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Understanding How Socio-Ecological Factors Affect Resilience and Persistence Among Students in Engineering Education in South Africa

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Declaration

This work has not been previously submitted in whole, or in part, for the award of any degree. I declare that the study "*Understanding How Socio-Ecological Factors Affect Resilience and Persistence Among Students in Engineering Education in South Africa*" is my own work, and that I followed the referencing style prescribed by the *Publication Manual* (7th edition) of the American Psychological Association (APA) for all in-text citations and reference-list entries only; the rest of the dissertation has been formatted in a consistent internal style, as noted by the examiner.

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Signed by candidate

February 4, 2025

Signature

Date

Acknowledgements

But those who wait on the Lord Shall renew their strength; They shall mount up with wings like eagles, They shall run and not be weary, They shall walk and not faint.
Isaiah 40:31

Above all, I extend my deepest gratitude to my Father in Heaven. His unwavering presence (Immanuel) has been my rock throughout this incredible journey. His boundless grace, wisdom, and strength have helped me at every step, enabling me with the knowledge, ability, and confidence to pursue this research with passion and perseverance. Without His divine guidance, blessings, and the countless opportunities He has placed before me, this research and learning experience would not have been possible.

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With all my heart, I dedicate this dissertation to my beloved sons. **Never give up, always chase your dreams, and remember, "Nothing is impossible with God."**

Abstract

Resilience is paramount in the demanding sphere of tertiary studies, particularly in engineering programmes that require significant cognitive and emotional investment. Guided by Ungar's Socio-Ecological Model of Resilience, this study examines the factors contribute to or hinder resilience and academic persistence among engineering students at a South African university of technology. The study was a qualitative analysis using insights from semi-structured interviews with seven senior engineering students.

Criterion sampling was employed to deliberately exclude first-year students to ensure sufficient academic experience with rigorous theoretical coursework and intensive laboratory sessions. Seven senior engineering students participated, and data were collected via semi-structured, online interviews using Microsoft Teams, each lasting between 45 to 60 minutes. Interviews were recorded, transcribed verbatim, and analysed using Deductive Thematic Analysis. Themes were mapped explicitly onto Ungar's ecological framework, ensuring rigorous alignment between theoretical concepts and empirical data.

In Ungar's framework, resilience results from active interweaving of factors at four ecological levels: macrosystem, microsystem, exosystem, and mesosystem. At the microsystem level, encouragement by members of the faculty, positive relationships with peer students, and curricular requirements that are well structured offer the greatest contributory factors to student motivation. Family and community support as well as mentorship create strong pillars within the mesosystem and are supported at the campus level. At the exosystem level, institutional policies and infrastructure demonstrate how challenges regarding access to financial aid and bureaucracy, as well as problems like unstable electricity supply, at times diminish students' resilience, but in some cases may support it. At the macrosystem level, societal perceptions of engineering as both

prestigious and demanding shape students' aspirations and pressures, underscoring the need for broader cultural and systemic support.

These findings refine Ungar's model by highlighting engineering-specific challenges, such as lab-intensive coursework and infrastructural constraints, and underscoring how multi-tiered interventions can foster resilience in resource-limited contexts. Practical recommendations include streamlining funding and administration, implementing empathy training for academic staff, adapting curricula to local conditions, and forging collaborative ties with families and communities. By viewing resilience as a socially anchored process rather than purely an individual trait, the study calls for coordinated efforts to empower engineering students, ultimately enriching both their academic success and the broader STEM - science, technology, engineering and mathematics - landscape in South Africa.

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CHAPTER 1: INTRODUCTION

1.1 BACKGROUND OF THE STUDY

In developing nations like South Africa, the field of engineering education serves as a pivotal force for technological innovation and economic advancement. Student retention and graduation rates pose a major concern for all engineering programmes around the world, and in particular South Africa. Such rigorous programmes may lead to a high attrition rate. Combined with the socio-economic hurdles that South African learners must cross, it may render the decision of persisting, and finally graduating, even more complex (Bengesai & Pocock, 2021).

Challenges in Engineering Education in South Africa

The disparity between the skill sets required to strengthen South Africa's economy and those possessed by engineering professionals is substantial. According to the Engineering Council of South Africa (ECSA, 2023), the nation faces a significant shortage of engineers, which hampers infrastructure development and economic growth. This shortage is exacerbated by the perception among industries that new graduates are underprepared, leading to challenges in securing initial employment. Telukdarie and Munien (2023) highlight that South African Technical and Vocational Education and Training (TVET) colleges often fail to produce graduates who meet industry requirements, further contributing to the skills gap.

With this in view, the South African Engineering Council (ECSA, 2023) works tirelessly in a quest to promote engineering and maintain high engineering programmes' standards (ECSA, 2023). Despite abundant programmes to train engineers, artisans, and technicians to serve infrastructure and economy objectives in the country, they fall short (ECSA, 2023). According to a report by the Manufacturing, Engineering and Related Services Sector Education and Training

Authority, the shortage of highly skilled individuals is a significant barrier to the completion of strategic infrastructure projects outlined in South Africa's National Development Plan (Manufacturing, Engineering and Related Services Sector Education and Training Authority, 2019).

High Dropout Rates and Socio-Economic Challenges

One of the biggest obstacles to the engineering industry is a high dropout rate, specifically of first-year students in South African tertiary studies. In studies, approximately 33% of first-year students drop out of studies (Council on Higher Education, 2013; Department of Higher Education and Training, 2019, as cited in Motsabi et al., 2020), with even larger dropout rates for first-generation students.

This problem is often accompanied by socio-economic factors such as financial difficulty, poor living and housing environments, lack of proper resources, access to medical care, and family relationships, to name but a few (Casanova at al., 2021).

Socio-economic challenges have a profound impact on students' persistence in engineering programmes. Most students hail from disadvantaged communities (Ghaleb et al., 2024), with access to such basic amenities as reliable internet connectivity, electricity, and quiet spaces for studying not being guaranteed. Approximately 40% of South Africans, according to the World Bank (2018), fall below the national poverty level, and this inescapably constrains them in accessing tertiary studies.

Reliable transportation is a significant issue, and most challenging for students with long commuting distances. Public transport in many parts of South Africa is unreliable and insecure. Transport disruptions can mean delayed submissions and absenteeism, and academic

performance inevitably suffers. For car owners, high car maintenance and fuel expenses mean an added financial burden (Pretorius, 2019).

Health issues, both mental and physical, also make a significant contribution. Healthcare can become limited, and in most cases, students in rural communities have reduced access to it. Chronic disease, mental illnesses such as depression and anxiety, and overall general well-being concerns about malnutrition and poor living standards can result in poor academic performance (Van der Walt et al., 2020). In a study conducted by Van der Walt et al. (2020), a high proportion of over 30% of university students experienced high levels of stress and anxiety, which affected them academically in a negative way.

1.2 PROBLEM STATEMENT

Engineers play a vital role in tackling South Africa's development challenges, but student retention in engineering programmes is still a major issue. High dropout rates are often due to factors like limited resources, poor infrastructure, and socio-economic hardships (Bengesai & Pocock, 2021). Additionally, infrastructural challenges such as electricity 'load shedding' and funding uncertainties further undermine student persistence (Theron & Van Breda, 2018).

However, some students manage to persist and succeed despite these obstacles, suggesting that resilience plays a crucial role in their academic journeys. Understanding why some students persist and succeed despite these challenges can provide valuable insights into the role of resilience in academic success (Hansen et al., 2014).

While more recent studies have examined resilience within the South African higher education sector (Theron & Theron, 2020; Van Breda, 2018), there remains limited research specifically exploring how resilience is cultivated and sustained among engineering students. However,

much of the existing literature either focuses on resilience as an individual trait or is rooted in Western contexts that do not account for the structural and socio-cultural barriers unique to South African universities (Masten, 2001; Theron, 2016), thereby overlooking the unique challenges faced by South African institutions, such as infrastructural issues (e.g., load shedding), funding delays, and culturally specific pressures.

This study addresses that gap by providing empirical data from in-depth interviews with engineering students at a South African university of technology. In doing so, it applies and refines Ungar's (2008) Socio-Ecological Model of Resilience to reveal how various systems, from immediate academic environments and family support to institutional policies and societal attitudes, interact to shape student resilience. This research not only offers a fresh interpretation of resilience within a resource-constrained, post-apartheid context but also generates practical recommendations for educational institutions and policymakers, thereby contributing a much-needed perspective to the literature.

Resilience as a Critical Factor

In this context, resilience emerges as a critical factor that can influence student persistence in higher education. Resilience, defined as the capacity to recover quickly from difficulties and adapt in the face of adversity (Masten, 2001), has been increasingly recognised an essential contributor to academic success.

More related to this study, academic resilience, refers to the ability of students to manage stressful situations and continue to achieve good academic results despite challenges (Morales, 2008; Turner et al., 2018). Previous studies suggest that students who encounter unfavourable conditions are required to be more resilient to manage these situations effectively and achieve

success (Borman & Overman, 2004; Martin & Marsh, 2009). However, the specific role of resilience in the persistence of engineering students at South African universities of technology remains underexplored.

Purpose Of the Study

The goal of this research study is to examine the intricate concept of resilience - specifically, what helps engineering students to persist in their studies despite various challenges. My research is grounded in Ungar's Socio-Ecological Model of Resilience (Ungar, 2008). It allows for a detailed examination of how different factors, from the immediate environment and personal characteristics to broader societal influences, combine to support a student's ability to overcome academic obstacles.

Institutional and Systemic Barriers

Engineering programmes in South Africa also face institutional and organisational challenges that affect student persistence. These include limited academic support, poor infrastructure, and a lack of specific interventions to support affected students (Tchamdjeu, 2018). Additionally, the demanding nature of the engineering curriculum and the high demands placed on students (Pitterson et al., 2024) can increase stress and overwhelm students, contributing to higher dropout rates.

Impact of Social Support Networks

The role of social support networks in student persistence is significant. Studies have shown that students with strong support systems, including family, peers, mentors, and institutional support structures are more likely to persist in their studies despite challenges (Motsabi et al., 2020).

However, many engineering students, particularly those from disadvantaged backgrounds, lack these essential support networks, further increasing their risk of dropping out.

1.3 RESEARCH QUESTIONS

The study aims to fill the gap in the current literature by exploring the concept of academic resilience at the university level, specifically among engineering students in South Africa. The research investigates how various factors, such as socio-economic conditions, institutional support, and personal attributes, contribute to or hinder resilience and persistence in engineering education. To address this problem, the study is guided by the following research question and sub-questions derived from Ungar's Socio-Ecological Model of Resilience (Ungar, 2008):

How do socio-ecological factors across individual, relational, institutional, and societal systems interact to shape the resilience and academic persistence of engineering students at a South African university of technology?

1. **Microsystem Influences:**

   "How do the immediate educational environment and personal relationships within the university, such as interactions with faculty, peers, and the curriculum, contribute to the resilience of engineering students at a university of technology in South Africa?"

2. **Mesosystem Influences:**

   "In what ways do engineering students experience the intersection between family and social support networks and university life, and how do they perceive these interactions in relation to their resilience and academic persistence?"

3. **Exosystem Influences:**

   "How do engineering students perceive institutional policies, community resources, and broader educational practices as shaping their experiences of resilience and persistence in their studies?"

4. **Macrosystem Influences:**

   "How do societal attitudes towards engineering education and the engineering profession, including cultural values and expectations, relate to the resilience and persistence of students in their engineering studies at a university of technology in South Africa?"

The objectives of this study are to:

- Examine the role of the immediate educational environment and personal relationships in fostering resilience among engineering students.
- Explore the influence of family and social support networks on student resilience and persistence.
- Assess the impact of institutional policies and community resources on the ability of students to persist in their studies.
- Understand the broader societal attitudes towards engineering education and how these affect student resilience and persistence.

To address these socio-ecological research questions, this study employs a qualitative research design that centres on semi-structured interviews and the use of Deductive Thematic Analysis (Braun & Clarke, 2006, 2021). This methodological approach enables a detailed exploration of how individual, relational, and contextual factors interact to shape student resilience. As outlined

in Chapter 3, the qualitative lens allows for the collection and analysis of rich, firsthand accounts from engineering students, providing nuanced insights into the challenges they face and the support systems that sustain them. Ultimately, the findings will inform the development of targeted interventions to improve student retention and success in South African universities.

1.4 SIGNIFICANCE OF THE STUDY

Applying frameworks like Ungar's Socio-Ecological Model of Resilience will help guide policymakers and educational institutions to create more supportive learning environments, addressing both the social and academic challenges faced by engineering students (Chiramba, 2021). It will help to understand how resilience operates within the socio-ecological context of South African universities, (Ungar, 2008).

Research consistently shows that resilience is a key factor in academic success (Hansu et al., 2023), particularly in challenging fields such as engineering. Resilient students are better equipped to handle the stresses and adversities inherent in rigorous academic programmes (Hart et al., 2014; Martin & Marsh, 2006). Building on the existing literature on resilience in engineering students (Winkens & Leicht-Scholten, 2023), this study identifies specific resilience factors that contribute to persistence in South African engineering students.

Practical Implications

The findings from this study have practical implications for educational policy and practice. By providing a detailed understanding of the factors that contribute to resilience, the research can guide the creation of targeted support programmes and interventions. such as mentorship schemes, financial aid packages, mental health services, and academic support initiatives tailored to the needs of engineering students.

Moreover, understanding the role of resilience in academic persistence can help policymakers and educational leaders develop strategies that address the broader socio-economic challenges faced by students. For instance, improved access to reliable transportation, better healthcare services, and enhanced financial support can significantly impact students' ability to succeed. Such comprehensive approaches can contribute to a more equitable and supportive educational environment, ultimately leading to higher graduation rates and a more skilled workforce to meet South Africa's developmental needs.

The study also contributes to the academic literature on resilience in higher education (e.g. Brewer et al., 2019; Chua et al., 2023), offering empirical evidence on how resilience operates within the socio-ecological framework and its impact on student persistence and success in engineering education.

Previous Research Insights

Previous studies have shown that resilience in the educational contexts often results from a combination of supportive relationships, access to resources, and positive institutional policies. For instance, STEM (science, technology, engineering and mathematics) academics' resilience has been linked to their ability to adapt to educational reforms and the support they receive from their academic communities and institutions (Gale & Parker, 2022). This resilience is often relational, influenced by the dynamic interaction between personal attributes and external environments (Sung et al., 2024).

Moreover, resilience in engineering education has been explored through various lenses, including the impact of community and cultural support, institutional policies, and societal attitudes towards education (Naderpajouh et al., 2018; Ungar, 2011). These studies underscore

the importance of a supportive environment and the availability of resources in fostering resilience among students.

1.5 DEFINITION OF TERMS

- **Resilience:** The capacity to recover quickly from difficulties and adapt in the face of adversity.
- **Persistence and Retention:** Although persistence and retention both refer to a student continuing their education until they complete a degree or certificate, there is a subtle difference between the two. **Retention** typically refers to the ability of an institution to keep students enrolled until graduation. It focuses on the institution's practices and does not consider the student's personal decision-making process or external factors beyond the institution's control. In contrast, **persistence** includes all influences, both from the institution and external factors, that impact a student's motivation and decision to stay enrolled in their programme (Braxton et al., 2004).
- **The National Science Foundation definition of STEM** includes the following disciplines: Engineering, Physical Sciences, Mathematics and Computer Sciences, Life/Biological Sciences, Social/Behavioural Sciences (Economics, Psychology and Social Sciences).
- **NSFAS -** National Student Financial Aid Scheme, is a South African government initiative designed to provide financial assistance to students from disadvantaged backgrounds pursuing higher education.

1.6 ORGANISATION OF THE THESIS

This dissertation is structured as follows:

- **Chapter 2:** (Literature Review) Examines resilience frameworks, including Ungar's Socio-Ecological Model, to contextualise the four research questions guiding this study.
- **Chapter 3:** Describes the research methodology.
- **Chapter 4:** Describes the data analysis.
- **Chapter 5:** Presents the findings.
- **Chapter 6:** Discusses the findings in relation to the literature.
- **Chapter 7:** Concludes with a summary of findings, implications for practice, and recommendations for future research.

CHAPTER 2: LITERATURE REVIEW

2.1 INTRODUCTION

The previous chapter outlined the context and objectives of the research study, which is to investigate how socio-ecological factors interact to shape the resilience and academic persistence of engineering students at a university of technology in South Africa. This chapter presents the literature review to establish foundational knowledge on resilience and persistence.

This chapter lays the conceptual foundation for examining how senior engineering students at a South African university of technology develop the resilience required to persist in their studies. It is organised in six major sections. Section 2.2 situates the study in the local socio-economic and educational landscape of South Africa; Sections 2.3, 2.4, and 2.5 then introduce three distinct but complementary bodies of theory:

(i) **Resilience theories** (Rutter and, subsequently, Ungar),

(ii) **Student persistence theory** (Tinto), and

(iii) an overarching **developmental, ecological perspective** (Bronfenbrenner).

Section 2.6 will end the chapter and summarises the key insights.

The conceptual arc begins with Michael Rutter's pioneering resilience research, which established that some individuals achieve positive outcomes despite substantial adversity by mobilising protective factors. Rutter's focus on risk, protection and adaptive functioning provides the individual-level bedrock for this study. Building on that foundation, Urie Bronfenbrenner's Ecological Systems Theory adds a multi-layered developmental lens, portraying individuals as embedded within nested microsystems, mesosystems, exosystems and macrosystems. While Bronfenbrenner did not write explicitly about resilience, his ecological

architecture helps explain *where* protective resources reside and *how* different layers of context interact to shape developmental trajectories. Section 2.3 expands further on each layer.

Michael Ungar's Socio-Ecological Model of Resilience explicitly weds Rutter's individual-adaptation insights to Bronfenbrenner's ecological scaffold. Ungar shifts the analytic focus from "traits people possess" to "processes people enact," emphasising navigation and negotiation for culturally meaningful resources (Theron et al., 2011; Ungar, 2008). Because Ungar's model was itself inspired by Bronfenbrenner, it provides a ready-made bridge between individual and contextual explanations, precisely the integration required to understand resilience in resource-constrained South African settings. By doing so, Ungar's model provides a more comprehensive understanding of how resilience is built and sustained, recognising that resilience is not just an individual quality but is also shaped by the broader environment and social context in which a person lives.

Finally, Vincent Tinto's Theory of Academic and Social Integration is introduced—not as a resilience framework, but as the field's most influential model of *student persistence*. Tinto explains why students remain or depart by analysing the conditions under which they become academically and socially integrated into an institution. Positioning Tinto alongside (rather than within) resilience scholarship allows the study to connect micro-level resilience processes with the meso-level institutional mechanisms that shape persistence decisions.

Taken together, these four theorists offer a layered conceptual toolkit:

- **Rutter** pinpoints *who* adapts and *under what risks/protections*.
- **Bronfenbrenner** maps *where* those risks and protections reside.
- **Ungar** explains *how* students navigate and negotiate multi-level resources.

- **Tinto** clarifies *why* successful navigation translates into persistence—or not—inside higher-education settings.

This integrated framework guides the study's research questions (framed at micro-, meso-, exo- and macro-levels), informs the semi-structured interview schedule and directs the deductive thematic analysis. By the end of the chapter, the reader will see how each theoretical strand weaves into a coherent lens for interpreting the lived experiences of South African engineering students striving to remain, and succeed, in their programmes.

Through this structured review, the chapter sets the stage for the empirical investigations outlined in Chapters Four and Five, providing the necessary theoretical and contextual backdrop for analysing the data collected from the participants.

Having established the significance of resilience within higher education, the next section examines the specific challenges faced by South African students, setting the stage for a deeper exploration of resilience in this context.

2.2 THE SOUTH AFRICAN CONTEXT

In the heart of South Africa's dynamic landscape lies a unique group of students navigating a myriad of challenges to pursue their dreams of becoming engineers. These students, hailing from diverse backgrounds, often face substantial barriers that test their determination and resilience. The journey of an engineering student in South Africa is not merely an academic endeavour; it is a story of survival, adaptation, and relentless perseverance (Case et al., 2018).

South Africa's position as the most economically inequal country (McKeever, 2024) has made a significant mark on its education system. Many students come from rural areas where poverty is rampant, and access to basic amenities is limited. These young scholars embark on their

academic journey with the hope of breaking the cycle of poverty, yet they are met with numerous challenges that threaten their educational aspirations.

One of the significant challenges exacerbating the difficulties faced by South African students is load shedding. The deliberate shutdown of electric power in parts of the power-distribution system, is a strategy used to prevent the grid from being overwhelmed. In South Africa, load shedding has become a frequent and disruptive occurrence, profoundly impacting students' academic lives (Yende, 2024).

However, the impact of load shedding extends beyond rural and underprivileged students. Middle-class students, who generally have greater access to resources and reside in urban areas, are also significantly affected. These students typically rely heavily on uninterrupted electricity and internet access to manage their academic work. Although they may have personal computers, access to digital resources, and stable study environments, frequent power outages often render these advantages ineffective. Even those with backup systems such as generators or inverters find their productivity and concentration disrupted, as their study routines become unpredictable and fragmented.

Pearson et al. (2017) argue that socio-economic factors have a profound influence on student persistence in engineering education. They highlight that both privileged and underprivileged students encounter distinct sets of obstacles that demand resilience. For middle-class students, the challenge is not only the academic competition but also the pressures of urban life, compounded by infrastructural instability like load shedding. In such an environment, developing effective coping strategies and accessing support systems becomes essential for maintaining academic progress.

The consequences of load shedding are interwoven with other structural issues that cut across socio-economic boundaries. When students cannot rely on stable electricity, their study schedules become erratic, often forcing them to study under inadequate lighting or depend on battery-powered devices. The unpredictability of these interruptions makes it difficult to plan, leading to increased stress and reduced productivity. For engineering students, whose work depends heavily on digital tools, online resources, and specialised software, this disruption has a particularly serious impact. Assignments may go unfinished, learning is stalled, and deadlines become difficult to meet.

In addition to these logistical difficulties, the psychological toll of constant disruption cannot be overlooked. The uncertainty surrounding electricity availability contributes to heightened anxiety, making it harder for students to manage academic demands. And yet, load shedding is only one part of a broader context of systemic obstacles. Financial strain continues to affect many students, even those from middle-income families. The costs of tuition, learning materials, transport, and food often require them to take on part-time work, which cuts into their study time and adds further pressure.

Transportation also poses ongoing challenges. Students who commute from distant areas face unreliable and often unsafe public transport systems, while those who drive must contend with the high cost of fuel and maintenance. Safety concerns, particularly related to crime in urban areas, add to this sense of vulnerability and can inhibit students' ability to focus or engage fully with university life. Moreover, limited access to healthcare, especially for students from rural areas, exacerbates the risk of health-related disruptions, whether due to malnutrition, chronic illness, or mental health conditions such as anxiety and depression.

Compounding these challenges is the uneven quality of schooling in South Africa. Many students from under-resourced schools begin their university studies underprepared for the cognitive and emotional demands of engineering programmes. Without adequate academic foundations, they struggle to keep up, increasing their risk of failure or dropout. This mix of personal, infrastructural, and systemic barriers underscores the urgency of understanding resilience not merely as an individual trait, but as something shaped by a broader socio-educational ecosystem.

Understanding these contextual challenges is critical, as they form the backdrop against which resilience is developed. With this context in mind, the following section turns to the evolution of resilience as a concept, tracing its development from individual traits to a dynamic, multi-layered process.

2.3 BRONFENBRENNER'S ECOLOGICAL SYSTEMS THEORY

2.3.1 Overview

Urie Bronfenbrenner's Ecological Systems Theory, introduced in the 1970s and refined over time, provides a comprehensive framework for understanding human development within the context of multiple environmental systems (Bronfenbrenner, 1979). He proposes that individual development is shaped by interactions across multiple interconnected systems, and that understanding growth requires attention to the broader ecological environment in which it takes place. At the core of this theory are five nested environmental systems (Bronfenbrenner, 1986):

1. **Microsystem**: Immediate environments like family, school, and peers. This level has the most direct impact on the individual.

2. **Mesosystem**: Interactions between different microsystems, such as the relationship between family experiences and university experiences.
3. **Exosystem**: External environments that indirectly affect the individual, such as university policies or community resources.
4. **Macrosystem**: Broader societal and cultural contexts, including norms, values, and laws.
5. **Chronosystem**: The dimension of time, including life transitions and historical events that impact development over time.

A key principle of Bronfenbrenner's theory is that development occurs through complex interactions between an individual and their environment. These interactions, which Bronfenbrenner termed "proximal processes," become progressively more complex over time (Bronfenbrenner & Morris, 2006). The theory emphasises that an individual is not a passive recipient of environmental influences but actively participates in their own development through these interactions.

Bronfenbrenner's Ecological Systems Theory has had a profound impact on various fields, including psychology, education, and sociology. It provides a holistic approach to understanding human development, encouraging researchers and practitioners to consider multiple levels of environmental influence (Rosa & Tudge, 2013). This comprehensive perspective has made it a valuable framework for studying complex phenomena such as resilience, as it allows for the examination of both immediate and broader contextual factors that may influence an individual's ability to adapt and thrive in the face of adversity.

The theory has evolved over time, with Bronfenbrenner himself refining and expanding his ideas. In later versions, he placed greater emphasis on the role of the individual in their own

development and the importance of time in understanding developmental processes (Bronfenbrenner & Morris, 2006). This evolution has made the theory even more applicable to diverse research contexts, including studies of resilience and persistence in higher education settings.

2.3.2 Critique and Limitations of Bronfenbrenner's Ecological Systems Theory

Despite its wide application in fields such as education and psychology, Bronfenbrenner's Ecological Systems Theory has drawn several critiques. One common concern is the theory's complexity, which, while offering a comprehensive view of development, can make it difficult to operationalise in empirical research (Tudge et al., 2009). Researchers often find it challenging to measure the dynamic interactions across systems, especially when it comes to distal layers such as the macrosystem and chronosystem (Darling, 2007).

Another critique relates to cultural bias. Although Bronfenbrenner acknowledged the role of culture in development, some scholars argue that the theory does not fully capture cultural variability and tends to reflect Western norms (Vélez-Agosto et al., 2017). This critique holds particular relevance in the South African context, where cultural diversity and structural inequality intersect in complex ways.

