Impact of Campus Environment and Personality Traits on the Academic Performance & Psychological Well-being of Engineering Undergraduates

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Dedication

Dedicated to my exceptional parents and supportive teachers, whose constant prayers and tremendous guidance let me to achievement of this milestone

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ABSTRACT

Engineering education plays a significant role in enhancing the quality of engineers. Certain factors such as personality traits, campus environment and engineering self-efficacy could potentially impact the academic performance and psychological well-being of engineering undergraduates. Therefore, it was analyzed how personality traits, campus environment, engineering self-efficacy and their interactions predict performance-related outcomes and well-being of engineering undergraduate students. It was hypothesized that significant relationship exists between personality traits, campus environment, and self-efficacy in predicting academic performance and psychological well-being. Data was collected from 1005 engineering undergraduates from 16 universities in Pakistan. Structural equation modelling (SEM) was used to investigate latent interactions between the variables. Personality traits and engineering self-efficacy had a significant impact on academic performance. Campus environment, personality traits and engineering self-efficacy had a significant impact on psychological well-being. Campus environment and personality traits had a significant impact on engineering self-efficacy. Engineering self-efficacy mediated the relationships between variables. However, there was no impact of campus environment on academic performance. The comparison of results on the basis of gender also suggests that males generally score higher in academic performance than females. The findings provide empirical evidence for linking campus environment, personality traits, and engineering self-efficacy with the academic performance and psychological well-being of students, and suggest how these relationships could guide educationists and policy makers to take steps to enhance the engineering self-efficacy, academic performance and psychological well-being of engineering undergraduates.

KEYWORDS: engineering self-efficacy, personality traits, campus environment, academic performance, and psychological well-being, big five model of personality.

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LIST OF ABBREVIATIONS

AP	Academic Performance
CE	Campus Environment
E	Extraversion
A	Agreeableness
C	Conscientiousness
N	Neuroticism
O	Openness to Experience
PWB	Psychological Well-being
ESE	Engineering Self-efficacy
GESE	General Engineering Self-efficacy
ExSE	Experimental Self-efficacy
TiSE	Tinkering Self-efficacy
DeSE	Design Self-efficacy
CFA	Confirmatory Factor Analysis
SEM	Structural Equation Modelin

CHAPTER 1: INTRODUCTION

1.1 BACKGROUND, SCOPE & MOTIVATION

Engineering education has a significant role in society and its needs to enhance students' learning are always increasing (Kittur, 2020). Universities produce engineers by providing them with the knowledge, skills, and experiences necessary for successful careers in engineering and related fields (Rosen, 2009). With the rapid pace of technological advancement and the increasing role of technology in all aspects of life, it is essential for engineering institutes to produce highly competent engineers with strong knowledge and skills to meet the needs of the industry (Sorby et al., 2020). Good academic performance of engineering undergraduates is a prerequisite for success as it influences their professional paths and contributions to technological breakthroughs providing them a solid foundation (Borrego et al., 2010). Furthermore, academic achievement is not just a metric used in the school system; it also shapes opportunities for the future. Studies have emphasized its importance as a deciding factor for getting into prestigious colleges and getting jobs (Beaujean et al., 2011; Poropat, 2009). This emphasizes how important academic accomplishments are to society as a whole and shows how success in school frequently leads to success in the workplace. In engineering education, Grade Point Average (GPA) is a critical measure of academic success. A student's GPA provides a standardized measurement that is easy to compare between individuals and acts as a quantitative reflection of their accomplishments (Gajda et al., 2017). Its application in engineering education implies that educational establishments in this domain give top priority to a quantitative evaluation of students' performance to determine their proficiency and preparedness for the engineering sector (Issah et al., 2023). Multidisciplinary researchers have studied the complex interactions between environmental and personal factors that either support or undermine academic success (Illeris, 2009; Richardson et al., 2012). This holistic approach recognizes that academic performance is influenced by a wide rane of factors, that include individual capabilities, learning environments, socio-economic backgrounds, and teaching methodologies (Song and Nfu, 2023). Understanding

this complex interplay is crucial for developing effective strategies and interventions to enhance overall academic performance.

Therefore, the attention given to academic performance is not merely a quantitative evaluation but reflects its profound implications for educational institutions, career prospects, and the broader societal landscape.

There are certain intrinsic and extrinsic factors that affect academic performance and psychological well-being of engineering undergraduates (Tamannaiefar et al., 2013; Qureshi et al., 2023). Several studies have been conducted on the impact of the campus environment and the educational setting on general well-being and academic success that explore the effects of the physical, social, and psychological aspects of a university campus on students (Zysberg and Schwabsky, 2020; Lombardi et al., 2019; Cornell & Huang, 2016). These circumstances are collectively referred to as the campus environment. A pleasant and encouraging campus climate combined with compassionate relationships at school is often linked to higher academic achievement (Benbenishty et al., 2016; Cheema and Kitsantas, 2014; Sakiz, 2017).

Academic success in school has been found to be significantly influenced by personality traits. The "Big Five" personality traits—also referred to as the Five Factor Model (FFM)—are among the most respected and influential models of personality. Five fundamental traits—often referred to as OCEAN or CANOE—are used to characterize personality in this model: extraversion, conscientiousness, agreeableness, openness and neuroticism. Psychology has given the Big Five model a lot of attention and investigation, and is now most widely accepted model for assessment of personality traits (Costa & McCrae 1987; Goldberg 1990). Numerous researchers (Bratko et al., 2006; Poropat, 2016; Vedel & Poropat, 2017) have examined the connection between personality traits and academic achievement at various educational level. Self-efficacy, defined as “an individual's belief in their own capability to succeed in specific tasks or domains”, has gathered substantial attention in the realm of academic performance. Self efficacy has been extensively studied and is recognized as a crucial factor influencing students' educational outcomes, motivation, and persistence (Bandura, 1997; Multon et al., 1991; Zimmerman, 2000). Students' psychological well-being is shaped by their campus environment, which

has a big impact on both their academic achievement and overall college experience. Students' mental and emotional well-being is greatly enhanced by a helpful and encouraging campus environment as well as resources and mental health services. A campus environment that prioritizes psychological well-being creates a conducive atmosphere for students to thrive academically and personally (Ruppel et al., 2015). This holistic approach recognizes the interconnectedness of mental health and academic success. Studies show a significant correlation between academic success and a healthy campus climate. Students are better able to handle stress, participate in learning, and overcome obstacles when they feel encouraged and their psychological well-being is fostered (Kuh et al., 2018). This beneficial effect on academic achievement highlights how crucial it is to take into account a student's entire education, including their mental and emotional well-being. Thus, a quantitative exploration of the impact of campus environment, self-efficacy, and personality traits on the academic performance and well-being of students is crucial for informed decision-making in education (Etherton et al., 2022; Cohen et al., 2009; Pascarella and Terenzini, 2005).

1.2 PROBLEM STATEMENT

Engineering education has a significant role in the progress of society built by engineers. A good quality education is essential for the grooming of engineers. Quality depends on a multitude of factors, some intrinsic factors (such as personality, self-efficacy, psychological well-being) as well as extrinsic factors (such as campus environment) that collectively contribute to the engineers' innovation and development. The inclusion of these factors in engineering context has not been studied so far especially in a developing country like Pakistan due to which academia is still unaware of their importance leading to production of low-quality engineers and low science and innovation index.

1.3 RESEARCH QUESTIONS

The following research questions were formulated:

1. To what extent do personality traits and campus environment have an impact on academic performance independently?
2. To what extent does engineering self-efficacy have an impact on academic performance and psychological well-being independently?

3. To what extent do personality traits and campus environment have an impact on engineering self-efficacy independently?
4. To what extent does engineering self-efficacy have an impact on academic performance and psychological well-being?
5. Does engineering self-efficacy mediate the relationship between personality traits and academic performance?
6. Does engineering self-efficacy mediate the relationship between personality traits and psychological well-being?
7. Does engineering self-efficacy mediate the relationship between campus environment and academic performance?
8. Does engineering self-efficacy mediate the relationship between campus environment and psychological well-being?

1.4 RESEARCH OBJECTIVES

The specific objectives of this study include:

1. To explore the impact of each personality trait and campus environment on academic performance.
2. To determine the impact of each personality trait and campus environment on psychological well-being independently.
3. To explore the impact of each personality trait and campus environment on engineering self-efficacy.
4. To analyze the impact of engineering self-efficacy on academic performance and psychological well-being independently.
5. To analyze the mediating role of engineering self-efficacy between personality traits and academic performance.
6. To analyze the mediating role of engineering self-efficacy between personality traits and psychological well-being.
7. To test the mediating role of engineering self-efficacy between campus environment and academic performance.
8. To test the mediating role of engineering self-efficacy between campus environment and psychological well-being.

1.5 RESEARCH RATIONALE

Significant research has been conducted in the last few years on academic self-efficacy, its effects on students' academic achievement, and its function as a mediator between personality traits and academic success. (Lei et al., 2022; Mornar et al., 2022). The impact of personality traits on academic performance has also been studied at different educational levels including secondary and undergraduate levels (Mammadov, 2021; Zysberg et al., 2020). Extensive literature is available to support the impact of sself-efficacy on performance outcomes (Affuso et al., 2023; Honicke & Broadbent, 2016; Deshon and Gillespie, 2005; Bandura 1997). Similarly, campus environment and personality traits also have a significant impact on academic performance (Hanaysha et al., 2023; Kuh et al., 2010; Harper & Quaye 2010; Trapmann et al., 2017; Poropat 2007) and psychological well-being (Eisenberg et al., 2013). This research aims to extend the existing literature with the exploration of the impact of campus environment, personality traits and engineering self-efficacy on academic performance and psychological well-being of engineering undergraduates as well as the mediating role of engineering self-efficacy between these relationships.

1.6 SIGNIFICANCE

The findings of this study will:

- Help educationists and policy makers to understand the factors that affect the performance and well-being of individual students in order to fulfill the needs of each student instead of considering them merely collective groups.
- Help the faculty understand their importance and role in enhancing the performance outcomes of students, how their counselling and encouragement can play a positive role in enhancing the engineering self-efficacy of undergraduates which leads to an increase in academic performance.
- Guide the academicians to how they can transform their campuses into interactive learning environments to let students participate in activities and interact with the faculty and staff to have hands on learning experiences with large scale projects, machines in order to feel more confident and prepared for the needs of the industry.

1.7 ORGANIZATION OF THESIS

The thesis is organized into five chapters, each serving its own purpose in presenting and developing the research.

1.7.1 Introduction (Chapter 1)

This chapter encompasses the research's contextual background, underscoring its significance for both local and global needs. It sheds light on the identified problem and articulates the study's objectives. Additionally, it explains the benefits of this research, specifically in the context of its applicability to Engineering Education.

1.7.2 Literature Review (Chapter 2)

A comprehensive overview of literature relevant to the research conducted in engineering education is given in Chapter 2, along with a detailed discussion of the key studies that have been done so far. It also covers the theories and concepts relevant to the research topic and their role in enhancing the academic success and psychological well-being of undergraduate engineering students.

1.7.3 Methodology (Chapter 3)

This chapter provides a deep insight into the methodology employed to achieve the results. It includes the research paradigm, data collection method, sampling technique, and instrument development (to measure the variables), with each step discussed in detail.

1.7.4 Results and Analysis (Chapter 4)

This chapter focuses on the statistical analysis performed during the study, to determine the model fit indices as well as the relationships between variables. Also, the hypotheses discussed in Chapter 2 will be evaluated to see if they are supported by the results of data analysis.

1.7.5 Conclusions & Future Recommendations (Chapter 5)

This chapter summarizes the research work by providing conclusions based on the results discussed in the previous chapter and their comparisons with the existing literature. The theoretical and practical implications of the study are also discussed in this chapter. Moreover, it includes the research limitations of the study and recommendations that might guide future research.

CHAPTER 2: LITERATURE REVIEW

This chapter provides a detailed review of literature on the variables and the types of relationships that exist between the variables with a detailed overview of the theory that forms the basis of the concept of self-efficacy and its impact on the performance outcomes.

2.1 SOCIAL COGNITIVE THEORY

The Canadian American psychologist Albert Bandura's Social Cognitive Theory (SCT) is a comprehensive framework that emphasizes the function of cognitive processes in human learning, motivation, and behavior (Bandura, 1997).

This theory serves as a foundation for understanding how people acquire and use new knowledge and abilities and regulate their behavior, and has a considerable impact on domains including psychology, education, and communication. Self-efficacy is one of the core ideas of Social Cognitive Theory and is essential to understanding how people think, act, and learn in diverse contexts. According to Bandura, people's perceptions of their own skills (self-efficacy) have a big impact on their motivation, behaviour, and decision-making. SCT offers a paradigm for comprehending the growth and operation of self-efficacy (Schunk, 2001; Bandura, 1991).

SCT emphasizes the importance of observational learning, in which people pick up knowledge by watching others. The growth of self-efficacy depends on this process. Seeing others who are similar to them excel at activities can increase people's self-efficacy beliefs. In contrast, seeing others struggle or fail might make people feel less capable—unless they see those people as being different in significant ways from themselves. Overall, the social cognitive theory offers a thorough framework for comprehending how people change their environments and how environments form them, as well as how self-efficacy beliefs contribute to this process. (Bandura, 1997).

2.2 ENGINEERING SELF-EFFICACY

Self-efficacy is defined as “an individual’s belief in their ability to execute behaviors required for specific performance attainments”. This belief is not a general sense of confidence or self-esteem but rather a domain-specific belief that is tied to a specific task or activity (Bandura, 1997). Self-efficacy can be modified in several ways. Sources of self-efficacy are: “vicarious experiences, mastery experiences, social and verbal persuasion, physiological and affective states.” The source of self-efficacy that may be the most important is mastery experience. It speaks to a person's prior accomplishments in similar jobs or circumstances. When people have mastered a task in the past, they are more likely to have confidence in their future success in comparable circumstances. On the other side, failure experiences can reduce self-efficacy unless people see them as chances for growth. Vicarious experience (modelling by others) self-efficacy can be increased by seeing people who are like oneself do well on a task. People may think, "If they can do it, so can I," when they witness someone with whom they identify achieving a goal or overcoming a hurdle. Because of this, mentors and role models can have a significant impact on a person's level of self-efficacy (Bandura, 1997; Zimmerman et al., 2011; Schunk et al., 2012).

