Exploring attitude towards skills and competencies across engineering career experience levels required for engineering leaders

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Abstract

This study investigates the perception of skills and competencies required for engineering leadership roles across different career experience levels. In the engineering field, engineers are reluctant to transition into leadership or managerial positions, often due to a promotion system prioritising technical knowledge over leadership abilities. To address this issue, this research aims to understand the perceived importance of various skills and competencies among engineering leaders from diverse industries and engineer types.

A quantitative approach was employed, utilising electronic surveys distributed to qualified tertiary-educated engineers representing various career experience levels and industry sectors. The survey collected responses from 85 participants across four career stages, where respondents ranked different skills and competencies using a Likert scale.

The findings revealed that cognitive skills were ranked highest, while business skills were rated lowest among the surveyed engineering leaders. Overall, the mean perception of skills and competencies for engineering leaders displayed minimal variation across career experience levels, with only a few notable exceptions. These results suggest that while certain skills may vary in perceived importance, there is a general consensus on the essential competencies required for effective engineering leadership.

This study contributes to the understanding of the evolving landscape of engineering leadership and highlights the importance of addressing skill gaps to facilitate the transition of engineers into leadership roles. By identifying key focus areas, organisations can better tailor training and development programs to nurture well-rounded engineering leaders capable of driving innovation and success in the engineering profession.

Keywords: Engineering Leadership, Leadership skills

Plagiarism Declaration

I declare that this research project is my own work. It is submitted in partial fulfilment of the requirements for the degree of Master of Business Administration at the Gordon Institute of Business Science, University of Pretoria. It has not been submitted before for any degree or examination in any other University. I further declare that I have obtained the necessary authorisation and consent to carry out this research.

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1. Introduction to the Research Problem

1.1 Introduction

Engineers are pivotal as problem-solvers and innovators in today's rapidly evolving technological landscape. They harness their expertise in science, technology, engineering, and mathematics (STEM) to design, build, and test complex equipment, structures, and systems. However, as organisations increasingly rely on engineering teams to drive innovation and competitive advantage, there is a growing recognition of the need for engineers to evolve beyond technical experts and develop into influential technical leaders.

According to Schell et al. (2022), professionals in engineering fields must possess not just technical expertise but also leadership skills to become successful technical leaders. Technical leadership plays a vital role in driving innovation and keeping organisations ahead of their competitors.

Rottmann et al. (2015) observed that many engineers are hesitant to take on the role of an engineering leader. Leadership skills in engineers face four main obstacles. Firstly, many engineers move from technical roles to managing projects or processes and may feel disconnected from their problem-solving roots when they have to deal with people's problems. Secondly, engineers who view leadership as hierarchical may find it difficult to adapt to the collaborative and team-based norms of their field. Thirdly, the term "leadership" may not resonate with engineers who see themselves as technical experts rather than leaders. Finally, when leadership development opportunities are only offered as optional extracurricular activities, engineering students may not see them as relevant to their core curriculum.

Craps et al. (2021) delineate three primary roles for engineers: Innovation, involving the development of new products or technologies; Optimisation, focusing on advancing and refining technological processes to enhance performance; and Customisation, which entails integrating

disciplines or subsystems in diverse environments to fulfil customer needs. Saunders-Smits and De Graaff (2012) suggest that engineers could also take on managerial or leadership as a primary role.

Hirudayaraj et al. (2021) defines soft skills encompass a blend of interpersonal skills and personal attributes that complement the technical skills necessary for triumph in engineering. They are not a static set of abilities, but rather a diverse collection of social skills, personal characteristics, and self-management techniques. Soft skills are not viewed as independent skills or competencies, but instead as a fusion of these traits that assist in attaining engineering achievements. Hirudayaraj et al. (2021) also noted that the soft skills required for engineering leaders are different from those required for regular technical engineers at different stages of their careers.

Schuhmann (2010) considers leadership a well-defined and mature field, but engineering leadership is still an imprecise field of study. In engineering leadership education, Didiano et al. (2022) provide educational approaches to developing engineering students' leadership skills. This research compares these skills and analyses the perception of engineers (graduate level to senior level) of the importance of these skills and competencies for engineering. Then, it will examine the perception of engineering leaders regarding the same skills and competencies.

Furthermore, the complexities of modern engineering projects, as highlighted by (Ash, 2009), underscore the need for strong leadership in navigating multi-project environments where engineering resources are often stretched thin. Therefore, this thesis seeks to address these gaps in knowledge by exploring and analysing the perception, skills, and competencies essential for engineering leadership, both from the perspective of engineers at different career stages and engineering leaders themselves. Through a comprehensive examination of these factors, this research aims to advance engineering leadership theory and practice, ultimately fostering the development of influential leaders capable of driving innovation, collaboration, and organisational success in the engineering profession.

1.2 Research Objectives

As described above engineers are problem solvers and innovators in many industry sectors, but are reluctant to take on the roles of engineering leaders. For the purpose of this study is to determine the attitude to various skills and competencies for engineering leaders from the perception of junior, intermediate and senior engineers compared to engineering leaders. Determine any differences in perceptions of skills and competencies across engineering career levels for engineering leaders.

2. Literature Review

2.1 Introduction

Effective engineering leadership drives innovation, fosters collaboration, and achieves sustainable success in today's dynamic organisational landscape. Engineering leadership comprises a multifaceted blend of skills and competencies that empower individuals to guide, inspire, and empower others toward common goals. This study explores the essential skill sets for effective leadership, spanning cognitive, interpersonal, business, and strategic domains.

Drawing on insights from prominent researchers and scholars, we delve into the intricacies of leadership competencies, clarifying their significance and application within organisational contexts. By meticulously examining relevant literature and theoretical frameworks, we aim to provide valuable insights into the dynamic nature of leadership skills and their evolving role in today's complex world.

By unravelling the complexities of cognitive processing, social dynamics, resource management, and strategic foresight, we equip aspiring engineering leaders with the knowledge and tools necessary to navigate challenges, inspire innovation, and drive organisational growth. Moreover, this study focuses on leadership skills and engineering leadership, highlighting the importance of interpersonal aptitudes and not just technical expertise in effective leadership.

Through this exploration, we aim to provide an understanding of leadership's multifaceted nature and empower engineers to enhance their capabilities as visionary leaders in today's ever-evolving business environment.

2.2 Leadership Skills

Leadership skills acquisition and improvement are influenced by various factors, including cognitive capacity, personality, temperament, emotion regulation, cultural background, identity, and personal values.

Guzmán et al. (2020) organised leadership skills into four categories, as seen in Table 1 below 1) **cognitive skills** are necessary to comprehend and analyse patterns, requiring innovative thinking., decision-making and problem-solving; 2) **interpersonal skills**, face-to-face interactions, to bring about desired results; 3) **business skills**, the skills to operate an organisation, financially, personally and operationally; 4) **strategic skills**, which are skills to achieve organisations' mission and vision. Below the table, further expansion of each pillar will be explored.

Table 1 - Four Categories of Leadership Skill (Guzmán et al., 2020).

Cognitive Skills	Business Skills	Interpersonal Skills	Strategic Skills
CS1: Speaking	BS1: Operations analysis	IS1: Social Perceptiveness	SS1: Visioning
CS2: Active Listening	BS2: Management of personnel resources	IS2: Coordination	SS2: Systems perception
CS3: Writing	BS3: Management of financial resources	IS3: Negotiation	SS3: System Evaluation
CS4: Reading Comprehension	BS4: Management of material resources	IS4: Persuasion	SS4: Identification of downstream consequences
CS5: Active Learning			SS5: Identification of key causes
CS6: Critical Thinking			SS6: Problem identification
			SS7: Solution appraisal

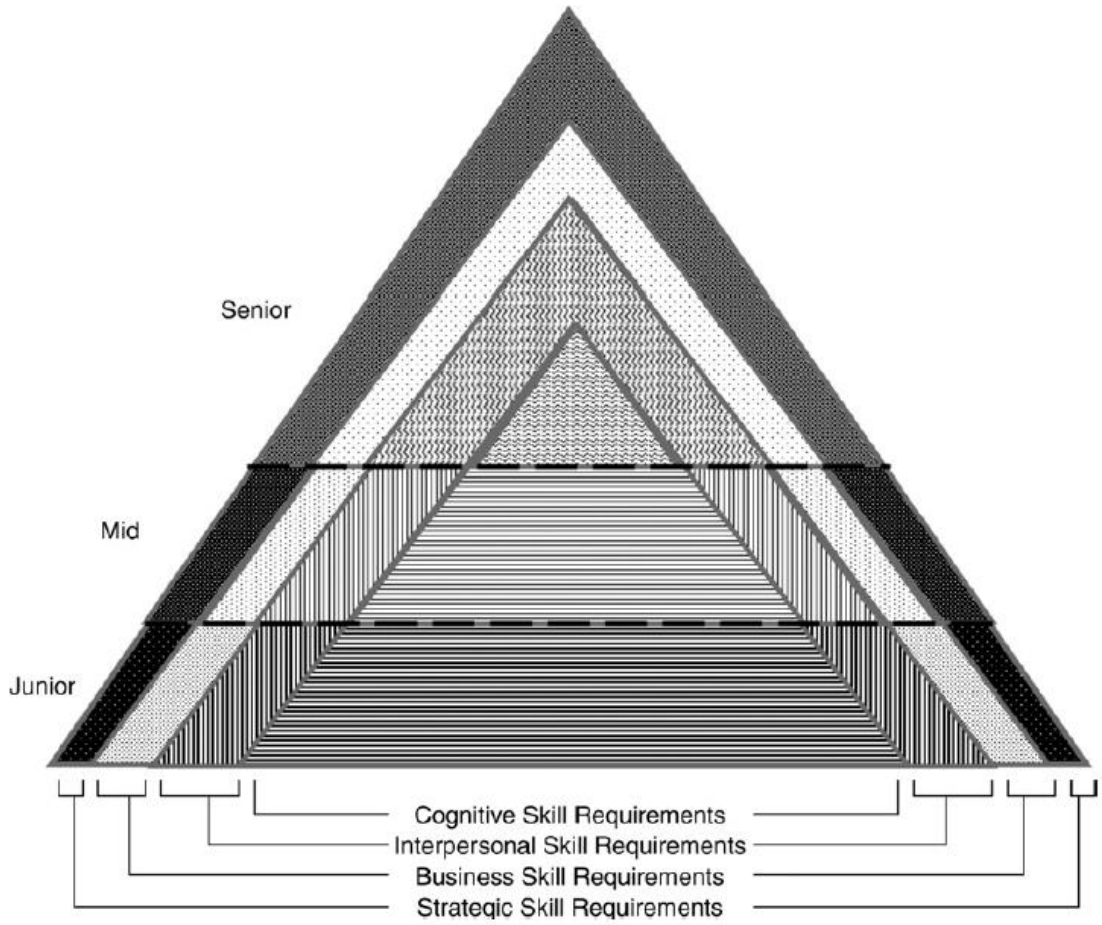

Figure 1 - Leadership Skill Strataplex (Mumford et al., 2007)

Firstly, Figure 1 by Mumford et al. (2007) showcases a breakdown of leadership skill requirements through four distinct triangles. Dotted horizontal lines divide the skill requirements across different managerial levels within an organisation, with a focus on junior, mid, and senior positions. However, this framework can be tailored to accommodate additional organisational layers. Each triangle and segment within it represent the necessary leadership skills for the corresponding job level. For instance, a larger area covered by the Cognitive triangle (horizontal lines) in comparison to the Interpersonal triangle (vertical lines) suggests a higher demand for Cognitive skills over Interpersonal skills overall. Similarly, in the senior-level strata (covering the remaining two triangles), a more significant proportion of the total area allocated to Strategic skills

highlights their relatively increased importance for senior-level roles. In the next section, we'll explore the four leadership categories in greater detail.

