Understanding the Bias and Culture for Women in Engineering

Charlotte L. Toma[1], and Max T. Stephens[1]

1. University of Auckland, Department of Civil and Environmental Engineering, 20 Symonds Street, Auckland, New Zealand.

Abstract

Women continue to be underrepresented in the engineering industry. The focus in New Zealand to increase the proportion of women in industry has been to raise the visibility of engineering as a career for women through hands-on and wide-ranging programmes. However until we can address the issues around retention and promotion of women in engineering, we are going to struggle to shift this imbalance. This study investigated the factors that affect the professional success of New Zealand engineers in their first 10 years following graduation, across gender. Barriers inhibiting and initiatives positively influencing the career progression of men and women were identified. Empirical data was gathered in a mixed-method approach, both quantitative and qualitative. Analysis of the results identify women are often subject to serious discrimination, harassment and stereotyping. Many women did not identify serious company culture issues as barriers, rather just the norm. Respondents all cited very high levels of career discontent with 84% of all engineers within the early stages of their career expressing some level of dissatisfaction, a concerningly high statistic.

Keywords: Diversity, Engineering, Gender Representation

1 Introduction

Progress toward gender equality in male-dominated careers has stalled. Women are doing what conventional wisdom says is necessary for success: They're earning advanced degrees, entering high-paying industries, and acquiring impressive qualifications at rates equal to or higher than men (Campbell and Hahl 2022). However, it still takes women longer to get promoted, there is still a recognised gender pay gap and a noticeable lack of women in senior leadership positions. A 2015 Engineering New Zealand (formerly IPENZ) study illustrated the ongoing disparity, with 9% of technical leaders and 8% of senior managers and board members being women engineers, although 16% of engineers within the participating organisations identifying as women (IPENZ 2005)

International studies show the retention of women in engineering is lower than in other industries (Frehill 2012; Hunt 2016). The higher proportion of women leaving engineering suggests factors within the industry are pushing women to exit the field. The purpose of this study is to understand the factors that affect engineering graduates' career progression in New Zealand, how these contribute to the persistence of gender disparity in the industry and how they can be addressed.

2   Method

This research project utilised a mixed-method approach combining quantitative and qualitative data to develop breadth and depth in the analysis of experiences within the engineering industry in New Zealand. Data was gathered in three stages. First, publicly facing LinkedIn data was mined using a list of engineering students who graduated from the University of Auckland between 2011 and 2017 and across all engineering specialisations and genders. Next, anonymous surveys were sent through LinkedIn using the same list of graduates. Finally, focus groups were held with self-identifying women currently employed in the engineering industry, and not specifically University of Auckland graduates, participants were all early career having graduated between 2011 and 2017. This stands in relative contrast to other studies on this topic, which tend to collect data only from women and/or focus only on relatively narrow barriers to career progression. The survey and focus group methodology was approved in University of Auckland Ethics Application UAHPEC-024520.

2.1   Factors Studied

An extensive preliminary literature review was conducted to analyse gaps within previous research and discover common factors affecting women in workplace environments. The researchers then distinguished 12 factors to shape the questionnaire and focus group interviews. These factors were then separated into two groupings;

Company Culture - These are administrative measures which can be implemented by companies to improve career progression of early career engineers. These measures include programmes, policies and philosophies within companies which influence the experience of those working there, and often address known areas of concern. The nine factors within this grouping are:

- Leadership Opportunities
- Mentors
- Role Models
- Technical Skill Development Opportunities
- Workplace Flexibility
- Parental Leave
- Pay Transparency
- Networking Opportunities
- Professional Development Opportunities

Societal Bias – Where we have grouped workplace experiences which result from person-to-person behaviour rather than company led actions, and have been shown to negatively influence career aspirations, retention of staff within a company or industry, and wellbeing of people. Questionnaire participants were asked to identify how frequently they experience societal bias of 'Gender Stereotyping' and 'Workplace Harassment' in the engineering industry. Career Discontent was also measured, which arguably is intrinsically linked to the 11 other factors studied. Both the questionnaire and focus group interviews were designed to be semi-structured to recognise additional factors influencing the participants' experiences in engineering.

