). The reverse outcome, which would be to limit or impede national progress, may result from excluding women from the workforce.

In conclusion, STEM skills, especially digital skills, are anticipated to be in increased demand in the Malaysian workforce given the growing infusion of technology into the economy (Khan et al., 2021). Although more

women are earning degrees in these industries and displaying greater technical proficiency, they are still hired at a lesser rate than males. Employers should and ought to take further steps to encourage gender equity in hiring procedures.

STEM Girls in Universities in Malaysia

Tienxhi's (2017) study on Malaysian public universities showed that 13 out of 20 had a Gender Parity Index (GPI) over 1.5, signaling a significant gender gap, including the University of Malaya. Interestingly, Malaysia displayed closer gender parity in engineering, manufacturing, and construction fields compared to other Asia-Pacific nations and developed countries like the US and the UK (Ismail, 2015; Wan, 2018). Despite this, a gender gap persisted in Malaysian public universities, while private universities and Malaysian international students demonstrated better gender equality. Male enrollment in community colleges and polytechnics was insufficient to address this disparity, even though males underperformed in secondary schools compared to females (Wan, 2018).

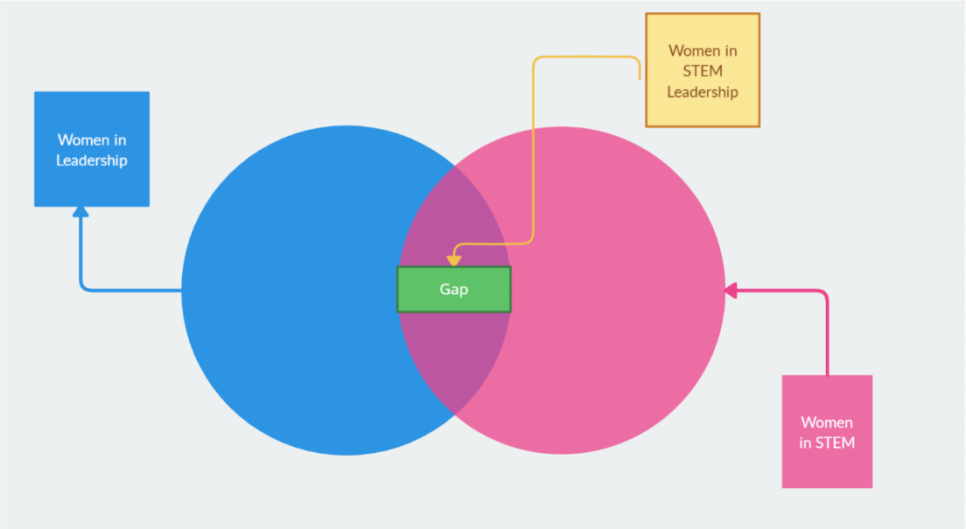
It's crucial to acknowledge that Malaysian women's involvement in various spheres of life has surged in recent years, notably due to advancements in education. Female literacy rates improved from 61% in 1980 to nearly 91% in 2010, emphasizing the progress in educational attainment for Malaysian women (Lim, 2019). The strides made in equal access to education for both genders have contributed to reducing gender disparities in elementary and secondary education (Wan, 2018). However, the question remains: where do these young women progress to?

Women in Leadership Roles in STEM Fields

The underrepresentation of women in STEM leadership roles has hindered addressing gender pay disparities and achieving gender equality (Vasina & Sloka, 2019). Despite comprising 47% of the global labor force, women are scarce in higher-wage roles and leadership positions (Martínez-Rosales et al., 2021). Government interventions have increased gender diversity in corporate boardrooms (Andrew, 2020; Gillard & Okonjo-Iweala, 2022). However, it's uncertain if a higher proportion of women on boards impacts the career prospects of women in the company. Research suggests that companies with more female board members are likely to hire female senior executives (Guldiken et al., 2019), and having more female CEOs associates with smaller gender salary inequalities at the top but larger wage gaps at the bottom (Maida & Weber, 2022). Quota regulations, for example, in Norway didn't significantly benefit women in quota-required companies (Bennouri et al., 2022).

The intersection of women in leadership positions and women in STEM (Figure 6) has been minimally explored (McCullough, 2019). Understanding the proportion of women in leadership roles within STEM is fundamental since they have fewer leadership roles than their PhD representation in the respective fields (Gillard & Okonjo-Iweala, 2022; Maida & Weber, 2022; McCullough, 2019). Achieving gender parity in STEM requires effective study and promotion of women in STEM leadership positions.

Figure 6 – The Gap in the Literature on Women in STEM Leadership.



List of Major Findings from Literature Review

In sum, the crucial findings from the literature review pertaining to the thesis of this research are:

1. Women have historically had trouble gaining entry *and* acceptance in STEM related fields.
2. This has been because of a variety of socio-economic and familial factors.
3. However, the rise, in recent years, of women in STEM education has not translated into women in the workforce, despite the evidence that more diversity enhances the organization's performance.
4. This is especially noticeable at leadership and policy making levels despite a number of enactments by governments around the world.
5. In Malaysia, specifically, a miraculous amount of strides have been taken in the inclusion of women in education and the workforce, however, this has not yet resulted in the parity expected at senior management levels.
6. The literature does not have an answer to why this lack of parity between women graduates in STEM and women leaders in STEM professions exists.

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