2.2.1 Cognitive Skills

Cognitive skills are the foundation of the leadership skill requirement. These skills are related to collecting, processing and disseminating information and learning and are the fundamental skills required for many activities that leaders are engaged in (Mumford et al., 2007). Hard skills are mainly cognitive and are influenced by an individual's IQ (Denney et al., 2020).

Communication as speaking is an ability to convey information effectively in a spoken format (Reed et al., 2019). As part of leadership, communication is a critical skill in executing and managing projects (Zulch, 2014). The communication style will differ from leader to leader, but this skill remains an intrinsic part of leadership. *Writing* skills are a form of communication that can convey information effectively in a written format (Reed et al., 2019). Communication is the cornerstone of effective leadership. Leaders who excel in communication can inspire trust, foster collaboration, resolve conflicts, motivate teams, and drive organisational success.

Dewan and Myatt (2008) explains a clear communicator is a skilled individual who has the ability to articulate their thoughts and ideas in a well-structured and coherent manner. By using language that is precise, concise, and easy to understand, they create a shared understanding of the message being communicated. This ensures that everyone involved in the communication process comprehends the full implications of the message, which is crucial for effective decision-making and problem-solving. In essence, a clear communicator is a leader who uses their communication skills to inspire trust, build relationships, and foster collaboration among team members.

Datta et al. (2021) show that communication skills are crucial for any manager aspiring to climb the leadership ladder. The time managers spend communicating daily highlights the

importance of solid communication skills for anyone looking to advance to a leadership position. Therefore, mastering leadership communication should be a top priority for managers who want to be considered potential leaders within their organisations or the broader business community. Zulch (2014) asserts that for a leader to guarantee the implementation of strategy, decisions, and values by resources, they must inevitably possess strong communication skills. This underscores the pivotal role of communication skills in leadership, highlighting its importance for aspiring managers and established leaders. Effective communication facilitates organisational alignment and distinguishes capable leaders who can navigate complexities and inspire action.

Active listening involves paying attention to both verbal and nonverbal cues to comprehend and question the message being conveyed. There are three key elements: listening for content, meaning and intent, and feelings and values (Baker et al., 2019). It is a crucial skill for successful communication and building strong relationships. Effective listening is a crucial skill in any situation, but it is especially important in a managerial role. To manage others effectively, it is essential to pay attention to what others are saying and truly hear their message (Zulch, 2014).

Reading comprehension is the skill of understanding voluminous and complex written information (Mumford et al., 2007). Reading comprehension is essential for leaders to gather information, make informed decisions, understand policies and procedures, communicate effectively, solve problems, engage in continuous learning, and cultivate empathy. Leaders prioritising reading and developing strong comprehension skills are better equipped to navigate complexities, drive organisational success, and inspire their teams to achieve their goals.

Active learning empowers leaders to engage with new information actively, comprehending its significance and potential implications. These skills are pivotal for leaders to dynamically adjust their behaviours and strategies in response to evolving, non-routine challenges (Mumford et al., 2007).

Critical thinking is an essential aspect of leadership to use logic to analyse the strengths and weaknesses of various approaches to the work. From a leadership perspective, critical thinking entails thinking complexly, a leader entails the ability to gather diverse and often complex pieces of information, analyse them, and integrate them into a coherent and meaningful whole (Flores et al., 2012). Critical thinking necessitates a profound understanding of a subject and the capacity to effectively apply that knowledge to novel, authentic, or unfamiliar situations (Chikeleze et al., 2018). Critical thinking encompasses the skill set required to articulate crucial questions, gather pertinent information, draw well-reasoned conclusions, make informed decisions, evaluate source credibility, discern cause-effect relationships, and adeptly communicate with others to devise effective solutions.

In summary, leadership encompasses diverse cognitive skills essential for effective communication, decision-making, collaboration, and problem-solving. From active listening and reading comprehension to critical thinking and active learning, leaders must continuously develop and refine these skills to navigate complexities and drive organisational success. By prioritising continuous learning and honing their communication, analysis, and adaptation abilities, leaders can inspire their teams, foster innovation, and achieve meaningful outcomes in an ever-evolving landscape of challenges and opportunities.

2.2.2 Interpersonal Skills

Interpersonal skills are pivotal in navigating social interactions and exerting influence over others. These skills, rooted in various social capacities such as social judgment, social complexity, and differentiation, enable individuals to connect with and impact those around them effectively.

Social perceptiveness is the ability to discern and understand others' reactions and the underlying reasons behind those reactions. Leaders must comprehend how to equip and cultivate individuals to thrive in digital environments. This involves providing the necessary technological

tools and training and fostering a culture of participation, trust, and collaboration. Leaders can foster a more participative culture where team members feel empowered to contribute, innovate, and collaborate effectively in digital spaces by promoting open communication channels, encouraging active engagement, and recognising the value of diverse perspectives (Guzmán et al., 2020; Mumford et al., 2007).

Coordination of actions, whether of oneself or others, is fundamental to effective leadership and teamwork. It involves synchronising efforts, aligning goals, and ensuring everyone works towards a common purpose (Mumford et al., 2007).

Negotiations are the ability to reconcile differences and guide a group towards a shared decision (Reed et al., 2019). Leaders must establish agreements prioritising collective benefits for all members of their organisations. This will foster a culture of collaboration and active participation, encouraging employees to innovate, experiment, and contribute fresh ideas. Leaders can drive engagement, creativity, and organisational success by creating an environment where everyone feels valued and empowered.(Guzmán et al., 2020).

Persuasion are skills to influence others to accomplish organisational objectives more effectively (Mumford et al., 2007). Leaders must establish a learning and innovation environment that fosters collaborative decision-making among team members. This encourages individuals to embrace an open and digitally oriented mindset, promoting organisational adaptability and creativity (Guzmán et al., 2020).

A leader who uses power wisely often embodies the principles of servant leadership. Servant leadership theory underscores the significance of selfless service and acknowledges organisations as platforms for cultivating individuals who shape a brighter future (Gotsis & Grimani, 2016). Leaders are tasked with motivating, influencing, and inspiring staff to achieve outstanding

patient outcomes. This is best accomplished through wise use of power and leveraging their influence (Sherman & Cohn, 2020).

Day et al. (2004) refer to *team building*, also known as team development, as a widely used intervention to enhance team effectiveness. These interventions often target role clarification, goal setting, problem-solving, and interpersonal relations. Teamwork is vital for the effective operation of organisations, particularly in temporary settings like projects, where diverse, cross-functional teams with varied backgrounds often carry out work. Team-building focuses on uniting individual employees from different organisation segments into a cohesive and collaborative unit (Nauman et al., 2022).

The effective application of interpersonal skills is essential for leaders to successfully navigate social interactions and exert influence. Social perceptiveness, coordination of actions, negotiation abilities, and persuasion skills are all integral components of effective leadership and teamwork. By fostering a culture of collaboration, trust, and innovation, leaders can create an environment where individuals feel empowered to contribute, innovate, and drive organisational success. Leaders must prioritise establishing learning and innovation environments that encourage collaborative decision-making and embrace digital transformation. Through these efforts, leaders can inspire their teams to adapt, innovate, and thrive in today's dynamic and ever-changing business landscape.

2.2.3 Business Skills

Business skills are related to specific functional skills for an individual’s position, including managing personnel, material, and financial resources to accomplish critical business goals (Guzmán et al., 2020; Kalargyrou et al., 2012).

Management of material resources is where leaders manage equipment, facilities and materials needed to do particular work. Influential leaders must ensure the organisation has the

right resources available at the right time to support operations and achieve objectives. This includes coordinating procurement, maintenance, and utilisation of resources to optimise efficiency, minimise waste, and maximise productivity. By effectively managing material resources, leaders can enhance operational performance, reduce costs, and support the organisation's overall success.

Operations analysis plays a vital role in the decision-making process for managers tasked with procuring and allocating equipment, technology, and materials (Kalargyrou et al., 2012; Mumford et al., 2007). By conducting thorough analysis, managers can assess current operational needs, evaluate available resources, and identify opportunities for improvement. This involves examining resource availability, utilisation rates, cost-effectiveness, and technological advancements to make informed decisions that optimise efficiency and support organisational objectives. Operations analysis enables managers to strategically allocate resources, mitigate risks, and ensure that the organisation's material needs are met effectively and efficiently.

Management of personnel resources involves various strategies to identify, motivate, develop, and promote individuals within the organisation. Effective leadership in this area requires a multifaceted approach that prioritises the well-being and growth of employees (Guzmán et al., 2020; Mumford et al., 2007). Personnel management's primary purpose is searching, selecting, and accepting qualified employees. Effective personnel management is crucial for engineering enterprises. It should focus on fostering new knowledge, utilizing the skills of employees, rebuilding team cohesion, and making efficient use of labour resources. These efforts will ultimately boost competitiveness and profitability (Kopytko et al., 2023).

Management of financial resources is a critical responsibility for leaders, involving strategy determining how money will be allocated to support organisational objectives. This encompasses

various activities such as budgeting, accounting, and fundraising. (Guzmán et al., 2020; Mumford et al., 2007)

Business skills encompass effectively managing personnel, material, and financial resources to achieve critical business goals. Leaders must ensure the availability of the right resources at the right time to support operations and achieve objectives. This includes coordinating procurement, maintenance, and utilisation of resources to optimise efficiency and productivity. Operations analysis plays a crucial role in decision-making by evaluating operational needs, resource availability, and opportunities for improvement. Effective management of personnel resources involves strategies to identify, motivate, develop, and promote individuals within the organisation. Additionally, leaders must strategically allocate financial resources through activities such as budgeting, accounting, and fundraising to support organisational objectives and ensure long-term success.

2.2.4 Strategic Skills

Strategic skills are characterised by a high level of conceptual thinking, enabling leaders to adopt a systems perspective and navigate complexity, ambiguity, and change within the organisation (Kalargyrou et al., 2012). Leaders possessing strategic skills are known for their ability to think beyond the surface level and delve deep into the core of the problem. They possess a high level of conceptual thinking, which allows them to see the bigger picture and take a systems perspective. They are adept at navigating through complex situations, dealing with ambiguity, and adapting to changes with ease. Their ability to identify patterns and connections between various elements helps them to develop a clear understanding of the situation and make informed decisions. Strategic thinkers excel at synthesising information, identifying patterns, and making informed decisions that drive organisational success in dynamic and uncertain environments.

Visioning becomes relevant for a leader when formulating a vision and a direction for constructing an innovative, collaborative, participatory, and decentralised learning culture (Guzmán et al., 2020). Leadership at the top levels of the firm involves establishing a vision and setting broad objectives for the organisation (Samimi et al., 2022). Leaders must be big thinkers in terms of both quality and responsibility(Farr et al., 1997). The leadership skill of being a "big thinker" involves envisioning bold and ambitious goals, thinking strategically, and inspiring others to embrace innovative ideas and possibilities. Big thinkers challenge conventional thinking, push boundaries, and drive transformative change within their organisations.

Leaders need to have a *mission that matters* because this will inspire and motivate followers (Farr et al., 1997). The leadership skill of embodying a mission that matters involves effectively communicating a compelling vision, connecting individual roles to the mission, leading by example, empowering others, building a values-driven culture, inspiring passion and commitment, celebrating successes, and adapting to change. By prioritising a mission that resonates with employees, leaders can foster a sense of purpose and drive performance and innovation within their organisations.

*Systems evaluation and solution appraisal are s*kills for leaders include analysing acquired technologies, evaluating communication platforms, and identifying gaps that require immediate solutions (Guzmán et al., 2020). Leaders must master change and be responsive to people in diverse societies (Farr et al., 1997). Mastering change leadership skills is essential for navigating and driving successful organisational change initiatives. Change leadership involves guiding individuals and teams through transitions, overcoming resistance, and effectively implementing change to achieve desired outcomes.