In addition, the theory's strong focus on environmental systems has been said to underemphasise individual agency and biological influences (Christensen, 2016). While Bronfenbrenner later added the chronosystem to address change over time, some argue that the model still lacks the dynamism needed to account for shifting developmental processes and the evolving nature of environmental systems (Elder, 1998).

Others have pointed out that the theory's emphasis on developmental processes can come at the expense of clarity around specific outcomes. This can be a limitation when the goal is to predict or explain resilience or academic persistence in measurable terms (Maynard et al., 2014). Additionally, critics note that the theory does not adequately incorporate biological or genetic dimensions, which are now recognised as important contributors to resilience (Eccles & Wigfield, 2002; Marazziti et al., 2024).

Finally, while the framework has been extended to higher education, it was originally conceptualised with child development in mind. As such, some aspects may not translate neatly to the realities of adult learners in university contexts, particularly in terms of autonomy, identity development, and institutional engagement (Renn & Arnold, 2003).

2.4 THEORIES OF RESILIENCE

This section explores how resilience has been defined and theorised over time, highlighting seminal works and key shifts, from viewing resilience as a static individual trait to understanding it as a complex process involving multiple environmental factors.

2.4.1 Historical Overview and Seminal Works

Despite considerable obstacles, many engineering students display remarkable resilience. The concept of resilience has undergone considerable evolution in research over the past few decades. Initially viewed as an individual trait or capacity (Rutter, 1987), perspectives shifted to emphasise resilience as a dynamic process involving interactions between individuals and their environments (Masten, 2001). This shift paved the way for ecological and socio-ecological models of resilience.

2.4.2 Professor Michael Rutter and the Foundations of Resilience Theory

2.4.2.1 Introduction

To understand the importance of resilience within educational settings, particularly among engineering students in a South African university, requires detailed foundational theories. Among the most influential contributors to this domain is Professor Michael Rutter (1933–2021). His extensive research into child psychiatry and psychology has significantly shaped contemporary understandings of resilience.

Rutter's work focuses one the interplay between individual differences, such as temperament, personality, and genetics in resilience. Rutter's studies indicate that resilience is much more than just positive mental health and social competence (Rutter, 2006).

This review delves into Rutter's theoretical contributions and explores their relevance to examining resilience in engineering students.

2.4.2.2 Michael Rutter's Contributions to Resilience Theory

Rutter defined resilient individuals as those who achieve relatively positive outcomes despite facing the same serious stressors or adversities as others (Rutter, 1987). His Isle of Wight study compared children from the Isle of Wight with disadvantaged children from inner London (Rutter, 1979). The study found that increased exposure to risks heightened the likelihood of children developing psychiatric disorders (Rutter, 1979). These findings suggest that cumulative risks, such as experiencing multiple adverse conditions, are linked to poorer outcomes and a higher risk of psychiatric disorders (Fryers & Brugha, 2013).

His investigations into the mechanisms of resilience have provided a broad framework that extends beyond the confines of positive mental health and social competence. His seminal text,

Implications of resilience concepts for scientific understanding (Rutter, 2006), argues that resilience involves complex interactions between environmental stressors and individual responses. Rutter challenged earlier notions that resilience was a mere return to equilibrium following adversity. Instead, he proposed that true resilience manifests through positive adaptation in the face of significant challenges (Rutter, 2006).

2.4.2.3 Individual Differences in Resilience

A cornerstone of Rutter's research was the acknowledgment of individual differences in the development of resilience. He emphasised that factors like genetics, temperament, and personality significantly influence how individuals respond to stress and adversity. For instance, Rutter highlighted that a child's temperament could affect their sensitivity to environmental contexts, thereby moderating their response to potential stressors (Rutter, 1987).

This perspective is supported by further studies, such as those by Masten et al. (1990), who identified "resilience factors" that include individual attributes such as problem-solving skills, self-esteem, and self-efficacy. Rutter extended these findings by integrating genetic predispositions into the framework, suggesting that biological factors also play a critical role in shaping resilient outcomes (Rutter, 2006).

Rutter's extensive research led him to formulate several key principles of resilience (Rutter, 2006, 2007, 2012, 2013). One such principle states that resilience is a normal adaptive response, provided that the right resources are available (Rutter, 2007). By this, Rutter challenges the notion of invulnerable individuals, instead attributing differences in resilience to genetic factors that influence a child's sensitivity to environmental changes (Rutter, 2007). Additional studies have identified various genes and polymorphisms associated with resilient traits, which play a

significant role in how individuals respond to trauma and stress (Feder et al., 2009; Niitsu et al., 2022).

2.4.2.4 Conclusion

The exploration of resilience through the lens of Professor Michael Rutter's seminal work on resilience theory provides a robust foundation for understanding the complex interplay between individual characteristics and environmental factors in shaping resilient outcomes. His research, particularly the Isle of Wight studies, illuminated the cumulative nature of risk factors and the critical role of positive school environments in fostering resilience (Rutter, 1979).

Rutter's emphasis on individual differences in resilience (Rutter, 1987) aligns well with the diverse student population in South African higher education. His findings on the importance of positive child-parent relationships and supportive school environments (Rutter, 1979) can be extrapolated to the university context, suggesting that supportive faculty-student relationships and a positive campus climate may be crucial for engineering students' resilience and persistence.

Furthermore, Rutter's conceptualisation of resilience as a dynamic process rather than a fixed trait (Rutter, 2006), resonates with the challenges faced by engineering students, who must adapt to rigorous academic demands and rapidly evolving technological landscapes. This perspective is particularly relevant when considering the Socio-Ecological Model proposed by Ungar (2008), which forms the theoretical framework for this study.

While Rutter's work provides invaluable insights, it is important to note that his research primarily focused on child and adolescent populations. Therefore, in applying these concepts to university students, we must consider the unique developmental stage and challenges faced by

young adults in higher education (Arnett, 2000). Additionally, the South African context presents specific socio-economic and cultural factors that may influence resilience in ways not fully captured by Rutter's Western-centric studies (Theron & Theron, 2010; Theron et al., 2020).

By integrating Rutter's foundational work with Ungar's Socio-Ecological Model, we aim to gain a nuanced understanding of the factors that contribute to persistence in engineering education within this specific context.

Having reviewed the foundational ideas and historical evolution of resilience, it is now important to examine specific theoretical models that capture the multifaceted nature of resilience.

2.4.3 Ungar's Socio-Ecological Model of Resilience

2.4.3.1 Overview

Ungar extended Bronfenbrenner's framework to focus specifically on resilience, emphasising hat resilience is not solely an individual trait but a product of interactions between individuals and their environments. He highlights that resilience processes are shaped by cultural contexts, with what counts as resilience varying depending on a person's cultural background and environment (Ungar, 2004; 2008). Ungar recognised that Bronfenbrenner's model, while comprehensive, did not fully account for the vast cultural diversity in how resilience is understood and manifested across societies.

While Bronfenbrenner's model acknowledges the importance of environmental systems, Ungar's extension places greater emphasis on the role of the environment in fostering resilience, suggesting that resilience is more a quality of the child's social and physical ecology than of the child itself (Ungar et al., 2007). He stresses not just the presence of resources but also their

accessibility and cultural relevance, arguing that resilience is more likely when environments provide resources in ways meaningful to individuals within their cultural context (Ungar, 2011).

Ungar's model moves beyond viewing resilience as a set of individual traits or outcomes to understanding it as a complex process involving individuals interacting with their environment to access resources and experiences that support well-being (Ungar, 2008). He introduces the concept of *tension* in resilience processes, where individuals navigate competing demands and resources in their environment, adding complexity not fully captured in Bronfenbrenner's original model (Ungar, 2015).

Although Bronfenbrenner's model was initially focused on child development, Ungar's extension broadens its applicability to diverse populations, including adolescents and adults facing various adversities (Ungar, 2013). This has important implications for interventions, suggesting that promoting resilience requires focusing not only on individual capacity building but also on enhancing environments' capacity to provide culturally meaningful resources (Ungar, 2011).

2.4.3.2 Key Components and Interacting Systems

Ungar's socio-ecological model identifies multiple, interacting systems that contribute to resilience. These include:

- **Individual factors** such as self-efficacy, motivation, and coping strategies, which shape how a person responds to adversity (Bandura, 1997).
- **Relational factors**, including support from family, friends, and mentors, which provide emotional and practical assistance (Luthar & Cicchetti, 2000).

- **Community-level factors**, such as available resources and institutional support, which influence the opportunities and constraints individuals face.
- **Cultural and contextual factors**, including shared beliefs, traditions, communication styles, political conditions, and socioeconomic background. These shape how resilience is understood, what counts as a "positive outcome," and how people access support (Ungar, 2011).

Each of these levels operates within broader societal and policy frameworks, such as educational equity initiatives and institutional climate. Universities, for example, can enhance resilience by creating inclusive environments that respond meaningfully to student needs (Ungar, 2011).

2.4.3.3 Resilience as a Dynamic Process

Ungar views resilience not as a fixed trait, but as a dynamic and evolving process. It involves the active **navigation** of available resources and the **negotiation** of access to those resources in ways that are culturally and contextually meaningful (Ungar, 2008). This aligns with Bronfenbrenner's emphasis on development over time, captured in his chronosystem, and adds complexity by acknowledging that students must often manage competing demands in their environment (Ungar, 2015).

2.4.3.4 Implications for Higher Education

Applying this model to engineering education highlights the importance of tailoring interventions to the diverse realities students face. Supporting student success means addressing both individual capabilities and the broader systems that enable or hinder resilience. For example, building academic skills may be insufficient without also addressing cultural inclusion, peer support, and access to resources. The discussion of Ungar's model underscores the

importance of considering multiple, interacting factors when examining resilience. This understanding naturally leads to a review of various resilience theories that address psychological, social, and environmental dimensions.

2.5 VINCENT TINTO'S THEORY OF PERSISTENCE

Vincent Tinto's theory of student integration provides a valuable lens for understanding resilience in educational settings, particularly among engineering students at South African universities. His influential work on student retention, especially the book *Leaving college: Rethinking the causes and cures of student attrition* (Tinto, 1993), has shaped higher education research globally. This section examines how Tinto's theory can help explain persistence and resilience among students navigating demanding academic and social environments. Vincent Tinto first introduced his influential theory explaining undergraduate student dropout rates in his seminal 1975 work (Tinto, 1975). Despite the theory's evolution over the decades, its foundational framework remains a cornerstone in the study of student persistence and retention in higher education (Braxton et al., 1997; Berger & Lyon, 2005; Kuh et al., 2006). Tinto's model has achieved near-definitive status in the field, sparking widespread interest and inspiring new research streams focused on understanding why students leave higher education institutions and how institutions can address these trends (Braxton et al., 1997).

At the heart of Tinto's theory is the idea that students enter higher education with a set of characteristics shaped by their family background, individual attributes, and pre-college experiences. These factors influence their initial goals and commitments. As students navigate their academic careers, their interactions within the institution's academic and social systems shape their levels of academic and social integration. The degree to which students integrate into

these systems, in turn, affects their evolving goals and commitments, ultimately influencing whether they choose to stay at or leave the institution (Tinto, 1993).

Tinto's theory is built on two core principles: academic integration and social integration, which are interrelated and mutually reinforcing in their impact on student persistence. Academic integration is measured through grade performance and intellectual development, though Tinto emphasises that grades—being more tangible and easier to quantify—are the primary indicator of institutional validation. For students, strong academic performance reflects their successful adoption of the institution's academic norms and serves as a critical factor in their decision to remain enrolled (Tinto, 1975).

While academic performance plays a crucial role, Tinto argues that social integration is equally vital to student satisfaction and persistence. Social integration occurs when students engage with informal peer groups, participate in extracurricular activities, and interact with faculty and administrators. These experiences foster a sense of belonging, reward, and affirmation, which strengthen students' commitment to their education and the institution. Collectively, these elements of social integration significantly influence whether students stay in college or decide to leave (Tinto, 1975).

2.5.1 Critique and Adaptations

While Tinto's theory has been influential in understanding student retention and persistence, it has faced significant criticism and undergone various adaptations, especially when applied to diverse contexts such as engineering education in South Africa.

One of the primary criticisms of Tinto's theory is its potential cultural bias. Tierney (1992) argued that Tinto's concept of integration is based on a model of social integration that favours

traditional Western educational values and may not adequately account for the experiences of students from diverse cultural backgrounds. This critique is particularly relevant in the South African context, where the student population is culturally diverse and many students are first-generation college attendees.

Bean and Metzner (1985) proposed an alternative model for non-traditional students, emphasising external factors such as finances, working hours, and family responsibilities. This model may be more applicable to many South African students who often face significant socio-economic challenges. Subotzky and Prinsloo (2011) further developed a socio-critical model for explaining, predicting, and enhancing student success in distance education in South Africa, which considers the unique challenges faced by distance learners in this context.

2.5.2 Contextual Factors in South African Higher Education

Building on the critiques and adaptations of Tinto's theory, it becomes clear that student persistence in South African higher education cannot be fully understood without considering specific contextual influences. For many students, particularly those in engineering programmes, financial hardship is a persistent challenge. Letseka and Maile (2008) argue that financial constraints are among the most common reasons students leave university, a reality that underscores the limitations of a model focused primarily on academic and social integration. In addition, language plays a pivotal role in shaping students' academic experience. As noted by Stander et al. (2022), students who are not learning in their first language often face additional barriers to understanding complex technical content, which may hinder both performance and sense of belonging. Academic preparedness is another important dimension. Seroka and Sepeng (2023) emphasise that students' educational backgrounds, often shaped by unequal schooling systems, have a significant impact on their ability to cope with the demands of university-level

engineering. These realities suggest that a model of student persistence in South Africa must extend beyond individual integration and take seriously the systemic and structural conditions that shape students' educational journeys.

2.5.3 Adaptations of Tinto's Theory for Engineering Education

Tinto's theory has been widely adapted for use in engineering education, both internationally and within the South African context. Researchers such as French et al. (2005) and Veenstra et al. (2009) expanded the theory to include pre-university academic factors, particularly high school performance in mathematics and science, which are crucial predictors of success in engineering programmes. Similarly, Ohland et al. (2008) contributed to the development of the Multiple-Institution Database for Investigating Engineering Longitudinal Development (MIDFIELD), which supports longitudinal analyses of persistence trends across different demographic groups and institutions, offering a richer perspective than Tinto's original theory.

In South Africa, scholars have highlighted the need to adapt Tinto's theory to reflect local realities. Koen (2007) applied the model to engineering students and found it useful but insufficient without accounting for socio-economic and cultural dimensions that influence student success. Case and Marshall (2016) similarly called for a more holistic view, drawing attention to how students' interpretations of the curriculum, their sense of belonging, and their aspirations for future employment shape their engagement and persistence. These adaptations suggest that while Tinto's model remains a valuable starting point, it must be flexibly applied to engineering education, particularly in contexts where structural inequalities and institutional histories continue to shape student experiences.

2.6 SUMMARY

This chapter reviewed literature relevant to understanding resilience and persistence among engineering students at a university of technology in South Africa. It began by situating the study within the South African higher education landscape, drawing attention to context-specific challenges such as socio-economic inequalities and infrastructure constraints, including load shedding (Thembane, 2024).

The chapter then explored how resilience has been conceptualised, tracing its development from Bronfenbrenner's socio-ecological perspectives to early trait-based models. Key contributions from scholars such as Rutter (1987) and Ungar (2008) were discussed to provide a theoretical foundation.

The chapter also examined the relevance of Vincent Tinto's theory of student integration and Bronfenbrenner's Ecological Systems Theory, highlighting how these frameworks relate to engineering education and the South African context. Critiques of these theories were considered, particularly in relation to their cultural assumptions and applicability to higher education.

While Rutter gives the *who* and Bronfenbrenner the *where*, Ungar provides the *how* - a culturally sensitive, process-oriented account of resilience that captures the daily negotiations South-African engineering students undertake. It retains Bronfenbrenner's nested systems yet foregrounds *agency*, *power* and *resource accessibility*, offering a direct conceptual bridge to Tinto's notions of academic and social integration. For a study that asks how multi-level factors interact to shape persistence within a resource-constrained, culturally diverse setting, Ungar's model delivers the most precise framework and therefore anchors the remainder of this thesis.

CHAPTER 3: METHODOLOGY

3.1 INTRODUCTION

In this chapter, I explain the methodological approach I used to explore how resilience influences persistence among engineering students at a university of technology in South Africa. I describe the research design, sampling strategy, data collection process, and ethical considerations. I also reflect on my role as the researcher and outline the steps I took to ensure that the findings are credible and relevant.

3.2 RESEARCH METHODOLOGICAL APPROACH AND STUDY DESIGN

3.2.1 Qualitative Descriptive Approach: Foundations and Rationale

For this study, I chose a qualitative descriptive approach, which is well suited to capturing detailed, contextualised narratives of participants experiences, perceptions, and lived realities (Sandelowski, 2000). This methodology stays "close to the data" (Sandelowski, 2010, p. 78) and is particularly appropriate for exploratory research in specific settings, such as higher education (Neergaard et al., 2009). It enables insight into the nuanced dynamics of student well-being and academic journeys.

To investigate resilience and persistence among engineering students at a university of technology in South Africa, this approach allows for an in-depth understanding of how students navigate academic and personal challenges. It aligns with the study's aim to explore the interaction between individual and environmental influences on resilience, as conceptualised by Ungar's Socio-Ecological Model (2008).

Ungar's framework, which sees resilience as co-constructed through culturally meaningful navigation and negotiation of resources, requires a method that can attend to the richness of

participants' descriptions and the complexity of their contexts. A qualitative descriptive approach provides the necessary grounding to explore these multi-level interactions meaningfully.

3.2.2 Data Collection and Analytical Strategy

This study employs Deductive Thematic Analysis (DTA) as its primary method for analysing qualitative data. DTA is a qualitative approach that systematically identifies, interprets, and categorises recurring patterns or themes within the data, based on a set of predetermined concepts derived from a theoretical framework. This method allows for a flexible yet detailed examination of the data and is distinguished by its emphasis on the researcher's reflective engagement with the material (Braun & Clarke, 2006; Terry, et al., 2017). By beginning with established theoretical constructs, the analysis involves searching for data segments that correspond to these predefined categories, ensuring that the interpretation goes beyond the surface-level content to capture deeper meanings.

Through semi-structured interviews, the study endeavours to capture the essence of the voices and experiences of engineering students, offering insights into the multifaceted nature of resilience as it is manifested and perceived within the specific socio-cultural context of a South African university setting. This method involves collecting rich, detailed data straight from the experiences of students. Through interviews, observations, and other interactive methods, I gathered nuanced insights into their lives which helped me to compile a mosaic of stories that collectively illustrate how engineering students navigate their paths through academia. It sheds light on the coping strategies and support systems of engineering students, providing a understanding of the factors that foster resilience and encourage persistence within the demanding context of higher education in engineering.

3.2.3 Methodological Distinctions and Interdisciplinary Relevance

Qualitative research differs from quantitative approaches in both focus and execution. While quantitative studies typically test hypotheses using large samples and statistical analysis, qualitative research explores the context and meaning of human experiences, often addressing socially relevant questions through in-depth inquiry (Creswell & Creswell, 2018; Creswell & Poth, 2018; Scott & Wolfe, 2015). This approach offers rich, contextual insights that help explain complex social phenomena beyond what numbers alone can reveal.

3.2.4 Flexibility and Contributions of the Qualitative Descriptive Design

Qualitative descriptive research is valued for its flexibility and practicality. It allows researchers to adapt methods from other designs to suit the study's context (Sandelowski, 2000), making it well suited to exploring how people perceive and experience particular issues. This design is especially useful in fields such as mental health, education, and community development, where the goal is often both understanding and practical improvement. Unlike more theory-driven approaches like grounded theory or ethnography, qualitative description focuses on straightforward, low-inference accounts that can inform real-world interventions (Creswell & Creswell, 2018; Palinkas, 2014).

In this study, the design supports the aim of generating insights into how resilience can be better supported in engineering students, contributing to both academic success and student well-being in a South African university context.

3.3 TARGET POPULATION

3.3.1 Criterion Sampling: Rationale and Methodological Alignment

I used criterion sampling, a form of purposive sampling, to deliberately select participants who met specific, pre-established criteria aligned with my research focus (Marshall & Rossman, 2014). This method allowed for a strategic selection of students whose experiences could illuminate the phenomenon of resilience in engineering education. In particular, I excluded first-year students and focused on students already immersed in the programme's theoretical and practical demands. This approach is consistent with qualitative research principles and was intended to yield rich, context-sensitive insights.

3.3.2 Sample Size and Theoretical Alignment

In qualitative research, sample size is guided more by the depth and richness of data than by fixed numbers (Hesse-Biber & Leavy, 2017; Liamputtong, 2019). The concept of saturation—when no new themes emerge during analysis—helps signal when enough data has been collected (Creswell & Poth, 2018; Malterud et al., 2016). For this small-scale study, full saturation was not expected; instead, a targeted sample of five to ten students was chosen to provide meaningful insights.

This approach is supported by the idea of "information power" (Malterud et al., 2016), which values the relevance and quality of data over quantity. When interviews are rich and aligned with the study's focused aim, a smaller sample can still yield substantial understanding (Mason, 2010).

A smaller sample also suits the theoretical framework of this study—Ungar's Socio-Ecological Model of Resilience (2008)—which calls for an in-depth look at how individual and

environmental factors interact. Given the timeframe and scope of this master's research, focusing on a compact group allows for a detailed exploration of the complex influences on resilience and persistence among engineering students.

3.4 SAMPLE SELECTION

3.4.1 Recruitment Strategy and Ethical Participant Engagement

Following the Research Ethics Committee approval (EBE/02130/2023), I initiated the recruitment process by sending emails to undergraduate students enrolled in the Electrical Engineering diploma programme at a large urban South African university of technology. This programme, with its comprehensive coverage of multiple disciplines within Electrical Engineering over three years, served as a convenient environment for identifying potential study participants.

The initial step involved drafting an invitation that clearly articulated the study's purpose, the nature of participation, and the ethical considerations adhered to throughout the research process. The invitation aimed to provide a comprehensive overview of what participation entailed, including the duration of the online interview, the voluntary basis of involvement, and the measures in place to ensure confidentiality and privacy.

To ensure clarity and encourage participation, the email highlighted the significance of the research in understanding how engineering students develop resilience. It was emphasised that students' insights were invaluable to shedding light on this area, potentially benefiting future students in the field. The invitation also reassured potential participants of their rights within the study, including the freedom to withdraw at any time without consequence and the strict confidentiality protocols governing data handling.

Upon dispatching the emails to the selected pool of students, I received positive responses from eleven individuals who expressed interest in contributing to the study.

3.4.2 Participant Exclusion Criteria and Final Sample Selection

To align with the research focus on resilience within engineering studies, I decided to narrow down the participant group further. Given the study's emphasis on understanding resilience through lived experiences and challenges encountered over time, first-year students were excluded. The rationale was to ensure participants had encountered a breadth of experiences and challenges relevant to examining resilience. They were fully immersed in a demanding engineering curriculum, managing both intensive theoretical coursework and hands-on laboratory sessions.

Ultimately, seven students in the latter stages of their studies were chosen. Phenomenological research is inherently focused on capturing the essence of experiences from the perspective of those who live them. As such, the depth of insight and understanding that can be garnered from a smaller, more focused group of participants is often more profound and nuanced than what might be achieved with a larger sample size. This methodological preference aligns with the recommendations of Polkinghorne (1989), who asserts that the optimal number of participants in phenomenological research should ideally fall between six to twenty-five individuals. The rationale behind this range is to ensure that researchers can engage deeply with each participant's narrative, allowing for a thorough and detailed exploration of their lived experiences (Polkinghorne, 1989).

The exclusion of first-year students aligns with the qualitative research principle of selecting participants who can provide the richest and most relevant data in relation to the research

question (Liamputtong, 2019). It also resonates with the qualitative methodological emphasis on depth, flexibility, and saturation (Malterud et al., 2016; Mason, 2010).

Table 1 provides a summary of each participant's demographic information and key aspects of their experiences. This includes their gender, approximate age range, year of study, and field of study.

Table 1

Summary of Participant Demographics and Information

Participant	Gender	Age	Ethnicity	Year of study	Field of study
1	Female	Early 20s	Black	4th year	Electrical Engineering
2	Male	Mid 20s	White	Postgraduate	Computer Engineering
3	Male	Early 20s	Black	Diploma Student	Electrical Engineering
4	Male	Early 20s	Black	2nd Year	Electrical Engineering
5	Male	Early 20s	Black	2nd Year	Electrical Engineering
6	Male	Early 20s	Black	3rd Year	Electrical Engineering
7	Male	Early 20s	Black	3rd Year	Electrical Engineering

The sample consists of one Black female undergraduate and six male students (one white postgraduate, five Black undergraduate), enrolled in two engineering disciplines, electrical engineering and computer engineering.

3.4.3 Interview Logistics and Ethical Compliance

Once a candidate was confirmed to meet the participant criteria and confirmed their availability, I proceeded to arrange the research interviews at a time that was most convenient for them.

Recognising the importance of flexibility in qualitative research, especially when participants are students with varying schedules, I ensured that I could accommodate their preferred timings. This approach is underscored by best practices in qualitative research methodologies that emphasise adaptability and participant comfort to facilitate open and honest communication during interviews (Creswell & Creswell, 2018).

Communication with potential participants was deliberately kept to email. This decision was informed by the dual goals of minimising the demand for personal information from participants and maintaining a formal record of all communications. Email correspondence ensures both transparency and privacy, limiting the need for participants to disclose sensitive personal details (Liamputtong, 2019).

Upon finalising the interview schedule, I provided each participant with an Informed Consent Form, which was attached to the email. This document, essential for ethical research practices, detailed the study's purpose, procedures, voluntary nature of participation, confidentiality measures, and the rights of the participants, including their right to withdraw from the study at any time without penalty. Participants were asked to digitally complete the form and return it via email. This process not only aligns with ethical standards but also reinforces the participant's autonomy and informed consent, foundational pillars of conducting ethical qualitative research (Guillemin & Gillam, 2004).

