UNDERSTANDING THE EXPERIENCES OF FEMALE CAREER ADVANCEMENT IN ENGINEERING.

By

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DECLARATION

I declare that "*Understanding the experiences of female career advancement in engineering*" is my own work, that it has not been submitted before any degree or examination at any other university, and that all the sources I have used/quoted have, to the best of my knowledge been indicated and acknowledged as completed references.

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ABSTRACT

Engineering is a lucrative profession, contributing to the technological and economic development of nations; however, women still constitute a small percentage compared to their male counterparts in academia and industry. They continue to encounter unique challenges, hindering their career advancement. The research aimed to understand women's experiences working in the engineering sector. It aspired to identify challenges and barriers encountered, determining how women overcome these barriers and what initiatives enable them to continue their career paths. Several women who choose engineering as a profession soon depart the industry and change to a more gender-balanced or female-dominated career path. Thus, understanding women's experiences may, therefore, facilitate the reason for this occurrence while gaining insight into women who continue to pursue engineering despite the barriers. The research was conducted using a qualitative study, and, therefore, the thematic approach was employed to analyse the data. A non-probability sampling design was used based on a purposive sampling method. Ten participants—women employed in the engineering industry, were selected to participate in the study. For data collection, semi-structured interviews were conducted with each participant. The findings may guide engineering organisations in Cape Town to improve their policies and practices around gender equity. It may provide innovative strategies for attracting, retaining, and integrating more women in the engineering sector.

KEYWORDS

Gender equity

Career advancement

Male dominant

Underrepresentation

Engineering

DEDICATION

This thesis is dedicated to my grandmother, Gloria May Jean, with whom I would have loved to share and celebrate this milestone. Thank you for being my guardian angel.

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First, I would like to thank my heavenly father whom I place my faith and who has made it possible for me to complete my master's degree. I thank God for blessing me and giving me the courage, perseverance, and strength to complete this chapter of my life. His word that has carried me through this journey is "For I know the plans I have for you, declares the Lord, plans to prosper you and not to harm you, plans to give you a hope and future" – ***Jeremiah 29:11.***

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ASGISA	Accelerated and Shared Growth Initiative for South Africa
ECSA	Engineering Council of South Africa
IPA	Interpretive phenomenological approach
JIPSA	Joint Initiative on Priority Skills Acquisition
NGO	non-governmental organisation
STEM	Science, technology, engineering, and mathematics
WiE	Women in engineering

CHAPTER 1: INTRODUCTION

1.1 Introduction

This section provides information on the background and rationale of the study. It presents the research question and objectives. Moreover, it discusses the delineation and limitations of the study. Furthermore, it provides key terms and an overview of all the chapters.

1.2 Background

South Africa has one of the most progressive Constitutions globally (Kehler, 2001). Legal reform guides the Constitution and legislative frameworks to prevent discrimination and regulate gender equality (Bendeman & Dworzanowski-Venter, 2014). Section 9 of the South African Constitution encourages and promotes gender equality as a right, applying to women in all sectors (Bendeman & Dworzanowski-Venter, 2014). These legislative instruments were passed to rectify and eradicate discrimination against women (Grobler, Warnich, Carrell, Elbert & Hatfield, 2011):

- The *Labour Relations Act 1995* (LRA)
- The *Basic Conditions of Employment Act 1997* (BCEA)
- The *Employment Equity Act No. 55 of 1998*
- The *Promotion of Equality and Prevention of Unfair Discrimination Act No. 4 of 2000*
- The National Policy Framework for Women's Empowerment and Gender Equality (2000)
- The *Broad-Based Black Economic Empowerment Act No 53. of 2003*

The above laws were implemented to help women in their careers and provide them with opportunities in the workplace. However, despite strides in the right direction, a major contradiction is perceived; 21st-century societies still struggle to effectively implement structures and policies in the workplace, that support women and their career advancement. Several women are still underrepresented in traditionally male-dominated occupations and sectors (Masters & Meltzoff, 2017). This struggle is no different to the engineering sector, and although it is a lucrative profession, engineering is still considered a male-dominated sector (Masters & Meltzoff, 2017). The challenges women encounter to persevere in historically male-dominated industries and work environments display traditional gender hierarchies and societal gender-role expectations (Martin & Barnard, 2013). Traditional stereotypes about men

and women are pervasive in the workplace concerning policies and practices, resulting in marginalised work roles for women (Martin & Barnard, 2013). Furthermore, policy development in organisations were dominated by men (Acker, 2012), neglecting women's career patterns while impeding their need for work-life balance.

Du Plessis and Barkhuizen (2015) mention that women are attracted to engineering, but once they enter the sector, they are deterred from the practical and technical work that engineering encompasses. Women are subtly being driven towards managerial positions or other categories in engineering (Du Plessis & Barkhuizen, 2015). Subtle stressors relating to work efforts being less valued or tasks assigned to women being gendered directly influence gender divergence (Cardador & Caza, 2018). A lower attachment to the workforce cause women to find occupations that can adjust easily and quickly to entry and exit (Bendeman & Dworzanowski-Venter, 2014).

Dobson and Gurr (2021) mention the "leaky pipeline" used to describe the decline of WiE, indicating that more women are entering the pipeline; however, they are not flowing into careers in STEM due to "leaks" (unsupportive work environments, a lack of mentoring, training, and development) which result in them leaving the sector. Wilson and VanAntwerp (2021) emphasise a prevalent impediment women experience in the workplace, remarking that women encounter an invisible paradox barrier. Contrastingly, they are recognised for being WiE; however, their status as engineers is often challenged and invisible (Wilson & VanAntwerp, 2021). The cycle continues while creating a paradoxical state for women where they make progress but are still underrepresented and disregarded by policies and organisations (Yates & Skinner, 2021). This situation can be problematic and a detriment to the industry and country, therefore, concurring the need for further research and encouraging more women to pursue engineering.

Engineering forms part of the STEM (science, technology, engineering, and mathematics) fields and draws on each discipline, contributing to the technological and economic development of nations (Hill et al., 2010). With globalisation rising, technology and scientific innovation are vital for economic development and competitiveness (Martin & Barnard, 2013). Hence, it is important for the retention and encouragement of young girls and women to enter engineering fields (Hill et al., 2010). Several factors influence career development for women. Career barriers affect the flow of the career development process. Career barriers were theorised to influence career development by limiting career opportunities and inhibiting career

aspirations (Creed, Patton, & Bartrum, 2004). Career barriers can be distinguished between internal and external barriers. These barriers are further discussed in Chapter 2. Underlying problems indicate career barriers imbedded in organisations through invisible or implicit bias (Yates & Skinner, 2021).

Despite attempts, such as the labour law, and affirmative action from the South African Government, to eradicate discrimination and workplace inequalities, challenges persist in the engineering fields. More effort and initiatives may need to be created in society and in organisations to allow women a platform where they are valued, and their career advancement is supported. The study, therefore, attempted to understand why women are underrepresented in engineering and the challenges they encounter to persevere in their engineering careers.

1.3 Problem statement

Historically, engineering reveals a marginalisation of women due to male-dominance, women being out-numbered, and gender segregation experienced in the industry (Dasgupta & Stout, 2014). While many women in South Africa pursue engineering programmes in the industry, they still form a small percentage of the engineering students enrolling in engineering programmes (Martin & Barnard, 2013).

Figure 1.1

Professional Registration Statistics by Gender and Category

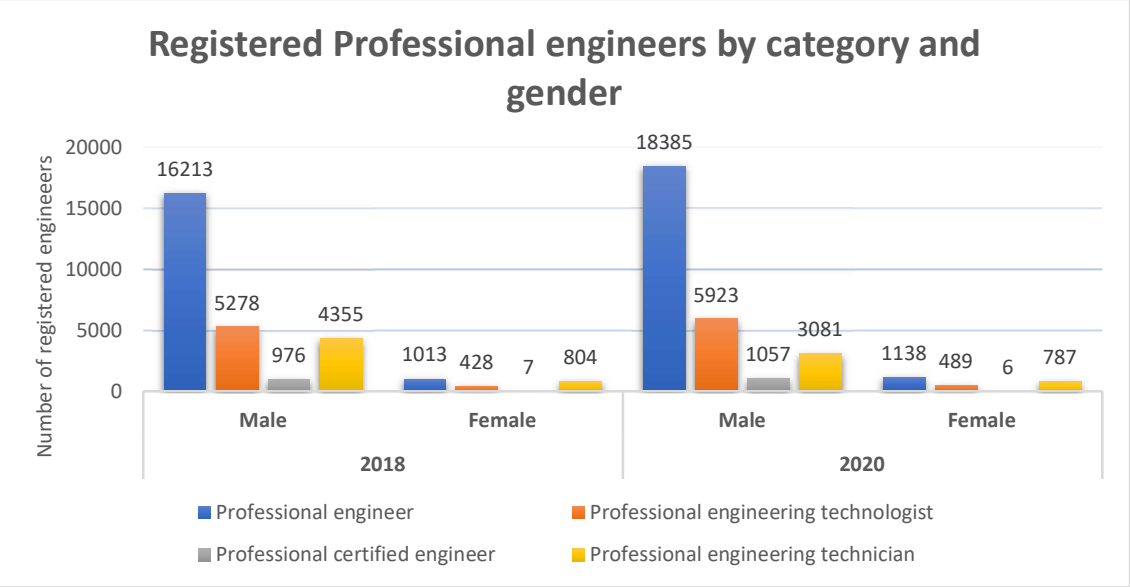

Figure 1.1 is adapted from the Engineering Council of South Africa Annual Report (2018) and the Engineering Council of South Africa Annual Report (2020).

Figure 1.1 illustrates the number of registered professional engineers by category and gender in South Africa. As depicted in Figure 1.1, men represent the bulk of registered engineers, whereas women only represent a slight portion. This aspect indicates that women have made strides in the right direction; however, they are still underrepresented compared to their male counterparts, as an insignificant portion succeed and register as professional engineers (Wilson & VanAntwerp, 2021).

A comparison can be made from the statistics collected from 2018 to 2020. It reveals an increase in registered male and female professional engineers—from 1013 registered in 2018 to 1138 registered in 2020 demonstrating an increase of 11.8% for men and 12.34% for women. Registered female engineer totals increased more than that of men. An increase in the number of registered professional engineering technologists can be identified, from 428 registered in 2018 to 489 registered in 2020, illustrating a 14.25% increase in registered female engineering technologists. A decline can be observed in the number of registered female professional certificated engineers and professional engineering technicians. Despite the increase, the statistics unveil an important message and the need for the participation and encouragement of women to pursue engineering.

The divergence between registered male engineers to female engineers is considerably high. According to the Engineering Council of South Africa (ECSA) (2013), only 11% of the total engineers registered with the council were women, and only 4% were professional engineers. Statistics collected from ECSA indicated that 70% of women who graduated with engineering degrees deserted the sector as they felt isolated in their jobs (Engineering Council of South Africa annual report, 2013).

Unsuccessful efforts to retain women in engineering (WiE) can be associated with the lack of career counselling, awareness, discouragement, gender stereotyping, and gender-role expectations, hindering young girls' and women's advancement in their engineering careers. These adverse circumstances lead to more barriers women must encounter in their careers, such as unsupportive environments, a lack of interest in engineering, and low self-confidence in their abilities and skills (Masters & Meltzoff, 2017).

The effect of these barriers to career trajectories causes personal and social consequences that women encounter; therefore, this poses unique challenges for women who pursue traditionally

male-dominated careers. Their careers are stalled due to work and organisational conditions that cause barriers to their progression (Acker, 2012). According to Acker (2012), women encounter more hindrances in their career paths than their male counterparts, and this indicates that work and organisations are not experienced in the same way by men and women, illustrating that the working environment is not gender neutral.

This research is, therefore, designed to examine what challenges women encounter, identifying why they are still underrepresented in this industry and how it influences women's career choices and advancement in engineering. This study discusses women's experiences during their career development, hindering their advancement in this industry.

1.4 Research question and objectives

Against this background, the study aims to discuss the subsequent research question and objectives:

1.4.1 Question

- What barriers/challenges are experienced by professional female engineers, and how do they overcome these to progress in their careers?

1.4.2 Objectives

- To explore the barriers experienced by professional female engineers in the engineering sector and their perceived association with their career advancement in Cape Town, South Africa.
- To explore female engineers' experiences of coping strategies or techniques employed to remain motivated and persevere in engineering.

1.5 Delineation

The study was conducted in Cape Town, South Africa. Current research focuses on the broad STEM disciplines or the engineering sector; however, this research aimed to specifically explore women's experiences in engineering in Cape Town. This situation is attributable to the accessibility and convenience of participants. South Africa has limited literature on women's experiences in engineering. There are insufficient articles that highlight the number of female engineers in the various provinces and how their experiences might be different. This position

may allow future research to explore women's experiences from various cities in South Africa while comparing results among the provinces. It focused on professional female engineers.

The specific sample was selected to ensure that the rich data was collected from women who experienced a male-dominated work environment. The study should concur with previous research and identify ways to improve the current policies and procedures. The engineering sector is considered a male-dominated environment; therefore, men have different experiences than women, who are usually minorities, in the sector. The research was analysed from women's experience and perception of occurrences in the engineering sector. The women selected could clarify workplace practices and divergences. The research, therefore, focused on women's experiences in engineering, discussing barriers and challenges they encounter, how they have overcome them, why they have stayed or left the engineering sector, and what initiatives can attract more women to engineering.

1.6 Limitations of study

For this study a qualitative approach was utilised thus, impacting biases, such as participant bias and researcher bias. The study was limited to professional women engineers; hence a bias is indicated as men were not interviewed. Furthermore, the sample group consisted of 10 participants; thus, it cannot be determined how well they represent the women engineering population. Hence, a larger sample size should be considered to ensure credibility of the research.

1.7 Key terms

1.7.1 Career advancement

Career advancement concerns the upward progression of an individual's career, inside and outside the organisation (Schreuder & Coetzee, 2016).

1.7.2 Engineering sector/industry

For this study, the engineering sector refers to the broad engineering industry and all its diverse engineering fields.

1.7.3 Gender equity

Gender equity can be described as the fair treatment of men and women according to their respective needs. It advances equal treatment concerning benefits, rights, obligations, and opportunities (Ganley et al., 2018).

1.7.4 Male dominant

This term refers to hetero-normative standards or the traditional position of men in society. This term links competitiveness, power, masculinity, and breadwinners (Martin & Barnard, 2013).

1.7.5 Management roles

For this study, management roles refer to leadership, managerial or senior roles in engineering, which exclude the practical and technical application of engineering.

1.8 Overview of chapters

Chapter **1** provided an overview and framework of the study. It presented the rationale, problem statement, and study aim.

0 conferred empirical evidence and the theoretical framework to support the research. The literature discussed and examined topics influencing WiE and career advancement. Topics, such as gender equity, factors influencing women's initial decision to pursue engineering, barriers/challenges that women encounter, and initiatives created to retain and attract more WiE are discussed.

0 provided the research methodology used in the study. It identified the population and sample size and the data collection methods and procedures used to obtain responses from participants. It described the data analysis process and the ethical considerations influencing the trustworthiness and credibility of the research.