Identifying *downstream consequences and key causes* offers valuable insights into the causal relationships within the environment and their potential long-term outcomes (Mumford et

al., 2007). Organisations can cultivate a more participative and networked culture by verifying the requirements that could contribute to fostering a culture of experimentation and collaboration. This understanding of causal relationships empowers leaders to make informed decisions and implement strategies that drive sustainable growth and success.

Problem identification skills are crucial for various roles within organisations, as they enable individuals to accurately discern the true nature of the challenges and obstacles the organisation may encounter (Guzmán et al., 2020; Mumford et al., 2007). These skills involve analysing complex situations, gathering relevant information, and identifying underlying issues or root causes. By honing problem-identification skills, individuals can effectively address issues before they escalate, develop innovative solutions, and contribute to the overall success and resilience of the organisation.

Leaders need to be able to make decisions after careful data and opinion gathering and analysis (Farrell, 2017). Decision-making is a crucial soft skill in both personal and professional life. It is the ability to evaluate different options and choose the best based on the available information. Good decision-making skills can help individuals and organisations achieve their goals effectively and efficiently (De Campos et al., 2020; Parris & Peachey, 2013). Practical decision-making skills enable leaders to navigate challenges, capitalize on opportunities, and guide their teams toward success.

Solution appraisal and objective evaluation are essential for leaders evaluating alternative courses of action to address organisational problems(Guzmán et al., 2020; Mumford et al., 2007). These skills involve systematically assessing the potential solutions based on predefined objectives, criteria, and constraints. Leaders must critically analyse each option, considering feasibility, effectiveness, cost, and stakeholder impact. By employing sound judgment and strategic thinking,

leaders can make informed decisions that align with organisational goals and priorities, ultimately driving success and sustainability.

In order to establish oneself as a respected and admired leader, it is crucial to maintain a *high level of ethics and integrity*. Demonstrating courage in one's leadership involves a range of attributes, including perseverance, resilience, stamina, moral fortitude, and sound decision-making (Farr et al., 1997). These qualities are integral to effective leadership that inspires and motivates others. As such, it is incumbent upon leaders to embody these traits in order to cultivate trust and loyalty among their followers, who depend upon their guidance and direction. The strength of one's work ethic is a clear indicator of their commitment to their profession. A robust work ethic improves one's reputation and reliability and enhances credibility among colleagues. Demonstrating a strong work ethic can be achieved through various means, including punctuality for meetings, consistently meeting deadlines, and taking accountability for one's actions. Maintaining a positive attitude and being adaptable to workplace challenges are essential to showcasing a solid work ethic (De Campos et al., 2020; Parris & Peachey, 2013).

Leaders are *risk-takers* and must have the courage to begin new projects, make changes, etc. The leadership skill of being a risk-taker involves assessing opportunities and challenges, making bold decisions, and taking calculated risks to drive innovation and achieve strategic goals. Leaders who are effective risk-takers understand that playing it safe can hinder progress and that calculated risks are essential for growth and success. In the dynamic world of modern business, the ability to adapt is a crucial soft skill that empowers individuals to stay ahead of the game. This skill enables employees to easily navigate change and stay updated with new technologies and methodologies, ensuring continued relevance in the workplace (De Campos et al., 2020).

Strategic skills enable leaders to navigate complexity and change, while visioning allows them to formulate a clear direction for fostering an innovative and collaborative culture. *Systems*

evaluation and solution appraisal skills help leaders analyse technologies and identify gaps for improvement. Understanding causal relationships and mastering problem-identification skills are crucial for addressing challenges and driving sustainable growth. Solution appraisal and objective evaluation skills empower leaders to make informed decisions that align with organisational goals and drive success. By honing these skills, leaders can effectively lead their organisations through dynamic and uncertain environments, ultimately achieving long-term success and resilience.

Effective leadership is a multifaceted concept that encompasses various attributes and skills. From being a visionary big thinker to mastering change, from using power wisely to making ethical decisions, each aspect plays a crucial role in shaping successful leaders and driving organisational success. Moreover, communication, team-building, and risk-taking are essential elements that contribute to effective leadership in navigating complexities and fostering innovation. By understanding and cultivating these leadership attributes, individuals can inspire others, drive positive change, and achieve meaningful outcomes in today's dynamic and ever-evolving business landscape.

2.3 Soft Skills

Interpersonal skills, also known as "people skills" or "soft skills", are not technical or job-specific abilities. Instead, they are personal qualities and social aptitudes that aid individuals in navigating diverse scenarios, cooperating productively, and accomplishing success in various domains (Van Heerden et al., 2023). Soft skills are helpful in any job and can be learned continuously throughout one's career. These skills can be personal or interpersonal, and developing both can help a person handle various situations, particularly in the workplace (Noah & Abdul Aziz, 2020). Representatives in contemporary management sciences consider soft skills critical for achieving organisational development and effectiveness (Marin-Zapata et al., 2022).

Despite possessing a commendable set of hard skills, graduates are found wanting in their soft skills, leaving their prospective employers unsatisfied. Research has established that employers place a higher priority on soft skills than hard skills when it comes to hiring employees (Noah & Abdul Aziz, 2020). Viswesvaran and Ones (2000) posited a robust theoretical framework in which they proposed that personality traits play a significant role in shaping job requirements such as technical skills (task) and soft skills (social). The model suggests that personality traits have a direct impact on work behaviour, which subsequently influences job performance. This theoretical framework highlights the importance of considering personality traits when evaluating employee job performance. Personal skills involve processing knowledge, thinking critically, striving for continuous learning, and planning and accomplishing goals (Farr & Brazil, 2009). On the other hand, interpersonal skills refer to forming and maintaining relationships with others. This includes communication, listening, negotiation, networking, problem-solving, and decision-making skills.

Examples of essential soft skills are as follows as mentioned by Parris and Peachey (2013) and De Campos et al. (2020) :

- Communication Skills
- Leadership
- Teamwork
- Creativity & Problem solving
- Time Management
- Adaptability
- Decision Making/Problem Solving
- Work Ethics
- Critical Thinking
- Conflict Resolution

- Emotional intelligence

While technical expertise is essential, soft skills play a critical role in fostering effective workplace communication, collaboration, and problem-solving. Continuous development of these skills is vital for career success and organisational effectiveness.

2.4 Engineering Leadership

As engineers climb the corporate ladder with increasing responsibility, leadership skills become more important than technical skills. Chetty (2012) shows in Figure 2 below that leadership skills are essential to the success of an engineer who moves to seniority.

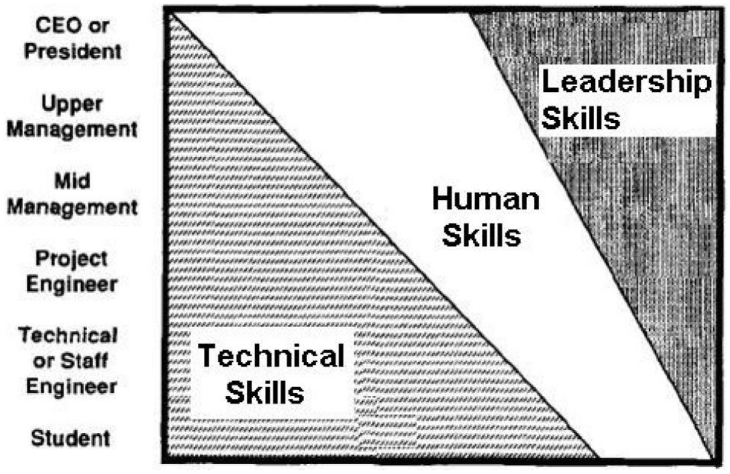

Figure 2: Evolution in skills of a successful engineer (Chetty, 2012).

Schell and Hughes (2022) and Rottmann et al. (2015) found three traits grounded in professional engineers: 1) technical mastery – technical experts willing to mentor others; 2) collaborative optimisation – engineers with the ability to build high-performing teams; 3) organisational innovation – entrepreneurial thinkers who bring engineering solution to market.

Engineering leadership is more complicated than other sectors as additional technological leadership and governance skills are required (Farr & Brazil, 2009). Additional skills, such as technology, leadership, and governance, are required to succeed in engineering leadership.

Engineering leaders are employed to lead technology-based companies focusing on a short-term product cycle of weeks instead of years (Farr & Brazil, 2009). Odusami (2002) listed ten essential skills for project managers;

1. **Team Building Skills** – the ability to use everyone's strength from various disciplines in an effective team
2. **Leadership Skills** – the ability to lead a team, integrate individuals' strengths and weaknesses, and lead individuals that will affect performance.
3. **Conflict Resolution Skills** – the ability to navigate conflicts fairly and respectfully to foster a positive work environment.
4. **Technical Skills** – the ability to manage technological innovation and adoption of solutions.
5. **Planning Skills** – the ability to prepare the team for projects that require good communication and information-pressing skills
6. **Organisational Skills** – the ability to understand the hierarchy of an organisation, and the reporting relationships and control within technical departments.
7. **Entrepreneurial Skills** – the ability to identify and chase objectives that will lead to the project or team's success, understanding the big picture.
8. **Administrative Skills** - Project managers must have strong administrative skills to effectively lead their teams and ensure projects are completed on time and within budget. Some key administrative skills for project managers include organisation, time management, communication, and problem-solving.
9. **Management support-building skills** – building strong personal relationships with senior management or directors.

10. **Resource Allocation Skills** - This involves identifying the resources needed for a project, such as personnel, equipment, and funds, and allocating them as efficiently and effectively as possible.

Chetty (2012) conducted a study emphasising a prominent global engineering organisation, SKF. SKF specialises in manufacturing bearings and provides technical field support for its products. The study primarily targeted individuals in key managerial positions within the organisation, including middle managers, senior managers, and executive managers, all with engineering backgrounds. Additionally, the study also included participation from human resource managers within SKF. Chetty (2012) aims to identify similarities or differences in competencies between engineers of different industry as his research only focused on a single organisation.

2.5 Conclusion

In conclusion, this comprehensive literature study has shed light on the multifaceted nature of leadership skills, encompassing cognitive, interpersonal, business, and strategic competencies. The exploration of cognitive skills highlighted the importance of effective communication, active listening, critical thinking, and problem-solving in leadership roles. On the other hand, interpersonal skills underscored the significance of social perceptiveness, coordination, negotiation, and persuasion in navigating social interactions and exerting influence.

Furthermore, examining business skills emphasized managing material, personnel, and financial resources to achieve organisational goals. Strategic skills enabled leaders to navigate complexity, ambiguity, and change, while visioning and systems evaluation were identified as critical components of strategic thinking.

Moreover, the discussion on soft skills emphasized their pivotal role in professional success, with communication, leadership, teamwork, creativity, adaptability, decision-making, conflict

resolution, emotional intelligence, and work ethics emerging as essential qualities for effective leadership.

Finally, the review delved into engineering leadership, highlighting the importance of technical mastery, collaborative optimization, and organisational innovation in engineering leadership roles. Additionally, project management skills such as team building, conflict resolution, technical expertise, planning, and resource allocation were identified as crucial for successful project execution.

This literature study provides valuable insights into the diverse skill sets and competencies required for effective engineering leadership across various domains. By understanding and honing these skills, aspiring leaders can enhance their capabilities and make meaningful contributions to their organisation's success in today's dynamic and ever-evolving landscape.

3. Research Question

Q1: How do engineers rank different skills and competencies?

The research question aims to rank the skills and competencies essential for a successful engineering leader. The purpose was to gather the perceptions from the participants, allowing them to rank the identified skills and competencies based on their perceived importance in an engineering leadership role.

Q2: Which leadership skills are more valued by engineering in various career stages?

This research question aims to identify and prioritise the leadership skills that engineers across various career experiences most value by understanding which skills are highly valued in engineering.