2.2   High-Level LinkedIn Survey

Data mining in LinkedIn was used to collect high-level data on the overall career progression of University of Auckland engineering graduates. Data was collected from the profiles of 300 men and 294 women who completed their undergraduate degrees between 2011 and 2017. This data was used to identify the number of graduates that were currently practicing in the engineering industry, how long graduates remained in the engineering industry before they left (for those who left), and how many graduates obtained any additional tertiary qualifications.

2.3   Questionnaire

An anonymous digital survey was used to collect more detailed information on the experiences of men and women in the engineering field. Using the list of University of Auckland engineering graduates from 2011-2017, 1,379 survey links were sent through LinkedIn. Questions in the survey were divided into four broad sections. The first section focused on general demographic information including gender, age, ethnicity, graduation year, engineering specialisation, current occupation, and job title. The second section focused on the impact and accessibility of factors associated with company culture which have the potential to influence career progression. Questions in this section used a five-point Likert-type scale. The third section focused on experiences with common challenges grouped as Societal Bias including gendered stereotypes, workplace harassment and career discontent. The final section allowed participants to include additional comments regarding any other factors that may have impacted their career progression and other resources and initiatives which could be made available within the industry.

Of the 1379 surveys sent, 271 questionnaires were completed (137 women and 134 men), corresponding to a response rate of 19.6%.

2.4   Focus Group Interviews

Both men and women were targeted for data collection in the LinkedIn data mining and survey to allow for evaluation of any gender specific perceptions of the gender disparity in engineering. However, only women were invited to participate in the focus group discussions to enable open discussion and a more comfortable environment for women respondents given the research objective of identifying factors affecting the retention of women in engineering.

Of the 27 companies approached to conduct focus groups, six companies participated, with a total of 18 women. Due to restrictions associated with COVID-19, the focus groups were conducted primarily online. The deliberate semi-structured nature of the focus group interviews was to create an open discussion about the participants' experiences in the engineering industry. This allowed for additional issues to emerge. The questions asked were open-ended and did not mention the factors investigated in the literature review to limit potential bias.

The preliminary questions used to start the discussions included: (1) Have you experienced any gendered related barriers in the workplace? (2) What initiatives, programmes or company structure have helped you with your career progression? (3) Do you think that any more initiatives in the workplace will be helpful for career progression? (4) Are there any colleagues or friends that you know who have left engineering or have experienced any gendered related barriers?

3   RESEARCH FINDINGS AND DISCUSSION

3.1   Attrition

Through the high-level data collection, it was found that 18% of women who studied engineering left the industry within nine years of their graduation, compared to 11% of men and among both men and women a considerable proportion of those who left the industry did so within the first year (41% of women and 32% of men). Of those who left engineering, 74% of women and 64% of men had another tertiary qualification, and 49% of women and 45% of men left within one year of graduation. This indicates the existence of the "leaky pipeline", even only a short time following graduation. There are similar proportions of women and men who have studied an engineering (or a related science) postgraduate qualification, 20% of women and 17% of men, suggesting that women may not see postgraduate engineering qualifications as a way of differentiating themselves from men.

3.2   Company Culture

Within the company culture grouping of factors, participants to the anonymous survey were asked to identify which out of the nine factors (listed in section 2.1) had impacted their career progression, and then for the factors they selected, how has access to these factors impacted their career progression. Their responses are shown in Figure 1.