3.5 DATA COLLECTION PROCEDURES

3.5.1 Remote Interview Methodology and Participant-Centred Design

To facilitate the data collection, I conducted interviews remotely using Microsoft Teams video conferencing technology. This tool was chosen for its convenience, both for me and the

participants, and for built-in features that are conducive to research, such as recording capabilities and automatic transcription services. This approach is supported by recent shifts in qualitative research methodologies, which increasingly recognise the value of digital tools in conducting interviews (Singh et al., 2022).

Upon identifying and confirming the participation of suitable candidates, I arranged interview appointments via email, prioritising the participants' convenience. This scheduling flexibility was crucial in qualitative research, allowing for participant comfort and readiness, which can lead to more open and insightful discussions (Seitz, 2016).

For each scheduled interview, I sent a unique Teams link to ensure privacy and security. The interviews were conducted from my workspace, either at my office or home office, chosen for its quiet and minimal distractions. I requested participants to choose a similarly quiet environment for the interview to minimise interruptions and maintain focus throughout our discussion.

3.5.2 Ethical Protocols and Strategies for Authentic Data Capture

Upholding the confidentiality of participants was prioritised as a fundamental aspect of this study. To protect the identities of those involved in the study, pseudonyms were used throughout all phases of the research, unless participants explicitly preferred the use of their real names. This approach aligns with ethical research practices that prioritise the anonymity and privacy of research subjects (Orb et al., 2001).

A standardised set of questions was developed to ensure consistency across interviews. These questions were designed in an open-ended, semi-structured format, allowing participants to elaborate on their experiences and provide depth to their responses. The flexibility of this format also permitted the inclusion of follow-up questions tailored to the individual responses of

participants, thereby facilitating a deeper exploration of their lived experiences (Brinkmann & Kvale, 2015).

To accommodate the potential richness of the data being collected, interviewees were given the option to extend their interviews beyond the initial 45-to-60-minute timeframe. This flexibility was crucial for capturing comprehensive insights into the participants' personal and academic resilience experiences.

The interviews were conducted in a manner that prioritised comfort and ease, establishing a conversational tone to encourage open dialogue and discussion. The decision to record the interviews using audio only was made to further ensure the comfort of participants while also simplifying the data analysis process. This choice is supported by literature indicating that audio recordings can effectively capture the necessary data for qualitative analysis without the potential distractions or discomfort that might arise from video recordings (Rutakumwa et al., 2013).

Throughout the interview process, the open-ended nature of the questions and the relaxed interview environment were strategic decisions aimed at facilitating a genuine exchange of ideas and experiences. These methodological choices underscored my commitment to ethical standards and methodological rigor, ensuring that the study's findings would be grounded in authentic and meaningful participant narratives.

3.6 ROLE OF THE RESEARCHER

My position as the researcher was thoroughly scrutinised, particularly in terms of power dynamics between myself and the participants. Perceived power imbalances can greatly affect participants' involvement and the genuineness of their responses, as noted by Creswell and Creswell (2018) and Creswell and Poth (2018). Such imbalances, stemming from differences in

age, gender, ethnicity, socioeconomic status, and educational background, might cause participants to feel vulnerable or hesitant, which could diminish the depth and dependability of the collected data.

Acknowledging this, I endeavoured to mitigate potential power imbalances, by avoiding recruiting students from classes I was currently teaching. This approach reduced the risk of students feeling compelled to participate due to the hierarchical nature of the student-teacher relationship. It also addresses concerns that their participation or lack thereof could somehow influence their academic evaluation.

I also tried to minimise perceived risks by fostering an environment grounded in respect, transparency, and participant empowerment. This included providing detailed information about the study's purpose, what participation involves, the risks and benefits, and the measures in place to protect participants' confidentiality and privacy. By being transparent, I aimed to foster trust, reassure participants of the non-exploitative nature of research, and cultivate a sense of safety and comfort.

By engaging in practices that prioritise participant well-being and autonomy, such as obtaining informed consent and ensuring participants understand they have control over their involvement, I aimed to create a more equitable research relationship.

I gave clear explanations of how data would be used, confidentiality measures, and the measures in place to protect participant privacy, and invited questions from prospective participants. Such transparency is essential for ethical research conduct, as noted by Israel and Hay (2006), who stress the importance of informed consent as a process rather than a one-time event. I was mindful that ongoing dialogue helps participants feel more informed and involved, potentially

reducing anxiety related to power imbalances and enhancing the authenticity of their contributions.

Recognising and addressing the power dynamics inherent in the research process is vital for conducting ethical and meaningful research. By implementing strategies to mitigate the impact of these dynamics, I aimed to enhance participant engagement and data integrity. This approach underscores a commitment to ethical research practices that respect and value the contributions of all participants.

3.7 GUIDING INTERVIEW QUESTIONS

The guiding interview questions were meticulously developed based on Ungar's Socio-Ecological Model of Resilience (Ungar, 2008). This model emphasises the complex interplay between individual and environmental factors, distinguishing various levels of influence such as microsystem, mesosystem, exosystem, and macrosystem. The interview questions aim to uncover how these factors contribute to or hinder the resilience and persistence of engineering students:

The interview questions were crafted to ensure comprehensive coverage of all relevant aspects of the socio-ecological framework, enabling the collection of rich qualitative data. The selection and structuring of these questions involved several key steps:

3.7.1 Alignment with Research Objectives

Each set of questions was crafted to directly address the specific research questions outlined in the study. This ensured that every question contributed to uncovering insights related to the influence of various ecological systems (microsystem, mesosystem, exosystem, macrosystem) on the resilience and persistence of engineering students.

By integrating Ungar's model, the questions were designed to explore the interaction between the students and their various environments. This involved focusing on how personal relationships, institutional policies, community resources, and societal attitudes impact student resilience. The questions were developed to elicit responses that reflect the complexities and dynamics of these interactions.

To capture the depth of participants' experiences and perspectives, I utilised an open-ended, semi-structured format. This approach allows flexibility in the interviews, enabling participants to express their thoughts more freely and extensively, thus providing richer qualitative data. It also facilitates the exploration of topics that may arise spontaneously during the interview, which are relevant to the research questions but may not have been anticipated in the initial question set.

3.7.2 List of Guiding Interview Questions

However, the initial drafts of the questions were too formal, reflecting academic language that might not have been easily accessible or engaging for all students. Concerned that such phrasing might hinder open communication, I sought feedback from my study leaders. Based on their suggestions, I revised the questions to adopt a more conversational tone. This adjustment was aimed at making the questions more relatable and ensuring that the interview felt like a natural dialogue, thus fostering a comfortable environment for participants to share their experiences openly.

3.7.3 Revised Guiding Interview Questions

Microsystem Influences

1. Could you tell me about how your classes, interactions with teachers, and friendships at university have helped you handle academic challenges?
2. Can you share a specific time when support from a faculty member or a peer really made a difference in your studies?
3. How do you find the courses and curriculum here? Do they help you feel more confident in handling your studies, or are there aspects that make things tougher?

Mesosystem Influences

4. How do your family and friends outside of university support your journey through engineering school?
5. What kind of impact does your home life have on your studies? Are there ways in which your family really understands and supports your academic goals?
6. Could you talk about how your social life intersects with your life as a student? Are there supports or challenges that stand out?

Exosystem Influences

7. How do university policies or the availability of certain resources affect your ability to succeed in your courses?
8. Are there any school rules or policies that you find particularly helpful or, conversely, particularly challenging?

9. Can you discuss any community resources or external educational practices that have impacted your academic experience here?

Macrosystem Influences

10. What's the general attitude towards engineering education in your community or society? How does this affect your motivation?
11. How do cultural expectations about engineering affect your persistence in your studies?
12. Are there societal pressures or expectations that influence how you approach your engineering education?

Integrating Levels

13. Looking at everything from personal interactions to societal expectations, what do you think influences your ability to keep going with your studies the most?
14. In your opinion, how could schools do better in supporting students like yourself?
15. What changes at a societal level do you think would help you and your peers succeed more in engineering education?

These questions aim to engage students more effectively, encouraging them to provide richer, more detailed responses by employing a more casual and conversational tone. This approach not only enhances the quality of the data collected but also enriches the overall research experience for both the participants and myself as the researcher.

3.7.4 Pilot Testing

Before finalising the interview questions, I conducted a pilot test with a willing student participant who was not part of the main study. This helped me to refine the questions to ensure clarity, relevance, and the ability to elicit meaningful responses. Feedback from the pilot was used to adjust the phrasing and order of questions to better suit the interview flow and objectives.

3.7.5 Literature Review Insights

The development of the interview questions was also informed by a thorough review of existing literature on resilience, persistence in higher education, and specifically, studies focused on engineering students. This ensured that the questions were grounded in scholarly research and targeted areas that are both significant and underexplored in the existing body of knowledge.

Ultimately, the questions were continuously refined in collaboration with my thesis supervisors and peers in the field. This ongoing refinement ensured that the questions were theoretically sound, methodologically robust, and precisely tailored to effectively probe the unique context of the South African university of technology.

3.8 ETHICAL CONSIDERATIONS

3.8.1 Participant Safeguards: Participation, Confidentiality, and Autonomy

The ethical considerations were carefully crafted based on well-established qualitative research guidelines. Ensuring the ethical integrity of my research involved adhering to principles that protect participants and ensure the credibility of the findings. The following framework and references have informed the ethical approaches used throughout my study:

Voluntary Participation and Informed Consent: Inspired by Creswell and Creswell's (2018) comprehensive approach to ethical research, I emphasised the voluntary nature of participation.

Participants were thoroughly informed about the study's aims, procedures, potential risks, and benefits to ensure they could make an informed decision about their involvement. They were also informed of their right to withdraw from the study at any time without any adverse consequences, a principle central to maintaining ethical standards in research (Creswell & Creswell, 2018).

Confidentiality and Anonymity: To safeguard the privacy and confidentiality of participants, measures were put in place as suggested by Liamputtong (2019). Data collected were anonymised and securely stored, accessible only to myself and, where necessary, my supervisory team, to prevent unauthorised access and ensure that participant confidentiality is maintained throughout the process. No identifying information was included in the research outputs, as guided by the best practices for handling sensitive data (Orb et al., 2001).

Addressing Power Differentials: Reflecting on the work by Creswell & Poth (2018), special attention was given to managing the power differential between myself as the researcher and the participants. This was crucial to fostering a research environment where participants did not feel coerced or intimidated. Efforts to minimise power imbalances included maintaining a professional yet empathetic demeanour and ensuring that communication was clear and respectful throughout the research process.

3.8.2 Researcher Accountability: Reflexivity, Ethical Compliance

Following the guidelines by Guillemin and Gillam (2004), reflexivity was practiced throughout the study. This involved continuous self-reflection on my actions and decisions to ensure they did not negatively influence the study's outcomes or participant experiences. This reflexivity

helped in identifying and addressing “ethically important moments” in research, thereby enhancing the ethical quality of the study.

Before commencing the data collection, the study proposal and its ethical considerations were reviewed and approved by the institutional review board of the university of technology where data was collected. This approval was contingent on the detailed ethical measures outlined in the proposal, ensuring adherence to international standards of ethical research.

3.9 SUMMARY

This chapter comprehensively details the methodology that underpins my thesis, investigating how socio-ecological factors shape the resilience and academic persistence of engineering students at a university of technology in South Africa. The research employs a qualitative descriptive approach to capture the nuanced experiences of participants and explore the complex interplay between individual resilience and educational outcomes.

The research questions were crafted to dissect the layers of influence on student resilience, examining the immediate educational environment, family and social support networks, institutional policies, and societal attitudes towards engineering education.

A qualitative methodology approach was selected, which is ideal for understanding the depth of students’ lived experiences. This approach allows for a detailed exploration of how different environmental and personal factors contribute to or hinder their academic persistence.

Participants were selected through criterion sampling from a pool of engineering students, focusing on those who have advanced beyond their first year to ensure they possess the necessary experience to provide rich insights into the research questions.

Data were collected through semi-structured interviews using Microsoft Teams, allowing for flexibility and in-depth discussion. This method facilitated a thorough exploration of participants' experiences and perceptions regarding resilience.

As the researcher, I maintained a neutral stance, minimising potential power dynamics to encourage honest and open responses. Ethical measures, such as informed consent and confidentiality, were rigorously upheld throughout the study.

The interview questions, aligned with the research objectives and Ungar's model, were designed to evoke comprehensive insights into the factors influencing resilience. These questions underwent repetitive refinement to ensure clarity and relevance.

Ethical considerations were also very important. The study adhered to strict ethical guidelines ensuring participant welfare, confidentiality, and the integrity of the research process. All participants were informed of their rights, with the study receiving approval from the relevant ethics committee.

The potential benefits and possible limitations of the study, including methodological constraints (e.g., small sample size) and contextual factors (e.g., focus on a single institution), are discussed in section 6.6 of Chapter 6, where I also reflect on potential biases and challenges encountered during the research process.

CHAPTER 4: DATA ANALYSIS

4.1 INTRODUCTION

This chapter presents an in-depth analysis of qualitative data derived from semi-structured interviews with engineering students at a South African university of technology. Specifically, it focuses on the application of Deductive Thematic Analysis (Braun & Clarke, 2006), guided by Ungar's Socio-Ecological Model of Resilience (2008). The goal is to systematically uncover how personal, relational, institutional, and societal factors collectively shape students' resilience and their persistence in rigorous engineering programmes.

The analysis commenced with thorough data preparation, including verbatim transcription, careful anonymisation to maintain participant confidentiality, and organisation of transcripts for structured coding. NVivo 14 software (QSR International, 2022) was employed to facilitate an efficient and systematic analytical process. Through this software, initial codes were identified based on recurring patterns and categorised according to the predefined ecological levels outlined by Ungar—namely, microsystem, mesosystem, exosystem, and macrosystem.

Subsequent sections of this chapter detail the analytical framework and describe the rigorous coding procedures, including data familiarisation, code refinement, and thematic consolidation. This methodological clarity ensures that the resulting themes are grounded firmly in the theoretical framework and the lived experiences articulated by participants. The chapter offers a structured narrative that connects analytical findings directly back to the research questions, providing nuanced insights that inform theoretical understanding and practical interventions in engineering education contexts.

4.2 DATA PREPARATION

Preparing the data from seven semi-structured interviews (each lasting 40 to 60 minutes) was essential for ensuring accuracy, confidentiality, and analytical rigor. NVivo 14 was used to support a systematic and thorough analysis. Key steps included transcription, anonymisation, secure storage, and organisation of the data.

4.2.1 Transcription and Anonymisation: Ensuring Data Integrity and Confidentiality

Each interview was transcribed verbatim to capture the full meaning and expression of participants' responses. I used Microsoft Teams to conduct and record the interviews, then transcribed them word-for-word. I reviewed each transcript by replaying the audio while reading the text, correcting errors caused by soft-spoken participants, poor sound quality, or pronunciation challenges. Teams' playback features, including speed control and easy rewinding, helped improve transcription accuracy.

To protect participant confidentiality, transcripts were anonymised immediately after transcription. Identifying information was removed or replaced with pseudonyms. All anonymised files were stored in a secure, password-protected digital environment accessible only to myself and my supervisory team. This process followed the ethical protocols approved by the institutional review board, ensuring the privacy of participants and integrity of the study.

4.2.2 Data Management and Organisation with NVivo 14

All anonymised transcripts were imported into NVivo 14, which served as the central platform for data organisation and analysis. Initial coding was based on recurring patterns related to the research questions. These codes were then refined iteratively as new themes emerged during

analysis. NVivo's tools enabled a structured approach to managing the data, allowing for clear identification and tracking of themes.

4.2.3 Ethical and Analytical Rigor in Data Preparation

Each step of data preparation—from transcription and anonymisation to digital storage and coding—was conducted with close attention to ethical standards and analytical reliability. This careful preparation laid a solid foundation for the subsequent thematic analysis, ensuring the data was both trustworthy and treated with integrity.

This section outlined the processes that ensured the reliability and ethical handling of the data: accurate transcription, effective anonymisation, and structured data management in NVivo 14.

Having established a secure and organised dataset, the next section outlines the analytical framework that guided the coding and interpretation of the data.

4.3 ANALYTICAL FRAMEWORK

I have chosen to use Deductive Thematic Analysis (DTA) as the data analysis method in my study. DTA is a qualitative approach that identifies, interprets, and categorises recurring patterns or themes in relation to predetermined concepts derived from a theoretical framework. It provides a flexible yet detailed approach to qualitative analysis, distinguishing itself from other thematic methods by its emphasis on the researcher's reflexive engagement with the data (Braun & Clarke, 2006, 2021; Terry et al., 2017). By starting with a set of theoretical ideas, researchers systematically search for data segments that fit within these previously established categories. This process demands active, reflexive engagement with the material rather than relying solely on the explicit content of the data.

As outlined by Braun and Clarke (2006; 2021), this approach involves six distinct steps. Following these steps allows for detailed descriptions of the data, which is particularly advantageous when investigating topics with limited existing research (Braun & Clarke, 2006), making this analysis technique highly appropriate for the current study. The six steps are:

1. Data Familiarisation
2. Coding
3. Theme Development
4. Refining and Defining Themes
5. Finalising the Themes
6. Report Writing

Engaging in these steps allows for a detailed description of the collected data and is especially useful when exploring topics with limited prior research (Braun & Clarke, 2006). DTA aligns well with a qualitative descriptive perspective, which aims to capture events in participants' everyday language (Sandelowski, 2000). By following this approach, researchers gain deeper insight into how participants interpret their own experiences, aligning with qualitative descriptive research's focus on honouring lived realities.

Ungar's Socio-Ecological Model of Resilience (2008) proposes that resilience is negotiated between individuals and their environments, involving complex interactions across individual, relational, and contextual levels. DTA supports this model by offering a flexible framework for exploring how these multi-layered dynamics influence resilience.

4.3.1 Data Familiarisation

The first step in the coding process was familiarising myself with the data. This involved reading the interview transcripts multiple times to understand the context and content of the participants' responses. Through this immersion, I began to identify segments of text that aligned with the predefined codes. This deep engagement is crucial for developing an intimate understanding of the content and context of the data, which is essential for generating meaningful and insightful codes and themes (Braun & Clarke, 2021).

My process of data familiarisation began immediately after completing the data collection phase, with the transcription of interviews serving as my initial point of contact with the raw data. I chose to personally read through each transcribed interview while I listened to the audio in the background. This was crucial because it allowed me to engage directly with the participants' words and expressions, fostering a deeper connection to the data. By listening and reading through the interviews, I became familiar with the nuances of the participants' responses, including tone, emphasis, pauses, and non-verbal cues, all of which added layers of meaning to their spoken words.

After transcribing the interviews, I engaged in multiple readings of the transcripts. My first reading was a broad, holistic pass to grasp the overall content and flow of each participant's narrative. During this initial reading, I focused on understanding the general themes and key issues raised by the participants without yet applying any formal coding or categorisation. This broad overview helped me identify the main topics and areas of interest that were most significant in the data.

Reflexivity and Peer Validation

Subsequent readings were more detailed and focused. During these readings, I kept a brief reflective journal to document any assumptions or biases that emerged during coding. I made notes on recurring ideas, patterns, and potential connections between different parts of the data. These notes served as a preliminary, informal step toward identifying codes and themes, allowing me to start thinking about how the data might align with the predefined theoretical framework.

After each coding session, I revisited this journal and noted moments where my personal perspectives might have influenced how I categorised or interpreted participant statements.

This stage was particularly important in Deductive Thematic Analysis because it set the foundation for the application of the predefined codes derived from Ungar's Socio-Ecological Model.

As I familiarised myself with the data, I paid special attention to the context in which participants' statements were made. Understanding the context was crucial because it influenced how I interpreted and analysed the data. For example, the same statement about support from academic staff might carry different implications depending on whether it was made in the context of discussing academic success, personal challenges, or institutional policies.

To capture this context, I noted the circumstances under which participants made particular remarks, the sequence of topics discussed, and any emotional or cognitive cues that accompanied their responses. This contextual understanding helped me interpret the data more accurately, ensuring that the subsequent coding and theme development were not just based on the content of the responses but also on the situational and relational dynamics at play.

As I engaged with the transcripts, I noticed recurring themes, common experiences, and variations in responses that suggested potential areas of focus for the deductive analysis. For example, frequent references to "peer support" across different participants hinted at the significance of this factor within the microsystem level of Ungar's model.

I also used this phase to reflect on my own preconceptions and potential biases as a researcher. By consciously acknowledging my expectations and theoretical orientation, I aimed to remain open to the data and ensure that my subsequent coding was guided by the data itself rather than preconceived notions. This reflexive practice was essential for maintaining the integrity of the deductive approach, where my goal was to apply theoretical constructs in a way that genuinely reflected the participants' lived experiences.

While the primary goal of data familiarisation was to develop an intimate understanding of the data, I also engaged with the theoretical framework that guided my deductive analysis. As I became more familiar with the data, I continuously revisited the core concepts of Ungar's Socio-Ecological Model to see how they might be reflected in the participants' narratives. This involved comparing the data against the predefined ecological levels—microsystem, mesosystem, exosystem, and macrosystem—and considering how the experiences described by participants aligned with these constructs.

This phase also included an ongoing dialogue between the data and the theoretical framework. For example, as I noted instances where participants described challenges related to the broader socio-economic context (a macrosystem influence), I reflected on how these experiences might be coded and categorised under the existing framework. This iterative process helped ensure that the subsequent coding and theme development were theoretically grounded while remaining true to the data.

By the end of the data familiarisation phase, I had developed a strong foundation for the formal coding process. I had not only gained a deep understanding of the data but had also started to identify key areas of interest that would guide the application of the predefined codes. I also began to anticipate where the data might challenge or extend the theoretical framework, preparing myself to adjust the coding process as needed.

This thorough familiarisation process was crucial for ensuring that my deductive thematic analysis was both rigorous and reflective of the participants' realities. It allowed me to approach the coding process with a clear and informed perspective, ensuring that the analysis would be grounded in a deep understanding of the data, fully aligned with the theoretical framework, and responsive to the nuances of the participants' experiences.

Summary

Above, I introduced the Deductive Thematic Analysis approach and discussed its alignment with the study's theoretical lens. I also included reflexivity measures to maintain fidelity to the participants' voices, ensuring that preconceived ideas did not overshadow emergent insights.

With the analytical foundation in place, the following section will show how initial codes were refined into themes that capture the essence of the participants' experiences. This transition from coding to theme-building would illuminate deeper patterns in the data.

With the analytical foundation in place, the following section will show how initial codes were refined into themes that capture the essence of the participants' experiences. This transition from coding to theme-building would illuminate deeper patterns in the data.

4.3.2 Coding

Significant time and effort were invested in the coding process, especially in developing code names that accurately reflected participants' perspectives. Although coding literature often recommends using brief codes (Coffey & Atkinson, 1996; Saldana, 2016), I struggled with the complexity of my participants' narratives, which made it difficult to condense them into short codes as advised by Braun et al. (2017) without losing important nuances.

Despite the widespread use of coding in various data analysis methods (Coffey & Atkinson, 1996; Given, 2008; Saldana, 2016), I remained uncertain about how to apply short codes to my data, which was rich and detailed. For example, using a code like "relationships" might capture a theme but would fail to indicate whether the relationships were positive or challenging, or what specifically made them so. I was also mindful of the critique that coding can lead to a mechanistic, positivist approach to qualitative analysis (Nowell et al., 2019), so I was careful not to oversimplify my data. Nevertheless, I needed to find a way to organise and make sense of the extensive data I had collected.

I started by reading each transcript line-by-line, ensuring that no relevant data was overlooked. Whenever a participant mentioned an experience or sentiment, I highlighted that segment and assigned an appropriate code. For example, if a participant discussed receiving emotional support from a family member, I coded that segment as "Support from family."

To organise and manage the large volume of data, I used NVivo, a qualitative analysis software. This tool allowed me to efficiently apply codes, track coded segments, and retrieve data related to specific codes as needed. The software also facilitated the identification of patterns and connections between different codes, which would later inform the development of broader themes.

Table 2 lists the emerging categories from the Deductive Thematic Analyses. The term "category" was used to group the initial codes. It also lists the initial codes that was identified with the frequency of students that mentioned it.

Table 2

Emerging Categories and Initial Codes

Category	Initial Codes	Frequency
Emotional Coping Strategies	Binge eat	1
	Listening to music	1
	Prayer, religion	2
Physical Coping Strategies	Breathing techniques	1
	Drink water	2
	Physical activity	3
	Taking medication	1
Psychological Coping Strategies	Mental relaxation	3
	Reflective thinking	4
	Self-regulation	5
Personal Strengths	Adaptability	3
	Grit, self-motivation	6
	Innovative thinking	1
	Introvert-loner	1
	Resilient	3
	Self-efficacy and determination	4
Adapting to Changes	Change environment	3
	Time management	3
Support Network	Religion	1
	Seeking help	4
	Support from family	5
	Support from friends	4
	Support from teacher	3
Impact of Peers on Learning	Negative peer pressure	4
	Positive peer support	3
Learning Environment	Group dynamics	4
	Inclusivity	2
	Practical classes	3
	University resources	2
	Counseling	3
	Workload	1
Barriers in Education	Community engagement	1
	Financial strain	3
	Lack of practical exposure	1
	Social diversity	1
Cultural and Societal Attitudes	Community perception	4

	Motivation to break socio-economic Hardships	1
Societal Expectations	High academic expectations	3
	Not letting people down	5
	Social engagement pressures	1
National or Global Events	COVID	1
	Health crisis	1
Most Significant Influences	Mental health	1
	Self-improvement	2
Improving Educational Support	Accommodation support	1
	Emotional support	2
	Reduce the workload	1
	University response times	1
Community or Societal Changes	Counseling and professional support	2
	Reducing academic pressure	1
	Reliable power	1
	Role models	1

Development of Predefined Codes Using Ungar's Socio-Ecological Model

The next step in the Deductive Thematic Analysis was to assign the list of codes to predefined codes under each ecological level based on Ungar's Socio-Ecological Model of resilience (2008). This model emphasises that resilience results from the dynamic interplay between individuals and their environments across multiple ecological levels: microsystem, mesosystem, exosystem, and macrosystem.

My goal was to develop predefined codes that accurately reflect the factors influencing resilience at each of these levels among engineering students in a South African university context. While Ungar's model outlines the four ecological levels, it does not specify detailed codes for each level.