Q3: Which of the four leadership categories do engineers think is more important?

This research question aims to determine which of the four leadership domains (interpersonal, business, strategy, and cognitive) engineers consider to be more important in their professional context. By understanding engineers' perceptions of the relative importance of these leadership domains, this research aims to provide insights that can inform leadership development programs, training initiatives, and organisational strategies within engineering firms. Ultimately, the goal is to enhance leadership effectiveness and organisational performance within the engineering industry by focusing on the domains engineers prioritise as most critical to their success.

Q4: Can possible relationships between the perceptions of various level engineers and engineering leaders be discovered?

Through statistical analysis of the data collected from questionnaires, this research aims to explore the relationship between engineers' perceptions and the experience of engineering leaders. By examining how engineers rank the identified skills and competencies for successful leadership,

the study seeks to bridge the gap and provide valuable insights to support engineers transitioning into management positions.

4. Research Methodology

4.1 Research Method and Design

A mono-methodological approach was adopted in this research methodology, specifically focusing on a single method: quantitative data collection and analysis. That method involved gathering categorical or numerical data to assess hypotheses. That research followed a deductive approach, wherein we evaluated hypotheses by collecting empirical data, as described by Saunders and Lewis (2017). This research is built on Chetty (2012) studies, emphasising a single global engineering organisation, SKF. This research will focus on the input of various engineers from different industries.

The primary objective of this research was to determine relationships between skills and competencies for engineering leaders, as perceived by engineers at various career experience levels - from graduate to engineering leaders. The research employed a quantitative data collection method, utilising an electronic questionnaire to gather empirical data. Subsequently, that data was analysed to ascertain the validity of the hypotheses under examination.

4.2 Population

The objective of the research study was to encompass a broad and diverse population comprising individuals actively engaged in the engineering profession. This population comprised many professionals with engineering degrees from reputable universities—the inclusive approach aimed to capture the engineering field's rich diversity and multifaceted nature.

The study included individuals from various sectors, industries, and hierarchical organisational levels. This diverse group consisted of recent graduates starting their engineering careers, junior-level engineers with some experience, mid-level engineers with advanced careers, and executive-level professionals with leadership positions in their respective fields.

In addition, the study's participants came from diverse companies and industries, surpassing organisational boundaries. This inter-industry representation guaranteed that the research results were not confined to a particular area but offered a comprehensive outlook on engineering leadership capabilities and competencies across different sectors.

The reasoning behind the thorough and all-encompassing selection of participants was to gather a diverse array of viewpoints and experiences. By engaging individuals from varying professions and career levels, this research plans to accurately capture the intricacies and variations in the skills and competencies deemed essential for engineering leadership. This comprehensive approach enhanced the research results and contributed to a more thorough topic comprehension.

The core focus of this research endeavour lies in exploring the skills and competencies exhibited by engineering leaders and engineers, spanning various disciplines such as mechanical, chemical, and electronic engineering. The objective was to facilitate effective communication and bridge the potential gap that may have existed between engineers from different domains. By conducting this cross-disciplinary analysis, the research aimed to identify commonalities and distinctions in leadership skills and competencies.

The overarching goal of this research was to cultivate a comprehensive understanding of the skills and competencies essential for engineering leaders. This understanding was derived from various perspectives, considering the opinions of professionals at different career stages and disciplines within engineering. This multifaceted approach aimed to provide valuable insights for engineers aspiring to transition into leadership roles and for Human Resource managers tasked with talent development and management. Additionally, the study tracked and assessed how the perceptions of engineers towards leadership skills and competencies evolved throughout their careers.

4.3 Unit of Analysis

The analysis was completed on engineering individuals with a background in engineering with tertiary education in engineering and based on their career experience and perceptions of engineering leaders. The final analysis ranked skills and competencies for engineering leaders based on perceptions of engineers at different career levels. The career stages are as follows: junior engineers (0-3 years), intermediate engineers (4-6 years), senior engineers (> seven years), and engineering management/executives (>10 years). The analysis was completed on engineering individuals with a background in engineering with tertiary education in engineering and based on their career experience and perceptions of engineering leaders.

4.4 Sampling Method and Size

The precision and representativeness of data collected in quantitative research were crucial. A meticulous approach was required for both the sampling method and the determination of the appropriate sample size.

In this research project, securing responses from at least 100 engineering participants was vital to ensure the statistical robustness of the data collection process. However, the general advice was to take a sample size as large as possible for better accuracy (Yaddanapudi & Yaddanapudi, 2019).

According to Henneberry (2023), engineering careers are divided into four experience levels: junior level (less than three years of experience), intermediate level (four to six years of experience), senior level (eight or more years of experience), and engineering management (usually with over ten years of experience, overseeing other engineers, and representing the organisation). To obtain accurate data and create a representative dataset for analysis, gathering a minimum of thirty respondents in each category was essential.

The central limit theorem asserted that regardless of the population's initial shape, when the sample size (n) grows more significant, the distribution of the sample means or proportion converges toward a normal distribution. The standard error decreased as the sample size increased, resulting in a narrower confidence interval. This, in turn, yielded a more precise estimate of the population parameter (Wegner, 2010). To ensure a balanced representation of different career stages in the engineering field, we aimed for a response rate of around 20%. To achieve this, we estimated that we needed to distribute the questionnaire to more than 500 engineers to reach the minimum required number of respondents.

The choice of a non-probability sampling method was deliberate, as it allowed for a targeted selection of participants from within the engineering community. This approach enabled the research to focus on individuals with specific expertise and experiences relevant to the study's objectives.

To ensure that the data collected was accurate and representative, meticulous planning for the sampling process was essential. By striving for a diverse and substantial pool of respondents and carefully considering the distribution of participants across various career stages, the research endeavour aimed to enhance the reliability and comprehensiveness of its findings. Ultimately, this approach contributed to a more robust and insightful analysis of engineering leadership skills and competencies. The eventual sample size collected was 85 respondents from various career stages, which will be discussed further in the next section.

4.5 Questionnaire Design

The research methodology chosen for this study involved using questionnaires as the primary data collection instrument. This approach required the development of a comprehensive questionnaire that aligned with the overarching research objective, which was to assess and rank the skills and competencies essential for effective engineering leadership.

The research delved into a comprehensive exploration of the subject matter by conducting an extensive literature review. This review was not limited to the engineering domain but instead encompassed leadership skills and competencies relevant to various other fields of operations. By taking on this broader perspective, the research aimed to tap into a vast array of insights and best practices from diverse domains, enriching our understanding of leadership in engineering.

During the literature review phase, a meticulous examination of scholarly articles, research studies, and publications from multiple disciplines was conducted to discuss leadership qualities, attributes, and competencies. Commonalities and variations in leadership requirements across different operational domains were identified, which helped create a more comprehensive framework for evaluating engineering leadership.

Mumford et al. (2007) and Guzmán et al. (2020) identified four leadership skill groups, including cognitive, interpersonal, business, and strategic skills. Chetty (2012) and Odusami (2002) outlined the necessary skills and competencies for an engineering leader, which could also be grouped into these four categories. A questionnaire was created based on these skills and competencies and divided into four leadership skill groups. The questionnaire was standardised to collect data from many respondents via electronic surveying applications. Table 2 displays all the skills and competencies included in the questionnaire.

Table 2: Skill and Competencies for Leadership adapted from Chetty (2012), Mumford et al. (2007) and Guzmán et al. (2020).

Skills and Competencies for Leadership			
Cognitive	**Interpersonal**	**Business**	**Strategic**
Communication	Managing people	Finance Management	Marketing Skills
Active Listening	Delegation	Resource Management	Survival of Business
Writing	Tough Conversation	Business Environment	Growth of Business
Read Comprehension	Public Speaking	Customer Desire	Sale of Product
Active Learning	Empowering Employees	Customer Value	Business Strategy
Critical Thinking	Honing Employees	Business Priorities	Ethical Decision Making
	Consideration of emotions	Project Management	Shared Vision
	Ability to influence		Problem Identification
			Solution Appraisal

Using Likert scale questions, participants were asked to rate engineering leaders' skills and competencies from four leadership groups. The rating questions were required to be unambiguous. The scale ranged from "not important at all" (1) to "extremely important" (5). As part of the survey, the questionnaire collected basic demographic information such as job experience and managerial experience. A qualifying question related to engineering and business qualifications was used to ensure the correct population was surveyed.

Two experienced engineers participated in a questionnaire pilot. The main goals of this test were twofold. Firstly, to confirm that the questionnaire had a smooth and logical flow for the respondents. Secondly, to ensure that the data collected through this questionnaire was

comprehensive and suitable for subsequent analysis. The test run was completed, and the questionnaire was effective in achieving its objectives.

The engineers meticulously examined the structure of the questionnaire to ensure that it flowed smoothly from one section to another, avoiding any jarring transitions or redundancy. They paid particular attention to the order of the questions, ensuring that it was intuitive and conducive to accurate data collection.

4.6 Data Gathering Process

Data was collected using questionnaires, where the population was asked the same closed-end questions to build and collect data. The questionnaire was modified to better suit engineers of different career levels, focusing on gathering their perceptions of the skills and competencies necessary to become an engineering leader. Additionally, the same questionnaire was utilised to gather data on the skills and competencies of current engineering leaders. The questionnaire was developed on an electronic survey software, Google Form, allowing the respondent to complete it at their convenience. These applications assisted with the data collection and stored the data for analysis at a later stage. The questionnaire was distributed electronically, with an HTML link to the questionnaire.

Gathered data through snowball sampling effectively acquired responses, particularly when participants were closely interconnected in a field (Wegner, 2010). This method relied on the principle that one respondent within the target sample could identify and refer another potential participant who fit the research criteria. The initial engagement was done within the researcher's professional network of colleagues, friends, and family, as they possessed correct engineering insights or expertise relevant to the research's focus.

The research study started by qualifying participants through questionnaires, who were then invited to participate and served as the starting point for a snowball effect. After their

involvement, they were asked for referrals within their professional network, which initiated a referral chain. These referred individuals, "second-generation participants," could be prompted to extend the chain further through additional referrals.

This approach offered the advantage of gathering input from a wide range of professionals within the network, enriching the research dataset with diverse perspectives and experiences. The foundation of trust and rapport, which was often established through referrals from trusted colleagues, enhanced participation and fostered authentic responses. Ethical considerations underpinned the entire process, with informed consent and data privacy protections at the forefront, ensuring the integrity of the research.

4.7 Analysis Approach

The questionnaire was designed to rate various skills and competencies of a successful engineering leader from the perception of various levels of engineers. The various levels of engineers were classified as categorical data. The ranking of the various skills and competencies created ordinal data (Saunders & Lewis, 2017). The final data was subject to editing and cleaning to ensure consistency and possible omissions of the questionnaires.

Determining the average ranking of the ordinal data of each skill and competency was the first step of the analysis, as illustrated Odusami (2002) and Chetty (2012). The categorical data was put through an allocation phase to allocate numerical data to the categorical data, allowing for a more straightforward analysis in IBM SPSS.

The data analysis involved comparing the rankings of skills and competencies among different career levels of engineers. The first step was to determine the mean and standard deviation of all the skills and competencies from the various leadership groups for the various engineering career experiences. A Kruskal-Wallis H Test was conducted, as the test's primary purpose was to evaluate the means of three or more samples. This nonparametric test allowed us

to assess whether there were statistically significant differences between the rankings of skills and competencies for multiple categorical groups (in this case, the various levels of engineers) on a continuous or ordinal dependent variable (the rankings of skills and competencies) (Chetty, 2012).