Academic self-efficacy refers specifically to “an individual’s belief in their ability to perform academic tasks at a designated level of proficiency” (Bandura, 1997; Bandura and Locke, 2003). numerous studies and meta-analyses have demonstrated the importance of self-efficacy in academic accomplishment (Lei et al., 2022; Dogan, 2015; Galla et al., 2014). In academic settings, motivation, perseverance, and performance have all been demonstrated to be strongly correlated with an individual's level of self-efficacy. High academic self-efficacy individuals are more likely than low self-efficacious individuals to be driven, tenacious, and effective in reaching their goals (Kryshko et al., 2022; Baron et al., 2015). Furthermore, research indicates that academic self-efficacy may have an indirect impact on stress, health, and life satisfaction; those with higher academic self-efficacy levels may also report lower stress, better health outcomes, and higher levels of overall life satisfaction (Chemers et al., 2001). Academic self-efficacy in the engineering context, referred to as engineering self-efficacy is defined as “a person’s belief in their

ability to perform engineering-related tasks or solve engineering-related problems" (Marmaril et al., 2016). Due to domain specific nature of self-efficacy, the specification of domain and an appropriate use of measurement scale for self-efficacy is necessary as its results are not generalizable. Studies have shown that engineering students with higher levels of self-efficacy tend to perform better in academics (Khan, 2023; Chen & Zimmerman, 2007). Engineering self-efficacy is not only an individual's belief (conviction) that they can achieve a goal with execution of specific behaviors (Bandura, 1997; Schunk & Pajares, 2002) but also one's capacity to successfully execute engineering operations, address issues and use knowledge and skills to apply in practical world (Pajares, 1996) Self-efficacy can be modified in various ways. Success in the engineering field depends on achieving and sustaining high levels of engineering self-efficacy. Some essential factors needed to understand the sources of self-efficacy are stated as follows:

Mastery experience is one of the most important source of self-efficacy. By gradually taking on engineering jobs and projects of increasing complexity, engineers can increase their self-efficacy. The accomplishment of difficult projects strengthens one's confidence in their engineering ability. Role models and mentoring interactions with seasoned mentors and role models can be beneficial for engineers, especially for students and early-career professionals. By giving examples of what is doable, observing and learning from people who have successfully negotiated the engineering profession helps increase self-efficacy (Hirscl et al., 2021; Clemons et al., 2019).

2.3 CAMPUS ENVIRONMENT

The term campus environment refers to "the physical, social, and psychological aspects of a college or university campus that have a significant impact on the experiences and results of students, professors, and staff" (Christie et al., 2017). Numerous studies highlight the important influence that the campus environment can have on students' academic performance. These findings demonstrate a favourable correlation between a number of school environment factors and students' academic achievement, including graduation rates, test scores, and grades. (Pang and Qiao, 2023; Haynes et al., 1997; MacNeil et al., 2009). A study that investigated the relationship between academic achievement and the social and physical characteristics of the campus environment

revealed that the campus environment plays a crucial role in determining educational performance by showing a connection between higher academic outcomes and well-maintained facilities as well as favorable social interactions (Benenishty et al., 2016). A thorough investigation of the relationship between school atmosphere and academic achievement suggested that higher test scores and graduation rates were linked to a supportive and upbeat school climate. (Hanaysha et al., 2023; Haynes et al.,1997). This is consistent with the more general idea that academic success is greatly influenced by the campus atmosphere. A pleasant atmosphere is crucial for encouraging students' dedication to studying, as demonstrated by investigation of the connection between school climate and student engagement (MacNeil et al., 2009). As the study pointed out, a major factor in the total educational experience is the social and psychological aspects of the campus environment (Uline & Tschannen-Moran, 2008) concentrated on how academic success is influenced by physical surroundings on academic success showed a significant correlation between student outcomes and physically well-designed and maintained settings. This emphasizes how important the physical aspects of campus life are to academic achievement.

It is essential to distinguish between campus climate and campus environment. Campus climate is the term used to describe how people feel about their quality of life when they are in an educational setting, whereas campus environment refers to the physical features and social interactions found there. It is critical to understand this distinction because efforts to improve the campus climate—a measure of perceived quality of life and interpersonal dynamics—require adjustments to the social and physical architecture of the campus (Kuh et al., 2012).

Campus environment has a significant impact on psychological well-being too (Lombardi et al., 2019). A supportive campus climate is essential for encouraging creativity and efficiency in the processes of learning and development. This beneficial influence enhances the educational process overall by fostering an environment that encourages creative problem-solving, teamwork, and inventive thinking (Thapa et al., 2013). Strong bonds, a feeling of community, and constructive interactions with teachers and staff are critical components of an environment that supports students' mental and emotional well-

being (Hwang and Chang, 2015). These findings were further supported by a study that emphasized the critical role that a supportive campus community with positive interactions with academic staff plays. The study stressed how a setting like this fosters an atmosphere that is favorable to engineering undergraduate students' general well-being (Zhang et al., 2019).

These findings reinforce the notion that, in the context of engineering education, a pleasant and encouraging campus climate is crucial for fostering students' psychological wellbeing. Educational institutions may play a key role in supporting the mental and emotional well-being of engineering students by building strong relationships, promoting a feeling of belonging, and encouraging pleasant interactions. Acknowledging and fostering these kinds of supportive surroundings is crucial to developing learning environments that prioritize the subjective well-being of students and their academic performance altogether.

2.4 PERSONALITY TRAITS

Personality traits are defined as distinctive and long-lasting thoughts, feelings, and behaviour patterns that distinguish people from one another (Goldberg, 1990; McCrae and Costa, 1997). These traits are characterized by their relative stability across time and various situations, forming a fundamental aspect of an individual's psychological makeup. The concept suggests that individuals exhibit consistent tendencies in how they think, feel, and act, contributing to the uniqueness of their personalities. The enduring nature of personality traits implies that these patterns exhibit a degree of stability over time, often persisting throughout an individual's life. Whether in professional settings, personal relationships, or various life circumstances, these traits manifest consistently, shaping how individuals interact with and respond to the world around them. Moreover, personality traits are crucial in influencing an individual's perceptions, motivations, and actions. They act as lenses through which individuals interpret the world, affecting how they perceive and process information (Robberts et al., 2006).

For the assessment of personality traits, a number of models have been developed as described below:

a. **RIASEC model** (Holland Codes) developed by Holland (1959) classifies the personality into the following types:
    1. Realistic
    2. Investigative
    3. Artistic
    4. Social
    5. Enterprising
    6. Conventional
b. **Myers-Briggs Type Indicator** (MBTI) classifies personality into the following sixteen types (Myers and Briggs, 1962):
    1. The inspector
    2. The crafter
    3. The protector
    4. The artist
    5. The advocate
    6. The mediator
    7. The architect
    8. The thinker
    9. The persuader
    10. The director
    11. The performer
    12. The caregiver
    13. The champion
    14. The giver
    15. The debater
    16. The commander
c. **Cattell's Sixteen Factor Model** developed by Raymond Cattell(1970) isn a comprehensive and well-respected model that offers a new perspective on personality. Cattell identified sixteen key characteristics that reflect various aspects of individual differences to portray the diversity of human personality. It classifies the personality traits into the following types:

1. Warmth.
2. Reasoning.
3. Emotional Stability.
4. Dominance.
5. Liveliness.
6. Rule-Consciousness.
7. Social Boldness.
8. Sensitivity.
9. Vigilance.
10. Abstractedness.
11. Privateness.
12. Fear.
13. Openness to Change.
14. Self-reliance.
15. Perfectionism.
16. Tension.

d. **Big Five Model of Personality** developed Costa and McCrae (1985) classifies the personality into the following five types:
    1. Extraversion
    2. Agreeableness
    3. Conscientiousness
    4. Neuroticism
    5. Openness to experience.

e. **Eysenck's PEN Model** developed by Eysenck (1991) classifies the personality traits into the following three types:
    1. Extraversion
    2. Neuroticism
    3. Psychoticism

f. **HEXACO Model of Personality** is a comprehensive framework that outlines the six main aspects of personality in people. The HEXACO model, created by Kibeom Lee and Michael C. Ashton (2001), adds Honesty-Humility as a sixth element to the standard Big Five personality traits described as follows:

1. Honesty-humility.
2. Emotionality.
3. Extraversion.
4. Agreeableness.
5. Conscientiousness.
6. Openness to experience.

A comparison of these models with their advantages and disadvantages is given below:

Table 2-1: Comparison of Personality Models

Model of Personality	Personality Traits	Advantages	Disadvantages
Eysenck's PEN Model	3	Combines both biological and social elements to explain difference in personalities.	Oversimplifies the complex nature of human personality (Mattews et al., 2003).
Big Five Model of Personality	5	Provides precise, accurate measurements for its individual traits.	Difficult to draw general insights and advice from results due to their individual and unique nature (Cervone, 2005).
HEXACO Model of Personality	6	Has been applied in a variety of disciplines, such as cross-cultural studies, organisational behaviour, and psychology.	Scholars have questioned the need for an additional factor and the distinctiveness of the Honesty-Humility dimension (Veselka et al., 2011).
RIASEC Model	6	Helps to gain more self-awareness by learning about their values, interests, and personality traits.	Authors argue that the model may oversimplify the complexities of personality and career choices (Larson et al., 2002).

Myers Briggs Type Indicator	16	Widely used for personal development, team building, and career counselling.	Lacks scientific validity and reliability (Pittenger, 2005)
Cattell's 16 Factor Model	16	Has been applied in various fields including clinical psychology, counselling, and organizational psychology.	Has faced criticisms regarding the generalizability of its factors and the interpretation of certain traits (Matz et al., 2016).

However, the Big Five model as examined by psychologists, has the highest level of scientific validity and reliability. It has been demonstrated that the Big Five has exact, accurate measurements for each of its distinct qualities described as follows:

Table 2-2: Personality Traits

Openness to experience	The willingness of a person to experiencing and learning new things. Research has linked intellectual curiosity and creativity to being open to new experiences (McCrae & Costa,1987; DeYoung et al., 2013).
Conscientiousness	The tendency of a person to be accountable, trustworthy, and well-organized. The degree of conscientiousness is a powerful indicator of both academic success and work performance (Barrick & Mount,1991; Poropat, 2009).
Extraversion	The level of confidence,friendliness and sociability exhibited by an individual. Positive feelings and social dominance have been linked to extraversion (Costa & McCrae, 1992; Buss & Craik, 1983; Lee et al., 2008).
Agreeableness	The tendency of an individual to exhibit empathy and cooperation with others. Prosocial behaviour and relationship satisfaction are significantly correlated with agreeableness. (Graziano & Eisenberg, 1997; Jensen-Campbell et al., 2002).

Neuroticism	An individual's tendency to feel depressive and anxious feelings. Low life satisfaction and poor health outcomes are linked to neuroticism (Lahey, 2009; Steel et al., 2008).

2.5 ACADEMIC PERFORMANCE

Academic Performance in Engineering refers to a student's level of achievement in an engineering program, typically measured by grades, test scores, and completion of assignments and projects (Deemer et al., 2019). Cumulative Grade Point Average (CGPA) is used as a predictor of academic performance in engineering, but it is not the only factor that determines academic success. Research has shown that CGPA can be a good predictor of academic performance in engineering, particularly for early-career engineering graduates (Kaloiya, 2017). In the realm of engineering education, the significance of academic performance cannot be overstated. The correlation between students' perseverance in STEM (Science, Technology, Engineering, and Mathematics) disciplines and their performance in foundational science and engineering courses is explained in the seminal study conducted by (Seymour & Hewitt, 1997) that investigates the factors leading to undergraduates leaving STEM disciplines, exploring the relationship between students' perseverance and their performance in fundamental science and engineering courses. Another research underscores the importance of foundational knowledge and skills acquired during the early years of education in enhancing students' success in engineering. It goes down into the developmental aspects of expertise in engineering education (Litzinger et al., 2011). The National Academy of Engineering's visionary work explores the qualities and skills expected of future engineers. Academic achievement is identified as a crucial factor, providing aspiring engineers with a robust foundation that influences their professional trajectories and contributions to technological advancements (National Academy of Engineering, 2004). While not specific to engineering, comprehensive analysis explores the critical factors impacting students' college experiences and success. The findings can be applied to understanding the long-term implications of academic performance on the professional paths of engineering students (Magolda & Astin, 1993). ASEE's comprehensive report provides statistical data and insights into engineering

education, highlighting the role of academic achievement in shaping the landscape of the engineering profession and contributing to technological breakthroughs (ASEE, 2013). Another study emphasizes the empirical aspect of learning in engineering education, underscoring the importance of applying theoretical knowledge gained through academic performance (Felder et al., 2005).