Chapter 4 provided the evidence and findings obtained from the thematic analysis of the data. It further established and examined the understanding of women's experiences in engineering sectors in Cape Town.

Chapter 5 described the findings in greater detail. The study's limitations and the implications of future research on this topic are discussed. The chapter also attempted to explain the findings by correlating them to literature and how that influences WiE in Cape Town.

1.9 Conclusion

Chapter 1 discusses the problem statement of understanding women's experiences in engineering in Cape Town, South Africa. The underrepresentation, the need for more research, and the attraction and retention of women to engineering are supported and demonstrated with statistics. While the statistics indicate an increase in registered female engineers in South Africa, the total lags far behind compared to their male counterparts.

To mitigate and approach the problem, the South African Government implemented laws to create more opportunities for women. This enactment has yet to solve the underrepresentation of WiE. Sources indicate that it is unclear if the needs of women are adequately met in organisational policies and procedures. The significance of the study and research objectives are proposed. To conclude, crucial definitions are identified and emphasised, and an overview of each chapter is provided.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This section reviews and provides literature on the career advancement of women engineers. The theoretical framework relating to career development and career barriers are presented to guide and support this study. Literature focusing on factors influencing women's decisions to pursue engineering is discussed. The chapter emphasises initiatives to improve opportunities for women in this sector. Last, a summary of the chapter is provided.

2.2 Theoretical framework

2.2.1 Career development

Despite legislative frameworks, laws, and affirmative action, passed by the South African Government, many organisational policies and structures have not been implemented effectively in modern workplaces. According to Yates and Skinner (2021), explicit bias towards WiE has significantly decreased over the years; however, implicit bias remains. To understand the notion behind this statement, it is necessary to reflect on the South African legislative framework. Affirmative action has been the policy instrument for the new democratic South Africa to rectify and eradicate imbalances from the past (Bendeman & Dworzanowski-Venter, 2014). In alignment with the *Employment Equity Act No 55 of 1998*, the recipients are disadvantaged groups, which include women (Naidoo & Kongolo, (2004). Affirmative action improved opportunities for all by providing equal rights and equity. Policies and strategies were implemented to eliminate imbalances in the workplace, provide education and allow gender equality (Naidoo & Kongolo, 2004).

The career development of WiE has been impacted by implicit or invisible barriers, limiting their advancement, often entrenched in the workplace structures and policies and gendered organisations (Yates & Skinner, 2021). Although many engineering organisations portray themselves as gender-neutral, there are underlining assumptions about gender or the ideal worker—usually a man. Various organisations may contend that their advancement processes and promotion opportunities for employees are unbiased and explicit; however, due to the perception of an ideal worker, women are less inclined to meet this perceived epitome (Yates & Skinner, 2021).

Acker (2012) emphasises that participation and promotion are gender-neutral in organisations, but processes are not. It is often suited towards the ideal worker and their career development and advancement continuing a bias towards men (Acker, 2012). To understand women's experiences in engineering and their career advancement, career development is discussed to establish its function in an individual's life while providing an understanding of the career development process.

Literature on career development defines it in various ways. Schulz and Enslin (2014) remark that career development concerns training, development opportunities, and applying programmes that employers provide to assist employees with their professional advancement and development. Schreuder and Coetzee (2016) remark that career development is a continuous process concerned with how individuals progress through life and are presented with stages that encompass a fresh set of issues, tasks, and themes. Sears (1982) describes career development as an alignment of educational, psychological, physical, sociological, economic, and other factors collectively affecting an individual's career over their lifespan (Patton & McMahon, 2014).

McDonald and Hite (2005) define career development as developing an individual's skills, abilities, and employability to attain work-related and personal goals. Super (1990) contends that career development concerns the ongoing process of consolidating and evaluating an individual's own internal variables, with abilities, interests, and values, and external variables relating to economic conditions, job markets, and employment practices. These definitions elucidate how WiE may progress through their careers and may identify restrictions that impact the flow of their career development process. These definitions present an uninterrupted flow of career development; however, several career barriers exist for WiE, inhibiting their growth. Career development theories are discussed to understand the career development process further.

2.3 Career development theories

Career development is an essential part of human development and is required to progress through life. It is recognised as an ongoing process enabling individuals to advance, grow and transition through their lifespan (Botha, Kiley & Werner, 2011). Many career development theories have gained considerable attention. However, for this study, theories by Levinson, Gottfredson, and Super are evaluated. These theories share commonalities, theorising development as a lifelong process.

2.3.1 Levinson's approach to life development

Levinson, Darrow, and Klein's (1978) theory originally focused on the structure of an individual's life cycle upon studying men in their mid-adulthood; however, Levinson (1996, cited in Aktu & Ilhan, 2017) contends that women experience similar development cycles, but in partially diverse ways. Levinson's et al. (1978) theory discusses life courses, comprising human development from beginning to end; therefore, it follows a process. The life cycle comprises stages, such as early adulthood transitions—ages (17-22) that discourse an individual leaving their family and home, starting education, and making a career choice. The second stage is entering adulthood—ages (22-28), focusing on committing to the career choice or occupation and developing intimate relationships and goals.

The third stage relates to the age 30 transition, discussing how individuals revaluate their career choices and make modifications to change their work and love life. The fourth stage focuses on settling down—ages (33-40), where individuals become more involved in the community and reinvest their time in family or work commitments. The fifth stage observes the midlife transition—ages (40-45), which includes drastic changes to talents and aspirations and feeling more urgency about life. The sixth stage discusses middle adulthood—ages 45-50, which emphasises commitment to new choices and decisions. The last stage is late adulthood—ages 60 and above, which represents a significant development period and a turning point in the individual's life cycle, creating a suitable and stable life for themselves (Levinson et al., 1978).

2.3.2 Gottfredson's theory of circumscription and compromise

Gottfredson's (1981) theory is similar to Super's theory of self-concept of career development; it converses the reasons for an individual's career choice and its developmental process. This theory emphasises the importance of self-concept and individuals developing their professions from preschool—ages (3-5) orientated towards power and size. Ages (6-8) are characterised by the orientation of gender positions and occupations consistent with an individual's gender-role preference.

Ages (9-13) discourse social variation and class by eliminating occupations lower than an individual's level of prestige. High school—ages (14 and beyond) is characterised by a unique sense of self and eliminating occupations, misaligned and incompatible with their interests and abilities, with various elements contributing to this decision. Elements include socioeconomic background, gender, skills, attitudes, intelligence, and knowledge (Gottfredson, 1981).

Gottfredson (1981) believes that an individual's perception of the world and themselves influences the range of occupational alternatives for themselves.

2.3.3 Super's self-concept theory of career development

Super (1990) conceptualises career development as learning and implementing self-concept, referring to how individuals observe themselves and their situations. Super (1990) developed a career stage theory by providing insight into how individuals experience various stages in their career development and explaining how each stage allows an individual to aspire towards a successful career. These life stages comprise growth—ages (4-13), focusing on developing ideas about self-worth, discovering personal abilities, interests, talents, and physical growth. Exploration—ages (14-24) discourses developing an individual's skills and learning about various career options while selecting or making a career choice. Establishment—ages (25-44) addresses when an individual acquires experience and experience in their chosen career choice. Maintenance—ages (45-65) discourse the maintenance of leaving a career and ongoing development/adjustment to improve the individual's position. Disengagement —ages (65 years and over), concerns the gradual withdrawal from the working world and preparing for retirement (Schreuder & Coetzee, 2011).

Super (1957) identified the first theory to acknowledge the homemaking role to depict the relationship between work and family. Super (1980), therefore, introduced life space and various roles influencing this, such as family, work, and leisure roles. Additionally, Super (1980) identified that career development stages were less accommodating for women, due to the influence of childbearing and marriage (Stead & Watson, 2017). Early career development theories, such as Super's (1990), can be interpreted as concise and uncomplicated; however, it only focuses on how individuals and their characteristics influence their career choices and how they perform in their chosen careers. Essentially, the emphasis is on intrinsic value, illustrating that people should find their work rewarding and gain satisfaction because they should choose careers accommodating their interests, skills, passions, and abilities. It disregards cultural and environmental influences on career development.

Early theories on career development are uncomplicated; however, 21st-century organisations have become highly diverse since the origin of this theory. Mavin (2001) contends that research on career development and early theories are based on a man's life course as a framework. Particularly white and educated men who can build cumulative career success by climbing up

the hierarchy. Current research on career development is outdated and limited in the conceptualisation of women at work (Mavin, 2001).

Acker (2012) remarks that, concerning career development and lifestyle stages, men and women have various work experiences. Astin (1984) indicates that work motivation is the same for both men and women; however, due to early socialisation and structural opportunities for women, their choices are ultimately different. Women, therefore, have a wider range of roles and responsibilities than men; this creates a wider range of career forms and lifestyle choices (Schreuder & Coetzee, 2016). Women are, therefore, more inclined to make career transitions for their families than their male counterparts. Research indicates that men and women experience similar stages of stability and transition; however, women have "split dreams" compared to men, focusing on "the dream" (Schreuder & Coetzee, 2016). For women, "split dreams" refer to women who enter a period where they encounter a delicate balancing act between motherhood and pursuing their careers (Schreuder & Coetzee, 2016).

This situation may stem from childhood socialisation, causing women to maintain societal norms or traditional family roles (Orr, 2011). Schreuder and Coetzee (2011) emphasise that some women fear career success because they believe it might lead to isolation. Those who pursue their careers in their twenties may have children at a later stage when they feel the pressure of their biological clocks. Although men and women share ideals about their careers and family life, women are often positioned in a predicament concerning biological timelines and societal norms (Schreuder & Coetzee, 2011).

Concurring, Mavin's (2001) notion about traditional models of career development that is based on the experiences of men, indicates a lack of women's experiences in existing models, therefore, affecting organisations and how they operate and approach career development for women. Through their career development process and stages, women experience various career barriers, discussed further. Thus, career barriers and their implications on career development for women must be understood.

2.4 Career barriers

A metaphor used to describe the decline in the retention and underrepresentation of WiE is a "shrinking pipeline" (Masters & Meltzoff, 2017). To understand the notion behind this statement a greater understanding of the career barriers women experience in engineering is discussed.

Early theorists, such as Crites (1969), describe career barriers as components that prevent the achievement of career goals. Career barriers were seen as an internal conflict, therefore, relating to an individual's lack of motivation and confidence; from an external perspective, it relates to poverty, a lack of education, or discrimination (Crites, 1969). Career development barriers predicted by O'Leary (1974) indicated six internal barriers and four external barriers influencing women's career development (Creed et al., 2004).

Creed et al. (2004) proposed emotional and cognitive aspects, such as hardiness, resilience, and coping, that play an intricate part in career barriers. Farmer (1976) identified six internal barriers that women experience, such as a reduction in academic self-confidence, fear of success, work discrimination, gender-role orientation, achievement motivation, and home-career conflict. External barriers include work discrimination and societal norm expectations (Farmer, 1976). Swanson and Tokar (1991) contend that career barriers can be divided into three categories, such as interpersonal/social, attitudinal, and interactional barriers (Lent et al., 2000). According to Lee et al. (2008), few researchers have adopted Swanson and Tokar's (1991) three-category career barriers approach. The model presented barriers that overlapped; however, it has since been revised, therefore, dissecting distinct career barriers.

Through the career barrier theories, it can be observed that several barriers influence people and their career development. Conversely, there is no agreement on classifying these barriers; previous empirical research alludes to a distinction between internal and external barriers (Urbanaviciute et al., 2016). Internal barriers can be described as person-focused, discoursing factors, such as motivation, interest in pursuing a career, and perceived lack of ability. External barriers relate to environment-focused factors, such as family demands, financial problems, and employment restrictions (Urbanaviciute et al., 2016).

Based on the aforementioned theories, an interpretation of the underrepresentation of WiE is discussed. Factors, such as career barriers, are divided into internal and external barriers.

2.4.1 Internal barriers

2.4.1.1 Perception about skills and ability

Self-efficacy is used to understand the success of WiE to explain women's beliefs about their skills and abilities, (Mamaril & Royal, 2008). A considerable influence of WiE is a lack of self-confidence in their intellectual abilities. This lack leads to isolation and a minority status in this industry (Mamaril & Royal, 2008). Botha et al. (2011) describe self-efficacy as an individual's

opinion of their ability to complete tasks in various situations. Individuals with high self-efficacy beliefs are seen to have the skills and abilities, are resourceful and can complete tasks using what is around them, can overcome hindrances that interfere with their goals and can provide effort and energy into completing their goals (Botha et al., 2011).

According to Schreuder and Coetzee (2011), self-efficacy is the understanding of individuals' capabilities that mobilise their course of action, cognitive processes and motivation required to meet organisational demands. Self-efficacy is the belief that individuals can affect and control an environment to produce the desired outcome or execute tasks (Schreuder & Coetzee, 2011).

Hackett and Betz (1981) hypothesised that men and women vary regarding self-efficacy expectations. Internal barriers for women are higher as they tend to have lower self-efficacy expectations because of their socialisation experiences. This variation influences their career choices and options (Schreuder & Coetzee, 2011). Martin and Barnard (2013) contend that women are inhibited from reaching their full potential because of their psychological barriers and gender-role expectations; therefore, this includes stereotypical conclusions and questions about their competencies, causing low self-confidence and self-efficacy (Martin & Barnard, 2013).

According to Hill et al. (2010), gender-role expectations and gender stereotypes may contribute to a lack of self- efficacy that WiE experience. Hill et al. (2010) indicate that significant factors, such as the influence of parents, teachers, and mentors, which convince women against entering male-dominated occupations, such as engineering, contribute to a lack of self-efficacy. This may drive women away from engineering fields as the narrative about competencies and abilities is often inaccurate. Self-efficacy is, therefore, an important predictor of a woman's choice when pursuing a career in engineering (Du Plessis & Barkhuizen, 2015).

2.4.2 External barriers

2.4.2.1 Support from others

Congruent to the research presented by Hill et al. (2010), Masters and Meltzoff (2017) contend that career paths should be a free choice; however, women experience social barriers to entering STEM fields. They are affected by the attitudes of parents, teachers, and others, perceiving that these fields are best suited for men. Cardoso and Marques (2008) indicate that barriers influencing women's advancement can relate to career constraints and family stressors. Family

constraints depend on how much women participate in marital, parental, and home roles and the support they receive from others or a spouse (Cardoso & Marques, 2008).

Buchter et al. (2017) remark that families play a vital part in expanding and building on children's learning in STEM. Encouraging and engaging in topics about STEM helps further their interest and understanding of STEM subjects. Empirical evidence supported by Farmer, Anderson, and Brock (1991, cited in Ericksen & Schultheiss, 2009) illustrates the importance of support in the career development of women. It was established that women were more responsive to support from significant individuals or others than men in career planning. Encouragement and social support may differentiate between women who pursue non-traditional occupations and those who decide not to (Ericksen & Schultheiss, 2009).

Dasgupta and Stout (2014) propose various developmental periods in an individual's life, presenting various challenges and obstacles. These development periods describe the learning environment and influence of parents, family characteristics, and peers contributing to gender differences in STEM fields. Dasgupta and Stout (2014) mention that peers play a vital role in influencing women's decisions to pursue careers in STEM fields. Peers are seen as models of behaviour and reinforcers of action (Dasgupta & Stout, 2014).