An alpha level (level of significance) of 0.05 was used for analysis. This indicated that the tails of the sampling distribution represented a 5% chance of rejecting the null hypothesis (Albright et al., 2011). P-values represented the probability of observing a sample statistic if the sample parameter's assumed value was the null hypothesis. If the calculated p-value was more significant than 0.05, this suggested similarities across the different career experiences. On the other hand, if the p-value was less than 0.05, this indicated significant differences between the various career experiences, and the null hypothesis should have been rejected (Wegner, 2010).

In order to conduct a Kruskal-Wallis H test, the dataset must satisfy certain assumptions. Failure to meet these assumptions can lead to incorrect interpretations of the results. Thus, it is crucial to scrutinise the dataset carefully prior to conducting the test. Properly fulfilling these requirements can ensure that the Kruskal-Wallis H test is utilised effectively and accurately to derive meaningful insights and conclusions.

Assumption #1: The dependent variable has been measured in ordinal levels. In this scenario, the dependent variables are the skills, and they have been evaluated using a 5-point Likert scale.

Assumption #2: The independent variable must consist of two or more categorical independent groups. In this context, the independent variables consist of four levels representing the career experience of the engineers.

Assumption #3: The sample must be independent of observations. In this context, the requirement for independence of observations is satisfied, as each respondent participated in the

survey voluntarily and independently. Each respondent completed the survey independently, using their devices, without interference from others or the researcher.

The null hypothesis (H_0) for a Kruskal-Wallis H test states no significant differences among the means of the groups being compared.

Null Hypothesis H_0: The dependent variable's mean of all groups is equal.

Alternate Hypothesis H_1: At least one of the dependent variable's means of all the groups are unequal.

4.8 Quality Control

Quality control was a crucial aspect of conducting quantitative research using survey methodology. It ensured that the data collected was reliable, accurate and valid. There were several quality control measures in place to achieve this. Firstly, the questionnaire must be well-designed with clear, concise questions that respondents could easily understand. It should also be free from any bias or leading language that may have influenced the results.

Before administering the questionnaire to the sample group, an independent respondent, who was not part of the sample, was used to assess the questionnaire's functionality and overall flow. Additionally, two engineers from the sample group were involved in a trial run of the questionnaire to validate its suitability for effectively capturing the perspectives and insights relevant to the engineering field. This thorough testing ensured that the questionnaire was sufficient to facilitate an in-depth understanding of engineering-related matters.

It was essential to select the correct sample and population for research, and sufficient respondents should have been collected to ensure the validity and reliability of the data. Any incomplete questionnaires should have been removed from the data collected. IBM SPSS software should have been used for data analysis using correct statistical methods to ensure the results were valid and reliable. An independent statistical analysis expert should have reviewed the data analysis.

The results should have been interpreted accurately and clearly without any bias or incorrect representation of data, with correct figures and descriptions provided.

4.9 Limitations

In the chosen research methodology, several noteworthy limitations warranted consideration. One significant concern was the potential for a limited response rate, a common challenge in quantitative research endeavours. While quantitative research provided valuable numerical data, it often lacked the depth and granularity required to comprehend complex phenomena fully. This limitation was particularly relevant when examining multifaceted topics such as the skills and competencies of engineering leaders.

5. Results

5.1 Introduction

This chapter comprehensively displays the data collected through the survey and the statistical analysis performed on the data. The aim is to provide a clear and detailed presentation of the information gathered, enabling a more in-depth understanding of the results obtained.

An electronic survey was utilised to collect data through personal networks, including WhatsApp, Email, and Telegram, as well as on social media platforms like Facebook and LinkedIn. The survey's objective was to gather ordinal data by using a Likert Scale, wherein engineers were requested to rank various skills and competencies necessary for an Engineering Leader.

5.2 Data Results

Electronic surveys were distributed to various career-stage engineers. The surveys provide engineers the chance to rank various soft skills, technical skills, and business competencies necessary for engineering leadership.

5.2.1 Sample Overview

The electronic survey was distributed via various personal networks, including WhatsApp, Email, and Telegram, and on social media platforms like Facebook and LinkedIn. Data collected started on the 17th of October 2023 until the 27th of January 2024. In this period, a total of 85 responses were collected. Table 3 below shows the qualification level of the respondents. Table 4 shows the years of experience of the collected respondents as engineers.

Table 3 - Qualification of respondents

What engineering qualification do you have?

	Frequency	Percent
Total	85	100.0
Technical qualification from a college eg. Diploma, certification (NQF Level 6)	6	7.1
Bachelor of Technology in Engineering (BTech Eng) (NQF Level 7)	6	7.1
Bachelors of Engineering (BEng) or Bachelors of Science in Engineering (NQF Level 7)	37	43.5
Honours Degree in Engineering (BEng Hons) (NQF Level 8)	18	21.2

Masters in Engineering (MEng or MSc) (NQF Level 9)	15	17.6
Doctorate in Engineering (PhD) (NQF Level 10)	3	3.5

Table 4 - Years of Experience for Respondents

Years of experience as an Engineer

	Frequency	Percent	Valid Percent
Junior Level (0 - 3 years)	20	23.5	23.5
Intermediate Level (4 - 6 years)	8	9.4	9.4
Senior Level (>7 years)	25	29.4	29.4
Engineering Management/leader (>10 years)	32	37.6	37.6
Total	85	100.0	100.0

An additional question was asked if any respondents attained any business qualifications. From the twenty junior-level engineer respondents, no business qualifications have been attained. Only two of the six intermediate-level engineering respondents had additional business qualifications in the form of postgraduate diplomas in business management (PGDip/PDBA). Six of twenty-five senior engineer respondents completed a PGDip/PDBA, and one respondent completed a Project Management Professional (PMP) qualification. Of the thirty-two-engineering management/leader respondents, six respondents have PGDip/PDBA, six respondents have completed a Master's in Business Administration (MBA), one respondent has also completed a PMP as well Lean Six Sigma and is a business turnaround analyst, one respondent is a registered engineer (Pr. Eng) at the Engineering Council of South Africa (ECSA), and final one respondent mentioned that they have over 40 years of experience as an engineer.

The respondents were also asked three additional questions: first, do the respondents have people reporting to them; fifty-one answered yes, and thirty-four answered no see Figure 8 in annexure A for the chart. Second, do the respondents have managers reporting to them; twenty answered yes, and sixty-five answered no see Figure 9 in annexure A for the chart. Finally, the respondents were asked if they consider themselves engineering leaders; sixty-two answered yes, and twenty-three answered no see Figure 10 in annexure A for the chart.

5.2.2 Skill Rankings

5.2.2.1 Complete Sample Ranking

The survey data has been organised into five categories: Cognitive, Interpersonal, Business, Strategic, and Other. Participants rated the importance of these skills for an engineering leader, utilising a Likert scale that spans from 1 (Not Important at all) to 5 (Extremely Important). Due to the ordinal nature of the data, statistical analysis has been applied to the entire sample. The mean has been computed from the ordinal responses, resulting in a ranking of the skills from most to least important.

Additionally, measures of variability, such as standard deviation, have been calculated to convey the dispersion of responses within each skill. This statistical approach aims to provide an overall ranking of importance and insights into the spread or diversity of opinions within each skill set. This analysis contributes to a more nuanced understanding of the perceived significance of cognitive, interpersonal, business, strategic, and other skills among the surveyed participants in the context of engineering leadership. The means and standard deviations have been computed to establish an overview and measure the variability within the complete sample of eighty-five respondents. The mean is determined by summing the scores assigned by each selected respondent for the specific skill and subsequently dividing this sum by the total number of participants in the sample. This calculation determines a general ranking of the surveyed data and assesses the extent of deviation within the sample. Table 5, Table 6, Table 7, Table 8 and Table 9 below show the mean and standard deviation of the complete dataset.

Table 5 – Mean of All Respondents for Cognitive Skills

Variables	Mean	N	Std. Deviation
Communication (talking to convey information effectively)	4.67	85	.497
Active listening (listening to what other people are saying and asking appropriate questions)	4.58	85	.564

Variables	Mean	N	Std. Deviation
Writing (effective communication in writing)	4.16	85	.670
Read comprehension (understanding written sentences and paragraphs in work related documents)	4.35	85	.719
Active learning (working with new information to grasp its implications)	4.33	85	.679
Critical Thinker (using logic and analysis to identify the strengths and weaknesses of different approaches)	4.61	85	.558

Table 6 – Mean of All Respondents for Interpersonal Skills

Variables	Mean	N	Std. Deviation
Interpersonal skill – managing people	4.21	85	.709
Interpersonal skill – delegation	4.13	85	.651
Interpersonal skill – being able to have tough conversations	4.21	85	.757
Interpersonal skill – public speaking	3.32	85	.848
Interpersonal skill – empowering employees so that they can conduct their responsibilities effectively	4.26	85	.726
Interpersonal skill – honing employees abilities so that they can achieve their full potential	4.15	85	.699
Interpersonal skill – consideration of emotions of staff which contributes to building trust	3.94	85	.761
Leadership – Ability to influence others	4.13	85	.720
Leadership – Managing the way people perceive you	3.39	85	1.001
Leadership – Managing your own reputation	3.64	85	.937

Table 7 – Mean of All Respondents for Business Skills

Variables	Mean	N	Std. Deviation
Management of Financial resources	4.02	85	.740
Management of Material Resources (obtaining and seeing to the appropriate use of equipment, facilities, and materials needed to do certain work)	4.00	85	.756
Business – Anticipate the business operating environment in the next 5 years	3.96	85	.823
Business – Determine what goods and services customer desire, including the price they are willing to pay	3.89	85	.913
Business – Determining what constitutes customer value	3.96	85	.823
Business – Determine business priorities	4.05	85	.800
Business – a knowledge of contemporary issues (current events)	3.60	85	.889
Project Management skills	4.25	85	.722
Economics – Being able to understand economic operating environment	3.82	85	.819
Economics – Being able to understand the functional drivers of the business	4.05	85	.770

Table 8 – Mean of All Respondents for Strategic Skills

Variables	Mean	N	Std. Deviation
Marketing Skills (product, positioning, advertising promotions, etc.)	3.04	85	.969
Business – Assume responsibility for the survival and growth of the business	3.92	85	.889
Sales – How to sell engineering products, different sales techniques, buying behaviour, etc.	3.35	85	.948
Business – Set direction including establishing a strategy	4.05	85	.722
Leadership – Make decisions ethically and understanding ethical responsibilities	4.44	85	.663
Leadership – Communicate direction including a shared understanding of the direction	4.27	85	.605
Visioning (developing an image of how a system should work under ideal conditions)	4.25	85	.722
Systems perception (determining when important changes have occurred in a system or are likely to occur)	4.04	85	.680
System Evaluation (looking at many indicators of system performance, taking into account their accuracy)	4.08	85	.658
Identification of downstream consequences (determining the long-term outcomes of a change in operations)	4.25	85	.671
Identification of key causes (identifying the things that must be changed to achieve a goal)	4.31	85	.557
Problem Identification (identifying the nature of problems)	4.45	85	.608

Variables	Mean	N	Std. Deviation
Solution Appraisal (observing and evaluating the outcomes of problem solution to identify lessons learned or redirect efforts)	4.26	85	.657

Table 9 – Mean of All Respondents for Other Skills

Variables	Mean	N	Std. Deviation
Technical Knowledge	4.04	85	.906
Quality Management	4.06	85	.792

5.2.2.2 Engineer Experience Ranking

As previously described, an identical methodology has been applied to calculate the mean and standard deviation. However, in this instance, the independent groups are organised based on the experience levels of the engineers. This approach allows for a nuanced analysis of the means and standard deviations within each experience group, providing insights into how perceptions of importance and variability in skill ratings may vary across different levels of professional experience among engineers. Table 10, Table 11, Table 12, Table 13 and Table 14 below show the means and standard deviation for the various experience levels of engineers.