The exploration of factors influencing academic performance has been a paramount focus within the realm of engineering education research. Numerous studies have accurately identified an array of personal, environmental, and institutional elements that profoundly impact student outcomes. Among these factors, prior academic preparation, motivation, study habits, instructor quality, course content, and the availability of academic support services have been consistently recognized as pivotal determinants (Qureshi et al., 2021; Holder, 2007). This holistic approach to understanding the multifaceted nature of academic success underscores the intricate interplay of various aspects within the educational landscape. Furthermore, psychological factors emerge as crucial predictors of academic performance, adding another layer of complexity to the educational equation. Motivation, self-discipline, and mental health are significant contributors to students' overall academic achievements (Duckworth et al., 2007). Recognizing the profound impact of psychological well-being on academic outcomes underscores the need for a comprehensive approach that considers not only intellectual aspects but also the emotional and motivational dimensions of the learning process. Personality traits, as integral components of an individual's psychological makeup, play a substantial role in assessing academic performance. Research conducted by O'Connor and Paunonen (2007) explored the influence of personality traits on academic success, emphasizing the need to consider individual differences in understanding student performance. This examination of personality's impact extends across educational levels, encompassing both secondary and undergraduate levels of study (Bratko et al., 2006; Poropat, 2016; Vedel & Poropat, 2017). The comprehensive nature of these studies contributes to a distinct understanding of how personality traits shape the academic journey, offering valuable insights for educators, administrators, and researchers alike. The intricate web of factors affecting academic performance in engineering education necessitates a holistic and interdisciplinary approach. Recognizing the diverse range of influences, from academic and environmental to psychological and personality-related, is

fundamental in fostering a comprehensive understanding of the dynamics at play in the educational landscape. This holistic viewpoint can guide the development of focused interventions and systems of support that are designed to improve the academic experience and success of engineering students at different educational levels. (Keyzar and Maxey, 2014; Trowler et al., 2012).

2.6 PSYCHOLOGICAL WELL-BEING

Psychological well-being refers to "an individual's total mental and emotional state. It entails having a sense of meaning and purpose in life, feeling content with life, and enjoying pleasant emotions" (Crego et al., 2020). A person's psychological well-being affects many aspects of their life, including their career, relationships, education, and physical health. It is a crucial component of total health. (Diener and Seligman, 1984; Bandura, 1977; Lombardi et al., 2019).

Here are few factors that constitute psychological well-being:

Autonomy: Psychological well-being is often associated with a sense of control and autonomy over one's life.. People tend to report higher levels of well-being when they feel free to make decisions and choices that are consistent with their preferences and values.

Self-acceptance: Having a positive opinion of one's self and accepting both one's strengths and weaknesses are characteristics of self-acceptance. It is a crucial element of self-esteem and supports general psychological health.

Personal Development and Mastery: A sense of personal development and the capacity to consistently acquire new abilities and information are factors contributing to well-being. People who are in good psychological health frequently look for opportunities for growth and mastery.

Purpose and Meaning in Life: Higher levels of psychological well-being are related to having a feeling of purpose and meaning in one's life. This frequently entails striving towards worthwhile objectives and ideals that concur with one's views.

Physical Well-Being: Psychological well-being and physical health are intertwined. A balanced diet, regular exercise, and enough sleep can all improve mental health.

Environmental Mastery: An individual's ability to effectively manage and control the diverse aspects of their life and surroundings, exhibiting competence in handling the external challenges and opportunities they encounter also contributes positively to psychological well-being (Seligman et al., 2005; Lyubomirsky et al., 2005; Ryff and Singer, 2008).

There's a growing body of evidence highlighting the significance of psychological well-being among undergraduate engineering students. A study investigated the impact of stress on the psychological well-being of engineering undergraduates in Vietnam (Nguyen et al., 2019). The findings suggest a substantial correlation, indicating that stress significantly predicted lower levels of psychological well-being among these students, underscoring the importance of addressing stress-related factors within engineering education. Moreover, the interconnection between psychological well-being and academic performance is well-documented. Research highlights a positive association between higher levels of psychological well-being and enhanced academic achievement among students (Shahzad et al., 2016). Similarly, a comprehensive literature review conducted by Sen (2018) consolidated various studies exploring the relationship between psychological well-being and academic performance. The review substantiated a positive correlation, concluding that psychological well-being significantly influences academic performance. It further advocated for universities and educators' proactive promotion of psychological well-being to promote student success (Sen, 2018). Overall, these studies advocate for universities to take proactive measures to support their engineering students' psychological well-being. Creating and nurturing a positive campus environment is critical, fostering an atmosphere conducive to well-being.

2.7 PERSONALITY TRAITS AND ACADEMIC PERFORMANCE

Personality traits, such as conscientiousness, openness, and emotional stability are positively associated with academic performance while neuroticism is negatively associated. All the human beings cannot be measured against one standard. Similarly, engineering students have diverse personalities coming from different backgrounds, so they have different type of connection with academic performance (Mammadov, 2022; Anderson et al., 2020; Caprara et al., 2011; Gatzka & Hell, 2018). Understanding the

intricate relationships between personality traits and academic outcomes is paramount for educators, facilitating the implementation of targeted strategies that accommodate the diversity inherent in engineering student populations which validates the relationship between personality traits and academic performance of undergraduate students (Moren et al., 2020). Therefore, the following hypotheses were formulated:

Hypothesis 1: Personality traits have a significant impact on academic performance of engineering undergraduates,

where:

H1a: Extraversion has a significant impact on academic performance of engineering undergraduates.

H1b: Agreeableness has a significant impact on academic performance of engineering undergraduates.

H1c: Conscientiousness has a significant impact on academic performance of engineering undergraduates.

H1d: Neuroticism has a significant impact on academic performance of engineering undergraduates.

H1e: Openness has a significant impact on academic performance of engineering undergraduates.

2.8 PERSONALITY TRAITS AND PSYCHOLOGICAL WELL-BEING

The intricate relationship between personality traits and psychological well-being has been the subject of extensive research, shedding light on how individual characteristics contribute to one's overall mental health. Literature suggests that certain personality traits play a significant role in shaping psychological well-being. Extraversion is consistently found to be positively associated with psychological well-being. Individuals with higher levels of extraversion often experience a greater sense of positive emotions, social connectedness, and life satisfaction. This inclination towards social engagement contributes to a supportive network and fulfilling relationships, key components of psychological well-being (Costa and McCrae, 1980). Agreeableness is also positively

linked to psychological well-being. Individuals who score high in agreeableness tend to foster harmonious relationships, experience lower levels of interpersonal conflict, and derive a sense of well-being from positive social interactions (Roberts et al., 2007). Conscientiousness emerges as another positive contributor to psychological well-being. Individuals with high conscientiousness often experience a greater sense of control over their lives, engage in purposeful activities, and exhibit resilience in the face of challenges. This proactive approach to life is associated with enhanced psychological well-being (Costa and McCrae, 1980). Openness to experience is also positively correlated with psychological well-being. Those with high levels of openness tend to seek out new experiences, find meaning in a variety of activities, and exhibit a broader perspective, all of which contribute to a richer and more fulfilling psychological life (Lahey, 2009). Conversely, neuroticism is consistently associated with lower levels of psychological well-being. Individuals scoring high in neuroticism may be more prone to stress, dissatisfaction, and emotional volatility, impacting their overall mental health negatively (Costa and McCrae, 1980; DeNeeve and Cooper, 1980). Therefore, the following hypotheses were formulated:

Hypothesis 2: Personality traits have a significant impact on the psychological well-being of engineering undergraduates,

where:

H2a: Extraversion has a significant impact on the psychological well-being of engineering undergraduates.

H2b: Agreeableness has a significant impact on the psychological well-being of engineering undergraduates.

H2c: Conscientiousness has a significant impact on the psychological well-being of engineering undergraduates.

H2d: Neuroticism has a significant impact on the psychological well-being of engineering undergraduates.

H2e: Openness has a significant impact on the psychological well-being of engineering undergraduates.

2.9 CAMPUS ENVIRONMENT AND ACADEMIC PERFORMANCE

A positive campus environment can enhance engineering student's academic performance by introducing more real-world learning projects, engaging into various activities while a negative one can have reverse effect. Innovative and progressive environments can foster creativity and improved learning outcomes. Conversely, an adverse or destructive environment can have detrimental effects on academic performance. Instances of faculty members exhibiting humiliating behavior or fostering a negative atmosphere can impede students' ability to concentrate, engage effectively with the material, and ultimately succeed academically. Such negative influences can lead to a decline in motivation, hindered creativity, and an overall deterioration in the quality of the learning experience (Zysberg and Nitza Schwabsky, 2021; Bandura, 2006b). In summary, the learning environment is a critical factor influencing academic performance in engineering education. A positive and innovative atmosphere can serve as a catalyst for success, while a negative one can hinder the potential for growth and achievement among students. Therefore, the following hypothesis was formulated:

Hypothesis 3: Campus environment has a significant impact on academic performance of engineering undergraduates.

2.10 CAMPUS ENVIRONMENT AND PSYCHOLOGICAL WELL-BEING

A positive campus environment with cooperative staff, interactive faculty, social gathering, availability of course materials, encouragement of student participation which eventually leads to improved psychological well-being whereas campus where there are unnecessary restrictions, hurdles affect students' psychological well-being in a negative way (Lombardi et al., 2019; Seligman, 2011). A positive interaction between faculty and staff members enhances the sense of belonging and establishes a conducive environment for learning. Social gatherings and opportunities for student participation create a sense of community on campus. Similarly, A well-equipped learning environment ensures that

students have access to the resources they need, reducing stress and contributing to a positive academic experience. Collectively, these positive elements contribute to enhanced psychological well-being by fostering a sense of support, connection, and academic engagement.

On the contrary, a campus environment characterized by unnecessary restrictions and hurdles can have a negative impact on students' psychological well-being. Restrictions and obstacles create an atmosphere of frustration, stress, and hindered personal growth. Arbitrary restrictions can lead to a sense of confinement and limit students' autonomy. This can result in increased stress levels and a diminished sense of well-being. Obstacles in academic progress, whether administrative or logistical, can create undue challenges for students. This may lead to feelings of frustration, inadequacy, and a negative perception of the learning environment (Chapman et al., 2013; Archambault et al., 2009). Therefore, the following hypothesis was formulated:

Hypothesis 4: Campus environment has a significant impact on the psychological well-being of engineering undergraduates.

2.11 SELF EFFICACY, ACADEMIC PERFORMANCE AND PSYCHOLOGICAL WELL-BEING

Academic performance and academic self-efficacy are positively correlated. People who have strong self-efficacy demonstrate a deep confidence that drives them to succeed academically (Widowati et al., 2023). This firm belief in their capabilities serves as a potent motivator, instigating a proactive pursuit of ambitious academic goals. Fueled by this conviction, these students demonstrate a robust work ethic and a resilient perseverance in the face of challenges. The impact extends to their study habits, as self-efficacious students are more inclined to maintain focus, diligently engage with their coursework, and cultivate a positive attitude throughout their educational journey. A constructive and determined approach to learning and academic accomplishment is facilitated by this positive mindset, which serves as a guiding force. It is more likely for students who have high self-efficacy to make challenging academic decisions. They are prepared to put up the effort necessary to achieve their goals because they believe they are attainable. Setting realistic goals is essential for academic success. High levels of self-

efficacy frequently result in more tenacity. When students face challenges or setbacks, they are more likely to persevere and discover solutions to them than getting upset (Putwain et al., 2016; Cohen, 2004). Research highlights that this association between academic success and academic self-efficacy has been noted across a variety of student populations. This shows that the impact of self-efficacy on academic success is a universal phenomena rather than being exclusive to any one group (Dogan, 2015; Galla et al., 2014). Research supports the idea that higher academic self-efficacy levels are associated with stronger motivation and more effort in studying, ultimately resulting in improved academic performance (Honicke & Broadbent, 2016).

Overall, the research shows how important academic self-efficacy is in both predicting and improving students' academic achievement. It is suggested that fostering students' belief in their own abilities can lead to increased motivation and effort, which are key factors in achieving success in their studies. The relationship between academic achievement and self-efficacy holds significant implications for academics, educators, and students who are concerned with the enhancement of educational outcomes.The impact of academic self-efficacy extends beyond academic performance, influencing various facets of an individual's well-being. Several studies provide compelling evidence that academic self-efficacy can play an indirect yet significant role in shaping stress levels, health outcomes, and overall life satisfaction (Milam et al., 2019 Chemers et al., 2001). One notable way through which academic self-efficacy influences well-being is by mitigating stress. Individuals with higher levels of academic self-efficacy tend to approach academic challenges with “a sense of confidence and belief in their ability to overcome obstacles”. The positive psychological state associated with academic self-efficacy can contribute to better overall health and well-being, creating a ripple effect that extends beyond academic realms. Importantly, academic self-efficacy is not confined solely to its academic consequences; it spills over into one's broader life satisfaction (Bandura, 1997). When individuals feel competent and capable in their academic pursuits, it can positively influence their overall life satisfaction. This connection suggests that the confidence and sense of mastery developed through academic achievements or overcoming academic challenges can contribute to a more positive and fulfilling life experience. Therefore, the following hypotheses were formulated:

Hypothesis 5: Engineering self-efficacy has a significant impact on academic performance of students.

Hypothesis 6: Engineering self-efficacy has a significant impact on psychological well-being of students.

2.12 CAMPUS ENVIRONMENT, PERSONALITY TRAITS AND SELF-EFFICACY

A positive campus environment plays a pivotal role in shaping the self-efficacy of engineering students, influencing their engagement and success in real-world engineering projects. The impact of the campus environment is profound, with positive conditions fostering a sense of competence and confidence, while a negative environment can lead to the opposite effect (Zysberg & Nitza Schwabsky, 2021). In a positive campus environment, students are afforded valuable experiences and opportunities to actively engage in real-world engineering projects. This hands-on involvement contributes to the development of practical skills and the application of theoretical knowledge, enhancing students' self-efficacy. Exposure to real-world projects allows students to see the direct relevance and impact of their academic pursuits, instilling a sense of competence in their ability to tackle challenges and contribute meaningfully to engineering tasks (Cheema et al., 2014). Conversely, an unfavourable campus climate might negatively impact students' self-efficacy. If the academic atmosphere is not conducive to collaboration, support, or the application of knowledge in practical scenarios, students may experience a decline in their confidence and belief in their abilities. A lack of positive experiences and engagement opportunities can hinder the development of self-efficacy, potentially leading to feelings of inadequacy and reduced motivation (Museus et al., 2013; Loo and Coy, 2013). The role of faculty is paramount in shaping the campus environment. Cooperative, motivating, and helpful faculty members contribute significantly to creating a positive energy among students. When faculty members actively support and guide students, providing mentorship and encouragement, it cultivates an environment conducive to hard work and perseverance. Students, in turn, develop a sense of confidence in their abilities, knowing that they have a supportive network to help them navigate challenges and succeed in their academic and professional pursuits (Graham et al., 2013).