Stead and Watson (2017) express that women experience more barriers than men as gender divergences constrain educational achievement and career decisions. The perception of parents, peers, and society also plays a factor in career barriers. Dasgupta and Stout (2014) emphasise the importance of social psychological research, explaining the fundamental importance and value of having a sense of belonging and being accepted. When women want to enter STEM fields, they often doubt belonging, causing them to question their skills and abilities, even if their aspirations are comparable with STEM fields.

2.4.2.2 Discrimination

Despite progress over the last few years, Grobler et al. (2011) contest that gender discrimination prevails, indicating a "glass ceiling" for women who aspire to progress in their careers. Similarly, Weisenfeld and Robinson-Backmon (2007) indicate that gender discrimination in the labour market is seen as the "glass ceiling" effect, representing job inequalities undefined by the job characteristics. In essence, minority groups are denied the same desirable opportunities, including networking, mentors, career advancement, and support; therefore, several women depart this working environment as they feel they are being treated unfairly (Lim et al., 2015). Botha et al. (2011) contend that gender discrimination

remains, despite the formulation of legislative frameworks. Furthermore, empirical research on women in their careers is compared and studied against studies formulated in the sphere of male workers (Botha et al., 2011). These conclusions are often inaccurate, as it does not facilitate the needs and wants of women at work (Stead & Watson, 2017).

Martin and Barnard (2013) suggest that gender discrimination continues as a compelling barrier for women in male-dominated occupations. Stead and Watson (2017) contend that although women compete and qualify in STEM studies, they are less inclined than men to work in these sectors because of gender inequality. Gender discrimination is noted as one of the most significant adverse psychological barriers. Attributable to these adverse experiences in male-dominated occupations, women move away from male-dominated industries to more female-orientated occupations. This is often due to employers appointing women to fulfil labour law requirements (Botha et al., 2011). Moreover, Weber (2018) mentions gender discrimination as a major reason the number of WiE is smaller than men. Gender discrimination causes women to feel inadequate and could be a factor distancing women from this field (Weber, 2018).

2.4.2.3 Stereotypes

Once women graduate in STEM and enter the STEM workplace, they encounter various career barriers influencing their advancement in the industry. Adverse stereotypes about women's capabilities and performance in engineering prevail despite significant efforts and considerable gains in performance and participation. Masters and Meltzoff (2017) discuss the stereotype of "cultural fit" within STEM. This concludes that men are associated with engineering and are perceived to enjoy this field more than women. In addition, stereotypes about culture in male-dominated industries exclude communal goals, such as collaborating and helping others and can be isolating for women (Masters & Meltzoff, 2017). According to Weber (2018), a stereotype threat causing women to depart from the engineering field, is that they sense they will be judged as less capable than their male counterparts. Based on this, women have a higher level of anxiety, driving them away from this line of work (Weber, 2018).

Stereotypes about "ability" in the engineering sector are discussed as the pervasive ideology or belief that men have more ability, potential, talent, and success than women in fields, such as engineering (Masters & Meltzoff, 2017). Lopez and McMillian-Capehart (2002, cited in Briggs, Jaramillo & Weeks, 2012) explain how employees evaluate their membership and participation in social groups formulated in organisations to feel a sense of belonging and safety. When characteristics, such as ability, cultural fit, and other commonalities, are

compared to the majority, employees assume roles in the out-group rather than the in-group. Employees associated with the out-groups experience a lack of cultural fit and struggle to compete over organisational resources and opportunities, thus, making it hard to succeed in that work environment (Briggs et al., 2012).

Heilman (2012) mentions descriptive stereotypes, promoting negative expectations about women's performances, by creating the idea of a "lack of fit" in organisations. Comparing attributes, women are thought to have, to the attributes necessary for a male-dominated work environment (Heilman, 2012). Martin and Barnard (2013) discuss challenges for WiE by examining societal norms contributing to psychological barriers, such as gender-role expectations. Indicating that women do not reach their full potential in male-dominated occupations due to their own gender-role ideologies. These beliefs include questions about their competencies, leading to them feeling inadequate, having low self-confidence, and low self-efficacy (Martin & Barnard, 2013).

Prescriptive stereotypes, described by Heilman (2012), involve the beliefs about characteristics and attributes that are considered appropriate and desirable within a certain context, situation, or culture, resulting in women violating gender norms. An opposing idea presented by Bastalich et al. (2007, cited in Weber, 2018) expresses the notion that engineering encompasses its own culture; women or anyone who does not conform to the strict codes and masculine culture is considered a foreigner or outsider. Alike Du Plessis and Barkhuizen (2015) remark that some women adopt an "anti-women" approach and attempt to act like their male counterparts to receive acceptance in the engineering workplace. A lack of fit may, therefore, be perceived as a career barrier to advancement in organisations.

2.4.2.4 Educational influences

Previous studies indicate a lack of women in STEM careers, particularly in engineering; however, several articles focus on the secondary or university level (Peixoto et al., 2018). According to Peixoto et al. (2018), the problem starts at a much younger age; therefore, early childhood should be a focal point when presenting potential solutions. Buchter et al. (2017) remark that early childhood is a critical and valuable time to incorporate STEM education, as the development period is suggested to be optimal in an increasing diversity of STEM students and STEM trajectories. Padwick et al. (2016) discuss the importance of challenging stereotypical perceptions of engineers and scientists, to encourage young people to peruse careers in STEM. Hill et al. (2010) explain that children are more susceptible to negative

stereotypes from an early age that can drive them away from engaging in STEM fields. The perception of science is unfortunately unrealistic; therefore, actual representations of science and scientists must be exposed concerning actual practices and what the subject matter entails (Buchter et al., 2017).

According to Dasgupta and Stout (2014), students will find STEM courses interesting and more meaningful when they connect classroom experiences with personal goals. For example, students will find mathematics interesting and exciting based on the approach to tackle problems or mathematic equations, such as having hands-on projects instead of abstract instructions. Similarly, Buchter et al. (2017) explains the value of scientific inquiry, including children engaging in participation and exploring scientific processes. This inquiry is conducted by presenting questions to investigate, data collection, and testing beliefs. This is where children participate in scientific inquiry using a hands-on approach to experiences and authentic scientific devices to engage with peers and adults. This process allows children to observe themselves as scientists, therefore, creating excitement and encouraging further exploration of STEM fields (Buchter et al., 2017).

It is suggested that technology has become an intricate part of life and, therefore, using technology in education is vital (Peixoto et al., 2018). When technology is used appropriately in classrooms, it can be an effective device for learning STEM-related concepts; however, not all teachers are trained to use the classroom's technical products correctly, resulting in STEM subjects being taught abstractly (Buchter et al., 2017). Peixoto et al. (2018) mention that newer generations have access to more options and technology than previous generations; therefore, to increase diversity among young people entering STEM fields, technology should be included to meet future job demands and skills.

Stead and Watson (2017) remark that female students experience barriers significantly greater than male students. These barriers constrain educational achievement and career decisions, and the perceptions of parents, peers, and society. Smith and Gayles (2018) mention that when women have positive experiences in STEM subjects at university, they are more inclined to continue their careers in STEM. These positive experiences are related to support from faculty members and peers, participation in engineering organisations and research. Negative influences, which can be experienced in academia, relate to a lack of mentors, isolation, discrimination, harassment, favouritism, and biases. These aspects deter women from STEM fields and contribute to their career barriers (Smith & Gayles, 2018).

2.4.3 Workplace barriers

2.4.3.1 Work/life conflict

Although the labour market has improved in recent years, gender-role expectations still negatively influence men and women in society (Du Plessis & Barkhuizen, 2015). Attaining more WiE is challenging as they encounter factors reducing their presence in career stages. These factors include their work environment, maternal/glass ceiling wall, performance evaluation criteria, a lack of recognition, and biases (Huyer, 2015). Starting a family affects women's STEM careers as work-life policies with family responsibilities affect job satisfaction more than they would for men, as women are perceived as caregivers (Dasgupta & Stout, 2014). Dasgupta and Stout (2014) indicate that women are more inclined to cite family-related issues and time for leaving STEM careers. Coinciding with this notion, Du Plessis and Barkhuizen (2015) indicate that women spend an inequitable amount of time on family responsibility and childcare, as they are perceived as the primary caregivers in households.

Martin and Barnard (2013) emphasise that male-dominated work environments preserve a male career progression model, where work performance is evaluated by presentism and working longer hours. Congruently, Du Plessis and Barkhuizen (2015) explain that the STEM work climate is rooted in the idea that working longer hours result in better performance. This can be perceived as a career or professional barrier for women as they are required to work long hours and overtime, leaving a detrimental impact on their families (Du Plessis & Barkhuizen, 2015). Hence, more women leave engineering occupations to satisfy family responsibility needs.

2.4.3.2 Lack of opportunities and social isolation

According to Letsebe (2018), a lack of female presence in STEM fields and higher education remains due to limited professional development opportunities, limited institutional support for work-life balance, and discriminatory practices concerning hiring, retention, and promotions. Dennehy and Dasgupta (2017) allude that the engineering environment can be openly hostile and subtly unfriendly to women. This hostility can be observed through the nonverbal behaviour displayed by men to exclude women engineers from professional conversations, the existing sexist jokes, and the masculine pronouns used to describe scientists/engineers (Dennehy & Dasgupta, 2017). Du Plessis and Barkhuizen (2015) explain the 'old boys' club' notion, discoursing a tradition in male-dominated occupations where men use discursive practices to exclude women. This behaviour or social interaction may be unintentional, as

cultural behaviour is often unconsciously displayed. The engineering environment can be described as hegemonically masculine; therefore, forming community and mentorship is often challenging for women (Benedict et al., 2018).

Holgersson and Romani (2020) discuss a process called 'gendering processes' referring to the preference for masculinity and men in organisations where gender hierarchies and differences are produced. This results in reproducing and reflecting gender divisions and can be observed in the separation of tasks and spaces. It can be identified through formal practices and policies, such as defining recruitment and promotion criteria. Furthermore, it can be experienced through the organisation's culture, influencing behaviour, beliefs, and everyday interactions. Consequently, if gendering processes remain implicit and continue to create gender divisions, the underlying gender hierarchies in male-dominated occupations will remain unchanged, thus, continuing to be a difficult challenge for women (Holgersson & Romani, 2020).

Hunt (2016) suggests that women exit engineering fields due to a lack of networks, mentoring, and discrimination from co-workers or managers. Tokbaeva and Achtenhagen (2021) state that access to support networks helps enhance women's experiences in male-dominated occupations. To avoid discrimination and favouritism, formalised and structured mentoring programmes were introduced in organisations. These programmes allow equal access and opportunities for all employees (Hopkins, 2017). The author concludes that formal mentoring programmes can assist and provide women with career support, which their male counterparts naturally receive (Hopkins, 2017). It is suggested that women receive more promotional opportunities through formalised programmes than those who attempt to find their own mentors in organisations (Hopkins, 2017). Similarly, Doubell and Struwig (2014) mention that organisational cultures with a lack of role models and female mentors cause barriers for women in their careers.

Seron et al. (2018) highlights a valuable point by demonstrating WiE as tokens. Tokenism displayed in the engineering culture can be observed as women experiencing a paradoxical state where their status as women is highly noticeable; however, their status as engineers is often contested and invisible (Seron et al., 2018). This imperceptibility can be explained by Kanter (1977, cited in Holgersson & Romani, 2020), theorising the minority status of women as tokenism through visibility, contrast, and assimilation, while emphasising how this contributes to the majority status and existing organisation culture. Visibility is described as performance pressure; women perform at high rates to prove they deserve their position while

attempting to remain socially invisible and not outperforming their male counterparts. The second effect discourses the stereotypical expectations tokenism is associated with, such as the work and positions women should have, often hindering their career opportunities. The third effect relates to male counterparts/dominants feeling uncomfortable or threatened by the tokens, therefore, emphasising their commonalities and highlighting the tokens' differences. This observation can lead to loyalty tests or informal exclusions (Holgersson & Romani, 2020). According to Rudman and Phelan (2010), the initiatives to ensure that women are included in various sectors can be portrayed as precarious rather than guaranteed. Women have, therefore, made progress in the right direction, yet they still experience career barriers, preventing them from advancing in their careers.

2.4.3.3 salary inequality

Although there has been substantial improvement regarding gender equity, the gender pay gap remains. Martin and Barnard (2013) explain that salary inequalities illustrate gender discrimination and gender inequality, which has various influences on a women's career progression. Attributable to societal norms, certain occupations are associated with lower pay; for example, secretaries, teachers, and nurses, because there is a greater number of women in that labour supply (Bendeman & Dworzanowski-Venter, 2014). Societal norms are emphasised as they consider men to be the breadwinners in households; therefore, more pay is associated with men to sustain their families (Bendeman & Dworzanowski-Venter, 2014).

Congruently, Weber (2018) indicates that women remaining in engineering tend to earn less than men in the field. Despite engineering being a lucrative profession with higher salaries, women are inclined to earn less than their male counterparts (Mamaril & Royal, 2008). According to Mamaril and Royal (2008), it takes longer for women to earn higher salaries in engineering as career progress is slow. It may cause women to feel like their organisations undervalue their efforts or do not take them seriously, as they forfeit pay or positions comparable to their talents (Martin & Barnard, 2013).

2.5 Coping strategies

Unfortunately, there is a significant number of women that exit male-dominated occupations and continue the paradoxical notion. Thus, regardless of the number of women who enter male-dominated sectors, the levels of segregation in organisations are continuously reproduced

(Torre, 2017). As minorities, women must, therefore, develop perseverance and coping mechanisms to continue their careers in these industries.

Existing empirical research concludes that coping is defined in numerous ways. According to Banyard and Graham-Bermann (1993), coping comprises actions to handle stress by making judgements about a person's resources and situation to overcome stressors. Schreuder and Coetzee (2011) describe coping as the cognitive, behavioural, or perceptual responses used to control, manage, or avoid situations perceived as potentially stressful or difficult. Stress can be defined in three ways. First, as a primary appraisal, where individuals identify a perceived threat to themselves. A second appraisal allows individuals to formulate a stress response. Last, coping is then used to execute the response to stress (Schreuder & Coetzee, 2011).

Schreuder and Coetzee (2011) mention Folkman and Lazarus (1980), indicating two general ways of coping. The first is problem-focused coping, where the individual resolves stress at its source. Second, emotion-focused coping relates to individuals enduring the source of stress and mitigating the discomfort experienced in that situation. Additionally, Schreuder and Coetzee (2011) explain that individuals can use active coping strategies encompassing the psychological or behavioural responses formulated to change the nature of the stressor or how it is observed. Individuals can respond to stress by adopting avoidant coping strategies, prompting individuals into mental remarks or activities, preventing them from directly processing the stress (Schreuder & Coetzee, 2011).

To cope and survive in the current workplace environment, women must develop career resilience and career adaptability. Career resilience refers to how individuals adapt to change by having self-confidence, taking risks, and acknowledging organisational change (Schreuder & Coetzee, 2016). This concept has become crucial in the working environment as individuals take charge of their careers, are adaptable and embrace change, continue learning and persevere to ensure the alignment of their skills and abilities to that of the organisation (Grobler et al., 2011). Career adaptability discourses an individual's readiness to cope with changing work conditions and concerns individuals that are proactive about their future, seeking to strengthen their confidence and self-efficacy (Schreuder & Coetzee, 2016).