Table 10- Mean of Cognitive Skills for Years of experience as an engineer

	Years of experience as an Engineer											
	Junior Level (0 - 3 years)			Intermediate Level (4 - 6 years)			Senior Level (>7 years)			Engineering Management/leader (>10 years)		
	Mean	N	Std. Dev	Mean	N	Std. Dev	Mean	N	Std. Dev	Mean	N	Std. Dev
Communication (talking to convey information effectively)	4.75	20	.444	4.88	8	.354	4.68	25	.476	4.56	32	.564
Active listening (listening to what other people are saying and asking appropriate questions)	4.45	20	.605	4.63	8	.518	4.60	25	.577	4.62	32	.554
Writing (effective communication in writing)	4.10	20	.718	4.50	8	.535	4.24	25	.663	4.06	32	.669
Read comprehension (understanding written sentences and paragraphs in work related documents)	4.15	20	.745	4.88	8	.354	4.52	25	.586	4.22	32	.792
Active learning (working with new information to grasp its implications)	4.10	20	.641	4.38	8	.744	4.32	25	.690	4.47	32	.671
Critical Thinker (using logic and analysis to identify the strengths and weaknesses of different approaches)	4.60	20	.503	4.62	8	.518	4.56	25	.651	4.66	32	.545

Table 11 - Mean of Interpersonal Skills for Years of experience as an engineer

	Years of experience as an Engineer											
	Junior Level (0 - 3 years)			Intermediate Level (4 - 6 years)			Senior Level (>7 years)			Engineering Management/leader (>10 years)		
	Mean	N	Std. Dev	Mean	N	Std. Dev	Mean	N	Std. Dev	Mean	N	Std. Dev
Interpersonal skill - managing people	3.95	20	.686	4.13	8	.835	4.44	25	.583	4.22	32	.751
Interpersonal skill - delegation	3.95	20	.759	4.25	8	.463	4.20	25	.764	4.16	32	.515
Interpersonal skill - being able to have tough conversations	3.75	20	.851	4.00	8	.926	4.44	25	.507	4.38	32	.707
Interpersonal skill - public speaking	3.30	20	.923	3.62	8	.916	3.52	25	.653	3.09	32	.893
Interpersonal skill - empowering employees so that they can conduct their responsibilities effectively	4.20	20	.768	4.13	8	.641	4.44	25	.712	4.19	32	.738
Interpersonal skill - honing employees abilities so that they can achieve their full potential	4.05	20	.759	4.13	8	.641	4.32	25	.690	4.09	32	.689
Interpersonal skill - consideration of emotions of staff which contributes to building trust	3.75	20	.786	4.00	8	.756	4.08	25	.702	3.94	32	.801
Leadership - Ability to influence others	3.75	20	.716	4.00	8	.926	4.36	25	.569	4.22	32	.706
Leadership - Managing the way people perceive you	3.20	20	.951	4.00	8	1.069	3.56	25	.821	3.22	32	1.099
Leadership - Managing your own reputation	3.60	20	.940	3.75	8	1.035	3.80	25	.764	3.50	32	1.047

Table 12 - Mean of Business Skills for Years of experience as an engineer

	Years of experience as an Engineer											
	Junior Level (0 - 3 years)			Intermediate Level (4 - 6 years)			Senior Level (>7 years)			Engineering Management/leader (>10 years)		
	Mean	N	Std. Dev	Mean	N	Std. Dev	Mean	N	Std. Dev	Mean	N	Std. Dev
Management of Financial resources	4.05	20	.759	4.13	8	.835	4.00	25	.764	4.00	32	.718
Management of Material Resources (obtaining and seeing to the appropriate use of equipment, facilities, and materials needed to do certain work)	3.90	20	.553	4.13	8	1.126	3.92	25	.759	4.09	32	.777
Business - Anticipate the business operating environment in the next 5 years	3.70	20	.865	3.88	8	.835	3.96	25	.790	4.16	32	.808
Business - Determine what goods and services customer desire, including the price they are willing to pay	3.95	20	.759	4.25	8	.886	3.84	25	.850	3.81	32	1.061
Business - Determining what constitutes customer value	3.85	20	.813	4.13	8	.641	4.16	25	.800	3.84	32	.884
Business - Determine business priorities	4.10	20	.718	4.00	8	.926	3.80	25	.764	4.22	32	.832
Business - a knowledge of contemporary issues (current events)	3.80	20	.696	3.50	8	.926	3.56	25	.712	3.53	32	1.107
Project Management skills	4.75	20	.550	4.63	8	.518	4.08	25	.702	3.97	32	.695
Economics - Being able to understand economic operating environment	3.75	20	.851	4.13	8	.641	3.68	25	.802	3.91	32	.856
Economics - Being able to understand the functional drivers of the business	4.00	20	.725	4.25	8	.707	3.80	25	.707	4.22	32	.832

Table 13 - Mean of Strategic Skills for Years of experience as an engineer

	Years of experience as an Engineer											
	Junior Level (0 - 3 years)			Intermediate Level (4 - 6 years)			Senior Level (>7 years)			Engineering Management/leader (>10 years)		
	Mean	N	Std. Dev	Mean	N	Std. Dev	Mean	N	Std. Dev	Mean	N	Std. Dev
Marketing Skills (product, positioning, advertising promotions, etc.)	3.10	20	.912	3.38	8	1.061	2.92	25	.909	3.00	32	1.047
Business - Assume responsibility for the survival and growth of the business	3.70	20	.801	4.00	8	.926	3.88	25	.881	4.06	32	.948
Sales - How to sell engineering products, different sales techniques, buying behaviour, etc.	3.30	20	.801	3.88	8	1.126	3.12	25	.881	3.44	32	1.014
Business - Set direction including establishing a strategy	3.85	20	.745	3.88	8	.991	3.96	25	.676	4.28	32	.634
Leadership - Make decisions ethically and understanding ethical responsibilities	4.60	20	.598	4.63	8	.518	4.48	25	.586	4.25	32	.762
Leadership - Communicate direction including a shared understanding of the direction	4.15	20	.587	4.00	8	.756	4.44	25	.583	4.28	32	.581
Visioning (developing an image of how a system should work under ideal conditions)	4.20	20	.834	4.62	8	.518	4.28	25	.678	4.16	32	.723
Systems perception (determining when important changes have occurred in a system or are likely to occur)	4.10	20	.852	4.25	8	.707	3.88	25	.600	4.06	32	.619
System Evaluation (looking at many indicators of system performance, taking into account their accuracy)	3.95	20	.826	4.25	8	.463	4.08	25	.640	4.13	32	.609
Identification of downstream consequences (determining the long-term outcomes of a change in operations)	4.10	20	.718	4.38	8	.744	4.36	25	.569	4.22	32	.706
Identification of key causes (identifying the things that must be changed to achieve a goal)	4.20	20	.523	4.63	8	.518	4.32	25	.476	4.28	32	.634
Problem Identification (identifying the nature of problems)	4.35	20	.587	4.75	8	.463	4.44	25	.712	4.44	32	.564
Solution Appraisal (observing and evaluating the outcomes of problem solution to identify lessons learned or redirect efforts)	4.10	20	.641	4.63	8	.518	4.40	25	.577	4.16	32	.723

Table 14 – Mean of Other Skills for Years of experience as an engineer

	Years of experience as an Engineer											
	Junior Level (0 - 3 years)			Intermediate Level (4 - 6 years)			Senior Level (>7 years)			Engineering Management/leader (>10 years)		
	Mean	N	Std. Dev	Mean	N	Std. Dev	Mean	N	Std. Dev	Mean	N	Std. Dev
Technical Knowledge	4.05	20	.887	3.88	8	1.126	3.88	25	1.054	4.19	32	.738
Quality Management	4.25	20	.639	4.25	8	.886	3.92	25	.862	4.00	32	.803

5.3 Statistical Results

In delving into the results derived from the statistical analysis of the data gathered through questionnaires, this research endeavours to uncover connections between engineers' perspectives and the experience levels of engineering leaders. By examining how engineers prioritise specific skills and competencies crucial for effective leadership, this study aims to contribute meaningful insights, facilitating a better understanding of the dynamics surrounding engineers transitioning into managerial roles.

5.3.1 Statistical Analysis Breakdown

A Kruskal-Wallis H Test was completed, as the test's primary purpose was to evaluate the means of three or more samples. This nonparametric test allowed us to assess whether statistically significant differences existed between the rankings of skills and competencies for multiple categorical groups in the engineers' experience.

An alpha level (significance level) of 0.05 was employed for the analysis, signifying that the tails of the sampling distribution accounted for a 5% probability of rejecting the null hypothesis (Albright et al., 2011). The p-values served as an indication of the likelihood of observing a sample statistic under the assumption that the actual value of the sample parameter was consistent with the null hypothesis—a calculated p-value exceeding 0.05 suggested similarities across diverse career experiences. Conversely, a p-value below 0.05 indicated significant differences among career experiences, leading to rejecting the null hypothesis.

5.3.2 Results of Statistical Analysis

Table 15 displays the mean ranks of various skills and competencies for engineering leaders among engineers categorized by their years of experience. These mean ranks represent the relative proficiency levels across different skill sets within each experience group. The Kruskal-Wallis H test was conducted to determine if there are statistically significant differences in the distribution of these mean ranks across the experience categories. By examining these ranks, we can gain insights into how the development and mastery of skills may vary across different stages of an engineer's career trajectory.

Table 15 - Kruskal-Wallis H Test Mean Ranks

Ranks

	Years of experience as an Engineer	N	Mean Rank
Communication (talking to convey information effectively)	Engineering Management/leader (>10 years)	32	39.02
	Intermediate Level (4 - 6 years)	8	51.25
	Junior Level (0 - 3 years)	20	46.00
	Senior Level (>7 years)	25	43.06
	Total	85	
Active listening (listening to what other people are saying and asking appropriate questions)	Engineering Management/leader (>10 years)	32	44.89
	Intermediate Level (4 - 6 years)	8	44.13
	Junior Level (0 - 3 years)	20	38.17
	Senior Level (>7 years)	25	44.08
	Total	85	
Writing (effective communication in writing)	Engineering Management/leader (>10 years)	32	39.56
	Intermediate Level (4 - 6 years)	8	54.00
	Junior Level (0 - 3 years)	20	41.00
	Senior Level (>7 years)	25	45.48
	Total	85	
Read comprehension (understanding written sentences and paragraphs in work related documents)	Engineering Management/leader (>10 years)	32	39.22
	Intermediate Level (4 - 6 years)	8	60.31
	Junior Level (0 - 3 years)	20	36.33
	Senior Level (>7 years)	25	47.64
	Total	85	

Ranks

	Years of experience as an Engineer	N	Mean Rank
Active learning (working with new information to grasp its implications)	Engineering Management/leader (>10 years)	32	47.89
	Intermediate Level (4 - 6 years)	8	44.81
	Junior Level (0 - 3 years)	20	34.85
	Senior Level (>7 years)	25	42.68
	Total	85	
Critical Thinker (using logic and analysis to identify the strengths and weaknesses of different approaches)	Engineering Management/leader (>10 years)	32	44.72
	Intermediate Level (4 - 6 years)	8	42.63
	Junior Level (0 - 3 years)	20	41.60
	Senior Level (>7 years)	25	42.04
	Total	85	
Interpersonal skill - managing people	Engineering Management/leader (>10 years)	32	43.69
	Intermediate Level (4 - 6 years)	8	40.56
	Junior Level (0 - 3 years)	20	34.17
	Senior Level (>7 years)	25	49.96
	Total	85	
Interpersonal skill - delegation	Engineering Management/leader (>10 years)	32	43.47
	Intermediate Level (4 - 6 years)	8	46.50
	Junior Level (0 - 3 years)	20	37.35
	Senior Level (>7 years)	25	45.80
	Total	85	
Interpersonal skill - being able to have tough conversations	Engineering Management/leader (>10 years)	32	47.88
	Intermediate Level (4 - 6 years)	8	37.13
	Junior Level (0 - 3 years)	20	30.25
	Senior Level (>7 years)	25	48.84
	Total	85	
Interpersonal skill - public speaking	Engineering Management/leader (>10 years)	32	37.80
	Intermediate Level (4 - 6 years)	8	49.00
	Junior Level (0 - 3 years)	20	42.25
	Senior Level (>7 years)	25	48.34
	Total	85	
Interpersonal skill - empowering employees so that they can conduct their responsibilities effectively	Engineering Management/leader (>10 years)	32	40.80
	Intermediate Level (4 - 6 years)	8	37.56
	Junior Level (0 - 3 years)	20	41.20
	Senior Level (>7 years)	25	49.00