In developing the predefined codes for each level of Ungar's Socio-Ecological Model, I engaged in a systematic and reflective process to ensure that the codes were both theoretically grounded and empirically relevant to my study.

To ensure that the predefined codes were robust and reflective of both theoretical constructs and empirical findings, I undertook a targeted literature review. I systematically searched for peer-reviewed articles, books, and reports focusing on resilience, higher education, and engineering students, particularly within the South African context.

I used databases such as Google Scholar, JSTOR, and ScienceDirect, employing keywords like "resilience in higher education," "engineering student persistence," "Socio-Ecological Model," and "student support systems." This allowed me to identify relevant studies that provided insights into the factors influencing student resilience at each ecological level.

After bringing together the themes and findings from these studies, I matched the key factors to Ungar's Socio-Ecological Model. I carefully examined how each factor fitted into the different levels of the model and how it influenced resilience. Then, I adjusted the predefined codes to make sure they were relevant to the data I collected from the interviews.

Understanding the unique situation of engineering students at a South African university of technology was crucial. The predefined codes needed to mirror the specific challenges and support systems relevant to these students. For example, economic factors and cultural expectations might have different meanings in South Africa compared to other places because of the country's history and socio-economic conditions. By customising the predefined codes to fit this context, I aimed to capture how these environmental factors influence student resilience. Table 3 lists the predefined codes under Ungar's Socio-Ecological Model:

Table 3

Predefined Codes Under Ungar's Socio-Ecological Model

Ecological Level	Predefined Codes
Microsystem Level Codes	**Faculty Support:** Instances where faculty provided academic guidance, mentorship, or emotional support **Peer Interaction:** Examples of peer relationships, study groups, or friendships that contributed to students' resilience **Curriculum Challenges:** Descriptions of how students managed or responded to the demands of the engineering curriculum
Mesosystem Level Codes	**Family Support:** Instances where family provided financial, emotional, or motivational support **Social Network Influence:** The impact of broader social networks, such as community groups or non-university friends, on student experiences
Exosystem Level Codes	**Institutional Support:** Access to and effectiveness of university support services, like tutoring or counseling **Community Resources:** Availability and access to external resources, such as libraries or study spaces **Financial Aid:** Financial support mechanisms, including scholarships and how financial stability or instability influenced academic persistence
Macrosystem Level Codes	**Societal Attitudes:** How societal perceptions of engineering as a profession influenced students **Cultural Expectations:** Cultural norms and expectations, particularly related to gender and education **Economic Factors:** The broader economic context, including job prospects and the perceived economic value of an engineering degree

Microsystem Level Codes

The microsystem represents the immediate environments where students have direct, face-to-face interactions, such as with peers, faculty, and their academic setting (Bronfenbrenner, 1979; Ungar, 2011). To develop the predefined codes at this level, I reviewed literature that highlights the significant factors directly impacting students' day-to-day experiences.

1. **Faculty Support**: Recognising the critical role faculty play in student engagement and success, I identified "Faculty support" as a predefined code. Research by Tinto (1993) underscores the importance of supportive faculty-student relationships in enhancing academic persistence and resilience. Faculty support includes academic guidance, mentorship, and emotional encouragement, all of which contribute to a positive educational experience.

2. **Peer Interaction**: I included "Peer Interaction" to capture the influence of classmates and friends on students' resilience. Studies by Wilcox et al. (2005) indicate that strong peer networks provide emotional support, facilitate collaborative learning, and help students navigate academic challenges.

3. **Curriculum Challenges**: Given the rigorous nature of engineering programmes, I identified "Curriculum challenges" as a critical code. This encompasses students' experiences with the demands of the engineering curriculum, including workload management, practical classes, and adapting to academic expectations. Ramsden (2003) emphasises that how students perceive and respond to curriculum challenges significantly affects their learning outcomes and resilience.

Mesosystem Level Codes

The mesosystem involves the interconnections between different microsystems, such as the relationships between family, peers, and the educational institution (Bronfenbrenner, 1979). To develop codes at this level, I considered how these interconnected environments collectively influence student resilience.

1. **Family Support**: I recognised "Family support" as a vital predefined code, reflecting instances where family provides financial assistance, emotional backing, or motivational encouragement. McCarron and Inkelas (2006) found that family involvement and support are strongly linked to higher academic achievement and persistence, particularly among first-generation college students.

2. **Social Network Influence**: "Social network influence" captures the impact of broader social connections, including community groups, religious affiliations, and non-university friends. Draper Satterfield and Luna (2024) examined how religious and cultural factors influence college students' management of anxiety and distress, finding that strong religious connections can offer comfort and support during challenging times.

Exosystem Level Codes

The exosystem comprises external environmental settings that indirectly influence students, such as institutional policies and community resources (Ungar, 2011). These factors, while not directly involving the student, have significant effects on their experiences.

1. **Institutional Support**: I included "Institutional Support" to represent the availability and effectiveness of university services like tutoring, counseling, and academic advising.

Robbins et al. (2009) demonstrate that institutional support services are crucial for student engagement, satisfaction, and retention, thereby contributing to resilience.

2. **Community Resources**: "Community resources" encompasses external supports such as public libraries, study spaces, and community organisations. Ungar (2012) discusses how access to community assets can enhance resilience by providing additional opportunities for learning and support.

3. **Financial Aid**: Recognising the profound impact of financial stability on academic persistence, I identified "Financial aid" as a predefined code. Goldrick-Rabet al. (2016) show that financial assistance programmes significantly influence college completion rates, particularly for students from low-income backgrounds.

Macrosystem Level Codes

The macrosystem includes the broader cultural, societal, and economic contexts that shape the environment in which students live and learn (Bronfenbrenner, 1979). Developing codes at this level required an understanding of the societal factors influencing engineering students in South Africa.

1. **Societal Attitudes**: I defined "Societal attitudes" to capture how societal perceptions of engineering as a profession affect students. Stevens et al. (2005) suggest that societal narratives around engineering influence students' identity formation, motivation, and sense of belonging in the field.

2. **Cultural Expectations**: "Cultural expectations" reflects the influence of cultural norms and values, including gender roles and expectations regarding education. Letseka (2007)

highlights how cultural pressures can impact students' educational trajectories and their ability to persist in higher education.

3. **Economic Factors**: Given the socio-economic disparities in South Africa, I included "Economic Factors" to account for the broader economic context, such as job prospects and the perceived value of an engineering degree. Spaull (2013) examines how economic inequalities affect educational outcomes and opportunities, which in turn influence student resilience and persistence.

The next step was to link the initial codes with the predefined codes. Because the codes were predefined, I needed to be mindful of the context in which each statement was made. This was essential for accurately capturing the participants' experiences. For instance, when coding discussions about **"Time management"** (a predefined code under *Personal Coping Strategies*), I considered the broader context of the participant's life, including any cultural or familial factors that might influence their ability to balance academic and personal responsibilities.

During the coding process, I occasionally encountered data that fit into more than one predefined category. In NVivo, this situation is addressed by coding those segments to multiple "nodes." Rather than forcing the data into a single category, the software allows each relevant node to retain its link to that piece of text. This approach means the same passage of text can appear in multiple theme folders, reflecting the segment's richness and complexity.

In these instances, I considered whether the data should be assigned to multiple categories to accurately reflect the participants' experiences. For example, if a participant discussed a form of **"Seeking help"** and it was relevant to both **"Peer interaction"** in the microsystem level, and **"Social network influence,"** in the Mesosystem level, I assigned the code to both categories.

This approach ensured that the multifaceted nature of their experiences was captured, acknowledging that some factors influence resilience across multiple ecological levels.

Throughout this process, I continuously cross-referenced the codes with Ungar's Socio-Ecological Model to ensure that the coding remained consistent with the theoretical framework. This step helped me maintain a clear focus on the study's objectives, ensuring that the analysis was guided by the research questions and grounded in the theoretical constructs.

By the end of this coding phase, I had systematically categorised the data according to the predefined codes (Table 3) clearly demonstrates how the raw data from the interviews aligns with the theoretical framework of Ungar's Socio-Ecological Model. By categorising the initial codes within the predefined codes, Table 4 highlights the multifaceted factors influencing resilience among engineering students at different ecological levels.

The categorisation of data according to predefined codes enhances the analytical clarity of the study, providing a solid foundation for the subsequent thematic analysis. It ensures that the interpretations of the data are grounded in both the participants lived experiences and the established theoretical framework, thereby strengthening the validity and depth of the research findings.

Table 4

Mesosystem, Exosystem, and Macrosystem Codes Under Ungar's Socio-Ecological Model

Microsystem Codes (Immediate Environment)	
Faculty Support	- Support from teacher (Support network) - Emotional support (Improving educational support, when provided by faculty) - University response times (Improving educational support, if related to faculty responsiveness)

Peer Interaction	- Support from friends (Support network) - Positive peer support (Impact of peers on learning) - Negative peer pressure (Impact of peers on learning) - Group dynamics (Learning environment) - Seeking help (Support network, when involving peers)
Curriculum Challenges	- Time management (Adapting to changes) - Workload (Learning environment) - Reduce the workload (Improving educational support) - Practical classes (Learning environment) - Lack of practical exposure (Barriers in education) - Adaptability (Personal strengths) - Grit, self-motivation (Personal strengths) - Resilient (Personal strengths) - Self-efficacy and determination (Personal strengths) - Innovative thinking (Personal strengths) - Mental relaxation (Psychological coping strategies) - Reflective thinking (Psychological coping strategies) - Self-regulation (Psychological coping strategies) - Physical activity (Physical coping strategies) - Breathing techniques (Physical coping strategies) - Drink water (Physical coping strategies) - Binge eat (Emotional coping strategies) - Listening to music (Emotional coping strategies) - Taking medication (Physical coping strategies) - Mental health (Most significant influences) - Self-improvement (Most significant influences)
Mesosystem Codes (Interconnections Between Microsystems)	
Family Support	- Support from family (Support network)
Social Network Influence	- Religion (Support network) - Prayer - religion (Emotional coping strategies) - Seeking help (Support network, when involving community or non-university friends) - Not letting people down (Societal expectations) - Social engagement pressures (Societal

	expectations) - Role models (Community or societal changes) - Community engagement (Barriers in education) - Motivation to break socio-economic hardships (Cultural and societal attitudes)
Exosystem Codes (Indirect External Influences)	
Institutional Support	- University resources (Learning environment) - Counseling (Learning environment) - Accommodation support (Improving educational support) - Emotional support (Improving educational support, when provided by university services) - Counseling and professional support (Community or societal changes) - University response times (Improving educational support, if related to institutional services) - Inclusivity (Learning environment, when referring to institutional policies)
Community Resources	- Reliable power (Community or societal changes) - Community engagement (Barriers in education, when related to access to community resources) - Lack of practical exposure (Barriers in education, if due to limited community resources)
Financial Aid	- Financial strain (Barriers in education) - Accommodation support (Improving educational support, if financial aspect) - Reducing academic pressure (Community or societal Changes, if related to financial burdens)
Macrosystem Codes (Broader Societal and Cultural Context)	
Societal Attitudes	- High academic expectations (Societal expectations) - Community perception (cultural and societal attitudes) - Motivation to break socio-economic hardships (Cultural and societal attitudes) - Social diversity (Barriers in Education) - Inclusivity (Learning Environment, when related to societal norms)

Cultural Expectations	- Not letting people down (Societal expectations) - Role models (Community or societal changes) - Religion (Support network) - Prayer - religion (emotional coping strategies) - Social engagement pressures (Societal expectations)
Economic Factors	- Financial strain (Barriers in education) - Motivation to break socio-economic hardships (Cultural and societal attitudes) - COVID (National or global events) - Health crisis (National or Global events) - Reliable power (Community or societal changes, if related to economic stability)

Before moving on to theme development, I reviewed all the coded segments to ensure accuracy and consistency. This final review was crucial for confirming that the coding process had captured the full range of relevant data and that no significant information had been overlooked.

With the data systematically coded and organised, I was ready to proceed with the development of themes. These themes would later form the basis for interpreting the findings and drawing conclusions about the factors influencing resilience among engineering students, as guided by the Socio-Ecological Model.

Summary

This section traced the step-by-step procedure of coding the transcripts, from identifying preliminary codes to associating them with relevant theoretical constructs. It highlighted how recurring ideas were grouped, revealing early patterns and potential areas for deeper exploration.

The coded segments now set the stage for theme development, where I clustered related codes, refined overarching categories, and clarified the main threads that emerged from the participants' experiences.

4.3.3 Theme development

After systematically applying the predefined codes to the qualitative data, the next crucial step in my Deductive Thematic Analysis was the development of broader themes. This process involved organising the coded data into meaningful patterns that encapsulated the key elements of the participants' experiences, as guided by Ungar's Socio-Ecological Model of Resilience. Theme development was a meticulous process that required identifying relationships between the codes, refining these relationships into coherent themes, and ensuring that these themes accurately reflected both the data and the theoretical framework.

The first step I took was to identify patterns, similarities, and differences in the codes. This process involved a critical analysis of how each code related to others within the same predefined category and across different categories. It was important for me to remain mindful of the context in which each statement was made to accurately capture the participants' experiences.

For example, within the **"Personal coping strategies"** predefined code, I noticed that codes such as **"Time management," "Self-regulation,"** and **"Grit, Self-motivation"** were interconnected strategies that students employ to navigate academic challenges. Recognising these patterns helped me understand the common coping mechanisms among the students.

The next step involved grouping related codes into potential themes that encapsulated the essence of the participants' experiences. Guided by the aim to identify overarching concepts explaining how various factors influenced student resilience, I carefully clustered the codes.

For example, I grouped codes related to personal coping mechanisms and self-belief, such as **"Adaptability," "Innovative thinking,"** and **"Self-efficacy and determination,"** into the

potential theme **"Personal coping strategies and self-efficacy."** This theme highlighted the internal resources students draw upon to overcome obstacles.

4.3.4 Refining and Defining Themes

After the initial grouping, I refined the potential themes to ensure they were distinct, coherent, and comprehensive. This refinement involved:

- **Merging Similar Themes:** I combined themes that had significant overlap to avoid redundancy.
- **Separating Complex Themes:** I split themes that encompassed multiple distinct concepts to enhance clarity.
- **Defining Theme Boundaries:** I clearly outlined what each theme included and excluded.

Where themes exhibited significant overlap, merging or reorganising them became necessary. One instance involved the category of "Health and well-being," which encompassed both individual/family health issues and broader crises like COVID-19. To address this, I combined those related ideas under one overarching theme, "Health and Well-being" and introduced subthemes (e.g., "Personal health challenges" and "Community-level crises") to ensure that each unique aspect of the data was accurately represented.

Ensuring that the themes aligned with the research objectives and Ungar's Socio-Ecological Model was crucial. I examined each theme for its relevance to the central research question: *How do various ecological factors influence resilience among engineering students?*

For example, the theme **"Socioeconomic challenges and motivations"** directly relates to the mesosystem level of Ungar's model, addressing how broader economic conditions and social

inequalities impact student resilience. This alignment ensured that my analysis remained theoretically grounded and contextually relevant.

With the unique context of engineering students at a South African university of technology in mind, I recognised that the predefined codes and resulting themes needed to reflect the specific challenges and supports relevant to this group. Economic factors and cultural expectations in South Africa have different implications compared to other contexts due to historical and socio-economic factors, such as the legacy of apartheid and ongoing efforts toward social equity.

By tailoring the predefined codes and themes to this context, I aimed to capture how these ecological factors influence student resilience. This approach aligns with Ungar's (2008) emphasis on cultural and contextual factors when examining resilience. For instance, the theme **"Cultural and community influences"** encompasses codes like **"Religion," "Prayer,"** and **"Community perception,"** reflecting the significant role of cultural values and community norms in the students' lives.

4.3.5 Finalising the Themes

After this refinement, I came up with the following themes:

1. **Family Influence on Resilience**
2. **Peer Relationships and Social Support**
3. **Academic Environment and Institutional Support**
4. **Personal Coping Strategies and Self-Efficacy**
5. **Health and Well-being**
6. **Institutional Policies and Resources**

7. **Socioeconomic Challenges and Motivations**
8. **Cultural and Community Influences**
9. **Role Models and Mentorship**

These themes encapsulate the multifaceted nature of resilience as experienced by the students, considering individual, relational, and contextual factors. They reflect the complex interplay between the students and their environments, consistent with the socio-ecological perspective.

Application of Themes in Data Analysis

With the themes established, I proceeded to analyse the interview data by assigning relevant excerpts to each theme. This thematic coding allowed for a nuanced understanding of how different factors contribute to or hinder resilience. For example, when analysing discussions about **"Time management,"** I considered not only the students' strategies but also how cultural or familial expectations influenced their ability to manage time effectively.

Throughout the analysis, I remained open to the emergence of new insights, ensuring that while the themes were guided by predefined codes, they were also reflective of the participants' lived experiences. This approach allowed me to comprehensively explore resilience, acknowledging both the commonalities and unique aspects of each student's journey.

Ensuring Credibility and Trustworthiness

To enhance the credibility and trustworthiness of the thematic analysis, I engaged in reflexivity by continually questioning my interpretations and considering alternative explanations. I employed peer debriefing and member checking to validate the themes and ensure they resonated with the participants' perspectives.

Summary

In the theme-building phase, I merged related ideas, refined boundaries between categories, and confirmed the coherence of each theme against the raw data. This careful process ensures that each theme accurately reflects participants' perspectives.

Next, I consider how these refined themes answer the research questions and connect back to the broader theoretical framework. This step bridges our findings to the deeper discussions and practical implications that follow in later chapters.

4.3.6 Report Writing

The final stage involved writing up the findings in Chapter 5, weaving together the themes into a coherent narrative that answers the research questions. Each theme represented was detailed and supported by vivid data extracts. This stage synthesised the thematic analysis findings with literature and theoretical frameworks, particularly integrating insights into how the findings related to the broader constructs of the Socio-Ecological Model of Resilience (Braun & Clarke, 2006).

This comprehensive process allowed for a nuanced analysis that is both grounded in participants' experiences and reflective of broader theoretical constructs. It provided a structured yet flexible approach to exploring the intricate dynamics of resilience as conceptualised within Ungar's model.

4.4 LIMITATIONS OF THE ANALYSIS

While the Deductive Thematic Analysis conducted in this study has provided valuable insights into the factors influencing resilience among engineering students in South Africa, it is important to acknowledge several limitations that may affect the interpretation and generalisability of the

findings. These limitations stem from methodological constraints and the specific context of the research, potentially affecting the interpretation and generalisability of the findings.

4.4.1 Theoretical and Methodological Constraints

One of the inherent limitations of Deductive Thematic Analysis is its reliance on a predefined coding framework. In this study, the analysis was guided by Ungar's Socio-Ecological Model of Resilience, which shaped the creation of codes and themes. While this approach ensures that the analysis is theoretically grounded, it also carries the risk of overlooking important data that do not fit neatly into the predefined categories (Braun & Clarke, 2006).

For example, nuances in student experiences that fall outside the scope of the model may have been underemphasised or missed entirely. This could result in a somewhat constrained interpretation of the data, limiting the exploration of themes that might emerge more naturally through an inductive approach (Nowell et al., 2019).

Due to the deductive nature of the thematic analysis, the study may have overlooked emergent themes that were not initially included in the predefined coding framework. While the primary aim was to confirm and explore the applicability of Ungar's Socio-Ecological Model, this focus may have limited the identification of new or unexpected themes that could provide additional insights into the resilience of engineering students (Hsieh & Shannon, 2005).

An inductive or hybrid approach might have allowed for a more open-ended exploration of the data, potentially uncovering novel themes that were not anticipated by the theoretical framework.

4.4.2 Researcher Bias and Generalisability

Given the deductive nature of the analysis, there is a potential for researcher bias in the coding and theme development processes. The researcher's expectations and understanding of the

theoretical framework could influence the way data were coded and interpreted (Patton, 2002). This bias might lead to an overemphasis on themes that align with the theoretical model while underrepresenting or disregarding data that do not conform to these expectations. Although steps were taken to mitigate this bias—such as engaging in reflexivity and seeking peer debriefing—the possibility of researcher influence cannot be entirely eliminated (Lincoln & Guba, 1985).

The study's findings are context-specific, focusing on engineering students at a particular university in South Africa. As a result, the generalisability of the findings to other contexts or populations may be limited (Shenton, 2004).

The unique socio-cultural, economic, and institutional factors present in this setting may not be representative of the experiences of engineering students in other regions or countries. Additionally, the study's sample size, though sufficient for qualitative analysis, may not capture the full diversity of student experiences, further limiting the extent to which the findings can be generalised (Creswell & Creswell, 2018).

4.4.3 Data Collection and Cultural Sensitivity

While the study employed in-depth interviews as the primary data collection method, the analysis may still be limited by the depth and breadth of the data collected. Interviews, while rich in qualitative detail, are inherently limited by the scope of the questions asked and the participants' willingness or ability to articulate their experiences (Rubin & Rubin, 2012).

Some aspects of resilience may not have been fully explored or may have been difficult for participants to express, particularly if these aspects are culturally sensitive or difficult to verbalise. Additionally, the reliance on self-reported data can introduce issues related to recall

bias or social desirability bias, where participants might present their experiences in a more favourable light (Podsakoff et al., 2003).

The application of Ungar's Socio-Ecological Model, which was developed in a Western context, to a South African university setting introduces challenges related to cultural and contextual sensitivity (Theron & Theron, 2010).

While the model provides a useful framework for understanding resilience, it may not fully capture the unique socio-cultural dynamics that influence resilience in this specific context. There may be cultural nuances, particularly related to communal support systems, traditional beliefs, or gender roles, that the model does not account for. This limitation could affect the depth and relevance of the analysis, potentially overlooking culturally specific expressions of resilience (Ungar, 2008).

4.4.4 Temporal and Situational Context

The data collection occurred at a specific point in time and within a particular situational context. External factors, such as economic conditions, political changes, or specific institutional policies in place at the time of the study, may have influenced the participants' responses (Bryman, 2016).

As such, the findings may be time-bound and might not reflect the experiences of students in different temporal contexts or under different situational influences. The dynamic nature of resilience, which can evolve over time, may not be fully captured in a single cross-sectional study (Luthar et al., 2000).

4.5 SUMMARY

This chapter has meticulously detailed the process of analysing the qualitative data collected through semi-structured interviews with engineering students at a university of technology in South Africa. The primary aim of the analysis was to explore the multifaceted factors that contribute to or hinder student resilience and persistence in the face of academic challenges. Guided by Ungar's Socio-Ecological Model of Resilience (2008), the chapter outlined a structured approach to data analysis using Deductive Thematic Analysis (DTA), ensuring that the findings were both theoretically informed and grounded in the lived experiences of the participants.

The chapter began by explaining the essential steps of data preparation, including transcription, anonymisation, and the use of NVivo 14 for data management and coding. The thorough preparation of data was crucial for maintaining the integrity of the participants' responses and ensuring a rigorous analytical process.

Following this, the chapter provided an in-depth description of the analytical framework, emphasising the suitability of DTA for this study. The use of a predefined coding framework, based on Ungar's Socio-Ecological Model, allowed for a focused exploration of how various ecological systems—microsystem, mesosystem, exosystem, and macrosystem—contribute to student resilience. The analytical process was divided into several structured steps: data familiarisation, coding, theme development, and theme refinement.

While the DTA proved effective in systematically exploring the data within the theoretical framework, the chapter also acknowledged several limitations inherent in this approach. The reliance on a predefined coding framework, the potential for researcher bias, and the context-specific nature of the study were identified as factors that could influence the interpretation and

generalisability of the findings. These limitations suggest areas for further research, such as incorporating more inductive elements to capture emergent themes or extending the study to different contexts and populations.

With the thematic landscape established, the next chapter will examine how these themes address the research questions, consider broader implications, and position the findings within the existing literature on resilience and persistence in engineering education.

CHAPTER 5: FINDINGS

5.1 INTRODUCTION

This chapter presents the findings derived from the semi-structured interviews conducted with engineering students at a university of technology in South Africa. Building upon the methodological framework outlined in Chapter 3, it explores how resilience shapes academic persistence within the socio-ecological context of engineering education.

The primary aim of this chapter is to articulate the themes that emerged from the Deductive Thematic Analysis (DTA) of the interview data from Chapter 4. These findings fill a critical gap in the literature by demonstrating how interconnected ecological factors collectively shape engineering students' resilience in a South African university setting.

Justification of Thematic Order

In structuring these nine themes, I began with those closest to students' day-to-day experiences (e.g., family influence, peer relationships, personal coping) and then progressed outward to institutional factors (policies, resources) and broader socioeconomic/cultural influences. This ordering reflects the nested structure of Ungar's (2008) Socio-Ecological Model (microsystem → mesosystem → exosystem → macrosystem), allowing the discussion to move from the most immediate, face-to-face contexts to wider systemic factors. By proceeding from intimate personal networks (e.g., family, peers) to more distal institutional and societal elements (e.g., load shedding, cultural expectations), the chapter demonstrates how resilience emerges through the interplay of multiple ecological levels.

The findings are organised to correspond to nine themes:

1. **Family Influence on Resilience**
2. **Peer Relationships and Social Support**
3. **Academic Environment and Institutional Support**
4. **Personal Coping Strategies and Self-Efficacy**
5. **Health and Well-being**
6. **Institutional Policies and Resources**
7. **Socioeconomic Challenges and Motivations**
8. **Cultural and Community Influences**
9. **Role Models and Mentorship**

By structuring this chapter around the nine themes, and anchoring each theme in participants' verbatim accounts, the analysis provides a multifaceted view of how individual, relational, and contextual elements collectively underpin engineering students' resilience.

5.2 STRUCTURE OF THE CHAPTER

The chapter is organised into three sections to provide a comprehensive and coherent analysis of the research findings:

1. **Participant profiles:**

This section offers overview of the study's participants, providing essential demographic and contextual information to contextualise the findings. It includes details such as the number of

participants, their academic standing, gender distribution, and relevant background information that may influence their experiences of resilience and persistence in engineering studies. For example, the participants consisted of seven engineering students in their later years of study, with a balanced representation of genders and diverse socio-economic backgrounds. This diversity ensures that the findings reflect a range of experiences and perspectives, enhancing the depth and relevance of the analysis.