Although various ways exist for women to cope and manage stress in male-dominated occupations, these work environments often struggle to accommodate women, therefore, making career development difficult for them (Martin & Barnard, 2013). Despite challenges, studies revealed that even if women earn less than their male counterparts, they still regard

themselves as highly successful (Hopkins, 2017). This observation helps build confidence in themselves and their abilities, reducing stress as they deviate from the norm. Women can become resilient and create a better and more meaningful working experience in their careers by reflecting and embracing identity complexity (Kim et al., 2018).

2.6 Initiatives created

With rapid economic changes attributable to globalisation and the rise of the Fourth Industrial Revolution (4IR), South Africa needs to encourage and support women in STEM industries through education and training. Encouragement will help alleviate the skill shortages and ensure that the country is equipped to handle the digital future. The National Gender Policy Framework (2003) stipulates the country's plans and vision by providing broad guidelines that should be used in organisations in South Africa; however, not all industries are the same, and sectors, such as engineering, require further policies and procedures when hiring and promoting women in the workplace. Engineering sectors should, therefore, align their organisational goals with the strategy of the framework to avoid discrimination and encourage women's empowerment (Martin & Barnard, 2013).

This alignment can be achieved by devising mechanisms for engaging women in science and technology to enhance productivity and increase the quality of national production (Hill et al., 2010). Women should actively be involved in designing, developing, and implementing ideas or projects to improve performance and motivation within the industry (Huyer, 2015). Involvement can be conducted with the assistance of affinity groups or non-profit organisations, such as Women in Engineering (IEEE), and South Africa Selection, attempting to promote global recruitment and retention of women in technical disciplines (IEEE South Africa, 2017). Projects aimed at tutoring, mentoring, and encouraging women to pursue engineering and science professions are some initiatives being pursued (IEEE South Africa, 2017). WomEng (Women in Engineering) is another non-governmental organisation (NGO) developed to assist and empower women engineering leaders in society by nurturing and developing the next generation of women engineers (WomEng, 2016). They achieve this by providing information sessions and weekend workshops, introducing young women to the world of engineering (WomEng, 2016).

According to Letsebe (2018), only 13% of graduates in STEM fields are women, despite South Africa being ranked 19th out of 144 countries recorded in the Global Gender Gap Report. Women's STEM empowerment is essential to the contribution of economic development for

nations (Letsebe, 2018). An initiative called the Accelerated and Shared Growth Initiative for South Africa (ASGISA) was launched in 2006 to eliminate binding constraints on the growth of the country (ASGISA annual report, 2007). This initiative is a national effort to target unemployment and poverty by tackling inequality and marginalisation of designated groups, shortages of skilled graduates, technicians, and artisans and insufficient competitive service and industrial sector strategies (ASGISA annual report, 2007). It aims to combat poverty, create jobs, and build a stronger economy by providing opportunities while focusing on black economic empowerment and women (ASGISA annual report, 2007). This is achieved by on-the-job training to learn skills and knowledge, environmental projects, and development projects can ensure growth and opportunities.

Moreover, the Joint Initiative on Priority Skills Acquisition (JIPSA) was established in 2006 to support the ASGISA (JIPSA Annual Report, 2006). The initiative aims to ensure that the rapid acquisition of priority skills is pursued consistently for the long-term, to prioritise skills and development, and to promote responsiveness and relevance in education and training systems to assist the employability of graduates. It directs national policies aligning them with its objectives (JIPSA annual report, 2006). The priority skills strategy involves broadening the retention of people and training pipeline in skilled employment, training them effectively and ensuring higher standards (JIPSA annual report, 2006).

High-priority skill areas are observed in the engineering sector, indicating that South Africa produces 1400 engineers with B.Sc. Eng. And B.Eng. degrees; however, only half of the graduates register with the ECSA as practising professionals (JIPSA annual report, 2006). TJIPSA aims to increase the number of engineering students, increase the number of graduates registering as professionals with ECSA, retain and re-employ retired engineers, and remove blockages experienced by engineers.

2.7 Conclusion

Based on the information provided in this chapter, significant initiatives were implemented to ensure an increase in WiE. While this is optimistic, the pace at which this is happening has been insignificant. Despite various legislation and policies to improve standards and eliminate barriers, women still encounter hindrances, resulting in them being underrepresented in engineering, and this instils a mind-set that they do not belong. Women are, therefore, discouraged from entering STEM fields as they encounter psychological barriers. Therefore, women who persevere in the engineering field are challenged to deal with more barriers within

the academic or educational setting, such as gender bias or a lack of support and networks. Women encounter elements such as discrimination, stereotypes, and limited opportunities when they enter the working industry. It is, therefore, important to subside gender socialisation and norms, dictating to women what they should do. Society must encourage women in STEM fields as it will aid the development and prosperity of the country, allowing women to make a difference and be successful.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Introduction

The research aimed to understand women's experiences in the engineering sector. A suitable research methodology needed to be employed to collect the information to understand these experiences. This chapter summarises the methodology used to conduct the study. The chapter refers to the population, the sample, and the sampling technique adopted. Moreover, it presents the data collection method and the procedure for collecting and analysing the data. It presents the research instrument and the data analysis technique. Finally, it provides ethical considerations for the study.

3.2 Research design

An interpretive phenomenological qualitative research approach was adopted to satisfy the objectives of this study. Bryman et al. (2014) remark that qualitative research concerns words rather than quantification in the analysis and the collection of data. Qualitative research elucidates ideas and identifies the positioning of participants' strategies regarding the concern or problem identified (Schiffman & Kanuk, 2014). It attempts to uncover opinions and thoughts and establish the root of the problem. Qualitative research methods are more unstructured, and flexible, and interpret data verbatim (Bryman et al., 2014). This method allows the researcher to capture participants' experiences in a holistic and more in-depth manner while eliciting rich data. According to Church, Dunn, and Prokopy (2019), qualitative research is a suitable approach when researchers attempt to answer questions about how a phenomenon is perceived, how it contributes to behaviour and perceptions and how it is reported. Teherani et al. (2015) explain that qualitative research draws on constructivist and post-positivist beliefs. Constructivists believe there is no single form of reality but evoke the participants' observations and beliefs of reality. Post-positivists consider individual differences and the environment, such as an individual's learning capacity or learning culture, affecting reality. These aspects are valuable in understanding the reality of those with directly lived experiences.

The aforementioned eludes that qualitative research was an appropriate method to use as the study aimed to understand the experiences of female career advancement in engineering. The study attempted to uncover how women experience barriers, what influences these barriers, the reasons for these barriers, and what these barriers mean to participants. The topic required testimonials of women who encountered or are encountering experiences of this nature.

Qualitative studies allow rich data to be collected and are suited to investigate human experiences (Bryman et al., 2014).

3.3 Research question and objectives

3.3.1 Question

- What barriers/challenges are experienced by professional female engineers, and how do they overcome these to progress in their careers?

3.3.2 Objectives

- To explore the barriers experienced by professional female engineers in the engineering sector and their perceived association with their career advancement in Cape Town, South Africa.
- To explore female engineers' experiences of coping strategies or techniques employed to remain motivated and persevere in engineering.

3.4 Research paradigm

3.4.1 Phenomenological paradigm

A phenomenological (interpretivist) method explored the real-life experiences of women in the engineering industry. Phenomenological designs can be described as researching the world through the eyes of those with direct lived experiences to discover how they make sense of and interpret their experiences in the world (Bryman et al., 2014). Mohajan (2018) mentions that a phenomenon is conceptualised through an individual's interior awareness. Additionally, phenomenological research is a research design that examines the psychological and philosophical aspects, in which the researcher describes the lived experiences of participants about a phenomenon, they have experienced (Mohajan, 2018). This research attempted to understand the subjective experiences of participants and attempted to make sense of it. The paradigm used for this study was the interpretivist approach. This approach helped in understanding and explaining human behaviour and thought, in social and organisational contexts (Kothari, 2004). It emphasised the importance of individuals' interpretations and perspectives of social realities (Kothari, 2004). This supports the qualitative research design used.

Alase (2017) describes the interpretive phenomenological approach (IPA) as an approach allowing the researcher to understand the innermost deliberation of lived experiences described by participants. It allowed exploring crucial issues or barriers experienced by women engineers in more detail, not necessarily known to the public. IPA attempts to make sense of the experiences and clarify the main issues that are not discussed. Furthermore, IPA helps identify problematic concerns through the research and interpret the influence on participants (Alase, 2017). With this research, empathy and a greater understanding for the participants was required by the researcher.

Being a woman and being passionate about women and their development helped to relate to the participants. It is, however, important to remain objective through the process, not allowing the passion for women's empowerment to overshadow the interpretation of the participants experiences. Participants need to share their experiences without distortions. The researcher had to put aside biases, prejudice, and preconceived ideas that may influence the research. The experiences shared assisted the researcher with comprehensive descriptions used in the analysis stage. Thus, this was a suitable qualitative design method to use, as the researcher grasped the subjective experiences of participants.

3.5 Sampling

3.5.1 Population

Population refers to "the universe of units, like people, nations, cities, regions, and firms from which the sample is to be selected" (Bryman et al., 2014). An accessible population was considered regarding reasonable access to the participants. Participants for this study were women working/worked in the engineering sector. The study population comprised ten women.

3.5.2 Sampling

Sampling refers to the subset or segment of the population selected for research (Bryman et al., 2014). The sampling theory is derived from probability sampling, where all population units are known and have a positive probability of inclusion (Vehovar, Toepoel, & Steinmetz, 2016). Attributable to the nature of this study, a non-probability sampling method was employed. Non-probability sampling indicates the absence of probability sampling and refers to the selection of a sample group using non-random criteria; therefore, not all members in the population

group can be selected for the study (Vehovar et al., 2016). The sample size for the study comprised ten qualified women engineers employed in the engineering sector in Cape Town.

3.5.3 Sampling design

This study was conducted using a non-probability design. Non-probability can be defined as a sample not selected using a random sampling method (Bryman et al., 2014). This method implies that some units in the population are more inclined to be selected than others. Various methods are included in deciding which elements will be used in the sample. Participants are usually selected based on their accessibility (Kothari, 2004). According to Etikan, Musa, and Alkassim (2016), non-probability sampling is a sampling technique where samples are collected in a process that prohibits all subjects or units within the population an equal chance of being included.

Non-probability sampling involves subjective judgements that play a role in selecting the sample as the researcher decides which units will be included (Etikan et al., 2016). This technique is adopted based on what is more applicable to the researcher's study. For example, it depends on the nature, type, and purpose of the study. This method allows the researcher to have more control of the selection process but limits the potential to generalise from the findings of the sample to the wider population (Etikan et al., 2016). Provided that non-probability sampling involves subjective selection when drawing a sample, it can lead to selection bias that can compromise findings and generalisations (Bryman et al., 2014).

3.5.4 Purposive sampling

This study employed a purposive sampling method. It can be described as research conducted strategically, in order to answer the research question (Bryman et al., 2014). Collecting data for research is a valuable part of conducting research. The data contributes to a better understanding of the theoretical framework used in the study. Purposive sampling is, therefore, a deliberate choice of subjects or participants based on their qualities (Etikan et al., 2016). This technique is typically used in qualitative studies and involves identifying individuals or groups proficient and well-informed about the phenomenon of interest (Bryman et al., 2014). Participants were selected purposefully to support the research aims and objectives.

Female engineers who obtained qualifications in engineering and/or are employed in the engineering sector were selected. The study attempted to understand why some women

persevered in this industry and why others have quit or left; hence, the inclusion of women that have worked or are still working in the industry. This information may reveal why some women do not use their qualifications and what happens in the industry. Men were excluded from this study as the study attempted to understand the experiences women encounter in this predominantly male industry. The engineering sector is a male-dominated industry; therefore, the experiences men and women have may differ in various ways. Men may experience various barriers; however, they are not considered minorities in this industry. All engineering fields were considered to allow variation and opportunity. This consideration may open a platform for future research on specific engineering fields that may be more male dominated than others.

3.5.5 Demographic characteristics of the study sample

The biographical information relating to the participants is presented in Table 3.1. The sample comprised ten qualified women engineers in various engineering fields.

Table 3.1

Biographical Details of the Participants

Participant	Job Title	Qualification	Age group
Participant 1	Industrial Engineer	BTech Industrial engineering	(31-40)
Participant 2	Chemical Engineer	BTech and MTech Chemical engineering	(41-50)
Participant 3	Civil Engineer	BTech Civil Engineering	(21-30)
Participant 4	Industrial Engineer	BTech Industrial Engineering	(21-30)
Participant 5	Industrial Engineer	BTech Industrial Engineering and MTech Mechanical Engineering	(31-40)
Participant 6	Chemical Engineer	BSc Chemical Engineering	(21-30)
Participant 7	Civil Engineer	BTech Civil Engineering	(31-40)
Participant 8	Mechatronic Engineer	BSc (Eng) Mechatronics	(21-30)
Participant 9	Electrical Engineer	BTech Electrical Engineering	(21-30)
Participant 10	Chemical Engineer	BTech Chemical Engineering	(31-40)

Table 3.1 presents the demographical information of participants by providing their current job titles, their qualification and field of engineering as well as which age category they belong to.

3.6 Data collection

Data collection involves collecting the basic information that the study requires to reach conclusions (Bryman et al., 2014). Semi-structured interviews were implemented to collect rich data and information from the participants. This technique was used to understand women's experiences in the engineering industry. An online platform was used to conduct interviews due to the COVID-19 restrictions. A one-on-one online interview was implicated, although not face-to-face, it still allowed the participants to feel less social pressure; it allowed a space for sensitive and confidential information to be expressed, compared to an online focus group interview.

Interviews were the most appropriate method of collecting data as the participants could be seen. The online video was recorded and used for transcription. The online video call interview allowed identifying nonverbal cues and gestures that a phone call interview would not allow. Field notes were taken during the online interview. Furthermore, notes or comments were made on environmental contexts, expressions, and behaviours while identifying nonverbal cues (Sutton & Austin, 2015). Field notes are valuable as they can provide context to the interpretation of the video-recording data and remind the researcher of context and situational factors that could be valuable during the data analysis stage (Sutton & Austin, 2015). To ensure the trustworthiness and credibility of the study, field notes were made during the interview process while transcribing the interviews and perusing the transcripts.

3.7 Data collection procedure

A data collection process was followed to collect the data required for this study. First, ethical clearance was obtained from the Human Social Sciences Research Ethics Committee (HSSREC) (HSSREC reference number: HS21/3/19) to conduct the study. Permission was obtained from participants to use the information collected from the interviews for the study—this provided information about the study, confidentiality, anonymity, and rights to privacy. The purpose of the consent forms was to provide the participants with an understanding of the study and what information will be used.