Personality traits also have a significant impact on academic self-efficacy. Academic self-efficacy is positively correlated with agreeableness, extraversion, conscientiousness, and openness to new experiences. However, neuroticism is negatively correlated (Abood 2020). In conclusion, the complex interplay among academic self-efficacy, campus climate, and personality attributes highlights the diverse aspects of student success in engineering education.. Recognizing and fostering positive traits, coupled with creating supportive and enriching campus environments, are pivotal steps toward empowering students to navigate the complexities of academic challenges with confidence and competence. Therefore, the following hypotheses were formulated:

Hypothesis 7: Personality traits have a significant impact on engineering self-efficacy of students.

H7a: Extraversion has a significant impact on engineering self-efficacy of students.

H7b: Agreeableness has a significant impact on engineering self-efficacy of students.

H7c: Conscientiousness has a significant impact on engineering self-efficacy of students.

H7d: Neuroticism has a significant impact on engineering self-efficacy of students.

H7e: Openness has a significant impact on engineering self-efficacy of students.

Hypothesis 8: Campus environment has a significant impact on engineering self-efficacy of students.

2.13 MEDIATING ROLE OF SELF-EFFICACY

Academic research has shown interest in the mediating function of academic self-efficacy in the relationship between personality factors and academic performance. Several studies have contributed significantly to this body of knowledge, highlighting how certain personality traits influence academic self-efficacy, which ultimately impacts academic performance (Mornar et al., 2022; Feyter et al., 2012). This suggests that the psychological beliefs individuals hold about their academic abilities play a crucial role in translating their personality characteristics into actual academic outcomes. Moreover, the association between personality traits and subjective well-being has been found to be mediated by academic self-efficacy (Strobel et al., 2011). This implies that individuals with certain

personality traits may cultivate a positive sense of well-being through their confidence in their academic abilities.

However, despite the existing body of research on the mediating role of academic self-efficacy, a literature gap is apparent when it comes to investigating the mediating role of self-efficacy in the relationship between campus environment and both academic performance and psychological well-being. To the best of the researcher's knowledge, no evidence has been found to establish this mediating link. Addressing this gap in the literature is crucial for a comprehensive understanding of the factors that contribute to academic success and well-being within the context of the campus environment.

Studies examining the relationship between academic performance and academic self-efficacy and the campus environment would provide insight into how students' perceptions of their own academic talents are shaped by the institution as a whole, which in turn affects their performance. This could encompass factors such as the availability of resources, quality of teaching, and the overall support system within the campus environment (Caprara et al., 2006). Analyzing how academic self-efficacy influences the relationship between psychological well-being and the campus environment is also crucial. The campus environment can significantly contribute to students' overall well-being through social interactions, a sense of belonging, and access to mental health resources. Understanding how academic self-efficacy mediates this relationship would provide valuable insights into the psychological mechanisms through which the campus environment influences students' mental well-being. Therefore, the following hypotheses were formulated:

Hypothesis 9: Engineering self-efficacy significantly mediates the relationship between personality traits and academic performance.

Hypothesis 10: Engineering self-efficacy significantly mediates the relationship between personality traits and psychological well-being.

Hypothesis 11: Engineering self-efficacy significantly mediates the relationship between campus environment and academic performance.

Hypothesis 12: Engineering self-efficacy significantly mediates the relationship between campus environment and psychological well-being.

2.14 RESEARCH GAP

Extensive literature is available for the impact of campus environment on students' academic performance and psychological well-being. Academic self-efficacy is well supported as a factor that predicts academic performance (Lei et al., 2022). Additionally, studies on university students have examined the direct effects of personality traits on academic performance, psychological well-being, and self-efficacy. They have also looked at the direct effects of the campus environment on these relationships as well as the mediating role that self-efficacy plays between personality traits and performance (Lombardi et al., 2019; Mornar et al., 2022; Moren et al., 2019; Zysberg and Schwabsky, 2021; Milam et al., 2019) . However, to the researcher's best of knowledge, no research has been done on the mediating role of self-efficacy between the campus environment and academic performance, between the campus environment and psychological well-being, or the combined effect of all these factors in the context of engineering, particularly for a developing nation like Pakistan.

2.15 HYPOTHESES DEVELOPMENT

Based on the review of existing literature and identification of the research gap, the following research hypotheses were formulated to achieve the objectives of this study:

Table 2-3: Research Hypotheses

RESEARCH HYPOTHESES	
Hypothesis 1	Personality traits have a significant impact on academic performance of engineering undergraduates, where
H1a	Extraversion has a significant impact on academic performance of engineering undergraduates.
H1b	Agreeableness has a significant impact on academic performance of engineering undergraduates.

H1c	Conscientiousness has a significant impact on academic performance of engineering undergraduates.
H1d	Neuroticism has a significant impact on academic performance of engineering undergraduates.
H1e	Openness has a significant impact on academic performance of engineering undergraduates.
Hypothesis 2	Personality traits have a significant impact on the psychological well-being of engineering undergraduates, where:
H2a	Extraversion has a significant impact on the psychological well-being of engineering undergraduates.
H2b	Agreeableness has a significant impact on the psychological well-being of engineering undergraduates.
H2c	Conscientiousness has a significant impact on the psychological well-being of engineering undergraduates.
H2d	Neuroticism has a significant impact on the psychological well-being of engineering undergraduates.
H2e	Openness has a significant impact on the psychological well-being of engineering undergraduates.
Hypothesis 3	Campus environment has a significant impact on academic performance of engineering undergraduates.
Hypothesis 4	Campus environment has a significant impact on the psychological well-being of engineering undergraduates.
Hypothesis 5	Engineering self-efficacy has a significant impact on academic performance of engineering undergraduates.
Hypothesis 6	Engineering self-efficacy has a significant impact on psychological well-being of engineering undergraduates.
Hypothesis 7	Personality traits have a significant impact on engineering self-efficacy of engineering undergraduates.

H7a	Extraversion has a significant impact on engineering self-efficacy of engineering undergraduates.
H7b	Agreeableness has a significant impact on engineering self-efficacy of engineering undergraduates.
H7c	Conscientiousness has a significant impact on engineering self-efficacy of engineering undergraduates.
H7d	Neuroticism has a significant impact on engineering self-efficacy of engineering undergraduates.
H7e	Openness has a significant impact on engineering self-efficacy of engineering undergraduates.
Hypothesis 8	Campus environment has a significant impact on engineering self-efficacy of engineering undergraduates.
Hypothesis 9	Engineering self-efficacy has a significant mediating effect on the relationship between personality traits and academic performance of engineering undergraduates.
Hypothesis 10	Engineering self-efficacy has a significant mediating effect on the relationship between personality traits and psychological well-being of engineering undergraduates.
Hypothesis 11	Engineering self-efficacy has a significant mediating effect on the relationship between campus environment and academic performance of engineering undergraduates.
Hypothesis 12	Engineering self-efficacy has a significant mediating effect on the relationship between campus environment and psychological well-being of engineering undergraduates.

2.16 CONCEPTUAL FRAMEWORK

This study examined how personality traits, campus environment and engineering self-efficacy interact to predict engineering undergraduates' academic performance and psychological well-being. The academic performance was assessed using self-reported CGPA. General engineering self-efficacy, experimental self-efficacy, tinkering self-

efficacy and design self-efficacy were combined to include all the aspects of engineering self-efficacy. The Big Five model of Personality was used to assess each student's personality type and understand the impact of all these factors on academic performance and psychological well-being. Significant support is available for direct relationships. However, the evidence for mediating role of engineering self-efficacy could not be found for the relationships between campus environment, academic performance, and psychological well-being, especially for a developing country like Pakistan. The study of the previous literature led to the formulation of the following conceptual framework.

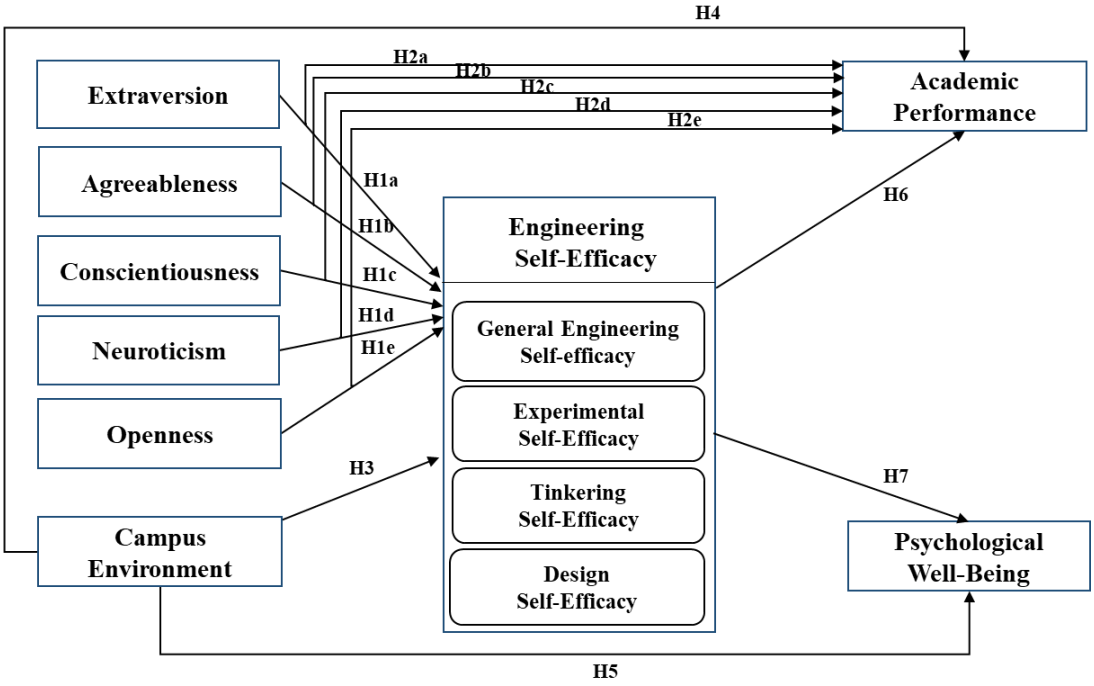

Figure 2-1: Conceptual Framework

CHAPTER 3: RESEARCH METHODOLOGY

This chapter explains the research methodology, including the research design, sampling technique, measurement instruments, and approaches used during the statistical analysis of the study.

3.1 RESEARCH PARADIGM

The term paradigm comes from the Greek word "paradeigma," which means "pattern" (Kivunja & Kuyini, 2017). It is defined as a perspective that shapes a research topic and influences the researcher's thought process (Hughes, 2010). This study follows a positivist research paradigm. It has been viewed from outside, without having any personal affiliation with the area of study to ensure objectivity and avoid any biases that might impact the results of the study. The data used for this study is Quantitative (numerical data). The data was collected through a pencil-paper survey for accessible universities in Rawalpindi/ Islamabad and AJK, and online form was used for other universities in Pakistan. Statistical analysis was done to determine the causal relationships between variables and produce objective and generalizable results.

3.2 MEASUREMENT INSTRUMENT

A measurement instrument is a standardized tool or device designed to systematically collect data on specific attributes, characteristics, or variables, ensuring objectivity and consistency in the assessment process (DeVellis, 2016).

A research questionnaire was developed with a total of 49 questions divided into two sections, Section A contained 9 items that examined General Information such as Name, Gender, Hometown, Type of hometown, Engineering Discipline, Year of Study, Name of Engineering University, Campus, and self-reported CGPA. Only CGPA was used in statistical analysis while the remaining were simply used as descriptors in data collection. The remaining 40 items were included in Section B, which contained 4 items for Campus Environment, 15 items for Engineering Self-efficacy (i.e., 4 for General Engineering Self-efficacy, 3 for Experimental Self-efficacy, 4 for Tinkering Self-efficacy, 4 for Design Self-efficacy), 17 items for Personality Traits (i.e., 4 for Extraversion, 3 for Agreeableness, 3 for Conscientiousness, 4 for Neuroticism, 3 for Openness to Experience),

and 5 items for Psychological Well-being. The responses were rated on a 5-point Likert Scale ranging from (1-Strongly Disagree, 2-Disagree, 3-Neither Agree nor Disagree, 4-Agree, 5-Strogly Agree) in an ordinal manner. The following are the details of the measurement instruments that were employed for the study:

3.2.1 Campus Environment

The environment of a campus encompasses both the physical and social aspects of the campus, including things like physical infrastructure, campus safety, and the social climate (Harper, 2011). This can influence the overall student experience and play a role in determining if a campus is a good fit for an individual. This term is often used interchangeably with campus climate, but it is different as campus climate is the quality of life perceived as a result of campus environment (Cuyjet & Beamon, 2005). Various scales to measure Campus Environment were studied but were not found appropriate according to the population.

Initially, a 43-item scale (Marian et al., 2015) was employed for the pilot study, but it was a bit too long and difficult to understand, so a brief and simple scale was needed for the purpose. Therefore, a 12-item scale (Gloria & Kurpius, 1996) was adapted to measure campus environment. The sample items were “The library staff is willing to help me find books/materials”, and “I feel comfortable in the university environment”.