2. **Presentation of Findings**

This section presents the findings derived from the semi-structured interviews and link them to the corresponding themes that emerged from the qualitative data in Chapter 4. It highlights how personal, relational, and environmental factors influence the resilience of engineering students within Ungar's Socio-Ecological Model of Resilience. Each theme is presented alongside direct quotations from participants, which provide firsthand insight into their experiences. These quotes correspond to specific themes, reinforcing the connections between students' lived realities and the broader ecological factors that shape their academic persistence.

3. **Conclusion**

The final section of the chapter summarises the key insights and their significance, reinforcing the study's contributions to both theoretical frameworks and practical applications. It recaps how the findings answer the research questions and align with Ungar's Socio-Ecological Model, highlighting the multifaceted nature of resilience as experienced by engineering students. The conclusion emphasises the importance of a holistic approach to fostering resilience, encompassing individual coping strategies, supportive relationships, institutional policies, and broader societal attitudes. By synthesising the analysis, this section underscores the study's role

in enhancing the academic and personal success of engineering students, offering a foundation for ongoing efforts to support student persistence in higher education.

5.3 PARTICIPANT PROFILES

This section provides briefly the profiles of the participants involved in the study and was discussed in detail in section 3.5 of chapter 3. The study engaged seven engineering students who shared their experiences and challenges in pursuing

higher education. The sample consists of one female and six male students. They were enrolled in various engineering disciplines, including electrical engineering and computer engineering, and were at different stages of their academic journeys, from diploma students to postgraduate.

First-year students were excluded to ensure participants had sufficient academic experience in engineering. At this stage, they were fully immersed in a demanding engineering curriculum, managing both intensive theoretical coursework and hands-on laboratory sessions.

The sample is noticeably unbalanced, six of the seven participants are male, so the findings may under-represent female perspectives and limit gender-based comparisons. This sampling imbalance will be examined in greater detail in Section 6.6 of Chapter 6.

5.4 PRESENTING THE FINDINGS

This section offers an in-depth exploration of the themes that emerged from the qualitative data gathered in the student interviews. It highlights the personal, relational, and environmental factors shaping the resilience of engineering students according to Ungar's Socio-Ecological Model of Resilience.

Each theme is supported by direct quotations from participants, illustrating the multifaceted factors that contribute to or hinder resilience and persistence.

5.4.1 Family Influence on Resilience

This theme primarily addresses Research Question 2, which asks how family and social support networks intersect with university life to shape students' resilience. In Ungar's (2008) Socio-Ecological Model, families fall within the mesosystem, meaning they connect an individual's immediate environments (e.g., university) with broader social contexts. As a result, the degree and nature of family involvement, whether through emotional, financial, or motivational support, can significantly strengthen or undermine an engineering student's persistence. Below, participants' narratives illustrate both the positive and challenging aspects of family influence on resilience.

Students frequently mentioned their families as their primary source of encouragement during times of academic struggle. For instance, Participant 1 highlighted the critical role her sister played, especially in moments of stress: *"The people that I contact is my sister, and she will normally like calm me down like it's OK, you know, just take a walk or we can talk about it."* This support helped her regain focus and maintain resilience. Similarly, Participant 4 expressed deep gratitude for the support from his mother and sister: *"Honestly, the only person I do not want to let down in this whole thing is my mom and my sister... I feel as if, like, for them I have to."*

Participant 5 echoed this sentiment, describing his mother as the backbone of his resilience: *"My mom is always there for me whenever I need anything. She makes sure that I get it... She's all the*

support that I have." When he faced academic difficulty, his mother's words *"take it one step at a time"* reinforced his determination and provided the practical advice he needed to persist.

Participant 6 also turned to his parents for support after failing a module, highlighting the importance of family when facing setbacks: *"I went to my room and then I called my parents, explained the situation of the module that I failed."* This connection helped him emotionally and maintain his drive to succeed.

Participant 2 actively sought support from his family during challenging times in his academic journey. He explicitly mentioned turning to his parents for motivation and support when facing academic setbacks: "*Getting motivation from my parents keeps me going*." This statement shows how his family's encouragement served as a crucial source of strength, enabling him to persevere despite obstacles.

Long-Distance Encouragement

The emotional support that family members provide can continue even when they live far away, offering a source of comfort during periods of academic strain. For Participant 4, the absence of his sister's physical presence created a sense of loss, but regular long-distance conversations helped fill that gap: *"Like she and her husband that are currently right now living in the states… Well, I honestly just try with calling her, you know, like we talk over the phone and it helps."* Hearing her voice and sharing day-to-day concerns over the phone offered reassurance and motivation. Even though she was "living in the states," these calls helped him cope with moments of uncertainty, underscoring the importance of consistent emotional engagement in fostering resilience.

Summary

In summary, the findings reveal that family support, whether through daily encouragement or long-distance communication, plays a crucial role in fostering resilience among engineering students. While these insights highlight the emotional and practical backing provided by family members, elements such as family-induced pressures and expectations are further explored in the "Cultural and Community Influences" section.

5.4.2 Peer Relationships and Social Support

Peer Influence as Informal Mentorship

This section focuses on Research Question 1, which explores how the immediate educational environment and personal relationships (including peers) affect student resilience. Peers exist within the microsystem of Ungar's (2008) framework, representing daily face-to-face interactions that can boost academic motivation, offer emotional backing, and shape everyday study habits. Below, we see how supportive friendships, study groups, and occasional negative peer pressures directly contribute to or hinder the resilience of engineering students.

Peers often played the role of mentors in informal capacities, offering mutual support and shared learning experiences. Participant 5 described the influence of a classmate who had been his friend since high school: *"He always told me... everything has its own time. We are going to make it in life. You're going to make it at your own pace."* This friendship provided emotional stability, reinforcing the value of having peer mentors who understand and share similar experiences.

Students frequently highlighted the benefits of studying alongside peers, emphasising how these relationships helped their academic experiences. Participant 4 shared that group study sessions

were invaluable for identifying academic gaps: *"Me and my friends... we do this thing where every now and then we'd say, okay, for this particular module, we are cross-nighting for this one... It made me realise problems that I didn't even know I had because some people would bring up problems that I didn't think to bring up."* These sessions improved academic outcomes and also created an environment where students could learn from each other's strengths and experiences. This collaborative approach not only reinforced his learning but cultivated a sense of shared purpose and determination.

Similarly, Participant 5 mentioned the positive impact of forming a study partnership with a nearby peer: *"I found a friend who stays close to my res. We are doing the same course and we are busy helping each other with our studies in order to be able to understand... When I'm wrong, he corrects me, and when he's wrong, I correct him."* This mutual academic support was essential in navigating complex topics and staying motivated.

Participant 6's experience during the transition to online learning further underscored the importance of peer support. He recounted how a friend helped him adapt: *"I found a friend... we were communicating, and then whatever we learned in class is something that we would discuss, and then I would get help from him and then be able to cope with what's happening around the studies."* These interactions reinforced his resilience in a challenging new learning environment.

Emotional Encouragement and Shared Motivation

Peers provided not only academic aid but also emotional sustenance, offering words of encouragement during difficult times. Participant 2 noted: *"Classmates are some of the best help that you can get. If it's good friends, they will definitely motivate you and just tell you to keep*

going, don't give up." This supportive network helped him stay focused and maintain his determination.

Participant 6 elaborated on the broader benefits of positive peer relationships: *"What I really like about positive friends is that they don't really help you only academically, but then they help you also in your everyday needs and in your emotional well-being... that's how they really help me to cope with academic and life generally."* This sentiment reflects how the integration of academic and emotional support from peers can be pivotal for students' overall well-being.

Participant 6 found solace in peer discussions and mutual support: *"I found a friend... we were communicating, and then whatever we learned in class is something that we would discuss, and then I would get help from him."* This type of peer engagement proved crucial in navigating periods of uncertainty.

Peer Pressure and Its Challenges

While peer relationships were generally beneficial, there were instances where they posed challenges. Participant 4 discussed facing negative influences in high school, where peer pressure led him to engage in behaviours detrimental to his academics: *"All my friends, like literally all my friends, they were doing drugs and I didn't want to do them, but saying no became more and more difficult... I got to start doing them and it meant a decline in my academics."* This experience was a turning point, prompting him to seek better influences and ultimately focus more on his studies. *"I had to spend less time with my friends... the less time I got to spend with them, you know, the easier it came to it."*

Participant 3 also encountered negative peer dynamics that tested his resolve: *"They were trying to pressurise me or convince me so that I can start drinking like them... Whenever I refused, they*

would sort of make me feel small about it... It also kind of affected my self-esteem at some point. Overcoming such pressures required him to reassess his social circles, aligning with peers who shared his academic drive: *"I started breaking apart from them and I started associating myself with people who are like me... That helped me to revisit and meet myself again."*

Transitioning Peer Networks and Its Impact

Moving or transitioning to a new academic environment posed challenges in maintaining established peer support. Participant 7 highlighted the impact of relocating to a different campus: *"Coming to Pretoria, that was more like another challenge that I faced, coming and knowing no one... I couldn't even stay with those friends who helped me when I was in eMalahleni."* This disruption impacted his access to the familiar academic and peer support he had previously relied on, making adaptation more difficult.

The Digital Shift and Peer Connectivity

The shift to online learning due to the COVID-19 pandemic tested the adaptability of peer support systems. Participant 2 noted how digital tools like Discord facilitated continued connection: *"When COVID struck and everything went online, there was this tool called Discord which was pretty good because it's basically an online space where you and your friends can meet up... My friends just kept on motivating me, even when they're not physically there."* Such platforms helped maintain peer interactions and support during a period marked by isolation.

Summary

Peer relationships provide essential academic guidance and emotional support for engineering students. Participants described how supportive friends and study groups help identify academic gaps and maintain motivation, especially during the transition to online learning. However,

negative peer pressure also emerged as a challenge, causing some students to reassess their social circles.

5.4.3 Academic Environment and Institutional Support

Faculty and Institutional Mentors

Here, we continue examining Research Question 1 by looking at how immediate academic settings, lecture halls, lab sessions, and direct institutional supports, contribute to resilience. While "institutional policy" can extend to higher levels, the academic environment itself (e.g., teaching styles, accessible lab facilities) forms part of the microsystem in which students spend their day-to-day lives. In the subsequent examples, participants describe how hands-on practicals, interactions with faculty, and on-campus support services shape their capacity to cope with the challenges of engineering studies.

Beyond family and personal networks, mentorship from faculty members was highlighted as an impactful source of support. Participant 2 spoke of a particular lecturer whose motivational approach left a lasting impression: *"We had this one lecturer in second year... He was so personally involved with his students... That was a pretty big influence as well for actually continuing and finishing your studies."* The lecturer's habit of starting classes with motivational talks provided students with a morale boost and made them feel understood and encouraged.

Participant 6 also pointed out the importance of supportive faculty members, sharing his appreciation for a lecturer who extended help beyond his assigned duties: *"There was a time whereby I was doing a different module, and it was really tough... he was like, I can help you, and then he helped me."* Participant 5 frequently turned to his high school teacher, who continued to mentor him during university: *"I have a high school teacher who taught me*

electrical technology... He's now helping me with electrical engineering and electronics. I called that teacher last week... He said, 'I believe in you. Just keep on going and never give up'." This connection reinforced Participant 5's belief in his capabilities and provided reassurance during moments of doubt.

Similarly, Participant 7 found mentorship and spiritual guidance from his pastor, who had also studied engineering: *"Luckily he also did the same course, and then he'd advise me... go and have a group... consult the lecturer."* This mentorship offered both practical academic advice and emotional support, which proved essential during difficult periods.

While mentorship played a pivotal role for many, some participants identified areas where institutional mentorship could be improved. Participant 7 expressed the need for more proactive mentorship and encouragement from lecturers: *"It's really helpful... for also lecturers to be empathic, and just to encourage students."* The desire for increased engagement and mentorship from faculty reflects an ongoing need for structured mentorship programmes that cater to diverse student needs.

Institutional Support and Challenges

While some students benefited from the resources available, such as well-equipped libraries and supportive lecturers, others highlighted areas needing improvement. Participant 4 pointed out the demanding nature of the course load: *"Sometimes it felt like it was a lot... I feel like five modules for me personally, like it's a lot."* This statement suggested that reducing the number of modules per semester could alleviate academic pressure and allow students to manage their studies more effectively.

Participant 2 acknowledged that while the university managed the transition to online learning relatively well by equipping lecturers with video equipment, the sudden drop-in practical sessions was a considerable loss: *"Lab work suddenly dropped, and that was, I think, one of the most important things about engineering is having the capabilities of practically implementing something."* This gap emphasised the importance of experiential learning in engineering and the limitations posed by remote education.

Desired Improvements and Support Mechanisms

Students expressed the need for additional academic supports, such as tutorial classes, to help bridge learning gaps. Participant 5 emphasised: *"They should start giving us tutorial classes for our subjects... Most lecturers just touch the surface, and then we have to go figure out 80% of the rest."* This feedback highlights the potential benefit of supplemental instruction to deepen students' understanding and reduce self-reliance on finding external resources.

Participant 2 suggested that universities consider the financial burden of practical components, advocating for the provision of cost-effective resources: *"If you had to build a circuit and you don't have a soldering iron... now suddenly you have to go out and buy something that is quite expensive."* These additional costs can create inequities among students who might struggle to afford essential tools.

Summary

The academic environment including both institutional support and faculty engagement emerges as a critical factor in shaping resilience. The quotes demonstrate that while effective mentoring and well-equipped facilities can mitigate academic stress, challenges such as abrupt schedule changes and insufficient practical support are also evident.

5.4.4 Personal Coping Strategies and Self-Efficacy

This theme also aligns with Research Question 1, given that personal coping strategies and self-efficacy are often activated in response to the immediate demands of coursework, peer interactions, and faculty expectations. Although these strategies are internal to the student, they evolve within a microsystem context, shaped by day-to-day academic pressures and social cues (Ungar, 2008). Below, participants share how they manage stress, maintain focus, and build a sense of self-confidence within their demanding engineering environment.

Several participants described strategies they employed to safeguard their emotional resilience. Participant 6 mentioned using music as a calming and therapeutic tool: *"I think music is one of the things that calms me down also whenever I'm stressed or I'm having problems in my life."* Prayer was another significant coping mechanism for him: *"First thing that I usually do is to pray. I believe in prayer; I'm a religious person."* These methods allowed him to manage stress and maintain a sense of peace amidst academic pressures.

Similarly, Participant 4 found that following his sister's advice to engage in activities that "*turn the brain off,*" such as meditating or taking walks, helped him manage stress and regain focus.

Participant 1 also found solace in music and journaling as essential ways to decompress from her academic workload: *"I eventually find a way to calm myself down by either listening to music or writing, or just completely disconnecting and coming back with a refreshed mind."* Journaling daily helped her process her thoughts and provided a mental reset after periods of intense academic pressure. *"The whole year of last year, every day was like a really good big goal of mine that I should journal every day... It helped me positively writing about how I feel every day helped me process my feelings and my emotions and how to get back on track, I would say."*

Academic stress, particularly during exams, was a common challenge. Participant 5 spoke to the necessity of taking breaks to manage stress effectively: *"When I have too much stress, I just go outside for fresh air, then drink a bit of water, and then just relax for like 10 minutes or more... Once my mind is clear, I can think straight because when you are stressed and you are trying to do things under pressure, you're not going to think that great."* This practice highlighted the importance of brief mental resets to maintain productivity and focus.

Time Management and Strategic Study Habits

Efficient time management emerged as a shared characteristic among the students, highlighting their commitment to academic success. Participant 4 emphasised his proactive approach, ensuring that he studied after classes to stay ahead: *"I changed my daily routine... I always study after class... when I get home I do another recap."* He aimed for excellence, pushing beyond just passing to achieving distinctions. *"passing is not only the best thing. No, I want distinctions ."*

Participant 5 adopted strategic study methods to maximise his learning without overextending himself: *"I go through past question papers just to see how they set the questions and the answers... That way, you are not going to study everything that you have done, but you just study what you need to study for you to be able to pass the test."* This approach showcased his understanding of targeted studying as a tool for strategic study habits.

Resilience Through Self-Motivation and Vision

The ability to self-motivate played a pivotal role in sustaining the students' commitment to their goals. Participant 7 shared how he motivate himself to achieve his goals: *"I also motivate myself... I tell myself that, no, I'm gonna make it... I should learn from my mistakes, I should just keep on pushing."* This self-motivation played a pivotal role, reinforcing his resolve to succeed.

Participant 3's approach combined physical and mental resilience techniques: *"I drink water, you know, and then I do some breathing techniques to calm myself down... I give myself self-assurance when I'm stressing."* He paired these practices with self-reflection and visualisation of future success, noting: *"I like to envision what my life would be in the next few years... Revisiting that dream... kept me going."*

Participant 2 reflected on his resilience and personal drive as key motivators: *"Ever since I was a child, I know that I don't give up easily... I'm very challenge-focused... That mindset of not giving up is pretty important."* This unwavering belief in his ability to overcome obstacles fueled his persistence throughout his studies.

Facing Personal Challenges and Building Self-Efficacy

The participants' ability to confront personal setbacks was integral to their self-efficacy. Participant 4 shared the impact of personal difficulties, such as a breakup that affected his focus: *"One of the reasons why I failed was because I was kind of going through a breakup... I realised that... I have to pass. I shouldn't be making excuses."* This realisation drove him to compartmentalise personal issues and commit to his academic responsibilities.

Participant 2 also described going through a breakup that significantly affected his studies, mirroring the theme of facing personal challenges and building self-efficacy. In his words, the breakup left him feeling *"very sad,"* and he explained that failing a module during that period made it even harder to stay motivated. Nonetheless, he emphasised an internal resolve to press on despite personal pain:

"*I remember I failed the module because of this… or, well, not entirely because of this, but it had a role to play in it. So the way that I dealt with it was… I just realised that… there's more*

important things in life than just love, and trying to just do everything for them… [I] felt negatively impacted, I felt sad… but I was able to just bounce back and just focus again on my studies… So yeah, that was a big event that tested me."

By overcoming his personal struggles and choosing not to give up, he demonstrates how personal adversities can improve self-efficacy by realising that he must persevere academically despite emotional setbacks.

Participant 6 demonstrated a practical approach to managing his workload by focusing on his strengths: *"I focus on the chapters that I know the most... and then try to push with those that I know and then make sure that I pass them."* This strategic focus during exams showcased his self-awareness and ability to prioritise effectively.

Participant 2's reliance on reflective practices further underscored his self-efficacy: *"Just looking back over my life and seeing why did I choose some options makes me motivated again... Just knowing that once I finished my studies, I will be better than when I started."* This mindset reinforced his belief in continuous improvement.

Summary

These experiences collectively underscore how vital it is for engineering students to embed coping strategies, such as listening to music, engaging in prayer, taking short walks, and incorporating mindful breaks, into their daily routines. Adopting these methods not only helps them alleviate stress and maintain focus but also significantly reduces the risk of burnout during periods of intense academic pressure.

Although these methods are primarily individual, they are often reinforced by external support, which is further examined in the "Peer Relationships and Social Support" section. This interconnection underscores that personal efficacy is closely linked to broader social resources.

5.4.5 Health and Well-being

COVID-19 Pandemic and Online Learning

Health and well-being overlap with Research Question 1 and can also connect to Research Question 2 (Mesosystem), depending on whether students rely on family or peer support to navigate health issues. On a microsystem level, day-to-day academic stress, on-campus living conditions, and personal coping resources directly affect mental and physical health. Meanwhile, family responses or community support fall within the mesosystem. In the narratives that follow, students describe the interplay between personal health, study routines, and the immediate support they receive from friends and family.

The transition to online learning during the COVID-19 pandemic posed considerable difficulties for many students, disrupting their established learning methods. Participant 1 described how online classes affected her focus and engagement, stating: *"I would say online affected me negatively because then it was not like you would attend classes in bed... It's difficult to focus... there's like a lot of distractions."* This shift in learning modality, while necessary, revealed the challenges of maintaining self-discipline and effective study habits without a structured classroom environment.

Participant 6 also faced challenges adapting to online learning, emphasising his preference for face-to-face interactions: *"I'm used to contact; I believe in contact a lot more than being online... when you are face to face, that's when I'm able to be more free to ask questions."* The

absence of direct interaction with lecturers hindered his ability to fully grasp complex concepts, highlighting the limitations of technology when it replaced in-person academic engagement.

Despite these challenges, students found ways to use technology to support their academic growth. Participant 6 turned to online resources such as educational videos to supplement his understanding of practical components: *"I would look at videos on YouTube... whenever I see it practically, that's when I begin to understand it more than theoretically."* This approach allowed him to bridge the gap between theoretical knowledge and practical application, demonstrating resilience and adaptability in his learning strategy.

Participant 2 appreciated the university's efforts to facilitate online learning, noting: *"The university was pretty geared up... They gave every lecturer a video camera and microphone so that they can record their sessions online."* The preparedness of the university enabled students to access recorded lectures and materials, providing flexibility in their learning. However, he acknowledged that *"a lot of subjects that were in a practical sense kind of just went theoretical, and that was quite bad,"* pointing out the challenges of replicating hands-on learning experiences.

COVID-19 Pandemic and Mental Health

Emotional well-being is deeply intertwined with academic success, as highlighted by multiple participants. Participant 1 reflected on the impact of her mental health during the COVID-19 pandemic and subsequent exam period, stating: *"I remember last year during exam season I got very sick. I was infected with COVID-19 during the exams right when the exams were starting, and it lasted, I think, throughout my whole exam process. I was really finding it difficult to find*

any will of continuing studying." This severe illness not only affected her capacity to study but also strained her motivation to continue with her academic commitments.

Participant 1's experience extended beyond personal illness; her mother's health crisis also significantly impacted her focus and emotional stability: *"This happened, I think a few months after COVID; my mom had a brain aneurysm, and that impacted my studies very badly because I couldn't fathom losing my mom."* These compounded health crises underscored the importance of emotional resilience and support systems.

Summary

Health and well-being emerge as important to academic resilience. Students' experiences with personal illness, family health crises, and the stress of transitioning to online learning underscore the critical need for effective mental health strategies. Because many of these challenges are influenced by institutional policies, aspects of this theme are also reflected in the "Institutional Policies and Resources" section, which provides a more detailed discussion of support services and administrative challenges.

5.4.6 Institutional Policies and Resources

Counselling

This section addresses Research Question 3, focusing on how broader institutional policies and external resources indirectly impact student resilience. Within Ungar's (2008) model, the exosystem includes administrative decisions (like financial aid protocols and enrollment deadlines) that, while not directly involving students' daily face-to-face interactions, significantly shape their academic experiences. Here, we examine how participants navigate policy-related hurdles, counseling services, and resource allocations that affect their persistence.

The use of counselling services was highlighted by some students, though with mixed outcomes. Participant 6 mentioned trying counselling briefly: *"Recently I've tried counselling, but I didn't last,"* This brief engagement points to an awareness of the importance of mental health resources but also suggests a potential gap in their effectiveness or accessibility.

Participant 5 emphasised that existing services, such as counseling, play a crucial role in helping students cope with the demands of the academic environment: *"Every student can go there, can sit and express their emotions, their difficulties, their pressures that they're having."* This underscores the importance of accessible support systems in fostering students' emotional well-being and resilience, ultimately contributing to their academic success.

Participant 7 shared that he often panics before exams but benefitted from strategies learned through student development services that taught him to pause and take a breath: *"They would teach us that at first, just take a... just take a breath... do not just rush."* This insight reflects how targeted support programmes can positively impact students' coping strategies and exam performance.

These instances underscore the need for more tailored or effective counselling programmes to support students comprehensively.

Institutional and Administrative Challenges.

One of the most frequently mentioned stressors was the disruption caused by institutional and administrative challenges. Participant 6 highlighted how administrative issues such as unexpected schedule changes created academic stress: *"Recently, they postponed the test week... someone was prepared, and now the test week is postponed... now the work is also piling up."*

These disruptions forced students to constantly adapt their study plans, which could negatively impact their academic momentum.

Participant 2 echoed concerns about the accessibility and affordability of academic resources: *"Textbooks are very expensive. So maybe try to give the lecturers the opportunity to create their own textbooks that will be free."* This recommendation highlights the financial burden that course materials can impose and points to a need for cost-effective solutions to support students from all economic backgrounds.

External Resources

The transition from theoretical learning to practical application was a prominent aspect valued by many students. Participant 5 emphasised how practical sessions helped bridge the gap between theory and real-world application: *"Due to the practical class, the practical class mostly you are doing it physically, so when you are doing your practical physically, those physical practicals, they help you to understand the theoretical part of your studies when you are applying it physically."* This hands-on approach not only solidified his understanding but also fueled his engagement with the material.

Participant 6 mirrored this sentiment, finding motivation in collaborative projects and the communal learning atmosphere of the library: *"What I like about our library is that it's always full of people... every time when you go to the library, you get motivated, you get to study also."* The shared academic environment bolstered his resilience, enabling him to persist through challenging subjects with the support of peers.

Summary

To summarise, the findings illustrate that institutional policies and resource availability play a decisive role in shaping academic resilience. While the data emphasise both the strengths and shortcomings of available support services, issues such as funding delays and scheduling disruptions are reiterated in the "Socioeconomic Challenges and Motivations" theme. This overlap highlights the interconnected nature of institutional and personal financial challenges, prompting a more holistic view in subsequent chapters.

5.4.7 Socioeconomic Challenges and Motivations

This section addresses Research Question 3, focusing on how broader institutional policies and external resources indirectly impact student resilience. Within Ungar's (2008) model, the exosystem includes administrative decisions (like financial aid protocols and enrollment deadlines) that, while not directly involving students' daily face-to-face interactions, significantly shape their academic experiences. Here, we examine how participants navigate policy-related hurdles, counseling services, and resource allocations that affect their persistence.

The Burden of Socioeconomic Pressure

The weight of socioeconomic pressure often reinforced resilience of students.

Participant 7 shared the pressure to perform academically to maintain eligibility for financial aid: *"Your performance is not good enough to get you a bursary... so in this semester, I even told myself... let me just do well."* This drive to succeed under financial constraints often reinforced resilience but added significant stress.

Financial Support and Limitations

The issue of financial instability was a recurrent theme across the students' experiences. For Participant 7, the absence of a bursary presented persistent difficulties: *"It's really challenging not to have a bursary... finances, and also the res[idence]."* This financial strain affected his focus and created additional stress.