An interview guide directed the semi-structured interviews. This allowed structure and the same protocols to be followed during the interviews. The interview guide was developed by focusing on the broad research question/aim as a mind-map, with the assistance of the supervisors. Broad areas relating to the topic were added to the mind-map. Questions were developed around the major topics. Probing questions were developed to follow-up on the major questions to elicit more detailed information. The questions asked followed a logical order progressing from topic to topic. Examples include: *"What is your field of engineering, and why did you make that career choice?"* and *"Do you think there is a stereotype attached to a female engineer?".*

This study employed interviews to capture and understand the participants' real-life experiences. Although interviews were conducted online, nonverbal signals and behaviours were observed. The interviews were planned, and organised meetings, contributing to a 100% response rate instead of sending surveys or questionnaires. Interviews helped understand women engineers' experiences better as the questions asked allowed participants to provide in-depth responses, contributing to the study greatly. The interview times were scheduled with participants. An online platform was used to conduct and record the interviews for transcription, with the participants' consent.

The interviews were scheduled according to the availability of the participants and took 30 to 40 minutes. The interview process followed the same procedure for all participants, therefore, adding to the reliability and validity of the study. After the interviews were conducted, the data derived from the interviews was analysed.

3.8 Data analysis

The data analysis involved a qualitative approach to allow subjective responses that further the understanding of women's experiences in the engineering sector. The transcription process was conducted after the interviews were completed. Interviews were transcribed verbatim using thematic analysis. Thematic analysis refers to systematically organising, offering, and identifying insight into patterns of meaning presented as themes in the data set (Clarke & Braun, 2014). The thematic analysis allows an understanding and makes sense of the data collected. The data was analysed from the transcriptions of the video interviews recorded online. An interview guide was used, ensuring the same protocol was followed and questions were answered according to the topic. The data collected allowed theme and pattern

identification, emerging from the data set, that is discussed in the findings and interpretation section (Chapter 4).

Six phases must be followed when completing a thematic analysis (Braun & Clarke, 2006). The phases identified assisted in combining the analysis of codes and their meaning in context, including the analysis of the frequency of codes, as outlined below.

3.8.1 Familiarisation and immersion

The first step in the thematic analysis involves researchers familiarising themselves and gaining an understanding of the data and transcripts; therefore, the examiner immersed herself in the findings of the current study. Her diary reflections were perused and reviewed while making notes to eliminate and limit biases. The video recordings were watched twice while perusing the transcripts (twice) to ensure the findings were accurately presented.

3.8.2 Generating initial codes

The second step encompassed the generation of initial codes by systematically analysing the data and identifying aspects of interest by recognising repeated patterns in the data. The transcripts were perused while emphasising and assigning codes to the data. The codes identified were grouped while relating them to the participants' responses, supporting the themes collected.

3.8.3 Pursuing themes

The third step focused on pursuing themes in the transcripts. After grouping the codes, the themes were identified with subthemes emerging from the data. These themes and subthemes were linked and combined with similar opinions and observations from the participants' responses. The themes were summarised according to importance and relevance to the research objectives and questions.

3.8.4 Examination and reviewing of themes

The fourth step entails the examination of the themes identified. The themes were distributed to the researchers' supervisors, and an evaluation was made.

3.8.5 Defining and naming the themes

The fifth step involved establishing the significance of each theme and the detail of the data identified by the particular theme.

3.8.6 Producing the report

The sixth step encompassed the final opportunity of analysis that was related back to the literature review, research questions and objectives.

3.9 Ethical considerations

The nature of this study requires ethical considerations to be adhered to. This ensured that the research was conducted ethically, following the ethical principles of research. The participants' rights, values, and desires were considered (Kothari, 2004).

3.9.1 The right to confidentiality/anonymity/right to privacy

Confidentiality refers to the ethical principle of not revealing information or data publicly that the participant does not want the researcher to reveal (Bryman et al., 2014). Participants have the right to confidentiality, protecting their identities. Participants were assured that the information collected from the interviews would not be revealed or repeated to unauthorised people without permission. The participants' identities would not be identified, and the information collected would be accessible only to the researcher while maintaining confidentiality for the study. Anonymity was maintained, meaning that the participant would not be linked to the data presented. Finally, the right to privacy was adhered to. The participants were presented with information about the study and what it entails. The participants had the right to choose whether they wanted to participate in the interviews.

3.10 Trustworthiness

To ensure the reliability and validity of the research, trustworthiness and credibility were considered. Qualitative research is trustworthy when it accurately presents the participant's experience (Kothari, 2004). The trustworthiness of data is established through Credibility, Transferability, Dependability, and Confirmability (Bryman et al., 2014). These terms are discussed below.

3.10.1 Credibility

Credibility is the criterion for assessing the accuracy or truth value of internal validity in qualitative research (Hammarberg, Kirkman, & de Lacey, 2016). Bryman et al. (2014) explain that research is credible when conducted in principles of good practice and is recognisable to the participants who shared their experiences. The research credibility is defended through practices of reflexivity to ensure congruency between the findings and the reality of participants. Reflexivity refers to a critical reflection on oneself to identify biases that could affect the study (Korstjens & Moser, 2018).

When conducting qualitative research, the researcher is an instrument in the collection of data and, therefore, the influence of the researcher on the research must be reflected (Hammarberg et al., 2016). To prevent biases, triangulation as respondent validation was completed to cross-check the findings and interpretation of the interview process. The participants were presented with a transcribed version of the interview to ensure the information was conceptualised correctly.

3.10.2 Transferability

Bryman et al. (2014) refer to transferability as thick descriptions, providing other researchers with information to judge the potential transferability of findings to various environments and contexts. Similarly, Korstjens and Moser (2018) describe transferability as a thick description that not only describes experiences and behaviours but also the contexts to allow outsiders to acquire meaningful interpretations of these behaviours and experiences. A study meets the criterion when its findings can apply to contexts outside the study situation. Findings are transferable when other researchers observe them as applicable and meaningful in their own experiences (Hammarberg et al., 2016). The research was conducted in Cape Town, therefore, allowing a platform for other researchers to explore women's experiences in the various provinces and workplaces, as well as specific engineering fields. The study captures women in Cape Town's experiences, which might differ in other provinces in South Africa.

3.10.3 Dependability

Korstjens and Moser (2018) describe dependability as an audit trail, describing the research phases from the start of the study to developing it to the final reporting and findings. Complete records of the process should be kept. This clarifies the problem formulation, how participants

were selected, taking field notes, interview transcripts, and how the data was analysed (Bryman et al., 2014). The “auditing” process ensures that good practice procedures are followed.

3.10.4 Confirmability

Confirmability recognises that, although it is impossible to be objective in social research, it can be revealed that the researchers did not willingly allow theoretical inclinations or personal values to influence the study (Bryman et al., 2014). Confirmability refers to how much other researchers can confirm the study findings. It concerns identifying those interpretations and that the findings are not constructed from the information or based on the researcher’s own biases but derived from credible data sources. Reflexivity was analysed, where the researcher examined her own conceptions while discussing preconceptions and assumptions to ensure that it does not affect the study (Korstjens & Moser, 2018). While conducting the interviews, reflexive notes were made, describing the aspects, and setting of the interview. The interviews were transcribed and analysed. An audit trail was used, indicating a clear narrative of the research process and specific phases completed from the start of the research to the report on the findings. Notes were made describing the setting, reaction, and context of each interview to ensure the information presented, are factual and based on the participants' responses.

3.11 Conclusion

This chapter outlines the research design used. It provides the population and sampling methods and the data procedure methods used to achieve the study. Ethical considerations are delineated, and the data analysis methods are discussed. Finally, the chapter discusses the trustworthiness and credibility of the study. The subsequent chapter presents the findings of the interviews.

CHAPTER 4: FINDINGS

4.1 Introduction

This chapter presents the research findings and discusses the data analysis derived from the interviews. It indicates themes and sub-themes emerging from the data collected. The biographical information of participants is presented.

4.2 Summary of major findings

The study aimed to answer the subsequent question:

- What barriers/challenges are experienced by professional female engineers, and how do they overcome these to progress in their careers?

Interviews ensured a response to the research question, where themes and sub-themes were derived. These themes emerged from the data findings:

- Male-dominance
- Support from others
- Stereotypes and discrimination
- Self-efficacy

Each theme identified comprises several sub-themes displayed in Table 4.1 below.

Table 4.1

Superordinate Themes and Subordinate Themes

Superordinate theme	Sub-category	Subordinate theme
Male-dominance	Engineering culture	Logical vs technical
	Equal opportunities	Male-driven and supported
	Support/Networks	Difference in exposure
		Exclusion/isolation
		Implicit biases
		Lack of recognition
		Lack of female presence
Support from others	Parents/teachers/peers	Parental encouragement
		Supportive environments
Stereotypes and discrimination	Biases	Physical appearance
		Gender bias
Self-efficacy as a coping mechanism	Beliefs in female competence	Passion and interest
		Utilise skills and knowledge

Source: Researcher's findings.

4.3 Male-dominance

Within the overarching theme of male-dominance, the subsequent sub-categories and subordinate themes were identified. Within the discussion of the findings, subordinate themes are italicised for emphasis.

4.3.1 Engineering culture

Participants were requested to describe their perception of engineering before entering the workplace and how it has changed from the time they started to where they are now. This question was specifically directed to frame the context for their responses and to establish how they observe the engineering sector. The study findings confirm that participants observed divergence between the theory and tutelage of engineering and the reality of what occurs in the industry. Below are some responses from participants. *Logical vs Technical:*

> "You don't always think you'll get your hands dirty", "many times I had to put on an overall and get dirty", "it's the things you are not told when you are studying. That you are not just using your brain there's a physical aspect to it to" (P1, 31-40, Industrial Engineer).

> "What I was taught versus the actual environment is, it is very different" (P2, 41-50, Chemical Engineer).

> "I think the main difference or shock to the system was when I had to work myself like that physical component in comparison to the theory" (P4, 21-30, Industrial Engineer).

> "I think varsity we are mainly taught the theory of engineering; we barely do any practical's that would be required in the workspace" (P5, 31-40, Industrial Engineer).

These findings reflect the perception that these women engineers are feeling overwhelmed or incapable, as they are expected to perform physical tasks without prior practical experience:

> "When you get here in the workplace you are expected to know each and everything, how things work and all of that" (P5, 31-40, Industrial Engineer).

> "They withhold those opportunities from women to learn to do to something over and over again because they are deemed physically weak or unable to do something", "When you try things for the first time let's say it's working with your hands and it's your first attempt that might not be that great. They like to judge you on that and then the assumption is you can't do it" (P3, 21-30, Civil Engineer).

> "I think it's difficult because your interest sparks at high and university level, but you don't always have exposure or an idea of the practical work or that field if I can say that" (P8, 21-30, Mechatronic Engineer).

This notion is supported by Heilman (2012), who mentions that descriptive stereotypes promote negative expectations about women's performance, therefore, creating a perception of a "lack of fit" in organisations. Weber (2018) remarks that women are more inclined to depart engineering as they are perceived as less competent than their male counterparts.

Furthermore, a universal perception was that the engineering industry was *male dominated,* which, according to history and the origins of engineering, remains. Participants 1, 3, 4, 7, and 10 shared commonalities, describing the engineering work environment:

> "It's difficult for females in such a testosterone-driven environment" (P1, 31-40, Industrial Engineer).

> "My perception of engineering that it was very much male-dominated" (P3, 21-30, Civil Engineer).

> "It is deemed a masculine environment" (P4, 21-30, Industrial Engineer).

> "Before entering the workplace my perception of engineering was that it's pretty much a male-orientated industry and to an extent it still is" (P7, 31-40, Civil Engineer).

P 10: “I definitely thought engineering was for a man and just a job most men do, just from what I saw and how I grew up” (P10, 31-40, Chemical Engineer).

This opinion correlates to Masters and Meltzoff (2017), remarking that women remain underrepresented in male-dominated occupations; although engineering is a lucrative profession, it is deemed a male-dominated sector. Martin and Barnard (2013) indicate that women will encounter several challenges in male-dominated occupations as it displays traditional gender hierarchies. With reference to the research findings, participants perceive the engineering culture as male-dominated, with a *lack of female presence and role models*. These statements from participants support this notion:

“You’re always the minority” (P1, 31-40, Industrial Engineer).

“I can tell you when I started work, I was told I was the first female at that company to work night shift”. “Guess it was a reflection of how little female presence there was” (P2, 41-50, Chemical Engineer).

“I had never seen A picture of a woman and like a description, saying she's an engineer or like she's studying to be an engineer so like when I thought of engineering back, then, like the face was a man you know. And most typically a white man, so that was my image” (P3, 21-30, Civil Engineer).

“Often times women are the only females in a team, I am currently experiencing that. I am a younger woman who has to manage a team of three older men, so it was quite intimidating in the beginning” (P8, 21-30, Mechatronic Engineer).

“When I started working, I was the only female and I started with another guy, the treatment was definitely different towards him, in a sense because he is a man, automatically he gets respect. If I can explain it in that way. And now where I currently work, I am a team leader and again I am young, black and the only female leading a team of older guys” (P9, 21-30, Electrical Engineer).

Briggs et al. (2012) discuss how in-groups and out-groups influence individuals’ success in a work environment by explaining that abilities, cultural fit, and other commonalities are compared to the majority. If an individual does not assume part of the in-group, they will experience a lack of cultural fit and struggle to compete over organisational resources and opportunities, therefore, finding it hard to succeed in that work environment (Briggs et al., 2012). Despite this stance, a few participants believed there was a change in the engineering industry in terms of including and retaining women in the industry. This is illustrated in the subsequent statements below by Participants 2, 3 and 10:

> "But my view of the white man in engineering started to change. That there are women running things in engineering and that sort of inspired me" (P3, 21-30, Civil Engineer).

> "I think the main thing is that there are changes and people are open, and more women are entering engineering" (P4, 21-30, Industrial Engineer).

> "I think there are definitely moves in the right direction to include women, and slowly but surely more and more women are studying and working in engineering" (P10, 31-40, Chemical Engineer).

Many initiatives were created to support the process of empowering women and attracting them to the field of engineering. The perceived perception of engineering and its culture, therefore, constructs the way women observe their jobs and how they persevere despite challenges and their knowledge about the industry (Miner et al., 2018).

4.3.2 Lack of equal opportunities

A universal perception held by participants was that engineering was a *male-driven and supported* sector with regards to opportunities in the workplace and in general. Although, engineering organisations portray themselves as gender-neutral working environments, there are assumptions about an ideal worker, that is usually male (Yates & Skinner, 2021). Participants 1, 3, 4, and 9 echoed this opinion:

> "Think it's the olden day's preconceptions about that when it comes to males, that males know more" (P1, 31-40, Industrial Engineer).

> "I think boys are encouraged to be engineers or you know all those things because it's seen as like a very hands-on job. People assume that you don't want to get your hands dirty" (P3, 21-30, Civil Engineer).

> "I think it's harder for a woman" (P4, 21-30, Industrial Engineer).

> "I think as women we have to work very hard, we get respect but are still undermined, because you are a woman in comparison to your male colleagues" (P9, 21-30, Electrical Engineer).

This could be compared to the progression of South Africa, where affirmative action and legislative frameworks were developed to eliminate these predicaments for women (Naidoo & Kongolo, 2004); however, they still experience barriers. Participants believed there is a *difference in exposure* and access that women and men receive in engineering, influencing their career development.