The highest cited factor as having impacted on career progression was Technical Skill Development Opportunities (75% of women and 73% of men), Role Models was the second highest cited factor for women (68%), however access to Role Models was identified as having a negative impact by 8% of the women respondents. Professional Development Opportunities ranked second for men (69%) as being impactful in their career. Access to Pay Transparency had the highest proportion of respondents stating that it had negatively impacted their career progression for both men and women. The least identified impacting factor was Parental Leave cited by less than 5% of participants. It is likely the low proportion of those impacted by parental leave is due to the participant criteria, excluding those further into their careers who would be more likely to have encountered this.
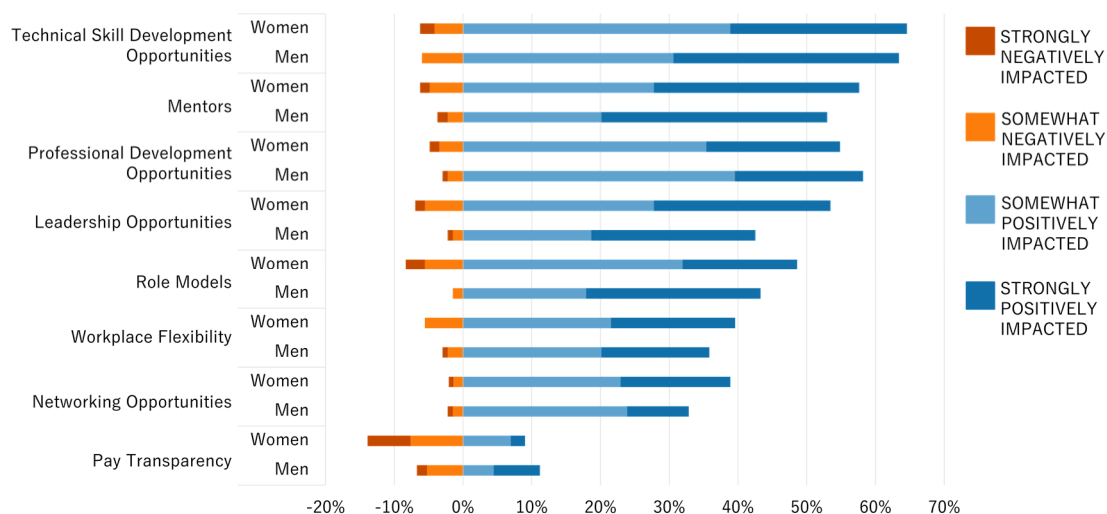

Figure 1 Percentage of respondents identifying which factors as having impacted their career progression and how has access to these factors impacted their career progression

Participants were asked how satisfied they were with their level of accessibility to these factors in their professional engineering career. Across most factors, approximately 15% of participants were dissatisfied with the level of accessibility. The factor which showed the greatest discrepancy between men and women was role models with more than 25% of women dissatisfied with their accessibility.

More detailed analysis and discussion on the results from the Company Culture part of the questionnaire can be found in pervious publications (Davidson et al. 2021). The balance of this paper will focus on the Societal Bias factors investigated.
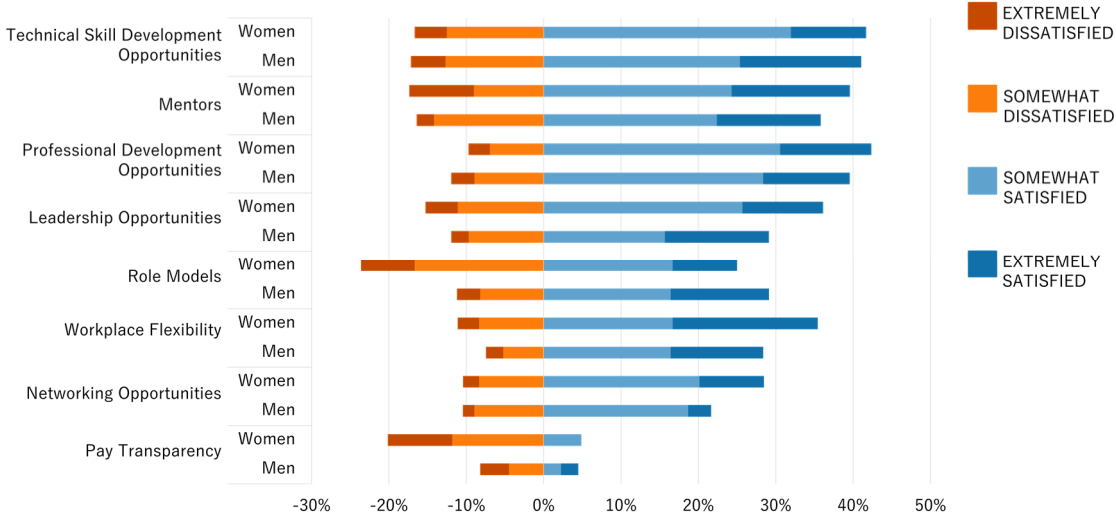