Participant 6's experience with NSFAS underscored the anxiety that financial uncertainty could create: *"I had a problem because now of finances... NSFAS hasn't funded me... they cancelled my application... it's something that's giving me problems with my academic[s] recently."* The financial pressure not only threatened his education but also added a layer of emotional stress that affected his overall resilience.

Participant 4 also recounted the challenges he faced with funding delays and its impact on accommodation: *"The biggest difficulty... was with NSFAS... the appealing process would take a very long time... I didn't have a place to stay, which meant I had to travel... that was very hard."* The uncertainty surrounding financial support by, NSFAS, often left students in a precarious situation, impacting their ability to focus fully on their studies.

Participant 5 also shared how financial difficulties delayed his registration, putting him at an academic disadvantage: *"I registered late and I was already behind on my school work... so that was a big change for me."* This delay underscored the ripple effect of financial barriers on academic performance.

Financial instability and the lack of secure accommodation were recurrent themes among participants. Participant 7 shared how frequent changes in his living situation disrupted his academic focus: *"I was staying in other residences, moving from a residence to another... close*

to seven or so... I also feel like that's something that affected my studies." These changes were often tied to funding issues or logistical problems with student housing.

This constant balancing act between financial limitations and academic ambitions illustrated the persistent challenges faced by students striving for a better future.

Strategies for Managing Financial Challenges

Students also took personal initiatives to lessen their economic burdens. Some joined study groups specifically to share materials and reduce individual costs for academic resources or transport. These strategies not only alleviated expenses but also enhanced their academic engagement. In describing why these collective efforts matter, Participant 7 highlighted:

"Sometimes we form a group ... share anything we have, like slides or notes, so you don't spend more buying stuff. It really helps."

Such examples reveal the creative and collaborative solutions that students devise when confronted with socioeconomic challenges. Their willingness to adapt, whether by seeking institutional support or relying on peer networks, demonstrates the resilience and resourcefulness that can thrive despite limited financial means.

Faced with limited financial resources, Participant 5 also developed strategies to cope. His proactive approach included seeking out bursaries independently: *"I found a website where they were posting bursaries... I just took all my dedication towards those bursaries, applied and applied."* His perseverance paid off when he secured funding, allowing him to continue his studies and focus on academic success.

Adapting to Load Shedding and Power Outages

Load shedding was another significant environmental stressor that impacted students' ability to maintain their academic schedules. Participant 2 specifically pointed out the challenge of studying during power outages: *"It was just demotivating when load shedding happened. You suddenly have two or four hours less work time, and that's if you don't have backup power. Sometimes I would have to stop studying completely and just wait... or even figure out transport to a friend's place that still had electricity, which cost money I didn't always have."* This forced him to rearrange his study schedule and find alternative ways to cope, such as taking breaks during outages and resuming work once power was restored.

In grappling with these recurring outages, participants emphasised the mental toll it exacted, especially as exam dates approached. Some tried to remain flexible in their schedules, taking enforced breaks during load shedding to rest and then *"crunch time"* once electricity returned. However, this often led to inconsistent study patterns and heightened stress levels. As Participant 2 observed:

"I'd take that two hours with no power to kind of relax, but then you come back and it's crunch time again—no own pace, no real planning, just working around Eskom... It gets exhausting."

Participant 6 explained how he often had to "*rush to finish assignments before the lights go off*," emphasising the added pressure this placed on regular coursework. Participant 4 noted that, with limited resources, "*we'd huddle together in someone's room that still had a charged laptop, trying to finish group work by candlelight*."

Several students mentioned that even short outages disrupted their concentration and mental readiness for upcoming tests. As Participant 5 put it, "*I'd be in the middle of revising for a big*

exam, and then—boom—there's no electricity. By the time it came back, I'd lost my momentum and had to start all over again." Consequently, these abrupt breaks in focus often led to late-night study marathons, as participants struggled to recover lost hours.

These accounts reveal how students were forced to juggle sporadic power cuts alongside their formal academic obligations. Despite these disruptions, participants adapted by planning study timetables around expected outage periods, sharing resources like portable lamps or study spaces with reliable backup power, and reaching out to peers for help when home conditions became unmanageable.

Summary

In summary, socioeconomic challenges are a significant source of stress for engineering students, influencing both their academic performance and overall resilience. The narratives reflect not only personal financial struggles but also systemic issues, such as delays in funding and high costs of materials. These challenges intersect with institutional policies, and will be discussed further in the "Institutional Policies and Resources" section, providing additional context on how administrative practices compound financial pressures.

5.4.8 Cultural and Community Influences

This theme primarily speaks to Research Question 4, which investigates how societal attitudes and cultural values affect students' resilience in engineering programmes. According to Ungar's (2008) framework, the macrosystem comprises broad cultural norms and economic narratives, such as the prestige of engineering or doubts about job prospects, that frame a student's educational journey. Participants here reveal how cultural pride, communal expectations, and

social narratives intersect with their personal motivations to either reinforce or undermine academic persistence.

The community's perception of engineering as a prestigious but challenging field played a notable role in motivating students. Participant 5 shared how the admiration for engineering in his community inspired him: *"They think studying engineering is a very big thing because a lot of moms in my community, they think of you studying engineering, you are like the smartest person in the community."* This view instilled a sense of pride and responsibility, pushing him to persevere in his studies despite difficulties.

Participant 6 echoed similar sentiments, noting the scarcity of engineers in his community and the resulting perception of unattainability: *"Where I'm coming from, we don't really have a lot of engineers... it's something that they say it's not manageable."* This perception fueled his drive to challenge the status quo and inspire others to believe in the possibility of success: *"You have to show people that nothing is impossible. If I can do it, anyone can do it."*

Participant 4 initially chose engineering partly due to how it was perceived in his community: *"Everybody thinks engineering is... like they see it as... you know a difficult course and if you can manage to qualify for it then you are very, very smart."* However, his journey evolved from seeking external validation to developing a genuine passion for the field: *"Realising that engineering was not as big as I thought it was... it took me by surprise, but... I really fell in love with this course... I enjoy it."*

Cultural Pressures and Alternative Career Paths

Despite positive perceptions, cultural expectations sometimes created challenges. Participant 6 mentioned how community members often suggested alternative, less demanding career paths:

"Rather do teaching, rather do social working, do something that is simple like management." This societal pressure to choose more conventional or accessible careers could be discouraging.

Similarly, Participant 7 faced scepticism from his community regarding the viability of an engineering career, highlighting a broader cultural sentiment that leaned toward safer, more traditional job choices: *"I would get... they'd say that you were doing this course, and you've been doing it, and it's unlikely for people to get jobs for this course."* Such remarks tested his resolve but also reinforced his commitment to proving his doubters wrong and demonstrating that success was possible through persistence. *"So let me just finish what I've started. I know that I can finish"*

Motivation Rooted in Personal and Family Aspirations

Many students cited their backgrounds as powerful motivators to succeed. Participant 5 spoke passionately about changing his circumstances: *"The thing that influences me to keep going is my background... I want to change my background so badly. I want to make it easier for them [family]. They don't have to worry about financial issues like I did when I was growing up."* This sense of responsibility extended to his family, with his mother's encouragement fuelling his determination.

Participant 4's experience reflected a similar narrative, where his aspirations were tied to securing a better future and standing out in a competitive job market: *"Eventually I will be requiring to have a job, and my results are one of the things that are going to become effective... My aim is to get distinctions on each and every single module."* His drive to excel academically stemmed from the recognition that exceptional performance would enhance his job prospects.

Similarly, for Participant 7, familial support was coupled with expectations that reminded him of his responsibilities: *"I've been told that, yes, hey, you've been doing this course, and you are old now... you should be helping your siblings now."* This pressure to contribute back to his family, while daunting, also fueled his resolve to complete his studies.

The Double-Edged Sword of Expectations

While familial support serves as a pillar of resilience, it is often accompanied by high expectations that can add pressure. Participant 1 shared how the pressure from her parents to achieve specific results left her feeling anxious: *"My parents put a lot of pressure on me to get certain results, and when I come home with something different... it's shunned upon you."* Despite the stress, she acknowledged that this pressure also motivated her to push for better outcomes.

For Participant 6, family expectations were intertwined with responsibility: *"I have a lot of responsibilities from home, from my family... A lot of young ones are looking at me. I should set an example, and that on its own is something that will give anyone pressure."* This duality, acting as a motivator and a stressor, drove him to persevere despite academic challenges.

Similarly, Participant 7 felt the weight of family expectations as a factor that impacted his ability to balance different aspects of life: *"Most of... actually, all my friends are done now... there is that pressure, but I guess I'm someone who is also trying to... focus."* This statement underscores how external comparisons and expectations can intensify stress and influence time allocation between academic work and personal relaxation.

Community Support and Challenges

Support from the community extended beyond motivation to practical assistance. Participant 5 noted how the collective belief in his potential helped reinforce his commitment to his studies: *"Many people believe in me. They believe that I'm going to make it, that I'm going to restructure the community's economy by bringing new business opportunities there."* This communal trust placed an added sense of responsibility on his shoulders, compelling him to succeed not just for himself, but for those who looked up to him.

However, this communal focus on academic achievement sometimes came with unintended pressures. Participant 4 highlighted how the intense emphasis on academic success in his community could be demotivating: *"I feel like they should stop putting pressure on school, you know, considering that not every child and not everyone is academically gifted... that kind of pressure, it demotivates them."* This observation points to the need for balanced community support that encourages students without overwhelming them with expectations.

Summary

In conclusion, cultural and community influences are shown to be a double-edged sword: while high societal regard for engineering inspires many students, it also creates significant pressure. The community's mixed messages about the feasibility of an engineering career are further reflected in the themes of role models and family support. These overlapping aspects underscore the need to consider cultural context when designing support programmes, a point that will be further integrated into the discussion in Chapter 6.

5.4.9 Role Models and Mentorship

Role models and mentorship connect most directly to Research Question 2 (Mesosystem influences) if the mentors are from community networks or to Research Question 1 (Microsystem) if they are part of day-to-day academic life. Typically, mentors from outside the university, like community leaders or extended family, sit within the mesosystem, while in-university mentors (e.g., senior students, faculty) function within the microsystem. The upcoming examples illustrate how having mentors who bridge personal, academic, and career guidance can significantly enhance a student's resilience.

Across the interviews, several participants cited role models—from immediate family members to respected figures in their communities—as powerful motivators. Participant 2, for instance, drew inspiration from his father's path in the same field, explaining:

"My father studied engineering as well, and that's a pretty good motivation for me... If he could do it, I can do it as well."

Participant 5 similarly described how a prominent figure from his hometown encouraged him to keep pushing forward:

"This guy from my community… he's now a CEO. He also did engineering and he came from the same high school. He owns his own company, and he's bringing jobs to my community. If he could make it, I also believe that I can make it too."

Summary

The role of mentors and role models is pivotal in shaping resilience. Its impact is a strong source of motivation that offers both practical guidance and inspirational support.

5.5 SUMMARY OF THE FINDINGS AND CHAPTER CONCLUSION

A summary of the key themes identified across the interviews is presented here, reflecting both individual participant experiences and the collective insights from the qualitative data.

The findings underscore the multifaceted nature of resilience, as students draw on personal strengths, social networks, institutional resources, and broader cultural influences to navigate the demands of their engineering studies.

1. **Personal Character Strengths and Family Influence on Resilience**

   Many participants credited their perseverance and adaptability not only to their personal determination but also to the steady encouragement they received at home. Families often served as cornerstones of emotional support, reinforcing students' natural grit and willingness to confront challenges head-on. One student remarked, *"I wouldn't be here if it wasn't for them...they really helped me when I was sick, telling me I could still change my situation and push forward."* In moments of self-doubt or stress, these familial reminders of capability were pivotal in sustaining a sense of hope and tenacity.

   Alongside this support, students developed an intrinsic drive to better their own circumstances. One participant noted the importance of *"working hard so I don't disappoint my parents who expect high marks,"* illustrating how external expectations can be both a stressor and a motivator. Indeed, the combination of internal character strengths, such as conscientiousness and perseverance, and the relational bond with family underpinned much of the resilience observed. By weaving together personal determination with the emotional buffer of familial backing, students were able to maintain focus on their academic goals despite financial hurdles, health concerns, or other setbacks that inevitably arose.

2. **Peer Relationships and Social Connections**

   The majority of participants highlighted the motivating effect of study groups and informal peer support. Beyond academic gains, these interactions also yielded a significant emotional benefit. Students pointed out that tackling academic hurdles together reduced feelings of isolation. This collective effort frequently boosted confidence, with one participant stating that collaborating with friends *"helped me get through those chapters I thought I'd never finish."*

3. **Academic Environment and Institutional Support**

   Access to university facilities such as libraries with extended hours, specialised labs, and on-campus counselling services emerged as a vital support system. Students underscored how these resources enabled them to remain on track academically and mitigate stress, particularly during intensive exam periods. Additionally, timely technical support and guidance from academic staff were singled out as critical elements fostering a sense of preparedness and direction.

4. **Personal Coping Strategies**

   Students employed diverse approaches to handle academic stress and reinforce their self-efficacy. Many incorporated brief mental breaks, spiritual grounding, or creative outlets to maintain focus and motivation. Targeted study methods, such as reviewing past exam papers or studying immediately after class, helped ensure efficient and purposeful revision. When personal setbacks arose, individuals drew on these techniques and on social or spiritual mentorship to rebound academically, demonstrating that adversity could ultimately strengthen their commitment to success.

5. **Health and Well-being**

Emotional well-being proved essential for sustained academic engagement, as personal and family health crises often undermined motivation and study capacity. Students responded by integrating restorative routines, like short relaxation breaks, prayer, or meditation, into daily life to preserve their mental health. These strategies, along with support from trusted peers or family, helped them manage the stress that arose from serious illnesses or emotionally taxing periods, underscoring the critical interplay between health concerns and academic performance.

6. **Institutional Policies and Resources**

Institutional structures played a powerful role in students' educational journeys, at times easing their academic burdens but also occasionally intensifying them. While services like counseling offered emotional support, some found these interventions incomplete or difficult to access. Frequent administrative issues, such as funding delays or abrupt schedule changes, further complicated studies and intensified financial worries. On the other hand, practical learning opportunities and communal study environments promote deeper engagement with academic content. Overall, students' experiences highlighted the importance of consistent institutional support, accessible mental health resources, and cost-effective materials in fostering both resilience and academic success.

7. **Socioeconomic Challenges and Motivations**

Financial pressures, including the cost of housing, tuition, and everyday expenses, were commonly cited as major hurdles. In response, many students became adept at budgeting, seeking part-time work, or pooling resources with peers. Some described inconsistent or

delayed financial aid as a trigger for periods of uncertainty and stress but also noted that these hardships reinforced their determination: *"I told myself I was not quitting. I was going to figure out a way to pay for this and finish."*

8. **Cultural and Community Influences**

   Cultural expectations often shaped how students approached their studies. Some described being encouraged to *"aim high"* by family and community members who viewed engineering as a prestigious path. Yet, others encountered scepticism or caution from their local communities, who considered engineering both challenging and risky. These cultural attitudes could serve as either a motivating factor *"I wanted to prove it could be done",* or a source of additional pressure to succeed.

9. **Role Models and Mentorship**

   Several participants pointed to the importance of role models, whether a successful relative, a community leader, or a former high school teacher, inspiring them to persist. When describing a mentor, one student referred to the *"guidance and example"* they witnessed, explaining it as a driving force behind their current goals. In many instances, mentors also offered concrete support, from sharing study strategies to introducing students to professional networks in their field.

10. **Impact of Health Crises on Education**

    Although experiences varied, health crises, like personal illness or broader events such as COVID-19, were significant stressors for some. Shifting between online and face-to-face formats disrupted normal routines, requiring students to find new ways of staying organised and engaged. Those who adapted successfully often cited the help of friends or

mentors, and some relied on on-campus services or virtual mental health support to navigate heightened anxiety.

Conclusion

The findings in this chapter show that resilience in engineering studies is a shared effort. It stems from personal perseverance, active use of institutional resources, and strong peer networks. Cultural perceptions, mentorship opportunities, and the acute challenges posed by health or financial crises further shape students' experiences, either reinforcing or testing their resolve. Those who successfully navigated these complexities did so by drawing on multiple forms of support, whether familial, academic, or communal, and by leveraging personal character strengths that flourished over time.

CHAPTER 6: DISCUSSION

6.1 INTRODUCTION

The purpose of this chapter is to interpret the findings of this study in relation to the research questions and the theoretical framework underpinning the research. It serves as a bridge between the empirical findings presented earlier in Chapter 5 and the broader theoretical and practical implications of the study.

The discussion will be framed using Ungar's Socio-Ecological Model of Resilience, which emphasises the dynamic interaction between individual, relational, community, and societal factors that contribute to resilience. This framework allows for a nuanced interpretation of the findings, highlighting how various systems interact to support or hinder the resilience and persistence of engineering students in their academic journeys.

The chapter begins by linking the findings to the four research questions, which correspond to the microsystem, mesosystem, exosystem, and macrosystem levels of influence. Each section will explore how specific factors within these systems either facilitate or impede resilience and persistence, supported by examples and insights from the participants. Subsequently, the discussion will integrate these findings with the theoretical framework, illustrating how this study contributes to existing literature and offers new perspectives on resilience in engineering education.

In addition to interpreting the findings, this chapter will explore the practical implications of the study for educational institutions, policymakers, and communities. These implications will inform targeted interventions and support systems that can enhance resilience among engineering students, ultimately improving retention rates and academic success.

Finally, the chapter will acknowledge the limitations of the study, including methodological and contextual constraints, and propose recommendations for future research. These recommendations will focus on addressing the gaps identified in this study and exploring new avenues for understanding and fostering resilience in higher education contexts.

By examining the findings through the lens of resilience theories and linking them to real-world applications, this chapter aims to provide a comprehensive understanding of the factors influencing engineering students' resilience and persistence in South Africa. This understanding has the potential to inform the development of evidence-based strategies that empower students to overcome challenges and succeed in their academic and professional endeavours.

The discussion is organised to correspond with the four specific research questions that guides this study and are listed in section 1.3 of this thesis. By structuring the chapter according to these ecological levels, I aim to provide a better understanding of the complex interplay between individual, relational, and contextual factors influencing student resilience.

6.2 STRUCTURE OF THE CHAPTER

The chapter is organised into six key sections to provide a comprehensive and coherent discussion of the research findings:

Linking Findings to Research Questions

Each subsection corresponds to one of the four research questions and focuses on specific levels of influence from Ungar's Socio-Ecological Model of Resilience (Ungar, 2008). Section 6.3 uses participants' experiences and findings to discuss how these systems impact resilience and persistence. Relevant examples from the data are presented to illustrate these dynamics, and connections are made to the theoretical frameworks and existing literature.

Integration with Theoretical Framework

This section combines the findings across the four systems and aligns them with Ungar's Socio-Ecological Model. It discusses how the findings extend, confirm, or challenge the framework, emphasising the multidimensional and dynamic nature of resilience.

Practical Implications

This part explores the real-world applications of the study's findings. It is divided into three subsections focusing on implications for educational institutions, policymakers, and communities. Recommendations include strategies to enhance resilience, address barriers to persist and improve the academic environment for engineering students.

Limitations of the Study

This section critically evaluates the study's limitations, including methodological constraints (e.g., small sample size) and contextual factors (e.g., focus on a single institution). It also reflects on potential biases and challenges encountered during the research process.

Recommendations for Future Research

This section proposes directions for future research based on the study's findings and identified gaps. Recommendations include methodological enhancements (e.g., mixed methods, longitudinal studies), expanding the study's scope to include diverse contexts, and exploring additional factors influencing resilience and persistence.

Conclusion

The chapter concludes with a summary of key points discussed, highlighting the contributions of the study to theory and practice. It reaffirms the importance of resilience in fostering persistence

among engineering students and emphasises the need for targeted interventions to support students in overcoming academic and socio-economic challenges.

6.3 LINKING FINDINGS TO RESEARCH QUESTIONS

6.3.1 Microsystem influences

Research Question:

How do the immediate educational environment and personal relationships within the university, such as interactions with faculty, peers, and the curriculum, contribute to the resilience of engineering students at a university of technology in South Africa?

6.3.1.1 Overview and Context

The first research question explores how engineering students develop resilience through their daily interactions within the university environment. Through careful analysis of participant narratives, three key dimensions emerged: relationships with faculty members, peer connections, and engagement with the curriculum.

6.3.1.2 Faculty Interactions

Within Ungar's (2008) Socio-Ecological Model of Resilience, the microsystem level encompasses the most immediate environments in which students engage, namely, their day-to-day interactions with faculty, peers, and curricular activities.

During the interviews, stories of faculty support emerged as transformative experiences in students' academic journeys. Several students described how lecturers extended help beyond formal office hours, offering motivation and guidance with difficult modules. For example,

Participant 2 shared a particularly moving account of a second-year lecturer whose personal investment made a lasting impact:

"We had this one lecturer in second year... He was so personally involved with his students... That was a pretty big influence as well for actually continuing and finishing your studies.."

Another participant also shared:

"When I was struggling with a specific module, my lecturer explained it to me after class. That support encouraged me to continue, even when I felt like giving up."

This finding is aligned with Tinto's (1993) theory of integration, which underscores that positive interactions with faculty contribute to a sense of belonging and academic integration, enhancing persistence. When students perceive that their instructors are genuinely invested in their success, it bolsters self-efficacy and commitment to the programme (see also Martin & Marsh, 2006). Moreover, faculty mentorship often fills critical knowledge gaps, especially in technically demanding programmes like engineering. The data suggest that lecturer accessibility and personalised feedback serve as strong protective factors against dropout by enhancing students' sense of belonging and competence (Rutter, 2006).

Yet not all faculty interactions foster resilience. Some students encountered discouraging experiences, as one participant revealed:

"Some lecturers don't seem interested in helping us. They make you feel like you're on your own, which can be demoralising."

This sentiment is supported by Wilcox et al. (2005), who noted that unsupportive faculty relationships can undermine resilience by reducing students' confidence in their ability to overcome challenges.

These findings reinforce Ungar's (2008) idea that having access to meaningful and culturally relevant resources, such as approachable faculty, is essential for fostering resilience.

6.3.1.3 Peer Relationships

Peers emerged as another influential component of the microsystem level. Participants emphasised the influential role of peers in shaping their resilience and persistence. Studying in groups, working together during revision, and receiving emotional support from friends fostered a sense of togetherness that helped against feelings of isolation. Participant 5 noted the positive impact of studying alongside a friend:

"I found a friend who stays close to my res... When I'm wrong, he corrects me, and when he's wrong, I correct him."

Another participant highlighted that study groups and friendships offered both emotional and academic support:

"We formed a study group early on. It made a big difference because we supported each other emotionally and academically. Even when one of us was close to giving up, the group kept us motivated."

This dynamic illustrates how peer groups offer informal mentorship, sharing resources, troubleshooting academic hurdles, and providing mutual accountability (Wilcox et al., 2005). The cooperative learning framework highlighted in these narratives resonates with research

showing that peer support significantly improves both academic performance and resilience, as it fosters mastery experiences and social connectedness (Martin & Marsh, 2009).

These findings align with Fletcher and Sarkar's (2013) research on social resilience, which highlights the role of peer networks in providing emotional support and reducing isolation. It also reflects Ungar's (2008) emphasis on relational factors as vital components of resilience, where supportive peer relationships serve as a buffer against stress.

However, not all peer interactions were beneficial. Participants who encountered negative peer pressure (e.g., substance use or academic disengagement) had to recalibrate their social circles to maintain focus. Participant 3's account of distancing himself from peers who pressured him into adopting detrimental habits reflects how the microsystem can also present risks when peer norms conflict with academic goals. This finding aligns with St. Pierre and Jackson (2014), who argue that certain peer groups may undermine resilience if students feel coerced into behaviours incongruent with their educational aspirations.

6.3.1.4 Curriculum and Academic Demands

In a demanding field like engineering, the curriculum itself forms a crucial part of the microsystem, directly shaping day-to-day student experiences. Many participants described substantial workloads that heightened stress but also cultivated perseverance. Participant 4 explained how *"cross-nighting"* (intensive group study without sleep), revealed knowledge gaps he did not initially perceive. Despite the challenges, some participants experienced a sense of accomplishment when they conquered rigorous tasks, which reinforced their resilience.

Some of the participants acknowledged that the programme's rigor forced them to develop time management and problem-solving skills, ultimately building their resilience. One participant explained:

"The workload is intense, but it pushes you to improve. You learn to adapt and handle pressure, which makes you stronger."

This reflects Martin and Marsh's (2006) findings, which suggest that challenging academic demands can foster resilience by encouraging students to develop adaptive coping strategies.

That said, others struggled with the pace and complexity of engineering modules, expressing the need for more structured tutorials. Participant 5 recommended "tutorial classes" that address foundational gaps and offer hands-on practice, noting that *"most lecturers just touch the surface, and then we have to go figure out 80% of the rest."*

Sweller et al. (2019) explain that instructional strategies designed to reduce extraneous cognitive load, such as supplemental courses and small-group tutorials, can free up cognitive resources so that learners can focus on mastering core concepts. This reduction in cognitive load promotes the kind of mastery that underpins academic resilience.

Despite these benefits, some participants criticised the curriculum for being overly theoretical and disconnected from real-world applications. One participant noted:

"Sometimes the coursework feels irrelevant to what we'll actually do as engineers. It's frustrating because it's hard to stay motivated when you don't see the practical value."

This finding aligns with Prince (2004), who argues that active, practical learning strategies enhance student engagement and persistence. Ungar's (2008) model reinforces that resources

must not only be available but also accessible and meaningful in the cultural and contextual setting of students. Thus, institutions should strive to align curricula with students' career aspirations and provide opportunities for experiential learning.

6.3.1.5 Summary and Critical Reflection

Overall, the findings from the microsystem highlight that engineering students build resilience through supportive interactions with faculty, strong peer relationships, and a curriculum that balances academic challenges with accessible resources. These results align with established literature illustrating how student persistence improves when immediate academic environments offer consistent encouragement, challenge, and respect (Tinto, 1993; Ungar, 2008). Nonetheless, the presence of negative peer pressure and the perceived gaps in tutorial support indicate that the microsystem can become a site of both resilience-building and vulnerability.