3.2.2 Engineering Self-efficacy

Engineering self-efficacy refers to “an individual's belief in their ability to successfully complete tasks and achieve specific goals in the field of engineering” (Salami & Akindehin, 2018). A 15-item questionnaire was adapted for measuring engineering self-efficacy. It included 4-items from Bong’s (2001) academic self-efficacy scale adapted to the context of engineering, 3-item Experimental Self-Efficacy scale, a 4-item scale for tinkering self-efficacy (Schreuders et al., 2009) and 4-item scale for design self-efficacy (Carberry et al. (2010), Schubert et al. (2012)) Sample items were “I can earn a good grade in my engineering related courses”, and “I can analyze data resulting from experiments”.

3.2.3 Personality Traits

Personality traits are “enduring patterns of thoughts, feelings, and behaviors that characterize an individual and influence their interactions, reactions, and overall behavior in a variety of situations”. These traits are relatively stable over time and can be used to describe and predict an individual's behavior (Mathews et al., 2003; Digman 1990). The Big 5 Model of Personality is one of the most widely accepted and studied models in the field of Psychology. The Mini-IPIP, a 20-item short form of the 50-item International Personality Item Pool—Five-Factor Model measure (Goldberg, 1999) was adapted for measuring Personality Traits. Sample items were “I sympathize with others’ feelings”, and “I have frequent mood swings”.

3.2.4 Psychological Well-being

Psychological Well-being refers to a person’s overall sense of emotional, social, and psychological health and happiness (Diener et al., 1990). The 18-item version of Ryff’s scale was adapted to measure Psychological Well-being (Ryff et al., 2010). Sample items were “I am good at managing the responsibilities of daily life”, and “I tend to be influenced by people with strong opinions”.

3.3 PILOT STUDY

A well-designed research study, a suitable experimental design, and exact execution are essential to achieve high quality results. Before conducting the full-scale study, it could be highly beneficial to assess the feasibility of this goal. The first stage of the entire research process is a pilot study. Planning and adjusting a larger study is typically aided by a smaller-scale study (Vemulakonda & Jones, 2015). In large-scale quantitative research, the pilot or small-scale study is frequently carried out initially to assess the validity of the primary experiment. Before starting a pilot study, researchers must have a complete understanding of the subject matter, purpose, experimental design, and schedule. With the help of the pilot study, which informs them about the steps needed in the major study, researchers choose the research methodology most appropriate for addressing the research issue in the main study. (Teijlingen & Hundley, 2001; Arnold et al., 2009; Thabane et al., 2010).

Pilot study was conducted in January 2023 that included students from 4 years of study in various engineering disciplines. A pencil-paper survey was conducted by the researcher for this purpose. Initially 12 participants took part in the study, but the obtained results were not reliable, therefore the size was expanded to 200 for better reliability. The students were encouraged to participate voluntarily, and improvements were made based on their suggestions. The collected data was analyzed using SPSS. After checking the results and making the necessary changes, the Cronbach Alpha values for all the variables were found to be between the range 0.7-0.9(Fornell & Lacker, 1981), passing the reliability test.

Table 3-1: Reliability of Scales

Construct	No. of items	Cronbach Alpha
Campus Environment (CE)	7	0.723
Extraversion (E)	4	0.734
Agreeableness (A)	4	0.721
Conscientiousness (C)	4	0.735
Neuroticism (N)	4	0.732
Openness to Experience (O)	4	0.734
Psychological Well-being (PWB)	11	0.736
Engineering Self-efficacy (ESE)	15	0.873

3.4 RESEARCH SETTINGS

Quantitative research is the numerical representation and manipulation of observations to characterise and interpret the phenomena reflected by those observations. (Watson, 2015). It is employed in many natural and social sciences, such as biology, psychology, sociology, physics, and geology. Moreover, a precise description of quantitative research as a field of study is "explaining, gathering and analyzing numerical data to study phenomena using statistical procedures" (Creswell, 1994). For high precision level results, statistical analysis was performed involving participants from Pakistani engineering universities. Data from respondents was gathered using a cross-sectional survey approach at a single point in time during the semester.. Questionnaires were distributed among participants from Engineering Students in Pakistan and AJK. The total targeted population size was approximately 214,000.

3.5 SAMPLING TECHNIQUE

This study employed a Mixed Method approach, stratified for pencil-paper survey as the respondents were divided into strata to have nearly equal representation and then data collection was done accordingly, purposive sampling approach used for online survey as the engineering undergraduates were contacted on purpose based on the nature of research audience eligible for the response. The online form's link and QR code was shared with Industry Liaison Officers (ILO's), students, and faculty all over Pakistan via emails, whereas pencil and paper survey were conducted for students who were accessible in Rawalpindi/Islamabad and AJK. For this purpose, preliminary permission was asked from the instructors to conduct the survey in classrooms during the allocated time with a brief introduction to the research and its purpose. The students were requested to fill out the form on a voluntary basis.

3.6 ETHICAL CONSIDERATIONS

All the researchers should be aware of the Research Ethics before conducting research and should take care of them to avoid any inconvenience or mishap during the research journey. First and foremost, the ethical principle of informed consent was strictly followed. This means that participants willingly agreed to take part in the research without any form of coercion. They were presented with the goals of the , which allowed them to make an informed decision about their participation. This not only respects the autonomy of the participants but also ensures that they are aware of what their involvement entails. Furthermore, the principle of anonymity was diligently observed. Protecting the identity and privacy of the participants is a fundamental ethical consideration. By keeping their identities confidential, the researcher ensured that the responses and data collected could not be linked to any specific individual. This is crucial in creating a safe and secure environment for participants to express their views and provide data honestly. Another critical aspect of research ethics is the responsible handling of data. In this study, the researcher clearly stated that the data collected would be used solely for research purposes. This commitment to data privacy and confidentiality assures participants that their responses will not be shared with third parties, safeguarding the integrity of the research.

In conclusion, adherence to research ethics is paramount in maintaining any study's credibility and trustworthiness. In this case, the researcher's unwavering commitment to informed consent, anonymity, and data confidentiality underscores their dedication to conducting ethical research. Researchers should continue to uphold these ethical standards in all their work to ensure the rights and well-being of their participants.

3.7 METHOD OF DATA ANALYSIS/STATISTICAL PROCEDURE

The strategy was based on a two-stage process,

3.7.1 Pre-Analysis

In the first stage of investigation, the sample data was cleaned and filtered from incomplete and improper responses, extreme outliers and redundant samples were also removed. The initially collected responses were 1420 after the first process stage, the remaining responses for the second stage analysis were 1005.

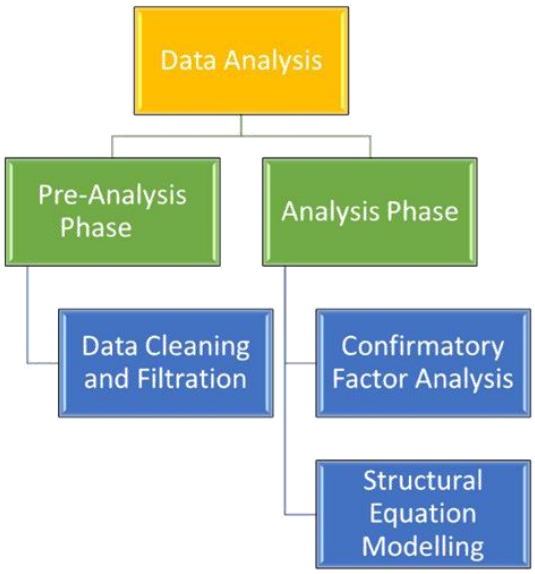

Figure 3-1: Phases of Data Analysis

3.7.2 Analysis Stage

The analysis was carried out in two phases during the second stage. Regression weights of the items on the latent variable and model fit indices were used to analyze and confirm the measurement model in the first phase of CFA. To evaluate the data's normality, descriptive statistics were also computed. In the second phase, SEM was used to test the conceptual framework's overall structure.

In the second stage, the analysis was performed in two phases. Based on the model fit indices and regression weights of the items on the latent variable, the measurement model was examined and validated in the first phase of CFA. In addition, the data's normality was evaluated through the computation of descriptive statistics. SEM was used in the last stage to test the conceptual framework's general structure. The direct impact of variables on academic performance and psychological well-being and the mediating role of engineering self-efficacy between these relationships was analyzed using SEM.

3.7.3 Structural Equation Modelling (SEM)

The structure of the theoretical framework is tested using the SEM approach, which is the combination of factor analysis and multiple regression. The SEM approach suits theory testing and development because it allows both confirmatory and exploratory modelling. The SEM extends the possibility of a relationship among the latent variables and encompasses measurement and structural models (Principles and Practice of Structural Equation Modeling, Fourth Edition - Rex B. Kline - Google Books, 1998).

3.7.4 Family Tree of SEM

Generally, there are two types of research questions depending on the research objective:

- Is there any difference among the samples/variables?
- Is there any association/relationship among sample/variables?

The figure shows two different paths; the first path starts with a t-test, and the second starts with bivariate correlation and concludes with a latent growth curve analysis. The paths shown in the model are the analysis approaches or techniques used to answer the research questions depending upon the research objectives. The latent growth curve models are used in SEM frameworks to find the growth trajectories in longitudinal studies, which is not the scope of this research. This research followed the second path, from bivariate correlation to structural equation modeling. This course of action was chosen since the goal of the research was to examine any possible associations or relationships between the variables that were being observed.

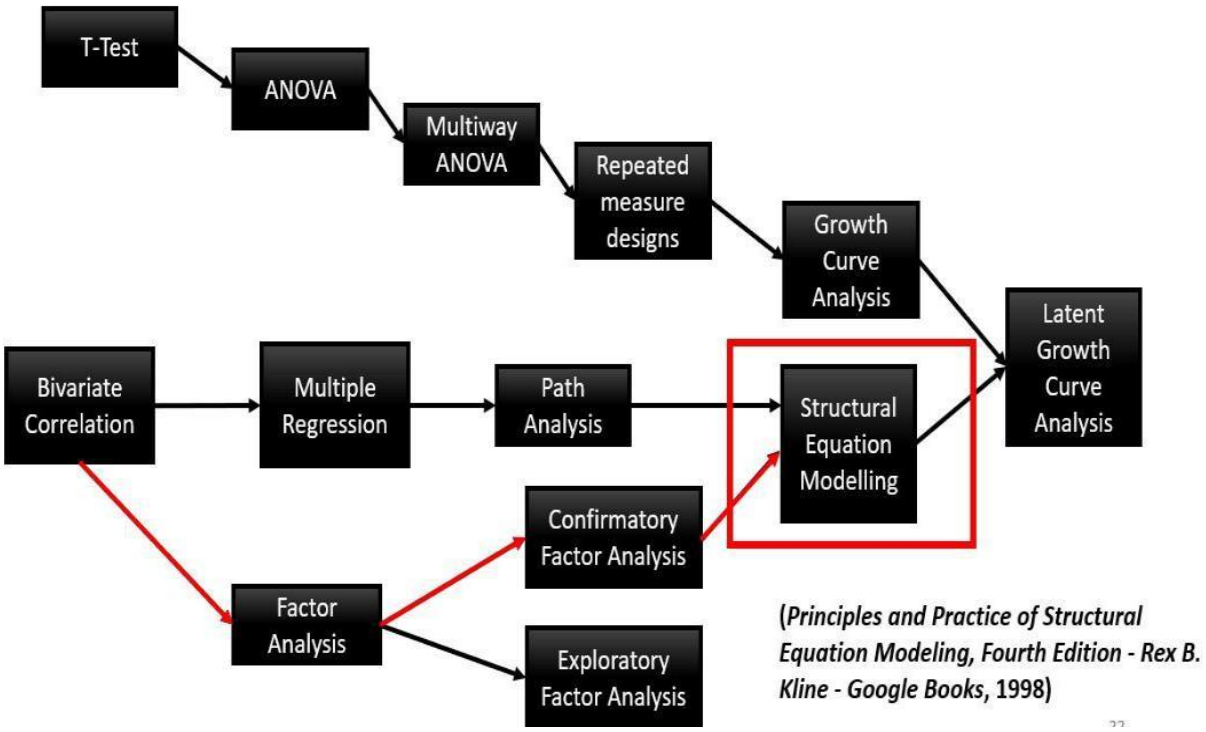

Figure 3-2: Family Tree of SEM

CHAPTER 4: RESULTS AND ANALYSIS

This chapter discusses the results of statistical analysis. Starting with demographic results it contains the results for scale reliability, discriminant validity, exploratory factor analysis, regression analysis, and finally concludes with the hypotheses testing for all the direct and indirect relationships involved in the study.

4.1 DEMOGRAPHICS

For the conduction of this survey-based study, the target population was engineering undergraduate students of Pakistan. Over 25 engineering universities were contacted via emails, phone calls and face-to-face meetings and a web-based questionnaire was shared with their Industry Liaison Officers (ILOs) and faculty/students, out of which only 16 responded. Over 2,000 paper surveys were distributed out of which only 1520 were returned and after removal of incomplete responses the final count including the online responses was 1420. After further screening and deletion of inappropriate responses and outliers, the final sample size included in the study was 1005.