Figure 2 Percentage of respondent's satisfaction with the accessibility of stated Company Culture factors

3.3   Societal Bias

Questionnaire participants were asked to identify if they had experienced, and if so, how frequently, Gendered Stereotypes, Workplace Harassment and Career Discontent in the engineering industry. Their responses are shown in Figure 3. This figure shows variation between the experience of men and women in the engineering industry.
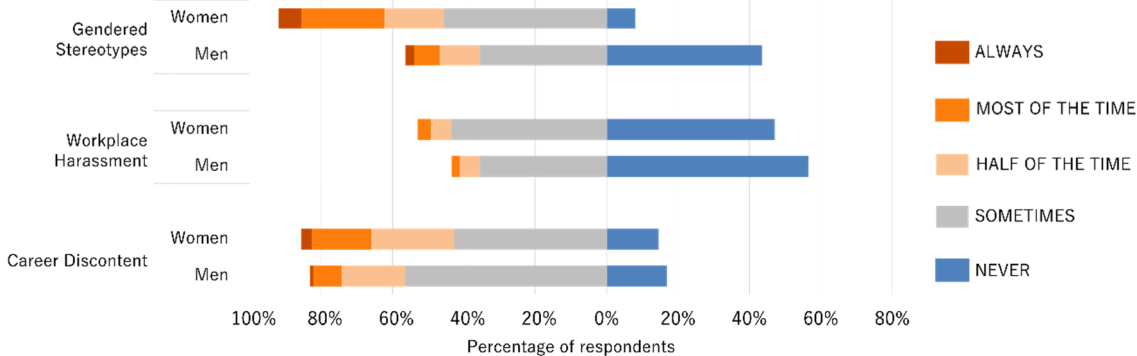

Figure 3 Response of questionnaire respondents to: Have you experienced these challenges in your professional career in the engineering industry?

3.3.1 Gendered Stereotypes

Gender stereotyping was found to be prevalent within the engineering industry evidenced by 92% of women respondents experiencing gender stereotypes 'sometimes' or more frequently, with 46% experiencing them 'about half the time' or more frequently, as shown in Figure 3. Men experienced gender stereotyping much less frequently with 32% of men experiencing these 'sometimes' and a further 24% experiencing stereotyping half the time or more. Within the focus groups, comments about gender stereotypes suggest women experience these in a range of different ways, including unconscious bias.

> *"Underlying culture of prejudice, not malicious, but foundation of how people see the world. Difficult to bring up because you can't blame someone when they don't know that they are discriminating against you." [Woman in focus group]*

Women felt these stereotypes contribute to their feelings of being out of place in the engineering industry, as they do not fit the mould of what an engineer should look like.

> *"In the industry, there is a view of what an engineer should be and should look like, historically it was just guys, some managers have a rigid idea of what an engineer should look like, women don't fit this mould, so can be hard to see a pathway for myself in engineering as people do not expect an engineer to look like me." [Woman in focus group]*

> *"Personal beliefs of worthiness as a female adopted from cultural/social conditioning." [Woman in anonymous survey]*

> *"In our lifetime I don't think we'll get to the point where it's completely, you know, without bias. And until then, we do sort of need the skills which can help all of us." [Woman in focus group]*

> *"I have struggled at multiple times during my career due to gender bias, and it very nearly made me want to give up. Reaching out and asking for mentorship outside of my company is what helped me get back my confidence." [Woman during anonymous survey]*