Ranks

	Years of experience as an Engineer	N	Mean Rank
	Total	85	
Interpersonal skill - honing employees abilities so that they can achieve their full potential	Engineering Management/leader (>10 years)	32	40.78
	Intermediate Level (4 - 6 years)	8	41.44
	Junior Level (0 - 3 years)	20	40.40
	Senior Level (>7 years)	25	48.42
	Total	85	
Interpersonal skill - consideration of emotions of staff which contributes to building trust	Engineering Management/leader (>10 years)	32	42.61
	Intermediate Level (4 - 6 years)	8	44.63
	Junior Level (0 - 3 years)	20	37.85
	Senior Level (>7 years)	25	47.10
	Total	85	
Leadership - Ability to influence others	Engineering Management/leader (>10 years)	32	45.80
	Intermediate Level (4 - 6 years)	8	39.56
	Junior Level (0 - 3 years)	20	31.20
	Senior Level (>7 years)	25	49.96
	Total	85	
Leadership - Managing the way people perceive you	Engineering Management/leader (>10 years)	32	39.75
	Intermediate Level (4 - 6 years)	8	57.50
	Junior Level (0 - 3 years)	20	38.33
	Senior Level (>7 years)	25	46.26
	Total	85	
Leadership - Managing your own reputation	Engineering Management/leader (>10 years)	32	40.42
	Intermediate Level (4 - 6 years)	8	45.88
	Junior Level (0 - 3 years)	20	42.23
	Senior Level (>7 years)	25	46.00
	Total	85	
Management of Financial resources	Engineering Management/leader (>10 years)	32	42.33
	Intermediate Level (4 - 6 years)	8	45.94
	Junior Level (0 - 3 years)	20	43.43
	Senior Level (>7 years)	25	42.58
	Total	85	
Management of Material Resources (obtaining and seeing to the appropriate use of equipment, facilities, and materials needed to do certain work)	Engineering Management/leader (>10 years)	32	45.97
	Intermediate Level (4 - 6 years)	8	49.50
	Junior Level (0 - 3 years)	20	38.75

Ranks

	Years of experience as an Engineer	N	Mean Rank
	Senior Level (>7 years)	25	40.52
	Total	85	
Business - Anticipate the business operating environment in the next 5 years	Engineering Management/leader (>10 years)	32	48.63
	Intermediate Level (4 - 6 years)	8	39.75
	Junior Level (0 - 3 years)	20	35.45
	Senior Level (>7 years)	25	42.88
	Total	85	
Business - Determine what goods and services customer desire, including the price they are willing to pay	Engineering Management/leader (>10 years)	32	41.91
	Intermediate Level (4 - 6 years)	8	52.00
	Junior Level (0 - 3 years)	20	43.28
	Senior Level (>7 years)	25	41.30
	Total	85	
Business - Determining what constitutes customer value	Engineering Management/leader (>10 years)	32	40.20
	Intermediate Level (4 - 6 years)	8	46.75
	Junior Level (0 - 3 years)	20	39.55
	Senior Level (>7 years)	25	48.14
	Total	85	
Business - Determine business priorities	Engineering Management/leader (>10 years)	32	48.81
	Intermediate Level (4 - 6 years)	8	41.38
	Junior Level (0 - 3 years)	20	43.80
	Senior Level (>7 years)	25	35.44
	Total	85	
Business - a knowledge of contemporary issues (current events)	Engineering Management/leader (>10 years)	32	42.23
	Intermediate Level (4 - 6 years)	8	39.31
	Junior Level (0 - 3 years)	20	48.08
	Senior Level (>7 years)	25	41.10
	Total	85	
Project Management skills	Engineering Management/leader (>10 years)	32	33.97
	Intermediate Level (4 - 6 years)	8	54.81
	Junior Level (0 - 3 years)	20	59.95
	Senior Level (>7 years)	25	37.22
	Total	85	
Economics - Being able to understand economic operating environment	Engineering Management/leader (>10 years)	32	45.55
	Intermediate Level (4 - 6 years)	8	51.31

Ranks

	Years of experience as an Engineer	N	Mean Rank
	Junior Level (0 - 3 years)	20	40.53
	Senior Level (>7 years)	25	39.06
	Total	85	
Economics - Being able to understand the functional drivers of the business	Engineering	32	48.70
	Management/leader (>10 years)		
	Intermediate Level (4 - 6 years)	8	48.75
	Junior Level (0 - 3 years)	20	41.00
	Senior Level (>7 years)	25	35.46
	Total	85	
Marketing Skills (product, positioning, advertising promotions, etc.)	Engineering	32	42.61
	Management/leader (>10 years)		
	Intermediate Level (4 - 6 years)	8	49.50
	Junior Level (0 - 3 years)	20	44.08
	Senior Level (>7 years)	25	40.56
	Total	85	
Business - Assume responsibility for the survival and growth of the business	Engineering	32	47.53
	Management/leader (>10 years)		
	Intermediate Level (4 - 6 years)	8	45.88
	Junior Level (0 - 3 years)	20	36.70
	Senior Level (>7 years)	25	41.32
	Total	85	
Sales - How to sell engineering products, different sales techniques, buying behavior, etc.	Engineering	32	44.88
	Management/leader (>10 years)		
	Intermediate Level (4 - 6 years)	8	55.00
	Junior Level (0 - 3 years)	20	41.70
	Senior Level (>7 years)	25	37.80
	Total	85	
Business - Set direction including establishing a strategy	Engineering	32	50.08
	Management/leader (>10 years)		
	Intermediate Level (4 - 6 years)	8	37.69
	Junior Level (0 - 3 years)	20	37.15
	Senior Level (>7 years)	25	40.32
	Total	85	
Leadership - Make decisions ethically and understanding ethical responsibilities	Engineering	32	37.45
	Management/leader (>10 years)		
	Intermediate Level (4 - 6 years)	8	48.69
	Junior Level (0 - 3 years)	20	48.68
	Senior Level (>7 years)	25	43.74
	Total	85	
Leadership - Communicate direction including a shared understanding of the direction	Engineering	32	43.19
	Management/leader (>10 years)		

Ranks

	Years of experience as an Engineer	N	Mean Rank
	Intermediate Level (4 - 6 years)	8	34.38
	Junior Level (0 - 3 years)	20	38.50
	Senior Level (>7 years)	25	49.12
	Total	85	
Visioning (developing an image of how a system should work under ideal conditions)	Engineering Management/leader (>10 years)	32	39.94
	Intermediate Level (4 - 6 years)	8	54.94
	Junior Level (0 - 3 years)	20	42.50
	Senior Level (>7 years)	25	43.50
	Total	85	
Systems perception (determining when important changes have occurred in a system or are likely to occur)	Engineering Management/leader (>10 years)	32	43.83
	Intermediate Level (4 - 6 years)	8	50.06
	Junior Level (0 - 3 years)	20	45.30
	Senior Level (>7 years)	25	37.84
	Total	85	
System Evaluation (looking at many indicators of system performance, taking into account their accuracy)	Engineering Management/leader (>10 years)	32	44.31
	Intermediate Level (4 - 6 years)	8	48.25
	Junior Level (0 - 3 years)	20	38.98
	Senior Level (>7 years)	25	42.86
	Total	85	
Identification of downstream consequences (determining the long-term outcomes of a change in operations)	Engineering Management/leader (>10 years)	32	42.23
	Intermediate Level (4 - 6 years)	8	47.69
	Junior Level (0 - 3 years)	20	38.30
	Senior Level (>7 years)	25	46.24
	Total	85	
Identification of key causes (identifying the things that must be changed to achieve a goal)	Engineering Management/leader (>10 years)	32	42.61
	Intermediate Level (4 - 6 years)	8	55.31
	Junior Level (0 - 3 years)	20	38.75
	Senior Level (>7 years)	25	42.96
	Total	85	

Ranks

	Years of experience as an Engineer	N	Mean Rank
Problem Identification (identifying the nature of problems)	Engineering Management/leader (>10 years)	32	42.09
	Intermediate Level (4 - 6 years)	8	54.00
	Junior Level (0 - 3 years)	20	38.95
	Senior Level (>7 years)	25	43.88
	Total	85	
Solution Appraisal (observing and evaluating the outcomes of problem solution to identify lessons learned or redirect efforts)	Engineering Management/leader (>10 years)	32	39.92
	Intermediate Level (4 - 6 years)	8	55.44
	Junior Level (0 - 3 years)	20	37.40
	Senior Level (>7 years)	25	47.44
	Total	85	
Technical Knowledge	Engineering Management/leader (>10 years)	32	46.03
	Intermediate Level (4 - 6 years)	8	40.00
	Junior Level (0 - 3 years)	20	43.15
	Senior Level (>7 years)	25	39.96
	Total	85	
Quality Management	Engineering Management/leader (>10 years)	32	41.14
	Intermediate Level (4 - 6 years)	8	48.75
	Junior Level (0 - 3 years)	20	47.93
	Senior Level (>7 years)	25	39.60
	Total	85	

Table 16 presents the results of a Kruskal-Wallis test examining the significance of differences in various skills and competencies among engineers with different levels of experience.

The grouping variable, "Years of experience as an Engineer," categorizes engineers into different experience levels. The test evaluates whether there are statistically significant differences in the mean ranks of these skills across the different experience groups. The significance level (Asymp. Sig.) indicates the probability of obtaining the observed results by chance. This analysis provides insights into the relative importance and development of different skills among engineers at different stages of their careers.