The demographics of respondents are given below:

Table 4-1: Demographics

Gender	Male 79%		Female 21%	
Hometown	North 16%	East 76%	South 7%	International 1%
Type	Urban 80%	Rural 20%		
Eng Discipline	Computer Engineering 18%	Electrical Engineering 28%	Mechanical Engineering 18.5%	Mechatronics Engineering 17%
	Software Engineering 13%	Information Security Engineering 2%	Others 3.5%	
Year of study	1st 26%	2nd 29%	3rd 16%	4th 29%

The universities that participated in the study are stated as follows:

Table 4-2: Universities that participated in the study

Name of Engineering University	Respondents (%)
College of Electrical & Mechanical Engineering, NUST	73%
Military College of Signals, NUST	4.2%
Main Campus, NUST	7.3%
Military College of Engineering, NUST	1.2%
Pakistan Naval Engineering College, NUST	1.5%
University of Azad Jammu & Kashmir	3.1%
National University of Modern Languages	3.7%
University of Engineering & Technology	1%
Khwaja Fareed University of Engineering & Information Technology	1.5%
Others	3.5%

4.2 DESCRIPTIVE STATISTICS

Normality testing is an essential step in statistical analysis, particularly when using parametric tests. It guides researchers in the pre-processing of data, promotes the selection of pertinent statistical techniques, and contributes to the dependability of statistical conclusions. Skewness and kurtosis of variables were used rather than the Shapiro Wilk, Anderson Darling, and Kolmogorov-Smirnov tests to determine whether the data was normal because the skewness and kurtosis values are more suitable for larger sample sizes. ($N<300$) (H.-Y. Kim, 2013; Mishra et al., 2019). The asymmetry of a probability distribution can be measured statistically using skewness. It shows how skew—a break from horizontal symmetry—the data is, as well as its direction. The distribution is skewness-free in completely symmetrical distribution. According to Fisher (1920), a

distribution is said to be positively skew if its tail is longer or fatter on the right side than the left. Conversely, a distribution is said to be negatively skew if its tail is smaller or longer on the left side. An indicator of the distribution of data points in a dataset is statistically measured and called kurtosis. By comparing the data to a normal distribution, it determines the "tailedness" of the data distribution—that is, whether the data are heavy or light. Kurtosis can be measured in several ways. For example, excess kurtosis can be calculated by deducting 3 from standard kurtosis. Positive excess kurtosis indicates heavier tails compared to a normal distribution, while negative excess kurtosis indicates lighter tails (Pearson, 1905). Since all of the variables' skewness and kurtosis values fell within the allowed range—that is, -3<skewness<+3 (Hair et al., 2010) and -7<kurtosis<+7 (Bryne, 2010) for univariate normality and kurtosis<5 for multivariate normality—the data was deemed to be normal (Curran et al., 1996; Kim, 2013).

Table 4-3 Descriptive Statistics

	Mean	Std. Deviation	Skewness	Kurtosis
Campus environment	3.2929	.63701	-.271	.033
Extraversion	2.6857	.91574	.192	-.449
Agreeableness	3.3763	.76997	-.173	-.271
Conscientiousness	3.5287	.81340	-.355	-.067
Neuroticism	2.8897	.91427	.126	-.479
Openness	3.5363	.78157	-.316	-.010
Psychological well-being	3.5196	.65842	-.297	.185
Engineering self-efficacy	3.5857	.60559	-.511	1.124

The results indicate that the kurtosis and skewness values lie in the acceptable range so parametric testing could be done and data can be considered approximately normal.

4.3 CONVERGENT AND DISCRIMINANT VALIDITY

The concept of convergent validity assesses the convergence of items at one construct, i.e., it measures if all the items measure the same construct instead of measuring other constructs that might seem similar to it. It is suggested that the value of correlation of a construct with itself should be higher than the correlation with other constructs as shown below:

Table 4-4: Convergent Validity

	O	CE	C	A	E	PWB	N	ESE
O	**0.645**							
CE	0.121	**0.548**						
C	0.499***	0.199*	**0.656**					
A	0.288**	0.230*	0.477***	**0.634**				
E	0.064	-0.026	0.146	0.118	**0.642**			
PWB	0.637***	0.154	0.660***	0.594***	0.236*	**0.471**		
N	-0.346**	0.019	-0.360**	-0.297**	-0.248*	-0.720***	**0.643**	
ESE	0.412***	0.321**	0.160†	0.155†	0.109	0.275**	-0.083	**0.566**

Discriminant validity determines if the respondents have clearly distinguished among the constructs, if the value of HTMT does not fall in acceptable range, it indicates that the respondents were unable to differentiate between the constructs. To evaluate the discriminant validity of constructs, the heterotrait-monotrait (HTMT) ratio was computed. HTMT<0.9 indicates liberal discriminant validity while HTMT < 0.85 indicates rigorous discriminant validity (Henseler et al., 2015).

	O	CE	C	A	E	PWB	N	ESE
O								
CE	0.098							
C	0.0517	0.277						
A	0.294	0.209	0.511					
E	0.055	0.039	0.112	0.155				
PWB	0.710	0.165	0.682	0.619	0.194			
N	0.319	0.016	0.298	0.259	0.276	0.683		
ESE	0.412	0.300	0.237	0.176	0.120	0.338	0.141	

Table 4-5: Dicriminant Validity

All the values were below 0.85 which means that the constructs are distinct from each other. HTMT ratios are given in table 4-5:

4.3 CONFIRMATORY FACTOR ANALYSIS

Confirmatory factor analysis is a statistical technique used to assess how well observed data fits into a proposed structural model. It is often used to validate measurement models and identify the essential relationships between latent ideas and observable variables in the social sciences and psychometrics. In order to determine how well the suggested model matches the observed data, this is done. In an iterative procedure based on factor loading values, the model is decreased if it is unable to fit the data. Items with low factor loadings are eliminated, and results are evaluated repeatedly until they reach the desired values. Factor loadings less than 0.4 typically result in poor model fit indices.As previously mentioned, well-known, established scales were used to measure our latent constructs. CFA is performed to check the validity and reliability of these scales. The analysis was started with the base model (Model 1). The models were tested and modified till the desrable results were achieved. The details of the models are discussed as follows:

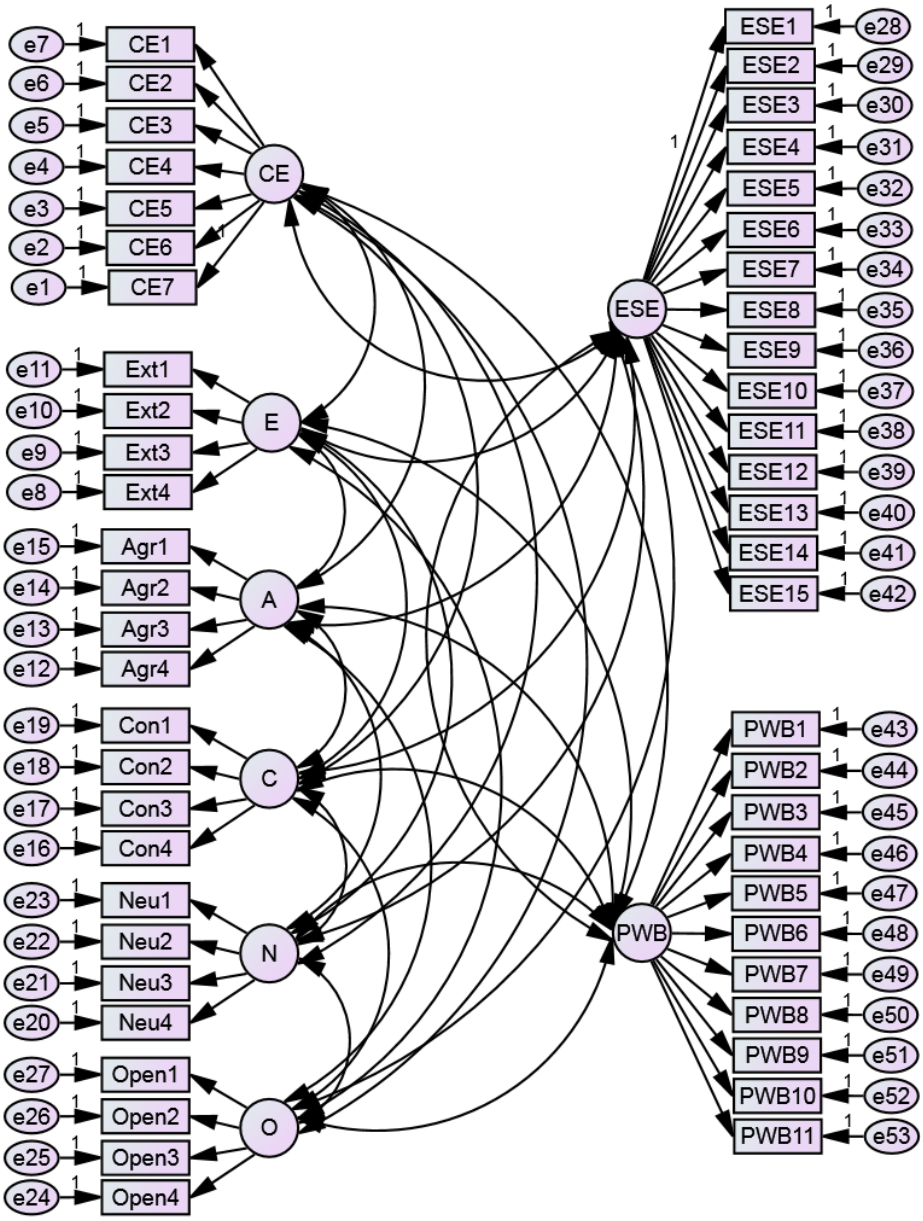

Figure 4-1: CFA: Model 1

Model fit indices for model 1 didn't lie in the acceptable range, so improvement in the model was required. CMIN/df<=3 acceptable fit (Kline, 1998), IFI> 0.9, CFI>0.9, TLI>0.9, RMSEA<0.05, 0.0<SRMR<0.08 (Hu & Bentler, 1999).

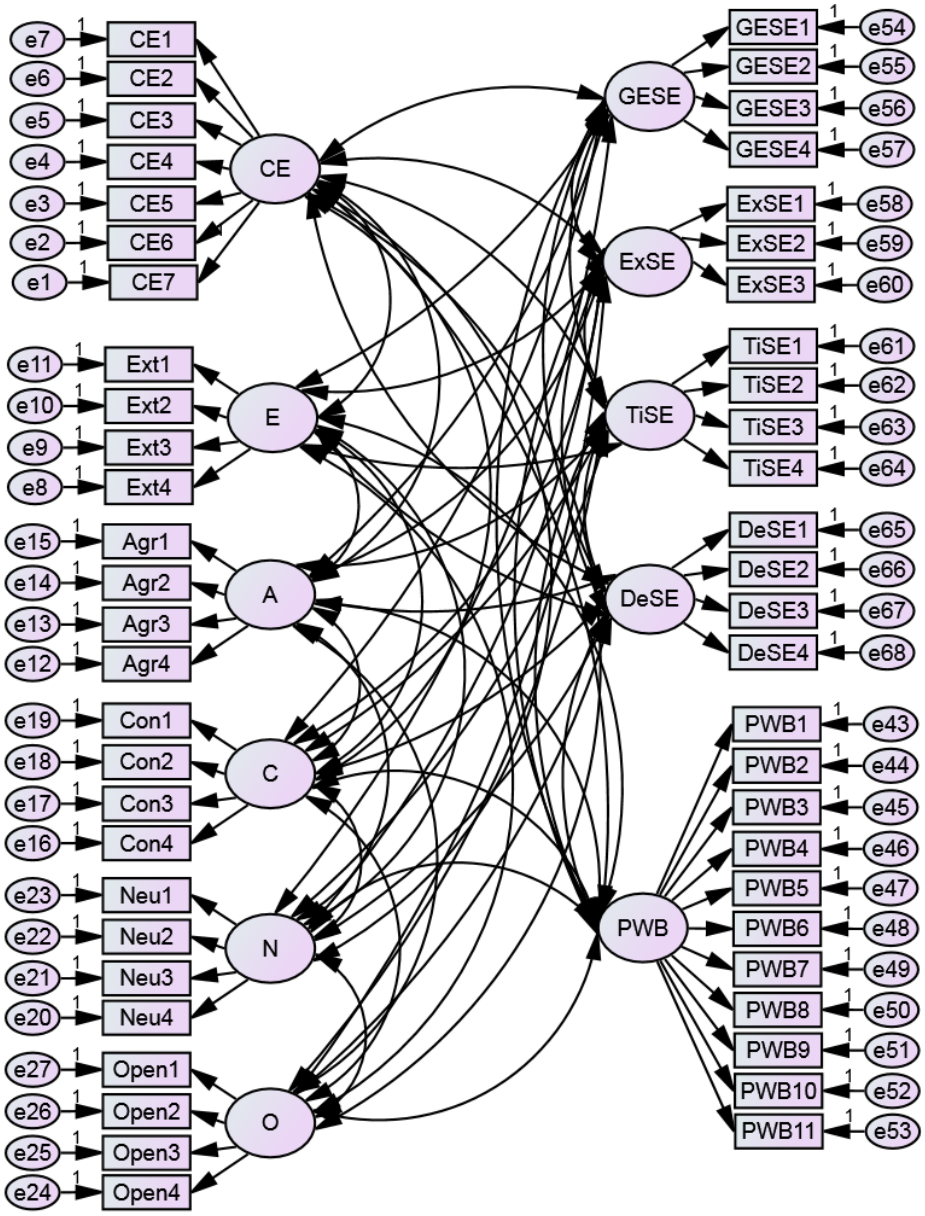

Figure 4-2: CFA: Model 2

Model 2 is the result of the modification in the base model 1. To achieve the model fit indices, the engineering self-efficacy was split into its factors, i.e., GESE, ExSE, TiSE, DeSE. Compared to the previous model, the fit indices significantly improved, but the fit indices were still not fulfilling the required model fit criteria

