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Vertical Segregation: Issues and Challenges of Women Engineers in Australia

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Abstract

International research shows that 75 per cent of the fastest growing occupations require Science, Technology, Engineering, Mathematics and Medicine (STEMM) skills. However, a recent survey report said that almost a third of global women working in STEMM expect to leave the sector within the next five years. This loss is very significant and wastage of resources, talent and expertise with respect to every nation's growth. Although number of national and international policies and programs have been implemented to promote and increase the inclusion of gender equity in the field of science and technology but there is significant gender gap about the participation of women at higher levels of science academic careers, referred to as 'vertical segregation'. This leads to understand the interplay of inclusive policies, organizational, societal and personal factors that exclude women from pinnacle of the hierarchy in academic and research institutions. Challenges are more in hard sciences like mathematics, physics, engineering and computer science where there is no equity in numbers even at start level. This study engages with women engineers located particularly in the middle management level to record the impact of ongoing policies & programs and compare the findings to unfold some of their struggles which is linked to the leadership questions in 'Women in Engineering'. Pay, progression and security issues are not only being barriers to women reaching the higher levels of science and technology professions but unconscious biases, stereotype, some myths, societal, cultural and institutional roots also impediments to support 'Women in Engineering'. This indicates that no single strategy can entirely plug the leak and there is need of sharing the best practices among different nations through multi-faceted approach across all levels to break the glass ceiling.

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1. Introduction

Continuous efforts to promote and retain women in Science, Technology, Engineering and Mathematics (STEM) are on high demand. However, there are several factors which are responsible for exclusion of women from field of engineering and technology. Australian government understands that exclusion of women engineers is a significant loss in terms of talent, resources, expertise, absolute terms of required engineers and economic growth of the country.

Women are participating in each field and contributing in economy. However, there are less than a third (28%) of women employed in scientific research and development across the world in 2014 [1]. Statistics shows that almost one-third (32%) of women in the United States, 30% in China followed by 22% in Brazil and 20% in India intend to leave their science, engineering and technology (SET) jobs within a year [2]. A substantial gender gap in engineering and computer occupations contributes to women's overall underrepresentation in STEM [3-6]. Isolation, hostile male-dominated work environment, ineffective executive feedback, and pay gap are main factors pushing women to leave SET jobs [7]. A peak engineering body, Engineering Australia's concern about Australia's reliance on imported engineers shows shortage of engineering's who are coming out from Australian universities [8].

'We're very concerned about the lack of graduates coming through. To have a strategy where we rely so heavily on migration for our workforce is very risky', statement of national president Trish White indicates the concern of the nation.

Despite Australia's continuous efforts in last years to reverse the decline in students studying STEM, 13 percent representation of women engineers in active workforce shows little success in this direction [8]. The recent report of the association of professional engineers Australia's gender and equity report indicates that Australia could not afford to ignore inequality and discrimination in the engineering workforce due to demand for professional engineers in Australia far outstripping supply in the long-term. Out of 18000 required positions of engineers every year, only 6000 are filled by engineering graduates who passed from Australian universities. However, other 12000 engineers come from outside Australia on temporary or permanent visa. The most alarming situation is under presentation of women in current situation. Women are not enrolling in engineering and once they are enrolling, system is not favourable to retain them. 13.1 percent of women workforce forced to leave the profession in between 20-30, compared with only 1.4 percent of male counterpart. Gender based discrimination, substantial pay gap and assigning low level of jobs responsibilities seems to be main factors behind this situation [9].

2. Work and Tool Material

First, an analysis of the secondary data on the government initiatives categorized into groups including specific policies and programmes, socio-cultural barriers and institutional support were undertaken. Further, a focused study was conducted by taking views of fifteen women engineers, aged between 30-50 years who were in their middle career and keen to take the leadership positions. Interview of such women engineers helped to understand the issues and challenges, which played important role to stop them to be in the field of engineering. The interviews were semi-structured in nature, conducted in a conversational manner, but adhering to a common set of points. These were conducted by the first author and care has been taken to disguise the identity of the respondents. All the interviews were audio recorded and fully transcribed. This study was approved by the QUT Human Research Ethics Committee with approval number 1700000460.