> "I think the access is there but giving them the access doesn't mean that that it's equal, or an equal opportunity", "think girl children are still encouraged to play with dolls and not with Legos. You know, so the basics of giving a child the option to play with both. So that when you start building blocks and building models with Lego, it stimulates different brain pathways to think different. And we wait too long to expose girls to those type of things" (P2, 41-50, Chemical Engineer).

> "The opportunities are equal; they are equal once you have the degree. But I think at maybe high school level or yeah, like Grade 10,11,12. But the exposure to engineering is not there" (P3, 21-30, Civil Engineer).

> "As a female you are undermined, and you don't get a lot of opportunities because its most likely given to a man" (P10, 31-40, Chemical Engineer).

This could relate to the notion presented by Weisenfeld and Robinson-Backmon (2007), indicating that gender discrimination in the workplace is observed as a "glass ceiling" for women. Minority groups are denied the same desirable opportunities, which include resources, mentors, and networks, causing women to depart this working environment as they sense unfair treatment (Lim et al., 2015).

This led to another perception collected from the findings where participants felt that the engineering environment could be isolating, and women could be excluded from decision-making processes if they did not voice their opinions:

> "I can tell you this, not necessarily as naturally as an engineer, but as a woman, I have found that, that men ignore, they don't necessarily think that you've got an opinion on the matter. So yeah. At times, you have to force your voice", "And it's sad because if you don't stand your ground or speak up there's no support and you will sort of be overlooked because they assume you are ok with whatever has been said, you know" (P2, 41-50, Chemical Engineer).

> "So, you know, they withhold those opportunities from women to learn do to something over and over again because they are deemed physically weak or unable to do something" (P3, 21-30, Civil Engineer).

> "Sometimes it's tough, you become so used to this way of being in a very male-dominated environment, if you don't speak up or voice your opinion you will literally be overlooked and excluded from some processes for example" (P7, 31-40, Civil Engineer).

> "It's challenging being a manager, they want you to come and do your job but don't do too much, they want you to give your opinion but they don't want you to say too much, don't show how smart you are but also don't play dumb because then it feeds the idea that you don't know what you are doing and don't belong there" (P9, 21-30, Electrical Engineer).

In order to cope, women are forced to adapt to the masculine environment and adapt an anti-feminine approach to receive acceptance in the engineering workplace (Du Plessis & Barkhuizen, 2015):

> "And it's because we are required to really fully step into that male energy in order to somehow try and survive and be heard" (P1, 31-40, Industrial Engineer).

Additionally, P 4 alluded to certain subtle or implicit biases evident in the engineering environment:

> "When recruiting they are scared that a woman would not fit in because of the working environment", ". I also think conscious or not there is biases and preference to men. There are certain behaviours that's hard to deal with its mainly masculine", "Misogyny is not good but in France you get belittled and in South Africa you are more of a social sex object rather than a working person" (P4, 21-30, Industrial Engineer).

> "But people can still be very biased towards women and questioning their abilities and gives them less opportunities to have more challenge" (P6, 21-30, Chemical Engineer).

According to Dennehy and Dasgupta (2017), the engineering environment can be openly hostile and unfriendly to women. Women are excluded are through sexist jokes, nonverbal communication, and masculine pronouns used to describe engineers. Moreover, Du Plessis and Barkhuizen (2015) mention the 'old boys' club' focusing on traditional male-dominated occupations, using discursive practices to exclude women. These practices are often unconsciously practised and displayed.

4.3.3 Support/networks

Unfortunately, due to unsupportive working environments there are more women that exit engineering fields due to a lack of mentoring, networks and discrimination from co-workers and managers (Hunt, 2016). A prevailing perception adopted by a few participants suggested that they believed they had to work harder to prove their worth and abilities to receive support and recognition in the workplace:

> "a woman has to work so much harder to have the same impact that a man would have. And to get to just get the cooperation and the input. So I have to now look at how I carry myself, put in more effort to prove a point and literally be willing to do more just to show that what I am presenting or suggesting is valuable and worth considering. It's exhausting" (P1, 31-40, Industrial Engineer).

> "And yeah, and then the reality is, then you unfold, fortunately, or unfortunately, when you're working, you have to kind of prove that what you've done is adding value, people give you more responsibility" (P2, 41-50, Chemical Engineer).

> "I think the support depends on the relationships formed in the workplace and like on your way towards being an engineer, you know. It really depends on the relationships and the bonds and the networks you formed throughout your university and within the workplace" (P3, 21-30, Civil Engineer).

Tokbaeva and Achtenhagen (2021) indicate that having support networks can help improve women's experiences in male-dominated work environments.

Participants also noted there was a *lack of female presence* in engineering, which affected their motivation and encouragement in the field:

> "Ok so in my office space in terms of support from a woman no, I don't have support from a woman, but I do feel my boss supports me. My boss is male by the way. So, I've mainly built support and relationships from previous things like high school and university" (P3, 21-30, Civil Engineer).

> "But the fact there is this one female that managed to overcome the barriers that were there, in order for her to get to that position, it also motivates me as well, because if she can do it the I can do it as well" (P5, 31-40, Industrial Engineer).

> "It's the desire to connect with people across the country, learn from them, to relate to them" (P6, 21-30, Chemical Engineer).

Doubell and Struwig (2014) remark that organisational cultures lacking female mentors and role models, can increase barriers for women in their careers.

4.4 Support from others

The perception of parents, peers, and teachers is crucial in supporting women in male-dominated environments (Stead & Watson, 2017). Emphasised as a motivating factor was helping them persevere and encouraging them to pursue their career goals. Universal perceptions are depicted below.

4.4.1 Parental encouragement

According to Hill et al. (2010), Masters, and Meltzoff (2017), women experience barriers when entering STEM fields, and this is affected by the attitudes of parents, teachers, and others, observing these fields as being best suited for men. Notably, based on the research findings,

the participants interviewed had positive experiences regarding the support and encouragement they received:

> "My teachers were very happy, especially when I qualified to actually like study that in university" (P3, 21-30, Civil Engineer).

> "Well, my mom was very supportive of it, I'm the first child to have an engineering degree in the family. High school teachers were also supportive; they knew that I loved- my favorites subject is physics so they would always motivate me to go into the engineering field" (P5, 31-40, Industrial Engineer).

> "So my dad is an electrical engineer, and when I wanted to do it he was over the moon because my brother chose the accounting route, so he was definitely supportive. The rest of the family because I'm Indian were shocked because why did I not decide to become a doctor, they call me sparky" (P8, 21-30, Mechatronic Engineer).

Participants 6 and 7 shared the same experiences with their parents and teachers. Having supportive environments and people can positively impact women's decision to pursue non-traditional careers (Ericksen & Schultheiss, 2009). Buchter et al. (2017) expresses the importance of family, and its crucial function it plays in building interest and development in STEM subjects, contributing to women's experience in STEM.

Some of the participant's parents perceived engineering to be a status-driven job, therefore, alluding to a high-paying salary, which equated to a successful career choice:

> "To them engineering sounded like a much better, more status driven job", "Choose something that's gonna give you money in the long term" (P1, 31-40, Industrial Engineer).

> "My parents were happy with the route I was taking. I was their first born and going to be making money" (P3, 21-30, Civil Engineer).

Bendeman and Dworzanowski-Venter (2014) explain that due to societal norms, certain occupations are associated with lower pay, such as secretaries, teachers, and nurses. Societal norms are emphasised, considering men as the breadwinners in households; therefore, higher salaries are associated with men to sustain their families (Bendeman & Dworzanowski-Venter, 2014). This association is applied to engineering as a male-dominated field; therefore, the assumption is that the job equates to higher pay and status.

Stead and Watson (2017) explain that women experience more career barriers due to gender divergences in educational achievement, career decisions, and the perceptions of parents, peers, and society. Participants' parents and teachers supported their career choices and believed in

their abilities to succeed in this field. This support and encouragement added value and improved participants' self-esteem, contributing to their self-efficacy.

> "Yeah, it meant a lot, especially my family", "It's really difficult and they're like, no, but like we know you can do it" (P3, 21-30, Civil Engineer).

> "It was always a positive thing, always a positive response". "I think they were so positive because they saw the potential in me like they knew I was more than capable of succeeding in engineering" (P5, 31-40, Industrial Engineer).

> P 10: "I think it's always a good thing when you have that support it makes you want to do and try so much harder" (P10, 31-40, Chemical Engineer).

4.5 Stereotypes and discrimination

Adverse ideals about women, their capabilities, performance, and skills remain a career barrier for women. Gender biases contribute to women feeling inadequate, resulting in many engineering exits; therefore, emphasis by participants is represented below, confirming the perception of women engineers and their experiences regarding gender biases.

4.5.1 Gender bias

Despite considerable gains in participation and performance, negative stereotypes about women's capabilities and performance prevail in engineering. Participants expressed doubts about whether they were fit enough to perform their duties.

> "The assumption that we can't do the job. As they assume that a woman is too weak to do something. That's the first barrier because then they assume that you're too emotional" (P3, 21-30, Civil Engineer).

> "That we are too emotional to lead. Like we, I don't know, I say that because every time we prove a point" (P5, 31-40, Industrial Engineer).

> "there's this assumption that you are too emotionally weak, or you won't get your hands dirty to get the job done" (P7, 31-40, Civil Engineer).

This can lead to the notion explained by Weber (2018), mentioning a stereotype threat that deters women from engineering, as the assumption is that women engineers are less knowledgeable or lack the necessary skills required to perform.

Furthermore, descriptive stereotypes promote negative expectations about women's performance by developing a "lack of fit" in organisations (Heilman, 2012). Stereotypes about

ability in the engineering sector are discussed as a pervasive ideology that men have more potential, ability, and skill and will be more successful in fields, such as engineering, than women (Masters & Meltzoff, 2017). The engineering sector has its own culture, and therefore, those who contradict the masculine culture are considered outsiders (Weber, 2018). Conversely, when women display their strengths and potential, they are further judged:

> "Then there's a very fine line between obviously, a guy can throw his toys and they will say, you know, well done, he stood up for what he believed in, and when a woman does the same, people will call her a bitch or being difficult.", "I got super offended when the production manager asked me to make tea and coffee when he had visitors. And I'm like, I didn't study engineering to be a tea lady" (P1, 31-40, Industrial Engineer).

> "Where I was overlooked in a room full of men even though I was on the same level or even better than them", ". When you stand up for yourself it seems aggressive which is not how you are, but you have to make a point" (P2, 41-50, Chemical Engineer).

Women enter that paradoxical state where they now stand up for themselves and their beliefs; however, it is perceived as throwing a tantrum or acting aggressively. This reflects the concept of tokenism displayed in engineering. The status of WiE is, therefore, highly noticeable; however, as engineers, they are often invisible or contested (Seron et al., 2018).

Participant 3 mentions an assumption made in engineering that women do not work hard enough compared to their male counterparts:

> "I think people assume that female engineers don't work as hard or as long as male Engineers because female engineers have responsibilities at home." "Yeah, people judge based on that, saying but he left at 8:00 PM, Surely he's the harder worker than she is you know because she left work at the normal time" (P3, 21-30, Civil Engineer).

According to Du Plessis and Barkhuizen (2015), the STEM climate is rooted in the idea that working longer hours cause better performance. Congruently, Martin and Barnard (2013) explain that male-dominated work environments maintain a male progression career model, where work performance is evaluated by working longer hours and presentism. Participants were notably against this notion, as many indicated that they had to work hard to prove themselves and their abilities. This included working long hours, working on projects, or working after hours.

Participant 2 indicated that being a married female engineer may cause different treatment:

> "And then also when I got married things changed. I really got upset about the assumptions made that yeah, that suddenly I if there's a breakdown in the factory that you know my priorities would have changed now because I'm married" (P2, 41-50, Chemical Engineer).

The assumption is that due to being married, women's priorities change and, therefore, need to be home to take care of their families and husbands and not stay after hours or be called out for certain jobs. This stems back to the societal norms or gender-role expectations still prevalent in society, where women are perceived as the household's primary caregivers (Du Plessis & Barkhuizen, 2015). Furthermore, participants mentioned physical attributes that contribute to a stereotype threat or barrier that women experience in engineering:

> "I'm a woman, and I look younger than I am, people tend to not take you seriously". "I mean, it would obviously be somebody that's a little bit more butch but, the thing is that in any corporate environment, whether you're an engineer, whether you are the finance lady, etc, you have to, unfortunately, step a lot more in your male energy" (P1, 31-40, Industrial Engineer).

> "I am qualified and I know what I am doing, why do I constantly have to defend myself, I even changed the way I dress and started wearing the engineering gear so that they can see I work here and see we are the same because I feel like the clothes I used to wear was a reminder that I was a woman, you know" (P9, 21-30, Electrical Engineer).

Du Plessis and Barkhuizen (2015) explain that some women adopt an anti-women approach to act like their male counterparts to receive acceptance in the engineering workplace. Similarly, participants mention that:

> "I think that engineering is associated with a man or males. If there is a female interested in engineering, they will think she's tough and rough not very feminine, like if she's into mechanical engineering and likes cars she must be a tomboy", "Stuff like your physical appearance plays a role like you'll get comments about that. It's a rough environment and there are also sexist's remarks" (P4, 21-30, Industrial Engineer).

> "Sometimes you are seen as one of the guys because you have to adjust to working in this environment" (P7, 31-40, Civil Engineer).

Some participants reflected an unconscious bias in the engineering sector:

> "Certain things like being married or when you are newly married, they think Oh well what if she falls pregnant, then we will have to find someone to fill her position. And those, you know, are real obstacles or maybe it's just unconscious bias of people" (P2, 41-50, Chemical Engineer).

> "I'd say in the industry, ok, small things like small subtle things like measuring the size of the structure or carrying something they would help me and not in the sense of sharing workload but taking over from me" (P3, 21-30, Civil Engineer).

According to Yates and Skinner (2021), explicit bias has decreased; however, implicit, or invisible bias exists and limits advancing women.

4.6 Self-efficacy as a coping mechanism

Self-efficacy is reflected as a coping mechanism for participants to overcome challenges and barriers experienced in engineering. It was emphasised as a positive, motivating factor for participants and their perseverance to continue their engineering careers.

4.6.1 Belief in female competence

This theme shared commonality among participants as they all shared the belief, they were more than capable and able to perform their functions as engineers:

> "But at the same time you believe you are capable, so I was willing to put in the hard work" (P1, 31-40, Industrial Engineer).

Mamaril and Royal (2008) explain that how women feel and believe about their skills and abilities influence their success in engineering. It is, therefore, signified that if women lack self-confidence in their abilities, it will lead to emotions of isolation and increase their minority status in the industry (Mamaril & Royal, 2008). Participants indicated that their self-efficacy was influenced by their passion and interest in STEM subjects, therefore, making them desire success:

> "So yeah I was more interested in that, and I was good at science and wanted to utilise my skills and knowledge I guess" (P2, 41-50, Chemical Engineer).

> "I knew I wasn't good at languages but more interested in organising and I was passionate about science and maths" (P4, 21-30, Industrial Engineer).

Participant 5 also shared her thoughts on how women observed their jobs. It was also mentioned that other jobs are glamorised, and women are encouraged to choose various career choices based on how glamourous it is. Martin and Barnard (2013) remark that women are inhibited from reaching their full potential owing to psychological barriers and gender-role expectations. Negative experiences lead to more barriers that women encounter, which influences their skills, abilities, and self-confidence (Masters & Meltzoff, 2017).