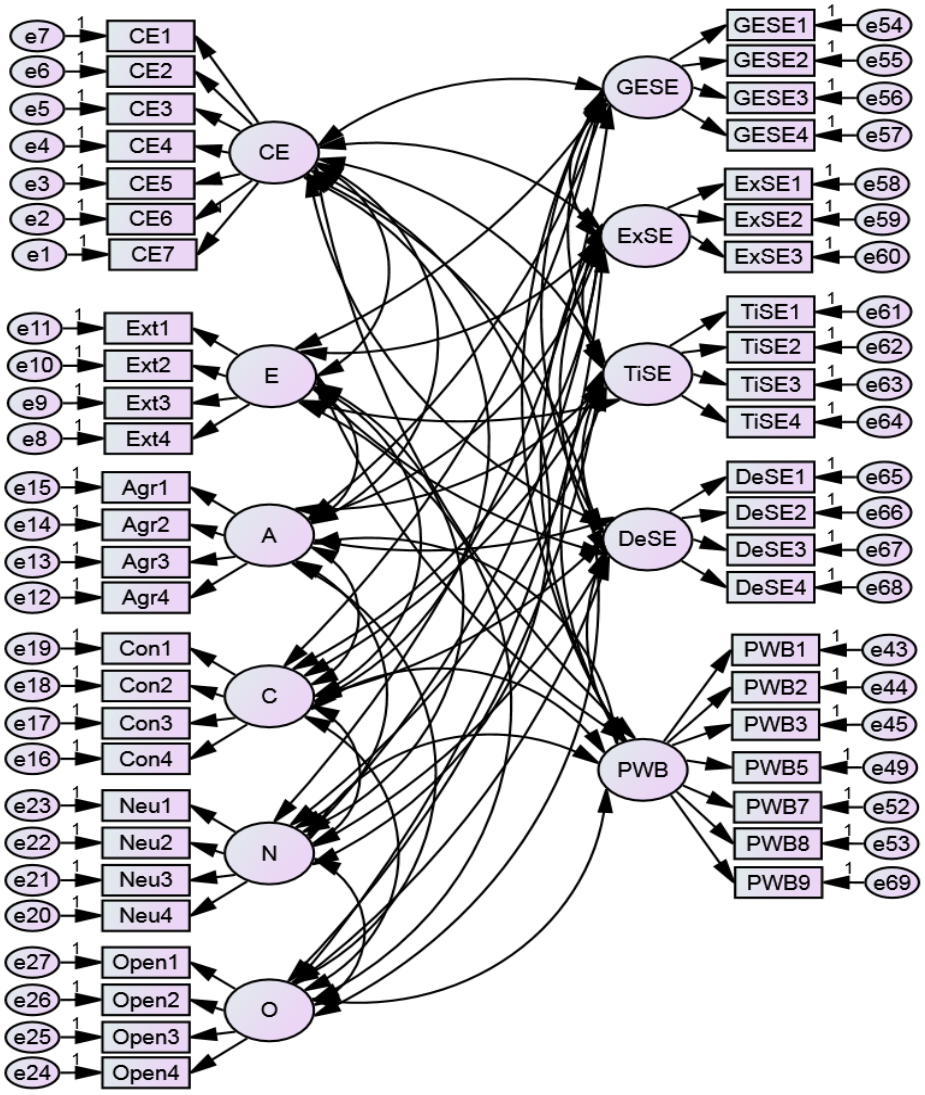

Figure 4-3: CFA: Model 3

Model 3 is the result of the modification in the base model 2. To achieve the model fit indices, the psychological well-being items with factor loadings less than 0.4 were removed and the results were assessed. Compared to the previous model, the fit indices improved, but the fit indices were still not fulfilling the required model fit criteria.

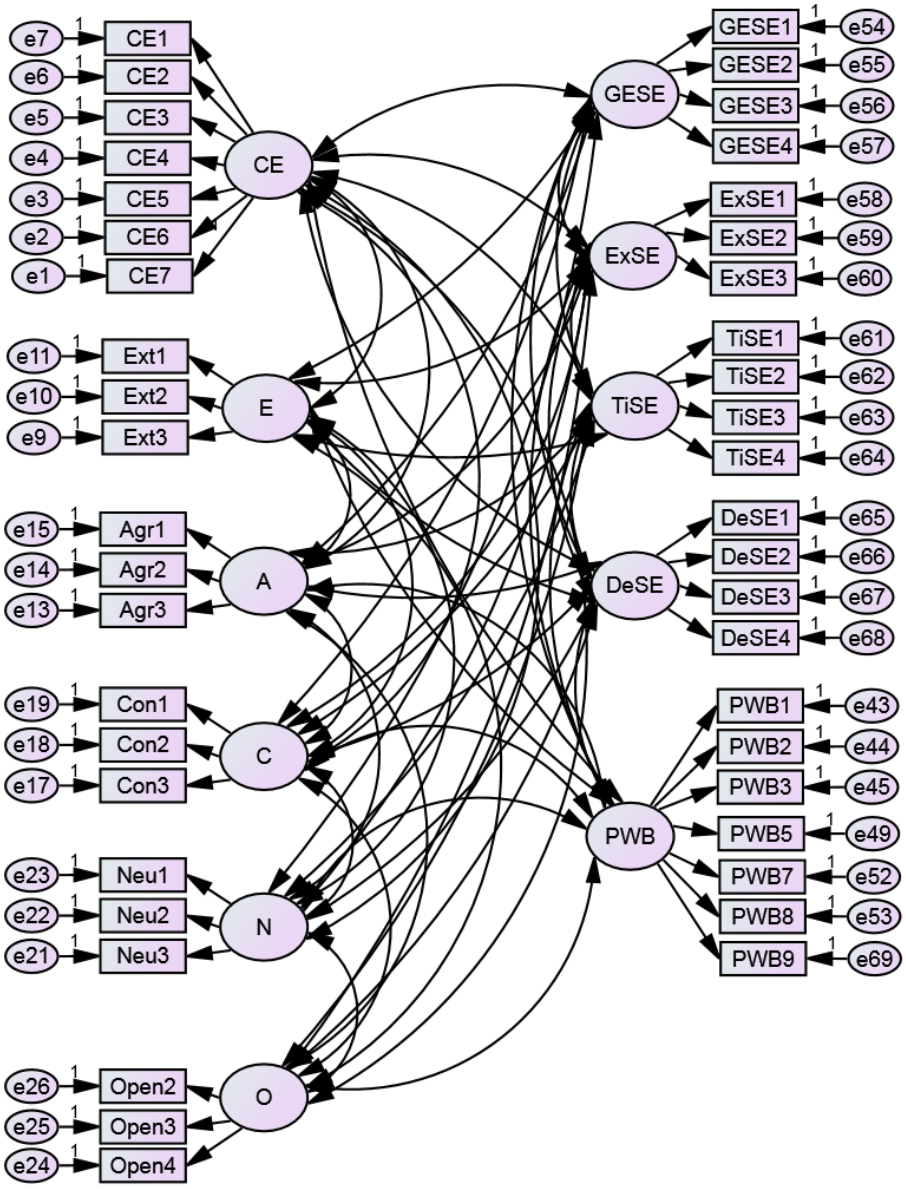

Figure 4-4: CFA: Model 4

Model 4 was obtained as result of modifications in model 3. The items for extraversion, agreeableness, conscientiousness, neuroticism, openness with factor loading less than 0.4 were removed and the results were assessed. Compared to the previous model, the fit indices improved, but the fit indices were still not fulfilling the required model fit criteria.

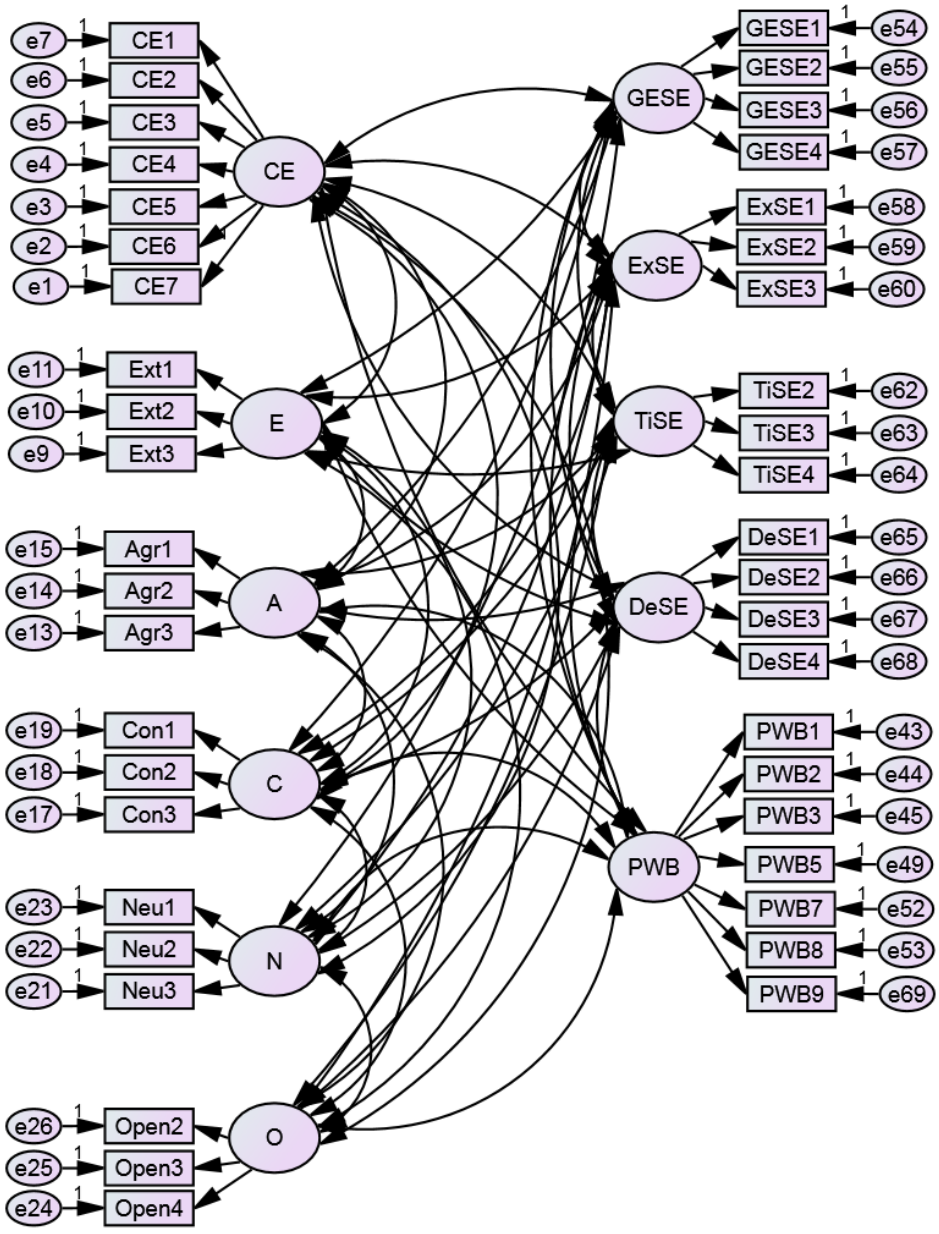

Figure 4-5: CFA: Model 5

Model 5 was obtained as a result of modification in model 4. The lowest factor loading item among general engineering self-efficacy, experimental self-efficacy, tinkering self-efficacy and design self-efficacy was removed and the obtained results were in the acceptable range.

Table 4-6: CFA: Model Fit Indices

	CMIN	df	CMIN/df	IFI	TLI	CFI	RMSEA	SRMR
Model 1	5895.615	1297	4.546	0.665	0.642	0.663	0.060	0.0663
Model 2	3942.627	1270	3.104	0.805	0.787	0.804	0.046	0.0568
Model 3	3009.474	1072	2.807	0.848	0.832	0.847	0.043	0.0535
Model 4	2003.967	847	2.366	0.899	0.886	0.898	0.037	0.0470
Model 5	1316.732	764	2.247	0.912	0.900	0.911	0.035	0.0460

4.4 RESEARCH HYPOTHESES AND HYPOTHESES TESTING

4.4.1 RESEARCH HYPOTHESES

For the testing of the hypotheses, structural equation modeling was done. The complete model was tested altogether to assess the relationships among different factors. Direct relationships of personality traits, campus environment, engineering self-efficacy, academic performance, and psychological well-being as well as the indirect relationships with engineering self-efficacy as mediator were assessed using Structural Equation Modeling (SEM) in AMOS 26. The path diagram is shown in Figure 4-1.

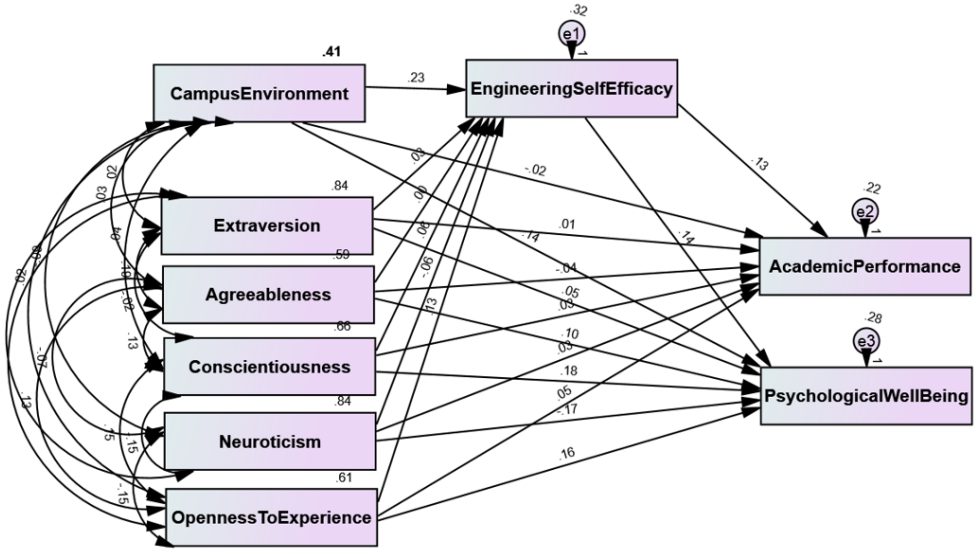

Figure 4-6: Path Diagram showing the results of SEM

1) Direct Relationships

SEM was used to determine the direct relationships among variables. The results are shown below:

Table 4-7: Direct Relationships

			Estimate
CE	→	ESE	0.241***
E	→	ESE	0.051
A	→	ESE	-0.002
C	→	ESE	0.080*
N	→	ESE	-0.092**
O	→	ESE	0.162***
CE	→	AP	-0.021
E	→	AP	0.016
A	→	AP	-0.066
C	→	AP	0.057
N	→	AP	0.065
O	→	AP	0.075*
ESE	→	AP	0.157***
CE	→	PWB	0.140***
E	→	PWB	0.070**
A	→	PWB	0.115***
C	→	PWB	0.224***
N	→	PWB	-0.234***
O	→	PWB	0.195***
ESE	→	PWB	0.130***

***p<0.001, **p<0.01, *p<0.05

The findings suggest that the campus environment has a major impact on the psychological health and engineering self-efficacy of students. Extraversion has a strong effect on psychological health, but it has a minor impact on academic achievement or engineering self-efficacy. Academic performance, psychological well-being, and engineering self-efficacy are all significantly enhanced by openness. Neuroticism negatively impacts engineering self-efficacy and psychological well-being. However, it does not affect academic performance. Conscientiousness significantly improves psychological health and engineering self-efficacy. However, it has no impact on academic performance. Agreeableness has a significant impact on psychological well-being. Academic achievement and engineering self-efficacy, however, are unaffected. Academic

success and psychological health are significantly impacted by engineering self-efficacy.