Gendered stereotypes have been shown across many studies to have significant negative consequences on women's professional aspirations. Often talked about is the process of socialisation through which the accumulation of gender-stereotype knowledge influences women's interest in, and perception of different activities. We see this right from early childhood with implicit and explicit messages about what toys and behaviours, roles and responsibilities are appropriate for their gender. The Eccles (1987) model of expectancy-value has been used in many studies to show that gender socialisation leads girls to devalue maths and scientific fields more than it does boys (Crombie et al. 2005). This devaluing and pulling away from maths and science pointed to as reasoning to why we have a gender imbalance in engineering fields.   Beyond this early gender socialisation, we have men in high-ranking positions suggesting that the underrepresentation of women in science and engineering might be due to inherent sex differences in cognitive ability (2005 address by president of Harvard University). Even for the women who push through all the socialisation gender stereotypes and enter into a male-dominant career, a second phase of 'stereotype threat' appears – encompassing the uncomfortable experience of being in a situation in which you might experience stereotypical judgement.

Women in this study have outlined they felt required to change their personality to be perceived as self-confident and "be able to survive" in engineering:

> *"You have to have thick skin. You have to go on with their stereotypes, and you have to be able to talk back to them when they make insulting jokes….That's the part of engineering that I hate." [Woman in focus group]*

Some women state that it was their biggest obstacle within the industry; for some, they wanted to give up.

> *"Self-confidence and trust in myself, likely influenced by societal views of young women, have been the biggest hurdles for me to overcome, and I am still working on taking ownership and addressing them."* [Woman in focus group]

The frequency of gendered stereotypes makes it challenging for women to fit the mould of a "typical" engineer. Feelings of discontent can arise as they are not able to bring their full selves to work. This resonates with the "I look like an engineer" movement, started by Isis Anchalee, where women are using online presence to bring awareness to gendered stereotyping. This is helping the global engineering industry redefine 'what engineers should look like' and break stereotypical beliefs (Anchalee 2015).

Building the confidence that many women have cited is how women cope with being the minority in this industry. Future industry progression should allow women to be comfortable in their own skin. Empowerment of women and all diversity within the industry, through role models and mentors, can give people the confidence to progress their career and be confident in their abilities.

3.4   Harassment:

Substantial proportions of the anonymous survey respondents reported the frequent occurrence of workplace harassment, with 44% of men and 53% of women experiencing it 'sometimes' or more frequently, as shown in Figure 3. However, due to the limited scope of questions in the survey, the nature of the harassment cannot be reported on here. Within the focus groups, multiple women cited having not experienced workplace harassment, before describing instances of harassment which had negatively affected their work and personal lives. Other respondents in the focus groups expressed the inevitability of harassment in the workplace as something to be expected in the engineering industry.

The 'Experiences of Workplace Bullying and Harassment in Aotearoa' report, released by the Human Rights Commission (HRC) in 2022, found that sexual harassment, racial abuse and bullying are widespread in New Zealand workplaces. The report's findings aligned with our questionnaire results, concluding that in the past five years, 30% of workers experienced sexual harassment and 39% experienced racial harassment, In the past 12 months, 20% experienced bullying behaviour frequently.

A concerning finding from the focus groups was that women often do not recognise negative experiences they encounter as barriers to their career progression in the workplace. When asked the question, "Have you experienced any gendered related barriers in the workplace?", often women would not mention any, then later state significant challenges experienced which would be considered gendered barriers. Comments from participants:

> *"I did obviously get the whole sexual harassment and everything. That's what slowed down my career progression, so that's annoying ... and now I'm changing teams because of one incident."* [Woman in focus group]

> *"...contractors...they would have posters of naked females. It's kind of like become this almost normalised thing...."* *"She went to site, and they were actually taking a photo of her face and sticking it on one of those posters."* [Woman in focus group]

Women reported seeing these gendered experiences as inevitable, which creates a cycle where they are normalised within the industry. Participants made statements such as "it is just

something I have to deal with" and "guys will be guys". This effort to normalise or justify behaviour speaks to the discriminatory culture of the industry which influences the treatment of women and their identity. The dismissal of gendered barriers may lead to women not confronting these issues, contributing to their ongoing persistence.