The interviews were based to provide an overview of the information obtained relating to five major areas: 1) the type of positions and roles women held 2) the extent to which they believed gender inequities occur within the field of engineering and factors related to inequities, 3) the ways in which they have balanced career and family obligations and major concerns in this regard, 4) role of role models and mentors in their professional life, and 5) plan to take future leadership positions. A final section includes general reflections from the interviewees and the

authors. The data explored for better understanding of why, so few women retain in the field of engineering, respondents' social situations and barriers, while analyzing the significance of available supportive measures for pursuing their engineering career and research were component of this study.

3. Results and Discussion

3.1 *Are girls' incapable to perform in math's?*

It is a general perception that girls are not good at mathematics [10, 11]. This belief push women to enter and perform to succeed in the field of engineering and technology inability. However, results of many international student's assessment like Trends in International Mathematics and Science Study (TIMSS) and Programme for International Student Assessment (PISA) didn't support this statement. Instead of innate gender differences, differing societal and cultural practices in many countries result in vastly different experiences of learning, levels of confidence in personal ability, and performance in international benchmarking tests. Pattern of gender differences in mathematics ability change over time, sometimes girls outperform boys and vice versa. During 2011, there were no significant differences in the mathematics scores of Australian boys and girls in Year 4 or Year 8 under TIMSS [12]. Singapore is one of the top five countries in PISA mathematics; and their female and male students perform equally. The Singaporean system proves that the girls can be world leaders in mathematics when placed in the right education environment [13]. Mathematics ability is not determined biologically by sex. Results of meta-analysis of more than 240 studies published between 1990 and 2007 shows that there is no statistically significant gender difference in mathematics performance [14]. Conducive environment, motivation and self- belief are few main factors which play significant role in determining gender differences in mathematics. PISA studies find that gender disparities in drive, motivation, and self-belief play a significant role in determining differences in male versus female mathematics performance [15]. In Australia, more girls are fearful and perceive that they have less capable to achieve higher grades or perform in mathematics as compared to boys [16]. This misconception impacts their performance and encourage to accept the fact that they are not good in mathematics. Recent 'Women in STEM' datasheet released by Office of the Chief Scientists depicts that attitudes affects the performance in STEM subjects. 24 percent fifteen years old Australian girls as compared to 16 percent think that mathematics will not help them to get a job and less confident in applying mathematics concepts to real-world problems [17].

3.2 *Are women disinterested in careers in Engineering, Physics and ICT?*

40 percent of women engineers in China [18], 44 percent of the engineering graduates in Malaysia [19], and accounted for 58 percent of engineers in the former USSR [18] demonstrate that women can be interested in these careers. However, there are only 14 percent women represented in engineering in Australia [20]. Factors like identity, perceived ability, and aspiration most influenced students' decisions. Though, a conducive cultural environment is responsible to retain them further.

There is need to learn from Muslim dominating countries like Jorden, Malaysia and Tunisia and even Saudi Arabia where 50 percent of women are working in engineering and technical professions. It is worth to mention here that despite of social, political, and economic restrictions on women's participation in public life in the fourth country (Saudi Arabia), women's engineering participation there is on the rise. Lyrics from a popular 1950s Arabic TV show in which mothers had sung to their baby girls showed the vision and envision her future in engineering, "*And I will say 'My girl has grown up, she will be an engineer' / Oh people, oh people! I love her! / She's her mother's lovely girl.*" The vision of a 1950s mother crooning such a song to her daughter probably sounds anomalous to mother of developed countries where most women neither encouraged nor permitted to work in a masculine career like engineering. There are a large proportion of women studying and pursuing STEM careers inside developing, Muslim-majority countries as compared to developed countries [21].

3.3 Are policies working at ground level?

Most of the respondents feel that they choose engineering as profession by their own choice. However, now they are feeling difficult to sustain in current situation. Professional world has prejudice opinion about women engineers which slows down their career growth.

They share their experiences like:

“Most of the industries don’t have policies, who ever have, it’s difficult to access these. Negotiations are not possible as per existing policies. However, your boss decides your work flexibility or work/ life balance as per industry’s convenience”.

“I am aware about government programmes and policies to support women engineers but there is large gap in theoretical papers and their implementation”.

Statement of senior executive of one of the leading universities also reflects that:

“Challenges are more in hard sciences like mathematics, physics, engineering and computer science, there is no equity in numbers even at undergraduate level and so in those disciplines, problem is compounded because we don’t have enough to start with. Lot of efforts have been done and there is need to do more in disciplines as these are the disciplines which are disrupting every sector of economy and important for economic competence. We are not leveraging the capacity of our half of the human capital.”