2) Indirect Relationships

The results of indirect relationships between variables with engineering self-efficacy as a mediator are shown in Table 4-6.

Table 4-8: Indirect Relationships

					Estimate
CE	→	ESE	→	AP	0.038***
E	→	ESE	→	AP	0.008
A	→	ESE	→	AP	0.000
C	→	ESE	→	AP	0.013**
N	→	ESE	→	AP	-0.014***
O	→	ESE	→	AP	0.025***
CE	→	ESE	→	PWB	0.031***
E	→	ESE	→	PWB	0.007
A	→	ESE	→	PWB	0.000
C	→	ESE	→	PWB	0.010**
N	→	ESE	→	PWB	-0.012***
O	→	ESE	→	PWB	0.021***

***p<0.001, **p<0.01, *p<0.05

The findings show that the relationships between the campus environment and psychological well-being as well as academic success are mediated by engineering self-efficacy. Additionally, the association between openness, conscientiousness, and neuroticism as personality traits and academic success is mediated by engineering self-efficacy. For openness, conscientiousness, and neuroticism, the association between psychological well-being and personality traits is mediated by engineering self-efficacy. However, no other significant relationship exists.

4.5 RESULTS OF HYPOTHESES

The summary of findings associated with each hypothesis is shown in Tabe 4-6.

Table 4-9: Results of Hypotheses

	Hypotheses	Findings	Result
H1	Personality traits have a significant impact on academic performance of engineering undergraduates.	Agreeableness and openness had a significant impact on academic performance i.e., CGPA.	PARTIALLY SUPPORTED
H2	Personality traits have a significant impact on psychological well-being of engineering undergraduates.	Psychological well-being was significantly positively impacted by agreeableness, conscientiousness, and openness to experience; neuroticism had a significant negative impact, while extraversion had no effect at all.	PARTIALLY SUPPORTED
H3	Campus environment has a significant impact on the academic performance of engineering undergraduates.	Campus environment did not have a significant impact on academic performance.	NOT SUPPORTED
H4	Campus environment has a significant impact on the psychological well-being of engineering undergraduates.	Campus environment had a significant impact on psychological well-being.	SUPPORTED
H5	Engineering self-efficacy has a significant impact on academic performance of engineering undergraduates.	Engineering self-efficacy had a significant impact on academic performance.	SUPPORTED
H6	Engineering self-efficacy has a significant impact on psychological well-being of engineering undergraduates.	Engineering self-efficacy had a significant impact on psychological well-being.	SUPPORTED

H7	Personality traits have a significant impact on engineering self-efficacy of engineering undergraduates.	Extraversion, conscientiousness, and openness to experience has a significant impact on engineering self-efficacy whereas agreeableness and neuroticism had no impact.	PARTIALLY SUPPORTED
H8	Campus environment has a significant impact on engineering self-efficacy of engineering undergraduates.	Campus environment had a significant impact on engineering self-efficacy.	SUPPORTED
H9	Engineering self-efficacy mediates the relationship between personality traits and academic performance of engineering undergraduates.	The relationship between conscientiousness, extraversion, and openness to new experiences and academic performance is significantly mediated by engineering self-efficacy; however, the relationship between agreeableness and neuroticism is not mediated by engineering self-efficacy.	PARTIALLY SUPPORTED
H10	Engineering self-efficacy mediates the relationship between personality traits and psychological well-being of engineering undergraduates.	Engineering self-efficacy significantly mediates the relationship between personality traits and psychological well-being for openness to experience, conscientiousness, extraversion whereas no such mediation exists for agreeableness and neuroticism.	PARTIALLY SUPPORTED
H11	Engineering self-efficacy mediates the relationship between campus environment and academic performance of engineering undergraduates.	Engineering self-efficacy significantly mediates the relationship between campus environment and academic performance.	SUPPORTED
H12	Engineering self-efficacy mediates the relationship between campus environment and psychological well-being of engineering undergraduates.	Engineering self-efficacy significantly mediates the relationship between campus environment and psychological well-being.	SUPPORTED

4.6 COMPARISON OF MEANS (T-Test)

Independent sample t-test is a statistical method used to determine whether the means of two independent groups differ significantly from one another.This parametric test is suitable when the data has approximately normal distribution. To determine whether the observed differences are statistically significant or may have happened by chance, researchers frequently compare the means of two groups using t-test (Kim, 2015).

The results of Group Statistics and T-test are as follows:

Table 4-10: Group Statistics

	Gender	N	Mean	Std. Deviation	Std. Error Mean
Academic Performance	Male	772	3.09	0.50	0.18
	Female	204	3.24	0.41	0.03

Table 4-11: Results of independent samples T-test

	Levene's Test for Equality of Variances		t-test for Equality of Means							
	F		Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Academic Performance	Equal variances assumed	7.67	0.01	-4.10	974	.000	-.16	0.38	-0.23	-0.08
	Equal variances not assumed			-4.56	373.67	.000	-.16	0.03	-0.22	-0.09

The results indicate that there exists a significant difference in academic performance based on gender. The mean score for academic performance of males is greater than females which suggests that males perform better in engineering than females. However, no

difference was found when tested for campus environment, engineering self-efficacy, and psychological well-being based on gender and other demographic variables.

4.7 DISCUSSION

This study aimed to investigate the impact of campus environment and personality traits on engineering students' academic performance and psychological well-being with engineering self-efficacy as mediator. The primary focus was engineering undergraduates only to explore the intrinsic and extrinsic factors that are usually ignored but play a significant role in assessing their academic performance and well-being. The findings of this study are mostly consistent with the previous research, but there are a few exceptions as well as new contributions to the literature. H1, H2, H7, H9, H10 are partially supported as all the personality traits do not support the hypothesized relationships (Shafaat et al., 2023; Lahey, 2003; Mirta et al., 2022). H4, H6, H8 are completely supported being consistent with the previous findings. However, H3 is not supported i.e., campus environment does not impact academic performance in this study in contrary to some previous findings (Benbenishty et al., 2016; Thapa et al., 2013) which may be due to the inappropriate choice of measurement scale, it might not reflect the true aspects of campus environment in a developing country and students might not be able to relate to it in terms of its impact on academic performance. H11 and H12 are supported as engineering self-efficacy acts as a mediator between campus environment and academic performance, and that between campus environment and psychological well-being, thus providing an indirect link between campus environment and academic performance. Additionally, the T-test results show that there is a considerable gender difference in academic performance, with males performing better than females.

CHAPTER 5: CONCLUSION AND FUTURE RESEARCH

This chapter contains conclusions based on the results shown in chapter 4. It starts with discussion by summarizing the research findings and discussing the effects, relationships, and impact of endogenous, exogenous, and mediating variables on each other. The contribution to the body of knowledge is also highlighted.

5.1 SUMMARY OF FINDINGS

Most of the hypotheses were partially or completely supported, proving that the students in a developing country like Pakistan are similar to those in developed countries. However, further investigations could be done to understand the underlying patterns.

5.2 THEORETICAL IMPLICATIONS

This research has undertaken a novel and comprehensive investigation into the intricate interplay of campus environment, personality traits, and engineering self-efficacy, evaluating their direct impacts on both academic performance and psychological well-being. Notably, this holistic examination has not been previously conducted, particularly within the context of a developing country like Pakistan.

It has examined the mediating role of engineering self-efficacy. This involves investigating the intermediary function of engineering self-efficacy in the relationships between personality traits and both academic performance and psychological well-being. This unique exploration brings a fresh perspective to understanding the intricate connections among these critical factors. One distinctive contribution of this research is the revelation of engineering self-efficacy's previously unrecognized roles as a mediator. It serves as a mediator not only between personality traits and academic performance but also between personality traits and psychological well-being. Furthermore, the study unveils a new found mediation role of engineering self-efficacy between campus environment and academic performance and psychological well-being, particularly in engineering education.

5.3 PRACTICAL IMPLICATIONS

The current findings provide implications for engineering education. The results of this study highlight the importance of engineering self-efficacy in predicting academic performance. It reveals the association among campus environment, personality traits, engineering self-efficacy, academic performance and psychological well-being which will serve as a basis for educationists/policymakers to make amendments in curriculum and policies to improve these outcomes. Similarly, the relationship between campus environment and engineering self-efficacy suggests that faculty can play a significant role in enhancing engineering self-efficacy as campus environment is directly associated with engineering self-efficacy, improving academic performance. Improvement in campus environment and engineering self-efficacy can improve psychological well-being too (Neroni et al., 2022). Also, the impact of personality traits on academic performance and well-being suggests that students should be treated in accordance with their personality types to enhance performance and well-being.

5.4 CONCLUSIONS

This study highlights the value of engineering self-efficacy by explaining how it enhances undergraduates' psychological health and academic success. Thus, students should develop engineering self-efficacy along with the relevant skill set to perform better in academics (Honicke and Broadbent, 2016). All the five personality traits have different strengths in their relationships with academic performance, psychological well-being and engineering self-efficacy, therefore different strategies should be applied according to the nature of relationship that exists between them. It is the responsibility of educators to provide engineering students with well-maintained physical environment equipped with latest technology as well as a warm, supportive, and interactive social environment to let them learn and remain equipped with up-to-date knowledge and skills required to survive and meet the demands of industry as they graduate (Feyter et al., 2012).

5.5 LIMITATIONS AND FUTURE DIRECTIONS

There are a few limitations in this study that may guide future research. First, the data was collected at one point in time only (cross-sectional study) therefore longitudinal studies should be done in future for better understanding of the impact of various factors and their possible outcomes. Data was collected from a limited number of universities (n=16) in Pakistan with a sample size (N=1005) only, therefore future research with a greater number of universities and a larger sample size should be considered for generalizability of results. Self-reported might question the reliability of some results, therefore future studies should use a systematic procedure to use the CGPA from records of students.

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APPENDIX A

Survey for Engineering Undergraduates

Section A

Name (Optional)		**Gender**	Male		Female	
Hometown		**Type (Hometown)**	Urban		Rural	
Engineering Discipline		**Year of Study**	1st	2nd	3rd	4th
Name of Engineering University		**Campus / School**				
CGPA						

Section B

Campus Environment

Sr no.	Statement	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
1	The library staff is willing to help me find books/materials.					
2	Faculty have not been available to discuss my academic concerns.					
3	Financial aid staff has been willing to help me with financial concerns.					
4	There are tutoring services available for me on campus.					
5	The university seems to value minority students (e.g., non-Muslims).					
6	Faculty have been available to help me make course choices.					
7	I feel comfortable in the university environment.					

Engineering Self-efficacy

Sr no.	Statement	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
8	I can master the content in even the most challenging engineering course.					
9	I can do a good job on almost all my engineering coursework.					
10	I can do an excellent job on engineering-related problems and tasks assigned this semester.					
11	I can earn a good grade in my engineering-related courses.					
12	I can perform experiments independently.					
13	I can analyze data resulting from experiments.					
14	I can solve problems using a computer.					
15	I can work with tools and use them to build things.					
16	I can work with machines.					
17	I can build machines					
18	I can fix machines.					
19	I can identify a design need.					
20	I can develop design solutions.					
21	I can evaluate a design.					
22	I can recognize changes needed for a design solution to work.					

Personality Traits

Sr no.	Statement	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
23	I am the life of the party (center of attention).					
24	I sympathize with others' feelings.					
25	I get chores (tasks) done right away.					
26	I have frequent mood swings.					
27	I have a vivid (clear) imagination.					
28	I don't talk a lot.					
29	I am not interested in other people's problems.					
30	I often forget to put things back in their proper place.					
31	I am relaxed most of the time.					
32	I am not interested in abstract ideas.					
33	I talk to a lot of different people at parties.					
34	I feel others' emotions.					
35	I like order (proper arrangement/sequence).					
36	I get upset easily.					
37	I have difficulty understanding abstract ideas.					
38	I keep in the background (remain reserved).					
39	I am not really interested in others.					
40	I make a mess of things.					
41	I rarely feel blue (sad).					
42	I do not have a good imagination.					

Psychological Well-being

Sr no.	Statement	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
43	When I look at the story of my life, I am pleased with how things have turned out so far.					
44	In many ways I feel disappointed about my achievements in life.					
45	Maintaining close relationships has been difficult and frustrating for me.					
46	I live life one day at a time and don't really think about the future.					
47	I am good at managing the responsibilities of daily life.					
48	I sometimes feel as if I've done all there is to do in life.					
49	People would describe me as a giving person, willing to share my time with others.					
50	I gave up trying to make big improvements or changes in my life a long time ago.					
51	I have not experienced many warm and trusting relationships with others.					
52	I have confidence in my own opinions, even if they are different from the way most other people think.					
53	I judge myself by what I think is important, not by the values of what others think is important.					