Negative behaviour, such as unconscious bias, from senior women to other women was observed in the qualitative data. This could contribute to a greater degree of normalisation of discrimination within the industry and the inevitability of the negative environment. Some participants raised this:

> *"A lot of women actually ... put down other woman. I thought, what would cause it and that would be inherent insecurity." [Woman in focus group]*

> *"The biggest barrier to women is ourselves, but half the time we are unconsciously bias against ourselves we just don't know it." [Woman in focus group]*

Some focus group participants mentioned their reluctance to deal with confrontation within engineering. Multiple women said within the qualitative data that they are hesitant to confront others who may have made them uncomfortable:

> *"Just the confrontation is quite daunting, but, you know, as a female, he could have reacted in two different ways." [Woman in focus group]*

Participants raised their uncertainty of how their colleagues will react and perceive them if their unfair comments are called out. Women want to know whether their colleagues are open to them calling out on their potential unconscious bias without creating unnecessary conflict.

Women in the focus groups noted finding the current systems for dealing with instances of discrimination or harassment inadequate. Multiple instances arose where women mentioned pulling their complaints from human resources. Some felt human resources were not on their side, were not handled in the way they would have liked, or the process was too long:

> *[when talking about HR] "First, when I talked to one lady, she was so empathetic. I didn't want to go on with her because she was not on my side what-so-ever…. But then I decided not to make it formal…I didn't want to go through with it because I have so much on my plate right now." "It ended up getting built up into an HR level and blowing up…. You become very aware of the situation and how people perceive of you within the company." [Woman in focus group]*

This hesitation in approaching human resources has resulted in some women ignoring instances of discrimination, contributing to the sense of inevitability.

Again these findings align with the Human Rights Commission Report where they found just 24% of workers who experience harassment or bullying raise a formal complaint. Dissatisfaction with the outcome of the formal complaint is high (43%), and even higher when the impact of the harassment is large or extreme (59%) (Human Rights Commission 2022).

To better deal with these problems, greater promotion of interpersonal skill development is recommended. It would be beneficial for those in the industry to be made aware of their unconscious bias. Learning skills to better deal with confrontation and communication in the workplace would also prove beneficial for women, so they feel comfortable approaching their colleagues when inappropriate comments are being made.

3.5   Career Discontent

A significant level of career discontent was expressed by both men and women who responded to the anonymous survey, with 84% of engineers within the early stages of their career

expressing some level of dissatisfaction with their career (shown in Figure 3). Women experience career discontent at a significantly higher rate than men; 43% of women reported experiencing career discontent 50% of the time' or more frequently, compared to approximately 27% of men who reported experiencing it with the same frequency. Within multiple focus groups, respondents cited themselves or their colleagues leaving the engineering industry due to career discontent.

The HRC (2022) survey found workplace harassment and bullying causes many workers to feel disrespected (60%), uncomfortable (57%), angry (47%), frustrated (45%) and anxious (44%).

With high levels of gender stereotyping and workplace harassment coupled with concerns over accessibility to career progression, lack of accessibility to mentoring and role models, concerns with pay transparency including a publicly reported gender pay gap, the high levels of career discontent within early career engineers are not surprising.

4   CONCLUSION

The presence of gender disparity in the engineering industry in New Zealand is ongoing, with many approaches currently being used to address this problem. A combination of quantitative and qualitative data has been used to assess engineers' career progression and their experiences in the early stages of their careers. The prominence of gender stereotypes in the engineering industry is a significant challenge. Their prevalence contributes negatively to the career progression of women across all disciplines of engineering in New Zealand. Women continue to feel out of place in the industry and can feel a need to change their personality to fit in, or become accustomed to uncomfortable experiences in the workplace, seeing these as inevitable. These challenges require a cultural shift within the industry to overcome. Mentors and role models have been vital in overcoming the barriers women face to their career progression. Having mentors to encourage and support women throughout the early stages of their career has prevented a number of women from leaving the industry. The presence of women in leadership roles also acts as inspiration for those progressing in the industry, showing what could be possible for them in the future.

Addressing gender disparity in the engineering industry in New Zealand and supporting women in their career progression will require contributions from those working at all levels of the industry. Programmatic factors can be utilised to improve the careers of all those working in the industry, and increased awareness of those that affect women is key. Cultural challenges will require ongoing work to overcome, particularly entrenched stereotypes and bias.

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