Despite of their wish to continue in this profession, they are forced to leave due to gender stereotyping and workplace culture. Eight out of fifteen women feel that their organisations involve them in more administrative work than complicated technical jobs. Report of professional Australia also reflects only 21 percent participation of women in professional, scientific and technical services [9].

Lack of women at senior roles, role models, mentors and lack of access to senior roles for women were reported by respondents as adversely impacting their career advancement. Role of mentor and role models are vital to building self-confidence and enabling them to retain into professional roles [22]. Respondents shared that:

“I don’t have any mentor and role model in my professional life. However, I would like to see women as my role model, so I can compare my situation with her and can motivate myself with her career path”

“I look forward to have some females in senior professional engineering roles for career advancement”.

Another major issue was flexible working hours and part time jobs. They generally choose part-time work to make a work-life balance. However, this is not easily acceptable and act as an obstacle in career progress. This also reflects in statements of few of the respondents:

“I felt like I was being judged as unprofessional and excluded from complicated technical projects because I was part-time”.

“Management is more comfortable to provide me administrative responsibilities rather than technical jobs. I am not sure about their perception towards my capabilities”.

“My motherhood responsibilities reflect me less professional as compared to my male counterparts, hindrance my career progress and create prejudice opinion about me”.

Decreasing number of students studying mathematics and science at high school is contributing to the serious under representation of women in engineering. Australia's declining performance and ranking in international programmes like TIMSS, and PISA also reflects lessening interest of students towards STEM education [23]. The situation is worst for female students in view of their less participation at entry level. There are only 6.7 percent of Year 12 girl students across the country who took an advanced mathematics as compared to 12.7 percent of boys in Australia [24].

Impediments to women in STEM have deep societal, cultural and institutional roots, and no single strategy can entirely plug the leak. Debunking the myths and spreading the facts is a start, but most of the countries require a multi-faceted approach across all levels of education and the workforce. It may not seem problematic if girls and boys develop different interests and careers. However, divergent attitudes formed by girls and boys in childhood such as confidence in their abilities to apply mathematics to problem solving have far reaching implications for the opportunities available to them in adulthood.

Apart from cultural, pay gap and other societal factors, it's more about engineering culture which force women to leave the profession. Women who leave this profession, go and perform well in other intellectual demanding STEM professions. Stereotype culture of engineering profession and sexual harassment makes male colleagues more uncomfortable in presence of women as compared to other professional like medicine or law. A latest report from Professional Australia reveal that 26.8 per cent of respondents reported that they had been sexually harassed in the course of their employment [9]. Scientists conducting fieldwork were at even greater risk, with two-thirds (64%) of researchers surveyed internationally experiencing sexual harassment, mostly at the hands of a senior researcher.

Despite many policies and concept of work flexibilities in many organisations, most of the respondents think that complaining and taking part time jobs play important role as primary barrier to their career advancement. This is very common to not take part time women as serious employee or committed to work. Women working as part time or flexible working hours are not considered to give equal technical responsibilities, promotion or increments in complex projects as their colleagues, working as full time [9]. Women seem the only solution to overcome the frustration developed through facing such situations is to leave their jobs.

To overcome all these issues, policy makers should take appropriate actions for implementation and compliance of existing diversity, anti-discrimination and sexual harassment policies at relevant workplaces. There is need to gather and monitor data on progress against gender equity policies including identifying over-and under-representation of women in particular areas or roles of the organisation that may indicate gendered occupational or role segregation within the organisation. To retain and nurture these talents, organisations should encourage to take the initiatives to develop options for part-time and flexible work at senior management and leadership levels. They should also ensure to include part time workers under performance pay systems. Apart from other administrative procedures, sexual harassment policies should also be transparent, objective and administered by trained personnel. Senior administrators should ensure that there is no penalty for an individual raising a complaint; and appeal process is in place. Apart from policies, the role of organisation is equally important to provide equal importance and respect to technical expertise of women at the leadership and management levels and not second-guessed at operational level.

4. Conclusion

A lack of women in engineering profession not only limit the attraction of talent to enhance organisational growth and performance followed by nation's productivity and economic growth but limit in terms of number of absolute engineers which Australia need urgently. Promotion of STEM education at school level, workplace improvement,

change in stereotype and addressing unconscious bias all are needs to address to improve the outcomes in near future.

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