4.7 Conclusion

This chapter focuses on the findings based on the themes emerging from the coding process. The themes identified assisted in understanding women's experiences in engineering. It also allowed identifying if the engineering sector has improved and whether the needs of women in this sector are being met. Four main themes were identified from the research findings; each theme was linked and corresponded. These themes indicated that one issue identified directly affects another issue. The findings reflect that the participants experienced career barriers, such as male-dominated environments that lack opportunities, networks, and support. Through the responses, positive reinforcers, and enablers, such as having supportive environments and encouragement from parents/peers and teachers, were emphasised. Self-efficacy as a coping mechanism helped the participants stay motivated and persevere in their careers. The subsequent chapter summarises the study findings and recommends assisting WiE to remain successful and improve their career development.

CHAPTER 5: DISCUSSION, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter presents the conclusions derived from the study findings according to the research objective described in Chapter 1. This study explored the barriers experienced by female engineers and examined the participants' experiences of coping strategies to remain motivated and persevere in efforts for career advancement. Study limitations and recommendations for future research are presented.

5.2 Research overview

The study was conducted to answer the subsequent question: What barriers/challenges are experienced by professional female engineers, and how do they overcome these to progress in their careers?

This question was answered through a qualitative method of semi-structured interviews. Participants were identified using purposeful sampling. Participation depended on availability and willingness. A sample size of 10 participants was selected for the study. All participants are employed in various engineering sectors in Cape Town, Western Cape. Thematic analysis was used to extract themes and subthemes from the data collected. The themes extracted from the research findings are male-dominance, support from others, stereotypes, and self-efficacy as a coping mechanism.

The first theme, male-dominance—discoursed how participants observed the engineering sector that encompassed various aspects, such as its culture, equal opportunities, networking, and support. Participants shared engineering experiences in a male-dominated sector, despite many changes and strides in the right direction to include women. Male-dominance was, therefore, perceived as a barrier to career development.

The second theme, support from others, refers to parents/teachers/peers focused on personal support structures influencing women's decision to pursue engineering. Notably, participants shared positive experiences regarding their support, which affected their self-efficacy and perseverance in engineering. Compared to previous sources, Martin and Barnard (2013), Du Plessis and Barkhuizen (2015) and Weber (2018), the participants in the present study experienced support from others as enabling their choice to pursue a career in engineering.

The third theme, stereotypes, discoursed the stereotypes/discrimination women experience in engineering. Despite legislative frameworks and considerable changes to include women in the sector, unfortunately, several women still experience judgement according to their performance and capabilities in male-dominated environments. Stereotypes are, therefore, still evident as barriers to the career development of women engineers.

The fourth theme, self-efficacy as a coping mechanism, focused on how these women observed themselves and their abilities. Some noted that despite negative stereotypes, discrimination, and being the minority, participants observed themselves as highly capable and would succeed at their jobs. Self-efficacy is, therefore, an enabling factor for the career development of women engineers.

5.3 Conclusions

5.3.1 Perception of engineering

Participants were requested to describe their perception of engineering before entering the workplace and how they perceived it. In line with previous research conducted by Masters and Meltzoff (2017) and Martin and Barnard (2013), a universal notion presented itself in that participants perceived the engineering sector to be male-dominated. Although engineering is a lucrative profession, as history and earlier research indicate, it is traditionally a male-dominated sector, despite efforts to include women in this sector (Maji, 2019). This narrative presented itself in the workplace as culture, the working environment, opportunities, networking, and mindsets.

Although participants were cognisant of engineering being a male-dominated industry, it did not deter them from pursuing a career in this sector; however, they felt they experienced subtle barriers influencing their career advancement. Society's influence on enforcing gender norms plays a huge role in career choices. According to Peixoto et al. (2018), from an early age, children are exposed to implicit assumptions about gender stereotypes that cause their own behaviours and beliefs. For example, an implicit perception presented is that mathematics and science are not for girls (Hill & Corbett, 2015). Yates and Skinner (2021) discuss how although explicit biases and stereotypes have decreased in the past few years, implicit bias continues to be a barrier for women. Consequently, this narrative filters through and becomes stronger in adolescence and predicts enrolment preferences that usually support explicit career choices (Ellemers, 2018). Explicit biases have become more egalitarian in that laws and legislative

frameworks were implemented to promote equality between men and women. Yet, at an implicit level, it continues to influence behaviours and judgements (Ellemers, 2018). In essence, the women who succeed in male-dominated industries are the exceptions, as they experience several hindrances before entering the workplace.

Martin and Barnard (2013) indicate that women often have their own psychological barriers. This inhibits them from reaching their full potential in male-dominated occupations, such as having their own stereotypical perceptions about gender-role expectations. It can lead to women having stereotypical thoughts and questioning their abilities, resulting in low self-efficacy (Martin & Barnard, 2013). Miner et al. (2018) explains how this can be observed from an individual lens perspective. Where women were conditioned to believe that they were not interested or capable of pursuing careers in STEM as "men have a greater aptitude for science and mathematics". This is derived from parental choices when encouraging hobbies and activities, early schooling, and early reinforcement deemed appropriate in society (Miner et al., 2018). Participants believed they were more than capable of being in this occupation and believed in their skills and abilities, hence, their perseverance. This also influenced their self-efficacy, emphasised as a positive reinforcer and driver to stay in engineering.

Furthermore, the status quo needs to be subsided, and gender norms need to be re-evaluated to accommodate emerging and modern societies. Education then becomes a valuable device in changing the narrative and promoting equality in engineering. According to Chung and Huang (2021), there are two types of social categorisations. The first category discourses shared characteristics within a group to decrease individual differences, which ultimately generate stereotypes. The second category emphasises strengthening differences among various groups. Unfortunately, gender becomes an influential social category and deciding factor concerning career choices if there is a lack of flexibility. It can lead to an individual encountering several obstacles in the workplace and life (Chung & Huang, 2021). This is affected by parents and what is taught in schools. To make it into the industry, the participants may have endured many barriers and, thus, rely on themselves, support structures, and their own career development.

5.3.2 Career development

The emergence of career development plays a significant role for women and their career progression. As identified, participants believed in their abilities to perform optimally at their jobs. Due to organisational structures and policies formulated to suit the "ideal" worker that is considered a male worker, women experience career barriers in engineering (Yates & Skinner,

2021). The assumption is that women are not "ideal" workers, as their traditional roles were assigned as caregivers and family-orientated roles (Miner et al., 2018). Participants emphasised that in engineering, they must work harder to prove themselves as their ideas and voices often went unnoticed due to the preferences of their male colleagues.

In order to do this, they would work more hours, stand up for themselves, not get easily offended, and voice their opinions; therefore, concentrating on their career development and adaptation to the working environment. Career development was used as the theoretical framework to shape the research as it focuses on the continuous process where individuals progress through various life stages and encounter various issues, themes, and tasks (Schreuder & Coetzee, 2016). Through career development, internal and external barriers were identified as hindering the career advancement for women.

Internal barriers discoursed person-focused barriers related to an interest in pursuing a career, motivation, and a perceived lack of ability. External barriers focused on environment-focused factors relating to family demands, employment restrictions, and financial constraints (Urbanaviciute et al., 2016).

5.3.3 Internal barriers

An internal barrier identified through the research was the perception of skills and abilities related to the participant's self-efficacy. A compelling influence of WiE is a lack of self-confidence in their intellectual ability and lack of fit (Masters & Meltzoff, 2017). Moridnejad et al. (2020) state that if girls think positively about science and their mathematic ability, it affects their achievement and success as they progress. Hence, individuals with high self-efficacy beliefs obtain the abilities and skills, are resourceful, and can complete tasks by overcoming hindrances that interfere with their goals (Botha et al., 2011). Based on the findings, although not an easy task for participants, they exhibited a high level of self-efficacy.

Participants expressed that they understood their capabilities and even felt that sometimes, in their careers, they performed better at their jobs than their male counterparts. Moreover, the findings suggest that their abilities were recognised early and grew in interest as they progressed. Participants were more concerned with making a difference in their field and using their skills and knowledge to improve their industry. The findings suggest that participants want to be the examples and role models they did not have to other young girls and aspiring

engineers. It was important for them not to give up, to assist other aspiring engineers and to illustrate that it can be done, that women can be engineers.

Negative perceptions and ideas about male-dominated industries may cause stereotypical conclusions about competencies and low self-efficacy (Martin & Barnard, 2013). Self-efficacy is, therefore, an important predictor of a woman's choice to pursue a career in engineering (Du Plessis & Barkhuizen, 2015). Emphasised in the responses were personal support structures, such as parents/teachers/peers perceived as positive reinforcers in their career choice and perseverance to stay in the industry. The perception of parents and society is a fundamental part of any career decision as it creates a sense of acceptance and belonging (Dasgupta & Stout, 2014). This also has a ripple effect on their self-efficacy, contributing to their self-confidence and beliefs about their skills and abilities.

Positively, responses involving the utilisation of skills, abilities, and knowledge in the industry, despite barriers faced, relate to career resilience and career adaptability. Schreuder and Coetzee (2016) explain that individuals have career resilience when they adapt to change or circumstances and have self-confidence in their capabilities. This is a crucial element to possess specifically in this industry as it is still largely male-dominated. The responses indicate that women have career adaptability where they learn how to cope in the workplace and rather focus their efforts on self-efficacy to pursue their aspirations. Hence, women, build resilience when working in engineering fields by aligning their personal and professional values. When external barriers, such as discrimination and a lack of self-confidence, are disregarded, women engineers can remain focused on their goals and aspirations (Cardador & Caza, 2018). Women can become resilient and create a better and more meaningful working experience in their careers by reflecting and embracing identity complexity.

The findings emphasise that although women encounter barriers and obstacles, their beliefs in themselves allow them to persevere. It highlights societal norms are still prevalent and subtle, resulting in women doubting themselves. It further indicates that support structures, such as education systems, parents, and peers, are vital in assisting women to overcome barriers.

5.3.4 External barriers

5.3.4.1 Paradoxical state for both men and women

A significant barrier highlighted through the findings was that engineering is a male-dominated industry, affecting women's career progression in this sector. Based on the findings, participants believed that certain opportunities were withheld from them, and they were excluded from certain projects or activities. This was due to often being judged on their first attempts, as the assumption is that women are "too weak" and do not want to get their hands dirty to complete certain tasks. This can lead to a lack of fit mentality that often contributes to women leaving engineering, as they fear being criticised as less adequate than their male counterparts (Weber, 2018).

The responses propose that women do not receive appropriate exposure and access to recourses compared to their male counterparts. Unfortunately, women experience a glass ceiling as gender discrimination, which prevents minority groups from receiving access to resources, networks, and mentors (Lim et al., 2015). This can cause women to feel isolated, as indicated in their responses. Isolation in the workplace excludes women from decision-making processes (Hunt, 2016). Thus, participants, voiced their opinions and "stepped into their male energy" to be heard. Responses conveyed that women felt they had to work harder to prove their worth and abilities to receive the required support.

An interesting notion presented itself through the findings. Various participants felt that their male counterparts took away simple and achievable tasks they could have completed themselves. For example, holding a ladder, climbing up a tower to check an electrical cable, or taking over a task without them requesting any assistance. What was, however, identified is that participants felt that their male counterparts were being mindful because they were "women" and, therefore, for example, took over and carried a ladder to help. Small instances contribute to the bigger picture and, therefore, emphasise the message demonstrated in society.

Men and women are placed in a paradoxical state. Men are taught in society that they need to be the providers, be gentlemen and take care of their families and work. Conversely, women are taught that they are nurturers and caregivers and often compete with their biological clocks to reproduce and start families (Dasgupta & Stout, 2014); however, in the workplace, a clash of ideas and standards occurs. Men are taught to be gentlemen and assist women if they require help in society. In the workplace, there is a fine line between assisting someone to be helpful and taking over tasks because it is assumed that women are not capable. Men now need to

"watch" their actions as their behaviour is eradicating opportunities and undermining women. Women encounter a predicament where they are treated as they would be treated at home by their husbands, where the man leads and takes control of situations; however, in the workplace, this is a barrier as they are never fully exposed to all opportunities.

Based on the findings, it was identified that most participants worked with older male-counterparts, which also exposes a different age group and associated mentality. An older generation would hold various ideals about women working in a male-dominated sector and may even be resistant to change compared to the younger generations.

5.3.4.2 Performance and capabilities

The study discovered during the data collection process, that participants highlighted the importance of hiring practices and the function of human resources. Some noted hesitation when hiring women as they were doubted about "fitting in" in the work environment. In most cases, women are hired to fulfil labour law requirements (Botha et al., 2011). This emphasises stereotypes about cultural fit and ability where women are doubted and judged less competent. Gendering processes are experienced in the engineering sector through the preference for men and masculinity in organisations where gender differences and gender hierarchies are produced (Holgersson & Romani, 2020). It then produces gender differences and can be observed in the separation of spaces and tasks through formal policies and practices, such as recruitment/promotion criteria and the organisation's culture.

This starts from early childhood when boys and men are exposed to certain aspects of engineering, for example, mechanical engineering. By the time they reach university, they know the requirements; they have had some direct exposure and know what to expect. Women only decide at a university level the engineering field they want to pursue and might have had no exposure or direct experience in the field (Maji & Dixit, 2020). It was established through the findings that there is a misconception between the theory and tutelage of engineering and the reality of what occurs in the industry. There are practical and physical components required to be fulfilled the job, which was stated to differ from what they imagined—shedding light on the lack of exposure received before entering the workplace. Thus, this remains a difficult challenge for women, as it remains implicit or unchanged.

Again, these emphasise the paradoxical state that women engineers experience. Seron et al. (2018) further uses the term tokenism to explain this predicament for women. WiE are observed as a token and highly noticeable; however, their status as engineers is often invisible or

contested (Seron et al., 2018). Substantiating the notion presented by Rudman and Phelan (2010) remarks that initiatives created and provided for women to be included are precarious rather than guaranteed. This is problematic as, despite legislative frameworks and affirmative action to prevent discrimination and gender inequality, it is still subtly being experienced in 21st-century societies.

The findings indicate that participants experienced this predicament and stated how they would need to act or present themselves in the engineering environment. Examples such as "*give your opinion and add your input, but don't say too much*" and *"don't show how smart you are, but also do not play dumb, as it feeds into the idea that you do not know what you are doing and shouldn't be here*". In essence, emphasising the tokenism displayed in organisations.

There is also a lack of female presence, such as mentors and support networks within engineering workplaces. Having support networks help improve women's experiences in this industry; therefore, a lack thereof can deter women and cause them to exit the industry (Hunt, 2016). Unfortunately, several female engineers encounter discrimination or stereotypes while in the industry. The responses from participants indicate this is still experienced by women, whether it is blatant or subtle. Again, instances, such as having to prove themselves and their abilities to be recognised, arose, and gender-role expectations and physical attributes contributed to the stereotype threat. The South African Government passed laws and acts, such as the Employment Equity Act No 55 of 1998, to assist disadvantaged groups where women were included (Naidoo & Kongolo, 2004). This and affirmative action were implemented, providing equal opportunities and rights in the workplace. Despite this, it is evident through this study and previous research that there is still a divergence in providing women with the same platform that their male counterparts receive in engineering.