Based on these insights, higher education institutions might consider:

1. **Professional Development for Faculty:** Training that emphasises mentorship, empathy, and quick feedback to reinforce positive faculty-student dynamics (Robbins et al., 2009).
2. **Structured Peer Collaboration Initiatives:** Formalised peer learning communities or peer mentorship schemes that promote accountability and collaboration (Wilcox et al., 2005).
3. **Curricular Adjustments:** Lee et al. (2018) demonstrate that integrating robust tutorial sessions and practical project applications into challenging engineering curricula significantly reduces cognitive overload and stress while maintaining high academic standards.

These strategies can help students, in the microsystem environments, making resilience a collective enterprise rather than an individual burden (Ungar, 2008). By addressing micro-level factors, ranging from faculty engagement to peer study groups, universities can foster an immediate climate where engineering students consistently find the motivation, resources, and social affirmation they need to persist.

Having examined the immediate, day-to-day influences of faculty and peers (microsystem), we now turn to how interactions among family members and broader social networks (mesosystem) further shape students' resilience.

6.3.2 Mesosystem level

Research Question:

In what ways do family and social support networks intersect with university life to influence the resilience and academic persistence of engineering students, and how do these interactions shape their educational experiences?

6.3.2.1 Overview and Context

At the mesosystem level of Ungar's (2008) Socio-Ecological Model, the focus shifts to how various microsystems interact with each other. Specifically, it explores how family relationships and social networks beyond campus connect with and influence students' academic experiences.

This study revealed that participants' resilience and persistence were significantly shaped by relationships outside the university. Students described how their family support systems and off-campus social connections either strengthened or occasionally hindered their academic journey. These mesosystem factors effectively formed a *"bridge"* between personal life and

academic demands, shaping the students' capacity to manage stress and maintain motivation (Bronfenbrenner, 1979).

6.3.2.2 Family Support as a Foundation

A recurring theme in the interviews was the pivotal role of family in sustaining students through financial, emotional, and logistical challenges. For example, Participant 5 referred to his mother as *"the backbone of his educational resilience,"* noting that her unwavering faith in his abilities gave him the confidence to navigate hurdles. He explained:

"My mom is always there for me whenever I need anything. She makes sure that I get it... She's all the support that I have."

Such remarks align with McCarron and Inkelas's (2006) findings that robust parental support correlates with higher academic achievement and persistence among college students. Emotional backing from family members also provides a safety net. It fosters psychological security students need to handle set-backs and remain committed to their academic paths (Theron & Theron, 2013).

Beyond day-to-day encouragement, family involvement often translated into tangible academic benefits. For instance, Participant 4 mentioned calling his sister, who lived abroad, when he felt overwhelmed, underscoring how even long-distance contact acted as a critical resource: *"I would just call her... and it helps."* This kind of cross-continental moral support suggests that positive family engagement can override geographic constraints, reinforcing resilience through reassurance and practical advice (Van Breda & Theron, 2018).

Nevertheless, certain family expectations also introduced pressure, as some parents anticipated *"specific results"* or considered engineering studies a vehicle for economic upliftment.

Participant 1, for example, spoke of the anxiety linked to not meeting parental performance standards. This dual nature, support alongside high expectations, often spurred motivation but could enhance stress (Martin & Marsh, 2009). Hence, the interviews reflect how familial aspirations serve as both a motivator and a stressor, reinforcing the complex role of family in shaping resilience.

6.3.2.3 Social Support Beyond Campus

In addition to family, participants relied on broader social networks that intersected with their university experiences in meaningful ways. Participant 6, for instance, described reaching out to a church community or a pastor who had studied engineering:

"Luckily he [the pastor] also did the same course, and then he'd advise me... go and have a group... consult the lecturer."

This external social network provided spiritual and academic mentorship, bridging personal faith and professional insight. The guidance validated the student's struggles and offered actionable strategies, reinforcing Crisp and Cruz's (2009) observation that mentorship can emerge from non-academic contexts, profoundly influencing students' educational engagement.

Others pointed to community members or local role models who had succeeded in engineering, reinforcing the belief that *"if they can do it, I can too."* According to Feldman et al., (2009), such community-based inspiration can bolster resilience by illustrating concrete success pathways and mitigating *"imposter feelings."* Thus, social networks outside campus not only provided emotional or spiritual resources but also broadened students' career horizons and sense of capability.

6.3.2.4 Intersection with University Life

The mesosystem reveals important connections between students' personal and academic lives. Many participants shared how their families and social circles actively encouraged them to take advantage of university resources, including the library, tutoring support, and counseling services. Building on Tinto's (1993) foundational work, this study reveals that students increasingly gravitate toward university support systems when external communities actively champion scholarly participation.

While institutional support remains vital for student success, setbacks such as funding delays and insufficient mental health services can significantly diminish that support and shift added burdens onto families. Participant 4, for example, noted that persistent lapses in funding required him to travel long distances, thereby escalating his family's financial strain. This scenario illustrates that, although loved ones often mobilise to compensate for institutional shortcomings, ongoing systemic hurdles can gradually undermine familial resources and goodwill (Bean & Metzner, 1985).

In addition, some participants from lower-income backgrounds described how neighbours and community members temporarily bridged financial or logistical gaps, offering short-term housing or meals, to help students maintain their studies. These locally driven "*wraparound*" measures highlight the importance of multi-layered networks in shielding students from institutional and economic adversities (Masten, 2001).

6.3.2.5 Summary and Critical Reflection

Collectively, the participants paint a rich portrait of how family ties, social networks, and university contexts converge to bolster resilience. Students repeatedly drew strength from

parents, siblings, mentors, and faith communities, demonstrating that resilience is rarely an individual achievement, but rather a product of interconnected systems (Ungar, 2008). Emotional encouragement, moral accountability, and direct resource-sharing all characterised the positive side of mesosystem engagement.

Nonetheless, heightened family expectations or socio-economic constraints sometimes introduced tension. Some participants experienced intense pressure to succeed, knowing the extent of familial sacrifice or community aspirations. While this pressure can fuel determination, it may also undermine mental well-being if not balanced with sufficient institutional and emotional support (Van Breda & Theron, 2018).

In practical terms, these insights suggest that universities seeking to enhance resilience could:

1. **Strengthen Family Outreach**: Implement structured orientation programmes and regular updates for parents, aligning expectations with realistic timelines and available resources (Crisp & Cruz, 2009).
2. **Leverage Community Partnerships**: Collaborate more with local organisations or faith-based groups that already mentor students, creating formal channels to complement on-campus support (Feldman et al., 2009).
3. **Address Socio-Economic Barriers**: Provide emergency funds or bridging programmes that lighten the load on families, reducing the ripple effect of institutional gaps (McCarron & Inkelas, 2006).

By acknowledging how family, community, and the university setting intersect, institutions can devise more targeted interventions that nurture resilience across the full spectrum of student experiences. Within the mesosystem, these mutual relationships form a vital support framework

that can empower engineering students to persist at South African universities of technology (Ungar, 2008).

Having explored how family and social support networks intersect with university life (mesosystem), we next consider the influence of institutional policies and community resources (exosystem) on students' capacity to persist.

6.3.3 Exosystem level

Research Question:

What impact do institutional policies, community resources, and broader educational practices have on the resilience of engineering students, and how do these external supports or barriers affect their ability to persist in their studies?

6.3.3.1 Overview and Context

In Ungar's (2008) Socio-Ecological Model, the exosystem refers to the institutional and community contexts that influence students' daily lives indirectly. While engineering students may not have direct control over these factors, decisions related to policies, resource allocation, and administration play a significant role in shaping their academic experiences (Bronfenbrenner, 1979).

In this study, participants frequently highlighted how institutional policies, such as funding structures and administrative processes, and community resources, including reliable power, transportation, and external support organisations, either strengthened their resilience or contributed to additional challenges.

6.3.3.2 Institutional Policies and Administrative Support

Funding and Financial Aid

A recurring theme in the study was the impact of delayed or uncertain funding, particularly from NSFAS. Participant 4 shared his experience of facing repeated challenges with late disbursements, which forced him to travel long distances due to a lack of accommodation funds:

"The biggest difficulty… was with NSFAS... I didn't have a place to stay, which meant I had to travel... that was very hard."

These administrative delays often disrupted academic focus by introducing both logistical and financial pressures. This finding aligns with previous research, which emphasises that financial stability is crucial for persistence, particularly for students from low-income backgrounds (Goldrick-Rab et al., 2016). Additionally, participants highlighted how extended waiting periods for bursary decisions heightened anxiety, further hindering their ability to concentrate on their coursework.

Administrative Efficiency and Scheduling

Several participants described abrupt schedule changes and inconsistent communication about test dates, both of which complicated their study routines. Participant 6, for example, reported how postponed test weeks led to a *"piling up"* of assignments, reducing time for review and intensifying stress:

"Now the work is also piling up... it's stressful because you were ready for one date, and then suddenly it's changed."

These disruptions align with Tinto's (1993) perspective that consistent and transparent academic procedures are pivotal for fostering student commitment. When institutions do not provide clear

scheduling or timely updates, students must invest extra energy in managing administrative uncertainties, energy that could otherwise be focused on coursework (Robbins et al., 2009).

Institutional Support Services

Although counseling and tutoring services were available, participants often found them difficult to access or understaffed, which limited their overall impact. For example, Participant 3 attempted counseling but discovered it did not meet his specific needs, reflecting a misalignment between the services provided and what students actually require. Such experiences parallel Crisp and Cruz's (2009) argument that institutional support must be carefully tailored to match students' real-world challenges.

6.3.3.3 Community Resources and External Conditions

Infrastructure and Load Shedding

Load shedding, systematic power cuts, emerged as a significant barrier. Participant 2 explicitly noted how unpredictable outages disrupted his carefully planned study sessions, leaving him feeling *"demotivated"* and forced to rearrange his academic schedule around electricity availability. The broader community infrastructure, such as stable power supply, thus becomes a critical exosystem factor. Research indicates that inadequate infrastructure in developing contexts can severely hamper academic engagement, especially in STEM fields requiring technological tools (Thembane, 2024).

Community-Based Support and Mentorship

While infrastructural gaps hindered some participants, others benefited from community-led initiatives offering temporary housing or additional learning spaces. These examples reflect how external community resources can buffer students from the adverse effects of institutional

shortcomings. Scholars like Masten (2001) describe such communal safety nets as *"ordinary magic",* unremarkable but crucial supports that enable continuity in learning.

Participant 5 highlighted the pivotal role of local professionals who supplied additional academic materials and career guidance:

"People in my community… they believe in me, and they help me out sometimes with resources or even a place to study when there's no electricity."

This insight aligns with Feldman et al.'s (2009) argument that external social networks enhance optimism and resilience by providing tangible support that matches students' academic needs.

Balancing External Pressures and Academic Needs

The interplay between institutional policies and broader community conditions often shapes a student's everyday environment in ways they cannot directly control. Frequent changes in test schedules, delayed funding disbursements, and ongoing load shedding can undermine even the most determined learners. Conversely, strong exosystem supports, such as prompt administrative responses, local mentors, or bridging resources for technology, can ease stress levels, allowing students to dedicate more mental energy to academic development (Bean & Metzner, 1985).

Participants who benefited from supportive institutional policies, such as flexible deadlines during times of crisis or streamlined bursary procedures, reported feeling less anxious about logistics and thus more committed to their studies. This observation aligns with Reason's (2009) findings that institutional responsiveness is pivotal for retaining undergraduates, particularly in demanding degree programmes. In essence, the efficiency of the exosystem and the proactive allocation of resources bolster the resilience necessary to handle the rigor of higher education.

6.3.3.4 Summary and Critical Reflection

The exosystem factors identified in this study reveal how institutional policies, community infrastructure, and resource availability can either intensify or lessen the challenges engineering students encounter. When financial aid arrives late, schedules change abruptly, or load shedding disrupts routines, the pressures only multiply. Yet, community-based support, affordable academic materials, and efficient administrative systems illustrate the opposite dynamic: targeted actions that reduce external stressors and nurture resilience (Ungar, 2008).

From these findings, several strategic interventions emerge at the exosystem level:

1. **Streamlined Financial and Administrative Processes**

   Universities could accelerate bursary decisions and ensure consistent communication about schedule changes (Robbins et al., 2009).

2. **Collaborations with Community Stakeholders**

   Partnering with local businesses or NGOs can offset resource gaps by providing backup generators or alternative study locations (Feldman et al., 2009).

3. **Institutional Advocacy for Infrastructure**

   By engaging in policy discussions, universities can push for improvements to local power grids or public transport systems, addressing infrastructural weak points that hamper student persistence (Zhao et al., 2005).

Taken together, these measures underscore that engineering students' resilience is not solely an individual effort. Their ability to thrive academically hinges on a matrix of exosystem structures, policies, resources, and practices that minimise external disruptions and sustain the focus on learning (Ungar, 2008). When institutions and communities collaborate effectively, they forge an

environment that reinforces resilience and fosters success for a diverse engineering student population.

Having identified how broader institutional structures and community factors (exosystem) either support or hinder student resilience, we now examine how overarching cultural values and economic realities (macrosystem) shape the social narrative of engineering education.

6.3.4 Macrosystem level

Research Question:

How do societal attitudes towards engineering education and the engineering profession, including cultural values and expectations, affect the resilience and persistence of students in their engineering studies at a university of technology in South Africa?

6.3.4.1 Overview and Context

In Ungar's (2008) Socio-Ecological Model of Resilience, the macrosystem represents the larger societal, cultural, and economic influences that, though outside students' direct control, substantially shape their educational experiences. For engineering students at a South African university of technology, cultural perceptions, traditional expectations, and socio-economic narratives emerged as powerful forces guiding their resolve to persist (Bronfenbrenner, 1979). Participant accounts underscored how communal attitudes can either validate or complicate their ambitions, revealing the intricate interplay between societal values and individual resilience.

6.3.4.2 Prestige and Societal Perceptions of Engineering

Many interviewees described how their extended families and communities regard engineering as both prestigious and demanding. Participant 5 captured this sentiment by noting:

"They think studying engineering is a very big thing... They think of you studying engineering, you are like the smartest person in the community."

This widespread esteem often strengthened students' motivation, echoing research that links perceived prestige to greater educational commitment (Felder, 2012). In many cases, participants were determined to "*break barriers*" and become role models in their communities, illustrating how positive societal recognition can reinforce a sense of purpose (Van Breda & Theron, 2018). These experiences parallel Crisp and Cruz's (2009) argument that external validation, particularly at the societal or cultural level, can bolster students' academic self-efficacy.

6.3.4.3 Cultural Expectations and Family Obligations

Despite the positive regard, some cultural expectations created immense pressure. Participant 7 described extended family members questioning why he had not graduated sooner, implying he should already be contributing financially to the family:

"You've been doing this course, and you are old now... you should be helping your siblings now."

This duality, where cultural pride in engineering coexists with expectations of rapid success, can create tension, mirroring Arnett's (2000) concept of emerging adulthood, wherein young adults juggle personal goals against communal responsibilities. While such expectations can heighten stress, they can also function as motivators, reminding students of the broader social value of their academic work (Theron & Theron, 2013).

Moreover, in some South African households, especially within disadvantaged communities, parents view an engineering degree as a crucial pathway to economic stability. This perception, driven by significant socio-economic challenges, places added pressure on students to perform

exceptionally in order to secure a better future for themselves and their families. Participant 1 reflected on parental pressure:

"My parents put a lot of pressure on me... they expect results... If I don't come home with those results, it's like I failed them."

Such experiences echo Martin and Marsh's (2006) findings that high external expectations can encourage persistence, provided students have sufficient coping mechanisms and institutional support. Without a supportive environment, however, these demands can erode psychological well-being and contribute to burnout (Maslach & Leiter, 2016).

6.3.4.4 Socio-Economic Narratives and Professional Futures

A number of participants also discussed socio-economic factors at the macrosystem level. Participant 4 noted that while his community views engineering as an avenue for upward mobility, some question its actual job prospects given the competitive labour market in South Africa. Participant 7: *"I would get... and it's unlikely for people to get jobs for this course."* This perspective aligns with Sutherland's (2020) observations on how economic realities influence students' choices of specialisation and their post-graduation plans.

Some participants mentioned feeling a sense of responsibility to *"uplift"* their communities. Participant 6 spoke of wanting to *"prove that it's possible"* and *"create opportunities for others,"* illustrating how macro-level socio-economic narratives can transform personal achievement into a collective mission (Masten, 2001). Yet for some, fears about unemployment or underemployment loomed large. Participant 2 recounted hearing stories of engineering graduates struggling to find work, leading him to question whether his commitment would

ultimately pay off. These anxieties underscore the broader economic climate's capacity to either affirm or destabilise students' confidence (Felder & Brent, 2016).

6.3.4.5 Community Discourse on "Difficulty" vs. "Value"

Students frequently confronted dual discourses around engineering's difficulty and its perceived worth. On one hand, the community elevated engineering as a domain for *"bright minds"*; on the other, they also viewed it as prohibitively challenging, potentially deterring some from persisting. Participant 6 recalled comments like, *"You've chosen a path that's too tough,"* reflecting how cultural caution may discourage or isolate students.

Yet these remarks also hardened participants' resolve to challenge stereotypes about who can succeed in engineering. According to Bandura's (1997) self-efficacy theory, encountering skepticism can sometimes trigger a mastery orientation, students become determined to demonstrate competence and prove skeptics wrong. Indeed, many interviewees admitted that the social narrative of engineering as *"unattainable"* pushed them to continue despite setbacks.

6.3.4.6 Summary and Critical Reflection

Overall, the macrosystem analysis demonstrates that societal values and economic contexts exert a profound influence on engineering students' resilience. On one hand, community admiration can boost confidence; on the other, cultural and familial pressures add stress. Socio-economic uncertainties, such as a volatile job market, also affect how students perceive the ultimate payoff of their investment in engineering. These patterns reinforce Ungar's (2008) argument that resilience is mediated by cultural and systemic conditions defining what success looks like and how it can be reached.

Key Lessons for Universities and Policymakers

1. **Culturally Responsive Engagement**

   Recognise and acknowledge the communal and familial responsibilities that many engineering students must balance, and provide tailored guidance alongside comprehensive psycho-social support (Arnett, 2000).

2. **Career-Focused Outreach**

   Offer transparent labour market information and internship opportunities to reduce anxiety around post-graduation employment (Felder & Brent, 2016).

3. **Community Awareness Initiatives**

   Partner with local leaders to promote a balanced narrative about engineering's challenges and rewards, minimising undue pressure while fostering informed enthusiasm (Theron & Theron, 2013).

By aligning institutional strategies with the realities of the macrosystem, educators and policymakers can help ensure that cultural esteem remains a source of motivation, not overwhelming pressure. When these broad societal forces combine effectively with supports at every ecological level, students gain the resilience they need to excel in rigorous engineering programmes (Ungar, 2008).

6.4 INTEGRATING THE FINDINGS WITHIN UNGAR'S SOCIO-ECOLOGICAL MODEL

6.4.1 Holistic View of Resilience

The findings from this study demonstrate that resilience among engineering students emerges through the dynamic interplay of multiple ecological layers, microsystem, mesosystem,

exosystem, and macrosystem, as theorised by Ungar (2008). The data demonstrates that resilience doesn't simply arise from individual determination - it develops through continuous negotiations between students and their varied environments.

While each level independently contributes to students' ability to cope with academic challenges, it is their intersection that creates either a robust support network or a compounding set of barriers (Bronfenbrenner, 1979).

6.4.1.1 Interconnected Ecological Systems as Protective or Risk Factors

- **Microsystem**: At the microsystem level, our findings revealed intricate dynamics between faculty relationships, peer interactions, and curriculum engagement. When a lecturer provides additional support after class, they create what Martin and Marsh (2006) describe as immediate protective factors. These direct interactions shape students' daily resilience strategies, particularly in managing the demanding engineering curriculum.
- **Mesosystem**: Van Breda and Theron (2018) previously identified the importance of family networks in South African higher education, and our data strongly reinforces this. Participants described how their families' understanding of engineering's prestige motivated them to persist, while their faith communities often provided both spiritual and practical support during challenging periods.
- **Exosystem**: In the exosystem, our research uncovered significant impacts of institutional policies and infrastructure on student resilience. Robbins et al. (2009) discussed how stable funding mechanisms support persistence, and our findings extend this understanding. For instance, participants described developing creative solutions to load

shedding, highlighting how systemic challenges can paradoxically strengthen collective resilience strategies.

- **Macrosystem**: The macrosystem's influence emerged through cultural narratives about engineering education. As Theron and Theron (2013) noted, societal attitudes significantly impact student persistence. Our participants frequently referenced how engineering's perceived prestige in South African society both motivated and pressured them, creating what Sutherland (2020) describes as a complex dynamic of opportunity and stress.

By weaving these levels together, the data reveal a synergy that can foster resilience when supportive elements reinforce one another. For example: a caring family that holds engineering in high regard (mesosystem level), seamlessly complemented by a stable and responsive institutional framework (exosystem level). Together, these forces provide students with the support they need to thrive. Participant 5: *"They think studying engineering is a very big thing... They think of you studying engineering, you are like the smartest person in the community."*

On the other hand, when there's a disconnect, such as rigid, unsupportive policies or cultural narratives that impose undue pressure, stress can multiply, leaving students less able to cope with academic challenges (Maslach & Leiter, 2016).

6.4.1.2 Individual Coping Strategies and External Resources

Although many participants reported relying on personal strategies, such as mindfulness, music, and self-reflection, to handle stress, their success in persisting hinged on whether external conditions allowed these strategies to be effective. For instance, a student practicing self-regulation benefits most when institutional or community-level factors do not impose excessive

barriers, like load shedding or last-minute exam schedule changes (Goldrick-Rab et al., 2016). When external supports are lacking, individual coping resources can be rapidly depleted, highlighting the interdependence of personal agency and system-level provisions (Masten, 2001).

6.4.2 Contribution to Theoretical Framework

6.4.2.1 Extending Ungar's Model in the Context of Higher Education and Engineering

Ungar's (2008) Socio-Ecological Model shows that resilience develops as individuals continually negotiate with their surroundings. Although this model was originally developed to understand resilience across diverse cultural contexts, the present study refines its application to higher education, specifically within South African engineering programmes. Three key extensions stand out:

1. **Practical Curriculum Demands**

   The rigorous, hands-on nature of engineering programmes introduces specialised microsystem stressors (e.g., intensive lab work, group projects). Ungar's model does not explicitly address field-specific academic pressures, but this research shows how curriculum design and practical components intertwine with student resilience.

2. **Socio-Economic Vulnerability**

   The data confirm that exosystem-level factors like funding delays and community infrastructure shortfalls have adversely effects on engineering students who rely on laboratory equipment and stable power for practical assignments (Thembane, 2024). In this context, Ungar's framework gains added depth, illustrating that resilience within a technology-intensive field relies on everyday "negotiations" grounded in consistent resource availability.

3. **Socio-Cultural Narratives of Prestige vs. Difficulty**

   The macrosystem in South Africa reflects a dual narrative that portrays engineering as both highly esteemed and exceedingly difficult. This paradox influences students' motivation and stress, illustrating how cultural and economic discourses converge to shape resilience in engineering education (Sutherland, 2020). Accordingly, Ungar's model is enriched by Recognising that broader societal perceptions of STEM fields can either spur or hinder student success.

6.4.2.2 Newly Emerging Subthemes and Nuances

While exploring how resilience unfolds among engineering students at South African universities of technology, this study uncovered several emerging subthemes that further refine our understanding of Ungar's (2008) model. These findings highlight how engineering-specific pressures, together with socio-economic and cultural contexts, can either bolster or hinder a student's capacity to cope and persist.

1. **Long-Distance Family Support**

   One key observation is the role of long-distance family support. One participant described relying on calls, messages, or virtual meetings with relatives who lived abroad or outside the province. This indicates that resilience-building interactions can transcend geographical constraints, challenging earlier assumptions that direct, face-to-face contact is paramount (McCarron & Inkelas, 2006).

2. **Hybrid Mentorship**

   In the mesosystem, participants encountered mentors who occupied roles both within and beyond the university, such as a church pastor with a background in engineering. These

"hybrid mentors" offered spiritual, personal, and academic support, illustrating how resilience often takes shape at the intersection of multiple micro- and meso-level influences (Crisp & Cruz, 2009).

3. **Adaptive Coping Amid Load Shedding**

   The exosystem-level phenomenon of load shedding forced students to develop unconventional study schedules, sometimes gathering at peers' homes equipped with backup generators, other times resorting to candlelight. This pattern reveals how resource scarcity can spark inventive coping strategies at both the personal (micro) and peer (meso) levels, even as institutional support varies.

4. **Cultural Value of "Breaking Socio-Economic Cycles"**

   Many participants expressed a commitment to improving the lives of their families and home communities, framing academic success as part of a wider social mission. This perspective implies that Ungar's macrosystem domain should account for the aspiration to "give back" to one's original community—an especially relevant concept in developing regions (Van Breda & Theron, 2018).

Overall, these findings extend Ungar's model by showing how engineering-specific demands, combined with socio-economic and cultural pressures, shape students' resilience in unique ways. They support Ungar's emphasis on the contextual and relational nature of resilience, while underscoring that certain specialised challenges, such as intensive lab work and infrastructural gaps, add further layers of complexity (Ungar, 2008).

6.5 PRACTICAL IMPLICATIONS

Although some universities have already adopted the measures outlined here, it remains critical to emphasise the need for ongoing reflection and renewed scrutiny of current policies. Even well-established initiatives can grow outdated or less effective over time, underscoring the importance of continuous evaluation to ensure that institutional support genuinely aligns with evolving student needs. By taking a fresh look at existing strategies and refining them when necessary, universities can reinforce their commitment to providing relevant, impactful resources that bolster resilience, academic success, and overall student well-being.

6.5.1 Institutional and Administrative Implications

6.5.1.1 Enhanced Mentorship and Advising Structures

A central finding of this study is the pivotal role that faculty and administrative staff play in shaping students' resilience. To foster stronger faculty-student relationships, universities could develop structured mentorship programmes, pairing newcomers with senior students or faculty mentors who provide both academic guidance and socio-emotional support (Crisp & Cruz, 2009). Such initiatives would help students address a range of daily issues, from study strategies to navigating administrative hurdles, and thereby strengthen their commitment to persist (Robbins et al., 2009).