Despite this, the findings suggest that the participants have established ways of coping and dealing with their barriers and challenges. The responses indicated that women often adapt to their behaviour and how they act. This was indicated through dress codes, being more assertive, and being tough to overcome the masculine environment. The 'old boys club' idea is presented; it refers to traditionally male-dominated occupations where men use discursive practices to exclude women. This social behaviour or interaction can be unintentional, as it is often unconsciously displayed (Du Plessis & Barkhuizen, 2015). Furthermore, the responses indicated that traditional gender-role expectations are still prevalent because women need to be doing jobs that are not physical, as the assumption is that they do not want to get their hands

dirty. Engineering is deemed to encompass its own culture; therefore, if women do not conform to this culture, they are considered outsiders (Weber, 2018). Women, therefore, adopt an anti-women approach, attempting to act like their male counterparts to receive acceptance (Du Plessis & Barkhuizen, 2015).

5.4 Limitations of study

Data was collected during the Covid-19 pandemic associated with restrictions to face-to-face contact. Interviews were, therefore, conducted using an online platform. Although this method proved effective in interviewing participants, Wi-Fi/Internet interruptions limited the interaction with participants, therefore, causing inconsistencies in the administering of the interviews. It resulted in connectivity problems and delayed the interview process. This study was conducted using a qualitative research method, providing for biases, such as participant bias. This refers to how an individual responds to interview questions based on what they believe is socially acceptable and not based on how they feel (Bryman et al., 2014). It can also produce researcher bias, which refers to the researcher interpreting and analysing data to subjectively meet their hypothesis and ask questions in a certain way to elicit a specific response (Bryman et al., 2014). The study was limited to only professional women engineers; therefore, a bias is presented as men were not interviewed.

Qualitative research is based on participants' own experiences and understanding/perception of events. A non-probability sampling method was used, and it cannot be determined how well the sample group represents the women engineering population.

The sample size used for the study was small, comprising 10 participants. While the intention was to obtain rich accounts of lived experience, the credibility of the research conducted may have been affected. For future research, a larger sample size should be considered.

5.5 Recommendations

Various recommendations are formulated based on the study findings and literature. Recommendations are discussed in four sections, indicating Recommendations for engineering organisations, Recommendations for education, Recommendations for mentoring, and Recommendations for improving the study and future research.

5.5.1 Recommendations for engineering organisations

According to the study and literature, several recommendations were presented for engineering organisations to inform them about practices and procedures that require improvement. The study suggests that formal and fair hiring practices be used while providing equal opportunities for aspiring engineers (Piwowar-Sulej, 2021). This includes identifying talent management requirements for professionals and aligning them with the company's goals and strategies (Piwowar-Sulej, 2021). The study suggests that organisations in South Africa change the status quo and create an engineering organisation that can be recognised for its encouragement and retention of engineers; this includes hosting job shadowing, providing coaching and being more involved in supporting men and women in this field.

This includes formalised onboarding programmes creating a space and work environment of inclusion and integrating new engineers into the organisation's culture, including common values, rituals, and languages (Du Plessis & Barkhuizen, 2015). Having performance appraisals in place to emphasise achievements, develop skills and provide feedback on areas of improvement is an important way to retain more engineers in engineering. Through these appraisals, women and interns starting their careers can, therefore, observe where they are adding value and how they can continue to grow in this industry (Laguador et al., 2020).

The researcher further suggests that organisations continue to encourage development by providing all employees with opportunities through job enlargement and rotation. They can, therefore, learn and grow (Grobler et al., 2011)—by involving them in bigger projects where they can add value by using their skills and abilities. This has a beneficial effect, as they are not only increasing their self-efficacy, but they are also connecting and networking with like-minded individuals.

5.5.2 Recommendations for education

A concern that arose in the research findings was that STEM subjecting and education around it was introduced too late to children. According to Peixoto et al. (2018), early childhood should be a focal point to incorporate solutions to introduce STEM subjects to children. Parents, teachers, and peers should encourage and promote STEM subjects to help assist development and interest at a later stage. Buchter et al. (2017) support this notion, explaining that the optimal development period for children to increase STEM interests and trajectories is early childhood.

Unfortunately, societal norms and gender-role expectations reinforce stereotypes and perceptions about STEM subjects. Hill et al. (2010) mention a common stereotype that regulates itself "boys are better at mathematics and sciences than girls"; this is often instilled into children's minds from an early age. This narrative should be changed, and children should be encouraged to understand that STEM subjects are acquired and not natural abilities; therefore, it can be worked on and improved.

Parents and schools are encouraged to introduce stimulating activities which involve simple and uncomplicated ways to grow passionate about science and mathematics. Activities should be introduced, such as science/chemistry kits where children can experiment with. It is a fun and informative way to learn about science. Introducing a microscope, educational programmes, visiting museums, and engaging in science experiments with children will help stimulate interest.

5.5.3 Recommendations for mentoring

Mentors and role models are integral in encouraging women to persevere and stay motivated in work environments. Formal mentorship programmes should be enforced where women are exposed to other female engineers. Women should be exposed to like-minded individuals, therefore, including men and women with a common goal of making a difference, thus, learning from everyone (Kazim et al., 2021). It is recommended that all support groups and mentorship programmes in the workplace follow a formal process where women's exposure to two mentors is a man and a woman; therefore, gender norms are not further encouraged and exclusion between "them" and "us" continue in the workplace (Du Plessis & Barkhuizen, 2015).

5.5.4 Recommendations for improving the study and future research

The study recommends a larger sample group to elicit rich data from and to gain a deeper understanding of the engineering sector and all that it encompasses. Qualitative research being subjective makes room for biases; therefore, a mix-research method combining quantitative and qualitative research would be appropriate. This will allow richer findings and improve the quality of the responses.

The research was conducted and not limited to a specific engineering field to allow a wider scope in Cape Town; however, a comparison should be made across South Africa, targeting major cities with women working in various engineering companies. This will allow

researchers to compare where the most improvements are concerning, including WiE, where we still fall short and to allow generalisation. The research could also target a specific engineering field that stands out as mostly male-dominated and research the experiences of men and women in that field. This will shed light on the significant issues in this field and what changes are needed to assist women.

Research should be conducted on men in the engineering sector to understand their experiences and their career progression better. This feedback should, therefore, be compared to that of WiE to emphasise the main differences and draw conclusions. Research can also be conducted on the challenges women experience at the various career levels in engineering. This may clarify which career-level women experience the greatest number of challenges/barriers that lead to the glass ceiling.

5.6 Conclusion

South Africa is recognised for its progressive Constitution (Kehler, 2001). The Constitution and various legislative frameworks eradicated discrimination and eliminate inequality in the country. Section 9 of the Constitution promotes and encourages gender equality and fair treatment (Bendeman & Dworzanowski-Venter, 2014). Organisations play a vital role in acting and practising the law to ensure equality in the workplace for all. This study, therefore, aimed to better understand women's experiences in a male-dominated industry and emphasise where improvements can be made and eliminate inequality. Previous research indicates that although there were improvements in the engineering sector and several initiatives created for women, they still lag compared to their male counterparts (Martin & Barnard, 2013; Masters & Meltzoff, 2017; Yates & Skinner, 2021).

The objective of the study was to explore the barriers women engineers experienced. Barriers were categorised between internal barriers (beliefs about skills and ability) and external barriers (support from others, discrimination, stereotypes, educational influences, work/life conflict, lack of opportunities/networks and mentors). Evidence suggest that societal norms still have a huge impact on women and their career choices/advancement. Men and women encounter a paradoxical state and there is often a clash between what is socially acceptable in households to what is acceptable in a workplace environment. Women engineers are seen as tokens and their contributions are often overlooked. Thus, women have found ways to cope and persevere in this industry. Women have adapted to the working environment by embracing and developing career resilience and career adaptability. This is achieved by stepping into their

"male energy", voicing their opinions, proving themselves, how they interact and dress, being role models and examples for future women engineers and developing self-efficacy.

It is evident through this research that there is room for opportunities for improvement by subsiding societal norms regarding gender-role expectations and providing more exposure, opportunities, and development for women in this sector. Furthermore, organisations providing mentors, support networks, and inclusive organisational cultures to assist women.

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APPENDIX A: INFORMATION SHEET FOR RESEARCH PARTICIPANTS (SEMI-STRUCTURED INTERVIEW)

Dear Participant,

I, Nina Jean, am currently studying towards my Master's degree in industrial psychology at the University of the Western Cape (student number: 3575662). At present, I am busy with my thesis and would like to invite you to participate in the research.

The title of my thesis is:

UNDERSTANDING THE EXPERIENCES OF FEMALE CAREER ADVANCEMENT IN ENGINEERING

Before you decide to participate in this study, it is important that you understand why the research is being done and what it will involve. Please take the time to read the following information carefully. Kindy advise me, as the researcher, if there is anything that is not clear or if you need more information.

1. PURPOSE OF THE STUDY

The purpose of the research is to understand the experiences of females working or have worked in the engineering sector. It aims to identify challenges or barriers that they encounter how they overcome these barriers as well as what initiatives have been created to enable them to continue their career paths.

2. PROCEDURE

If you volunteer to participate in this study, you will be invited to participate in a semi-structured interview (30-45 minutes) in which you will be asked different questions with the aim of reflecting on your own experiences and views to determine the following areas:

i. What is/was your field of engineering? Why did you make this career choice?
ii. Describe your perceptions of engineering prior to studying or entering the workplace and how and why it has changed from the time you started to where you are now?
iii. Do you think women and men have equal opportunities in engineering?

A copy of the semi-structured questions will be available to you before the interview. The interview will be voice recorded.

Risks:
The risks of this study are minimal. These risks are similar to those you experience when disclosing work-related information to others. You may decline to answer any or all questions and you may terminate your involvement at any time if you choose. The data will only be utilised for research purposes and will not in any way inform any performance management or promotion decisions related to yourself or your colleagues.

Compensation and Benefits:
There will be no compensation or direct benefits for participating in the research.

Confidentiality:
Any information that is obtained in connection with this study and that can be identified with you will remain confidential and will be disclosed only with your permission or as required by law. The results of this study will be published in the form of a completed dissertation as well as in an accredited journal(s), but confidentiality will be maintained. Participant's names will not be requested in the survey, nor published in any results.

Voluntary Participation:
You can choose whether to be in this study or not. If you volunteer to be in this study, you may withdraw at any time without consequences of any kind. You may also refuse to answer any questions you don't want to answer and remain in the study. The researcher may withdraw you from this research if circumstances arise which warrant doing so.

This study received ethical clearance from the Human and Social Sciences Ethics Committee of the

University of the Western Cape. They can be contacted at research-ethics@uwc.ac.za

Should you have any questions regarding this study or wish to report any problems you have experienced related to the study, please contact me at the details listed below:

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APPENDIX B: CONSENT FORM

Title: **Understanding the experiences of female career advancement in engineering.**
Researcher: Nina Jean (3575662)

	Please respond to the following statements:	**X**
1.	I confirm that I have read and understand the information sheet explaining the above research project and I have had the opportunity to ask questions about the project.	
2.	I understand that my participation is voluntary and that I am free to withdraw at any time without giving a reason and without there being any negative consequences. In addition, should I not wish to answer any particular question or questions, I am free to decline. (If I wish to withdraw I may contact the lead researcher at any time)	
3.	I understand my responses and personal data will be kept strictly confidential. I give permission for members of the research team to have access to my anonymised responses. I understand that my name will not be linked with the research materials, and I will not be identified or identifiable in the publications that result for the research.	
4.	I agree for the data collected from me to be used in future research.	
5.	I agree to take part in the above research project.	
6.	I agree that a voice recording of the semi-structured interview for this study may be done.	

Name of participant (or legal representative)	Date	Signature
Name of person taking consent (if different from lead researcher)	Date	Signature
Lead researcher (To be signed and dated in the presence of the participant)	Date	Signature

Student researcher:	Supervisors:	Head of Department:	Ethics Committee:
Nina Jean Masters student Tel: 071 298 1899 3575662@myuwc.ac.za	Mineshree Naidoo-Chetty Mcom Industrial Psychology Tel: 083 772 7875 minaidoo@uwc,ac.za Dr. Marieta du Plessis Tel: 021 959 3184 mduplessis@uwc.ac.za	Prof. Bright Mahembe Tel: 021 959 3184 bmahembe@uwc.ac.za	HSSREC Research and Development, UWC Tel: 021 959 2988 Researchethics@uwc.ac.za

APPENDIX C: INTERVIEW GUIDE

Understanding the experiences of female career advancement in engineering

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AGE: 20 or below ☐ 21-30 ☐ 31-40 ☐ 41-50 ☐ over 50 ☐

GENDER: Male ☐ Female ☐

ETHNICITY: White ☐ Coloured ☐ Black ☐ Indian ☐ Asian ☐ Other ☐

EDUCATION: Primary ☐ Secondary ☐ Certificate ☐ Degree or higher ☐

EMPLOYMENT: Employed ☐ Unemployed ☐

1. What is/was your field of engineering? Why did you make this career choice?

   _____
   _____
   _____
   _____

2. Describe your perceptions of engineering prior to entering the workplace and how it has changed from the time you started to where you are now?

   _____
   _____
   _____
   _____

   Probe: Explain why you have chosen to stay or leave engineering?

   _____
   ___

3. How did your parents, peers, teachers, academic advisors, and friends feel about your career choice?

   _____
   _____

   Probe: Describe their feelings/attitudes and opinions and what it means to you?

_____

___

4. Do you think males and females have equal opportunities in engineering?

_____

_____

_____

_____

Probe: Why do you think this occurs?

_____

___

Probe: What do you think are the main barriers/challenges females experience?

_____

___

5. Do you think there is a stereotype attached to female engineers?

_____

_____

_____

_____

Probe: Have you personally experienced or witnessed any discrimination/stereotypes in the engineering sector (in academia or in industry)?

_____

Probe: How does this impact you as a female in the engineering field?

_____

6. Do you perhaps feel that there is any support or successes females receive in engineering?

_____

_____

_____

_____

Probe: What do those experiences mean to you?

_____

_____

_____

7. What initiatives would you suggest, to create opportunities and encouragement for females in engineering or to join/stay in the engineering field? What initiatives can be created in the workplace as well?

_____

_____

_____

_____

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60 YEARS of hope, action & knowledge

21 May 2021

APPENDIX D: ETHICS CLEARANCE CERTIFICATE

Ms N Jean
Industrial Psychology
Faculty of Economic and Management Sciences

HSSREC Reference Number: HS21/3/19

Project Title: Understanding the experiences of female career advancement in engineering.

Approval Period: 19 May 2021 _ 19 May 2024

I hereby certify that the Humanities and Social Science Research Ethics Committee of the University of the Western Cape approved the methodology and ethics of the above mentioned research project.

Any amendments, extension or other modifications to the protocol must be submitted to the Ethics Committee for approval.

Please remember to submit a progress report by 30 November each year for the duration of the project.

The permission to conduct the study must be submitted to HSSREC for record keeping purposes.

The Committee must be informed of any serious adverse event s and/or termination of the study.

Ms Patricia Josias
Research Ethics Committee Officer
University of the Western Cape

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