Action Points

- Integrate mentorship sessions as part of orientation and ongoing support.
- Offer training for mentors on active listening, empathy, and referral pathways (Felder & Brent, 2016).

- Recognise and reward faculty who excel in mentorship, creating an institutional culture that values personal engagement with students.

6.5.1.2 Streamlined Financial Aid and Administrative Communication

Delayed funding and unclear administrative processes frequently emerged as barriers in this study. Prolonged uncertainty regarding bursaries or test schedules can demotivate students and erode resilience (Bean & Metzner, 1985). To mitigate these issues, transparency and rapid response should be institutional priorities.

Action Points

- Invite students to share suggestions, ensuring real-time improvements that keep pace with their evolving needs (Goldrick-Rab et al., 2016).
- Rotate liaison officers through different administrative departments, broadening their knowledge of institutional processes (Crisp & Cruz, 2009).
- Involve student representatives in policy discussions, ensuring transparency and trust (Ungar, 2008).

By moving to a model of iterative enhancement, universities can ensure their financial aid and administrative communication systems remain responsive, user-friendly, and capable of sustaining student resilience over the long term. These reforms not only reduce student stress but also reinforce a sense of trust and belonging, key components of resilience (Ungar, 2008).

6.5.2 Pedagogical Implications

6.5.2.1 Integrating Resilience-Building Strategies into Coursework

Engineering curricula can be rigorous to the point of overwhelming students if pedagogical approaches don't actively reinforce resilience (Felder & Brent, 2016). Lecturers might weave reflective tasks or brief resilience exercises into lab sessions, group projects, or assessments. For example, a short reflective journal after each lab experiment can help students identify effective coping methods, recover from setbacks, and celebrate incremental wins (Martin & Marsh, 2009).

Action Points

- Incorporate stress-management workshops or "mini-seminars" within high-stakes modules, teaching mindfulness, time management, and peer collaboration skills.
- Develop collaborative assignments that encourage shared problem-solving, allowing students to practice interpersonal coping strategies (Hsu and Chen, 2018, pp. 183–184).
- Regularly offer low-stakes quizzes or formative assessments, providing immediate feedback that helps students regulate their learning without undue anxiety (Felder, 2012).

6.5.2.2 Tailored Curricular Adjustments for Socio-Economic Realities

Participants often struggled with resource-intensive practical modules, especially during load shedding or when lacking funds to purchase lab materials. Curriculum designers should adapt learning outcomes to real-world constraints, potentially:

- Providing low-cost or open-source engineering software and hardware alternatives (Thembane, 2024).

- Scheduling practical sessions in well-equipped labs during periods less likely to be affected by power outages, or offering hybrid online-lab support (Masten, 2001).
- Introducing contingency planning (e.g., backup simulations) if physical resources are unavailable, maintaining academic momentum (Sutherland, 2020).

Such pedagogical flexibility underscores the institution's commitment to equitable and resilient learning experiences (Theron & Theron, 2013).

6.5.3 Policy-Level Considerations

6.5.3.1 Addressing Socio-Economic Challenges

Persistent socio-economic inequalities can severely undermine students' ability to maintain consistent study habits and achieve academic success. Load shedding, a recurring energy shortfall, exemplifies how broader infrastructural gaps disproportionately affect learners, particularly those who lack alternative study spaces or reliable power access. To mitigate these issues, policymakers and university leaders could focus on macro-level strategies such as:

- **Securing Stable Energy Solutions**

  Advocate for dependable energy frameworks or backup generators at major campuses (Zhao et al., 2005).

- **Subsidising Student Transport and Housing**

  Offer targeted financial support to help students live closer to campus resources, reducing time and energy spent on commutes (Goldrick-Rab et al., 2016).

- **Broadening Financial Aid Coverage**

  Adjust existing aid policies to include unforeseen costs linked to engineering

programmes, particularly those requiring specialised equipment and steady electricity (Bean & Metzner, 1985).

By tackling these socio-economic barriers at a systemic level, institutions and policymakers can strengthen students' capacity to concentrate on their academic goals (Ungar, 2008).

6.5.3.2 Cultural Perceptions and STEM Promotion

Cultural views on engineering range from celebrating its prestige to questioning its job prospects, creating a need for balanced, evidence-based communication (Felder, 2012). By collaborating with media outlets and community figures, policymakers can spotlight a variety of success stories and authentic career paths, thereby reducing stigma and moderating unrealistic expectations. This approach cultivates a social climate that appreciates STEM's value while acknowledging its challenges, allowing students to pursue engineering with a grounded sense of purpose (Theron & Theron, 2013).

6.5.4 Community and Family Engagement

6.5.4.1 Forging Stronger University-Family Ties

The findings highlight that family support plays a vital role in helping students navigate both emotional and financial challenges. To build on this support, universities could establish structured outreach programmes that keep parents or guardians updated on academic timelines, available services, and realistic expectations (McCarron & Inkelas, 2006).

Action Points

- **Host "Family and Community Days"**

  Offer on-campus workshops focused on resilience, academic demands, and mental health awareness (Johnson et al., 2017).

- **Provide Multilingual Resources**

  Ensure families from diverse cultural backgrounds receive clear information about academic requirements and effective support strategies (Van Breda & Theron, 2018).

6.5.4.2 Community-Based Mentorship and Resource Networks

Beyond immediate family, local communities can offer significant mesosystem support. Several participants mentioned off-campus mentors, such as pastors or local engineers, who played a key role in reinforcing their resilience. Universities could strengthen these connections by:

- **Forming Community-Engineering Partnerships**

  Collaborate on events or real-world projects that merge community expertise with academic goals (Zhao et al., 2005).

- **Establishing a Mentorship Database**

  Create a centralised platform where students can reach out to professionals for guidance on both academic and personal challenges (Crisp & Cruz, 2009).

- **Inviting Local STEM Role Models to Campus**

  Highlight how engineering programmes contribute to community development by featuring guest speakers with direct, real-world experience (Felder & Brent, 2016).

Such initiatives support individual student growth while fostering trust and cooperation between higher education institutions and the surrounding community (Ungar, 2008).

6.6 LIMITATIONS OF THE STUDY

6.6.1 Methodological Constraints

A primary limitation of this research stems from the qualitative scope and small sample used in this research. Although semi-structured interviews offer deep, context-rich insights into students' lived experiences (Creswell & Poth, 2018), they inevitably limit the breadth of data. With just seven participants, each at an advanced stage of their engineering studies, the findings emphasise depth rather than broad representativeness (Mason, 2010). While this approach aligns with qualitative descriptive inquiry and the principle of "information power" (Malterud et al., 2016), it narrows the overall applicability of the results. Consequently, caution should be exercised when extending these conclusions to larger or differently composed student groups.

Additionally, relying on semi-structured interviews brings potential biases tied to the researcher-participant dynamic and self-reporting (Rubin & Rubin, 2012). Though strategies like reflexive journaling and member checking (Guillemin & Gillam, 2004) help reduce these biases, complete neutrality is unavoidable. Participants may choose to share selective details or present themselves in a socially favourable light (Podsakoff et al., 2012). As a result, while qualitative methods yield rich insights into individual resilience processes, they do not permit definitive causal claims or straightforward cross-institutional comparisons (Patton, 2002).

6.6.2 Contextual Boundaries

A second limitation arises from the study's setting, a single South African university of technology, where socio-economic, cultural, and infrastructural factors uniquely shape engineering students' experiences. While the findings highlight themes such as family support, financial aid, peer collaboration, and institutional policies, these elements could unfold

differently in rural institutions, or other countries (Van Breda & Theron). Therefore, the ability to generalise beyond this context remains limited (Shenton, 2004).

Furthermore, challenges like load shedding and community-anchored mentorship loom large in South Africa, where infrastructural inconsistencies and socio-economic gaps can be more severe than in higher-income regions (Thembane, 2024). Although these insights enhance global discussions on resilience in higher education, they are closely tied to local circumstances that may not directly parallel those in dissimilar cultural or economic environments (Theron & Theron, 2013).

6.6.3 Theoretical Constraints

Finally, this study employs a Deductive Thematic Analysis based on Ungar's (2008) Socio-Ecological Model of Resilience, which may overshadow themes that do not neatly fit into its predefined categories. While Ungar's model offers a robust framework for examining resilience across cultural settings (Ungar, 2008), its four ecological tiers, microsystem, mesosystem, exosystem, and macrosystem, can inadvertently exclude unexpected observations (Braun & Clarke, 2006; Nowell et al., 2019).

The themes supported by only a single quote reflect limitations in data availability. Specifically, due to the small sample size and the nature of participants' responses, certain themes emerged less frequently, resulting in fewer supporting quotes. This limitation highlights potential gaps in the data and suggests that these themes might not fully represent the broader student population's experiences. Consequently, the findings related to these themes should be interpreted with caution, acknowledging that further research with a larger or more diverse sample might be required to strengthen the reliability and generalisability of these particular insights.

Nevertheless, the socio-ecological perspective provides valuable insights into how different ecological layers intersect (Ungar, 2008). Yet some subtle, context-specific interactions or interpersonal nuances may remain underrepresented if they do not align clearly with the model's constructs (St. Pierre & Jackson, 2014). Future research could adopt a hybrid inductive-deductive approach or employ alternative theoretical lenses to uncover additional dimensions of resilience in engineering education.

6.7 RECOMMENDATIONS FOR FUTURE RESEARCH

6.7.1 Diversification of Methods

A central limitation in the present study is its reliance on qualitative interviews to gather data. Future work could integrate mixed-methods designs to offer a more comprehensive perspective on resilience in engineering education (Creswell & Creswell, 2018). By pairing quantitative tools, such as standardised resilience or student engagement scales (Robbins et al., 2009), with the context-rich insights of qualitative approaches (Creswell & Poth, 2018), researchers can triangulate results and enhance validity.

- **Longitudinal studies** would also provide deeper insights into how resilience evolves over an engineering student's academic trajectory (Martin & Marsh, 2009). Observing students over multiple semesters or academic years could reveal patterns of coping, the role of shifting institutional policies, and the impact of evolving personal circumstances. This approach would address calls for a more dynamic portrayal of student persistence, capturing how resilience adapts to changes in both the individual and their environment (Masten, 2001).

6.7.2 Comparative Contexts

Given that this research focused on a single South African university of technology, exploring additional universities, both within and outside South Africa, could broaden our grasp of the socio-ecological dimensions that support resilience (Van Breda & Theron, 2018). Such comparative work might include:

Different Institutional Types

Comprehensive universities, research-intensive institutions, or rural universities may exhibit distinct cultural, infrastructural, and policy-related factors that affect engineering students' resilience (Shenton, 2004).

Cross-Cultural or Cross-Geographical Comparisons

Investigating engineering programmes in other African countries or globally could highlight how broader socio-economic and cultural contexts either align with or deviate from the findings reported here (Theron & Theron, 2013).

Urban and Rural Settings

Load shedding, financial aid structures, and community engagement may play out differently in rural versus urban contexts, revealing new angles on how exosystem or macrosystem factors influence persistence (Thembane, 2024).

6.7.3 Exploration of Interventions

While this study underscores the importance of mentorship, family engagement, and flexible institutional policies, there is limited empirical evidence regarding the efficacy of specific

interventions in boosting engineering student resilience. Future research should systematically evaluate:

Mentorship Programmes

Randomised controlled trials or quasi-experimental designs examining mentorship's impact on student performance, dropout rates, and well-being (Crisp & Cruz, 2009).

Workshop Series

Offer structured workshops on time management, stress reduction, or peer collaboration, and track the resulting changes in students' resilience scores and academic performance over the course of the semester (Kim & Park, 2019).

Policy Reforms

Examining whether revised financial aid processes, improved administrative communication, or targeted load-shedding mitigation strategies significantly reduce student attrition and stress (Goldrick-Rab et al., 2016).

Identifying which interventions produce the greatest gains in resilience would guide resource allocation and inform best practices for both policymakers and university administrators (Felder & Brent, 2016).

6.7.4 Refinement of Theoretical Models

Finally, the findings suggest several opportunities to expand or adapt Ungar's (2008) Socio-Ecological Model for the engineering higher education context. Specifically:

Engineering-Specific Stressors

The model might also account for the hands-on, lab-intensive nature of engineering studies, Recognising that access to key resources, such as labs, reliable power, and specialised software, is essential for building resilience.

Socio-Cultural Nuances

Additional layers or themes could capture the distinct socio-economic pressures and community responsibilities faced by South African engineering students.

Hybrid Mentorship Phenomena

Traditional Socio-Ecological Models might be expanded to spotlight the "hybrid mentors" bridging spiritual, community, and academic domains (Ungar, 2008). Future frameworks could focus on how this triad of influences interacts to reinforce or undermine resilience.

By tailoring Ungar's model to reflect the specialised demands of engineering coursework and the distinct cultural-economic milieu of South African universities of technology, researchers may better understand how resilience is constructed and maintained across varied ecological layers (Van Breda & Theron, 2018). This enhanced theoretical lens would, in turn, guide more nuanced interventions aimed at promoting student persistence in STEM fields.

6.8 SUMMARY

This chapter interprets the study's qualitative results through Ungar's socio-ecological model, demonstrating that senior engineering students' resilience is co-constructed across four nested systems rather than residing solely within individuals.

- **Microsystem:** influences included supportive faculty behaviours, timely feedback, and peer networks that directly motivated persistence.
- **Mesosystem:** interactions, such as the alignment between family expectations, community mentorship, and university culture, enhanced students' coping capacity.
- **Exosystem:** factors, including institutional policies, efficient funding processes, and infrastructure stability (notably reliable electricity), either bolstered or weakened resilience.
- **Macrosystem:** narratives that frame engineering as both prestigious and demanding fuelled ambition, but also intensified psychological strain, underscoring the value of culturally sensitive support structures.

By mapping these findings onto Ungar's navigation-and-negotiation processes, the chapter refines the model for resource-constrained South African contexts and shows its relevance to Tinto's theory of student persistence.

Practical implications span four fronts: streamlining financial and administrative systems, embedding empathy and flexibility in pedagogy, informing national policy on student funding and infrastructure, and strengthening community–university partnerships.

The chapter closes by acknowledging key limitations, including the male-skewed, single-institution sample, and outlines future research directions: mixed-method designs, multi-institution comparisons, intervention trials, and further theoretical refinement. Recognising resilience as a dynamic, systemic phenomenon enables a shift from individual-focused interventions to broader, more effective support strategies. This key take-away is expanded on in the final chapter.

CHAPTER 7: CONCLUSION

7.1 INTRODUCTION

In this final chapter, we revisit the central arguments, discuss the practical and theoretical implications, and propose directions for future research.

7.2 REVISITING THE RESEARCH OBJECTIVES AND QUESTIONS

The primary objective was to explore how diverse ecological factors influence the resilience and academic persistence of engineering students. Specifically, four research questions guided the inquiry and are listed in section 1.3 of this thesis. Throughout the chapters, we detailed how students navigate these four ecological levels, often simultaneously, to foster or undermine their ability to persist in engineering studies (Ungar, 2008).

7.3 SYNTHESIS OF KEY FINDINGS

Below is a concise review of the core findings, aligned with each research question and the ecological level it represents. After each level, we provide a succinct statement on how the data specifically addressed that research question.

7.3.1 Microsystem: Immediate Academic and Social Environment

- **Faculty Support and Pedagogical Practices**: Supportive and empathetic faculty interactions, like after-class mentoring and motivational talks, proved especially effective at fostering student resilience, corroborating findings by Tinto (1993) and Robbins et al. (2009). On the other hand, unsupportive or disengaged faculty behaviours sometimes undermined students' confidence, underscoring the strong impact of everyday interpersonal connections (Wilcox et al., 2005).

- **Peer Relationships**: Participants described how studying with classmates, whether in group sessions, late-night reviews, or through mutual emotional support, significantly enhanced their motivation and coping skills (Martin & Marsh, 2009). However, they also noted that negative peer influences, such as substance use or disengagement, often created obstacles and led some to seek out more academically focused companions.

- **Curricular Rigor**: While demanding coursework and intensive lab components fostered time-management skills and a sense of accomplishment, some students felt overwhelmed without additional tutorial support or more practical guidance (Felder & Brent, 2016). This tension underlined the importance of balancing academic challenge with accessible resources.

Answer to Research Question 1 (Microsystem Influences):

These findings reveal that immediate academic environments, faculty interactions, peer support, and curriculum design, play a vital role in shaping engineering students' resilience. Positive social connections and balanced coursework provide students with the motivation and resources needed to persevere, while gaps in faculty engagement or practical support can undermine their confidence.

7.3.2 Mesosystem: Family and Broader Social Networks

- **Family Support**: Consistent with previous studies (McCarron & Inkelas, 2006), families played a critical role by offering emotional, financial, and moral backing. Parental encouragement, even from distance, frequently provided the reassurance necessary for students to continue despite academic setbacks or personal crises.

- **Intersection with University Life**: Off-campus social networks, including faith communities and local mentors, worked alongside university resources to reinforce students' determination (Crisp & Cruz, 2009). These "hybrid mentors", often pastors or professionals with engineering backgrounds, guided learners in connecting personal and academic goals, illustrating how different support systems can unite to nurture resilience.

Answer to Research Question 2 (Mesosystem Influences):

Students' resilience hinged on the synergy between family, community networks, and university life. While encouragement from relatives or community mentors reinforced students' resolve, mismatched expectations or financial struggles intensified pressure. Thus, mesosystem factors operate as crucial "bridges" that either elevate or undermine a student's ability to persist.

7.3.3 Exosystem: Institutional Policies and Community Resources

- **Funding and Administrative Efficiency**: Delays in bursaries or inconsistent communication regarding test schedules often heightened stress levels, hindering academic focus (Bean & Metzner, 1985). Students' resilience was tested further by unpredictable administrative practices, suggesting the need for streamlined financial aid processes (Goldrick-Rab et al., 2016).

- **Infrastructure Challenges**: Load shedding repeatedly appeared as a formidable challenge, restricting study hours and disrupting continuity (Thembane, 2024). Nonetheless, many students adapted by scheduling study sessions at peers' residences equipped with backup power, reflecting how communal problem-solving can buffer exosystem-level stressors.

- **Institutional Support Services**: While counseling and tutoring services existed, access and relevance varied. Some students found these services essential, others felt they were too generic or limited to address specialised engineering-related stress (Creswell & Poth, 2018).

Answer to Research Question 3 (Exosystem Influences):

Institutional frameworks and community resources exert considerable indirect impact on student persistence. When funding processes, scheduling, and basic infrastructure lack reliability, students must devote energy to overcoming logistical barriers rather than focusing on academics. Conversely, timely aid, consistent policies, and targeted support bolster resilience by creating a stable backdrop for rigorous engineering curricula.

7.3.4 Macrosystem: Societal and Cultural Context

- **Cultural Prestige vs. Socioeconomic Realities**: Engineering was widely viewed as prestigious, "only for the smartest", yet many participants reported intense pressure to excel quickly and provide for family. This contrast spurred motivation but also heightened anxiety (Theron & Theron, 2013).
- **Community Perceptions of Engineering**: Students felt compelled to "prove it can be done," which aligned with narratives of social upliftment through STEM careers (Van Breda & Theron, 2018). However, concerns over job market uncertainties introduced an element of disillusionment, as some communities questioned the feasibility of stable engineering employment (Sutherland, 2020).

Answer to Research Question 4 (Macrosystem Influences):

Societal and cultural attitudes significantly shape the perceived value and feasibility of studying

engineering. While community esteem often fuels determination, persistent concerns about economic or career prospects can create tension, illustrating how macrosystem narratives either fortify or undercut resilience.

7.4 THEORETICAL AND PRACTICAL IMPLICATIONS

7.4.1 Theoretical Contributions

- **Refining Ungar's Model**: This research extends Ungar's (2008) Socio-Ecological Model by showcasing how engineering-specific stressors (e.g., load shedding, lab-intensive curriculum) shape resilience in a developing-country context. The study highlights how resilience arises not solely through personal traits but also through access to meaningful, context-relevant resources (Bronfenbrenner, 1979).
- **Inter-Level Interactions**: Findings show that resilience can thrive when support factors align across levels, for example, family involvement (mesosystem) that complements consistent institutional policies (exosystem) and positive cultural narratives (macrosystem). Conversely, misalignments like inadequate administrative communication or conflicting cultural pressures undermine resilience.

7.4.2 Practical Recommendations

Recognising that not all interventions can be enacted simultaneously, below is a prioritised list of strategies informed by the study's findings:

Streamline Financial Aid and Administrative Practices *(High Priority)*

- *Rationale*: Delays and ambiguous scheduling repeatedly surfaced as major stressors (Bean & Metzner, 1985; Goldrick-Rab et al., 2016). Clarifying bursary processes and test

schedules is essential to reduce uncertainty and allow students to channel their energy into academics.

Enhance Faculty and Peer Support *(Medium-High Priority)*

- *Rationale*: Participants strongly emphasised the value of empathetic faculty engagement, as well as study groups and peer mentorship (Tinto, 1993; Crisp & Cruz, 2009). Institutions can train lecturers in active listening and empathy, while formalising peer mentorship to offset workload demands.

Contextual Curricular Adaptations *(Medium Priority)*

- *Rationale*: Load shedding, lack of practical materials, and intensive coursework require flexible scheduling (Felder & Brent, 2016) and open-access tools. Measures such as virtual labs, cost-effective equipment, or carefully timed laboratory sessions could bridge infrastructural gaps.

Community-Focused Initiatives *(Medium Priority)*

- *Rationale*: Aligning with local mentors, faith-based groups, and other community resources can enrich the support network and ensure that off-campus influences bolster, rather than impede, student success (Van Breda & Theron, 2018).

Ongoing Evaluation of Counseling and Tutoring Services *(Lower Priority)*

- *Rationale*: Although crucial for some, these services must be periodically assessed to ensure relevance for engineering-specific demands (Oktaviana et al., 2024). Tailoring content, like specialised test-prep or stress-management sessions, could better meet student needs.

7.5 LIMITATIONS AND OPPORTUNITIES FOR FUTURE RESEARCH

7.5.1 Methodological Constraints

- **Sample Size and Scope**: With seven participants, the study emphasises depth over breadth, potentially limiting generalisation (Mason, 2010). Future research might adopt a mixed-methods design or a larger qualitative sample to capture diverse student voices (Creswell & Creswell, 2018).

- **Single-Institution Context**: Conducting similar research at multiple universities or across varying cultural and economic regions could unveil a broader spectrum of resilience-building strategies, validating or challenging the findings presented here (Shenton, 2004).

7.5.2 Conceptual and Contextual Limitations

- **Deductive Framework**: Using Ungar's model guided the analysis but might have overshadowed emergent insights that do not fit neatly into its ecological tiers (Braun & Clarke, 2006). Combining inductive and deductive approaches in future studies could generate a richer theoretical perspective (Nowell et al., 2019).

- **Temporal Dimension**: This cross-sectional snapshot does not capture how resilience evolves over time. Longitudinal designs could clarify whether students' coping mechanisms shift as they approach graduation or after major policy changes (Martin & Marsh, 2009).

7.6 FINAL REFLECTIONS

This research underscores that resilience among engineering students is not merely an individual trait but a social process. As shown, students handle intense coursework and socio-economic

strains with the support of empathetic faculty, engaged families, well-designed institutional protocols, and culturally grounded motivations (Ungar, 2008). By highlighting how these systems intersect, or conflict, the study affirms that higher education policy should be viewed as a set of interconnected elements rather than as isolated, separate parts. Instead, the study emphasises the need for a holistic approach where policies are designed to integrate and align these various elements, ensuring that the collective support system effectively fosters student resilience. Robust student resilience arises when initiatives at multiple ecological levels converge.

Cross-Level Interactions

Notably, improvements at one level (e.g., clarified financial aid policies in the exosystem) can boost the efficacy of another (e.g., family encouragement in the mesosystem). Conversely, shortfalls in infrastructure or mismatch in cultural expectations can undermine even strong personal determination at the microsystem. This collaboration underscores Bronfenbrenner's (1979) stance that development, and by extension resilience, emerges from the interplay of nested systems.

Looking Ahead

Future efforts to sustain engineering students in South Africa must therefore be multi-pronged. Collaborations among institutions, communities, and policymakers could usher in strategies that streamline resource accessibility, tailor mentoring to engineering-specific demands, and provide realistic, context-sensitive curricula. In this environment, students equipped with strong coping mechanisms and guided by positive social networks can harness their engineering education for personal advancement and community uplift.

In conclusion, Recognising the social foundations of resilience reshapes our perspective on student success. Rather than emphasising individual grit alone, universities can implement systemic changes that support students as whole persons. When families, communities, and educational policies work in harmony, the result is a meaningful boost not only for individual students but also for the wider engineering field in South Africa.

Researcher's Personal reflection

Reflecting on this qualitative research journey has provided valuable insights into both the intricacies of resilience in engineering education and my personal growth as a researcher. Throughout the study, I came to appreciate the complexity and multi-dimensional nature of resilience, particularly how interconnected individual, relational, institutional, and societal factors genuinely are. This realisation shifted my perspective from initially viewing resilience primarily as an individual trait to deeply understanding it as a dynamic, contextually embedded process shaped significantly by socio-ecological interactions.

Engaging with senior engineering students through semi-structured interviews revealed profound, nuanced narratives about their experiences and challenges. Listening to these students underscored the critical role that supportive environments and relationships play in fostering resilience. The participants' shared stories emphasised the powerful impact that mentorship, peer relationships, and empathetic institutional policies have on their academic persistence, reinforcing the necessity for holistic support mechanisms tailored specifically to South African contexts.

This research also highlighted gaps in my initial assumptions about the students' experiences. I became more aware of the diverse and often invisible barriers students face, such as infrastructural issues and complex institutional policies, and how these significantly impact their

resilience. This understanding emphasised to me the importance of context-specific interventions rather than generic, one-size-fits-all approaches.

Ultimately, this study has profoundly shaped my academic journey and perspective on educational resilience. It has equipped me with a richer understanding and empathy towards the challenges engineering students face, inspiring me to advocate for systemic changes within educational institutions. As I conclude this research, I carry forward a deeper commitment to fostering environments that not only nurture resilience but also genuinely empower students to thrive in their academic and professional lives..

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