Table 16 - Kruskal-Wallis H Test Significant

Test Statistics[a,b]

	Kruskal-Wallis H	df	Asymp. Sig.
Communication (talking to convey information effectively)	3.095	3	.377
Active Listening (listening to what other people are saying and asking appropriate questions)	1.398	3	.706
Writing (effective communication in writing)	3.178	3	.365
Read comprehension (understanding written sentences and paragraphs in work related documents)	8.549	3	**.036**
Active learning (working with new information to grasp its implications)	4.215	3	.239
Critical Thinker (using logic and analysis to identify the strengths and weaknesses of different approaches)	.372	3	.946
Interpersonal skill - managing people	5.608	3	.132
Interpersonal skill - delegation	1.943	3	.584
Interpersonal skill - being able to have tough conversations	10.012	3	**.018**
Interpersonal skill - public speaking	3.567	3	.312
Interpersonal skill - empowering employees so that they can conduct their responsibilities effectively	2.655	3	.448
Interpersonal skill - honing employees abilities so that they can achieve their full potential	2.103	3	.551
Interpersonal skill - consideration of emotions of staff which contributes to building trust	1.852	3	.604
Leadership - Ability to influence others	8.362	3	**.039**
Leadership - Managing the way people perceive you	4.915	3	.178
Leadership - Managing your own reputation	.947	3	.814
Management of Financial resources	.181	3	.981
Management of Material Resources (obtaining and seeing to the appropriate use of equipment, facilities, and materials needed to do certain work)	2.270	3	.518
Business - Anticipate the business operating environment in the next 5 years	4.174	3	.243

Test Statistics[a,b]

	Kruskal-Wallis H	df	Asymp. Sig.
Business - Determine what goods and services customer desire, including the price they are willing to pay	1.392	3	.707
Business - Determining what constitutes customer value	2.390	3	.496
Business - Determine business priorities	4.853	3	.183
Business - a knowledge of contemporary issues (current events)	1.408	3	.704
Project Management skills	20.207	3	**.000**
Economics - Being able to understand economic operating environment	2.419	3	.490
Economics - Being able to understand the functional drivers of the business	5.392	3	.145
Marketing Skills (product, positioning, advertising promotions, etc.)	.941	3	.816
Business - Assume responsibility for the survival and growth of the business	2.973	3	.396
Sales - How to sell engineering products, different sales techniques, buying behaviour, etc.	3.587	3	.310
Business - Set direction including establishing a strategy	5.463	3	.141
Leadership - Make decisions ethically and understanding ethical responsibilities	3.944	3	.268
Leadership - Communicate direction including a shared understanding of the direction	4.102	3	.251
Visioning (developing an image of how a system should work under ideal conditions)	2.905	3	.406
Systems perception (determining when important changes have occurred in a system or are likely to occur)	2.396	3	.494
System Evaluation (looking at many indicators of system performance, taking into account their accuracy)	1.236	3	.744
Identification of downstream consequences (determining the long-term outcomes of a change in operations)	1.791	3	.617
Identification of key causes (identifying the things that must be changed to achieve a goal)	3.503	3	.320
Problem Identification (identifying the nature of problems)	2.795	3	.424
Solution Appraisal (observing and evaluating the outcomes of problem solution to identify lessons learned or redirect efforts)	5.355	3	.148
Technical Knowledge	1.098	3	.778
Quality Management	2.210	3	.530

a. Kruskal Wallis Test

b. Grouping Variable: Years of experience as an Engineer

6. Discussion

In this chapter, we will delve into the findings derived from the statistical analyses conducted in the preceding chapter. Our primary objective is to interpret and elucidate the implications of these results, shedding light on their significance within the research questions or hypothesis context.

6.1 Research Question One - Overall sample discussion

The mean analysis of the attitude towards skills and competencies for an engineering leader within the complete sample set of engineers constitutes a fundamental aspect of this thesis, serving as a pivotal lens to understand this specialised cohort's proficiency levels and capabilities. This analysis provides essential insights into the overarching skill landscape of engineers and lays the groundwork for deeper exploration and interpretation within the context of the thesis's research objectives.

6.1.1 Ten highest ranked skills and competencies

As seen in Table 17 below and in, based on the leadership attributes for effective leaders by Farr et al. (1997), there is a similarity between the theoretical attributes and the calculated means of the sample set. Engineering leaders must possess strong communication skills like their counterparts in other fields to effectively convey information and comprehend work-related communications. Additionally, they must demonstrate proficiency in critical thinking, enabling them to grasp the organisational strategy and discern strengths and weaknesses. Given the ethical considerations inherent in their field, ethical decision-making is imperative for engineering leaders. Furthermore, they must exhibit adaptability to master change, recognizing requisite adjustments to achieve organisational goals amidst a dynamic technological landscape. Engineering leaders serve as team builders and empower employees to fulfil their potential, fostering a collaborative and

conducive work environment. Moreover, they must adeptly identify and solve problems using critical thinking, a skill indispensable for navigating the complexities of engineering projects.

Table 17 - Ten highest ranked skills and competencies from the complete sample set.

Report

Variables	Mean	N	Std. Deviation
Communication (talking to convey information effectively)	4.67	85	.497
Critical Thinker (using logic and analysis to identify the strengths and weaknesses of different approaches)	4.61	85	.558
Active Listening (listening to what other people are saying and asking appropriate questions)	4.58	85	.564
Problem Identification (identifying the nature of problems)	4.45	85	.608
Leadership - Make decisions ethically and understanding ethical responsibilities	4.44	85	.663
Read comprehension (understanding written sentences and paragraphs in work related documents)	4.35	85	.719
Active learning (working with new information to grasp its implications)	4.33	85	.679
Identification of key causes (identifying the things that must be changed to achieve a goal)	4.31	85	.557
Leadership - Communicate direction including a shared understanding of the direction	4.27	85	.605
Interpersonal skill - empowering employees so that they can conduct their responsibilities effectively	4.26	85	.726

Engineering leaders play a multi-faceted role, requiring strong communication skills, proficiency in critical thinking, ethical decision-making, adaptability, and problem-solving abilities. Their capacity to empower teams, navigate change, and uphold ethical standards is integral to driving organisational success in today's dynamic technological landscape.

6.1.2 Ten lowest ranked skills and competencies

Table 18 below shows the worst skills and competencies based on means. Engineering leaders often prioritise technical expertise over essential skills such as marketing, public speaking, and sales, perceiving them as secondary to their primary role. This lack of emphasis stems from a limited understanding and experience in promoting engineering solutions, leading to the underestimated importance of project success. Similarly, their focus on technical communication

within their specialized domain often relegates public speaking to a peripheral skill, hindering effective communication in diverse forums. Additionally, engineering leaders may overlook the significance of sales skills due to perceived incompatibility with their technical role. Moreover, they may underestimate the impact of perception on their leadership effectiveness, neglecting to manage their professional image and failing to recognize how others perceive them, potentially undermining their credibility and influence within the organisation.

Furthermore, their preoccupation with technical specifications may cause them to overlook customer preferences and needs, resulting in engineering solutions that lack market resonance and competitiveness. Additionally, their insulation from business considerations may lead to an assumption that technical excellence alone guarantees project success, overlooking broader strategic imperatives crucial for organisational growth and sustainability. Finally, prioritising technical proficiency over interpersonal skills may result in neglecting the emotional dynamics of team interactions, leading to strained relationships, low morale, and reduced productivity among team members, ultimately undermining project performance and team cohesion.

Table 18 - Ten lowest ranked skills and competencies of the complete sample set.

Report

Variables	Mean	N	Std. Deviation
Marketing Skills (product, positioning, advertising promotions, etc.)	3.04	85	.969
Interpersonal skill - public speaking	3.32	85	.848
Sales - How to sell engineering products, different sales techniques, buying behaviour, etc.	3.35	85	.948
Leadership - Managing the way people perceive you	3.39	85	1.001
Business - a knowledge of contemporary issues (current events)	3.60	85	.889
Leadership - Managing your own reputation	3.64	85	.937
Economics - Being able to understand economic operating environment	3.82	85	.819
Business - Determine what goods and services customer desire, including the price they are willing to pay	3.89	85	.913
Business - Assume responsibility for the survival and growth of the business	3.92	85	.889

Report

Variables	Mean	N	Std. Deviation
Interpersonal skill - consideration of emotions of staff which contributes to building trust	3.94	85	.761

Engineering leaders often rank these ten skills and competencies lower due to a combination of factors, including a prevailing focus on technical expertise, a lack of awareness of their importance, and a perception that they are secondary to core engineering responsibilities. However, recognising the significance of these skills and actively developing them can enhance leadership effectiveness and contribute to overall organisational success.

6.2 Research Question Two - Engineers experience sub-group discussion.

6.2.1 Ten highest and lowest ranked skills and competencies in engineer's experience sub-group

Table 19 below shows the ten highest ranked skills and competencies for an engineering leader from the perception of junior engineers based on the mean ranking of the results collected. Foremost, the most critical skill is communicating and conveying information effectively. Project management is followed second, representing the ability to strategize, organise and execute complex engineering initiatives while adhering to timelines and budgets.

Critical thinking holds a revered status among junior engineers, necessitating the ability to analyse problems, devise innovative solutions, and adapt to the evolving challenges of the field. Nevertheless, in addition to these responsibilities, engineering leaders are tasked with guiding junior engineers as they acquire technical skills and experience at the start of their careers. This underscores the ongoing need for critical thinking among leaders, as they must navigate complex situations, mentor junior colleagues, and make informed decisions that align with organisational goals and values. Thus, critical thinking remains a fundamental competency for engineering leaders, enabling them to effectively lead teams and cultivate the next generation of engineering talent.

Engineering leaders must have ethical integrity, underpin principled decision-making, and ensure that engineering solutions are sustainable and virtuous. Lastly, active listening is ranked fifth important, enabling engineering leaders to empathise with team members, comprehend diverse perspectives, and cultivate an inclusive work environment conducive to innovation and growth.

Table 19 - Mean table for junior-level engineers' perception of the ten highest ranked skills and competencies

Years of experience as an Engineer			
Junior Level (0 - 3 years)			
	Mean	N	Std. Deviation
Communication (talking to convey information effectively)	4.75	20	.444
Project Management skills	4.75	20	.550
Critical Thinker (using logic and analysis to identify the strengths and weaknesses of different approaches)	4.60	20	.503
Leadership - Make decisions ethically and understanding ethical responsibilities	4.60	20	.598
Active Listening (listening to what other people are saying and asking appropriate questions)	4.45	20	.605
Problem Identification (identifying the nature of problems)	4.35	20	.587
Quality Management	4.25	20	.639
Identification of key causes (identifying the things that must be changed to achieve a goal)	4.20	20	.523
Interpersonal skill - empowering employees so that they can conduct their responsibilities effectively	4.20	20	.768
Visioning (developing an image of how a system should work under ideal conditions)	4.20	20	.834

Table 20 below shows the ten highest ranked skills and competencies for an engineering leader from the perception of intermediate engineers based on the mean ranking of the results collected. The data collected from intermediate engineers reaffirms the significance of communication. In conjunction with proficient communication skills, engineering leaders must possess strong reading comprehension abilities to understand and interpret documents created by engineers. These documents often include technical specifications, design plans, reports, and research findings crucial for project development and implementation. A leader's capacity to

comprehend these materials ensures an accurate understanding of project requirements, enabling effective communication with team members, stakeholders, and clients. Additionally, adept reading comprehension allows leaders to identify potential issues, evaluate proposed solutions, and provide informed guidance to their teams.

From the perspective of intermediate engineers, the skill of problem identification stands out as a critical competency for engineering leaders. Intermediate engineers recognise that leaders must be able to pinpoint challenges effectively to ensure project success and team efficiency. This skill involves identifying technical issues and understanding the broader context in which problems arise, such as organisational dynamics, resource constraints, and stakeholder expectations.

From the perspective of intermediate engineers, the skill of project management is highly regarded as a fundamental competency for engineering leaders. Intermediate engineers recognise the pivotal role of effective project management in ensuring the successful execution of engineering initiatives. They value leaders who can plan, organise, and oversee projects from conception to completion while adhering to timelines, budgets, and quality standards. Intermediate engineers appreciate leaders who can allocate resources efficiently, mitigate risks proactively, and adapt to changing circumstances to keep projects on track. For intermediate engineers, being ethical is noted as similar to junior engineers. Engineering leaders must have ethical integrity, underpin principled decision-making, and ensure that engineering solutions are sustainable and virtuous.

Table 20 - Mean table for intermediate-level engineer's perception of the ten highest ranked skills and competencies

Years of experience as an Engineer			
Intermediate Level (4 - 6 years)			
	Mean	N	Std. Deviation
Communication (talking to convey information effectively)	4.88	8	.354
Read comprehension (understanding written sentences and paragraphs in work related documents)	4.88	8	.354
Problem Identification (identifying the nature of problems)	4.75	8	.463

Project Management skills	4.63	8	.518
Leadership - Make decisions ethically and understanding ethical responsibilities	4.63	8	.518
Active Listening (listening to what other people are saying and asking appropriate questions)	4.63	8	.518
Identification of key causes (identifying the things that must be changed to achieve a goal)	4.63	8	.518
Solution Appraisal (observing and evaluating the outcomes of problem solution to identify lessons learned or redirect efforts)	4.63	8	.518
Critical Thinker (using logic and analysis to identify the strengths and weaknesses of different approaches)	4.62	8	.518
Visioning (developing an image of how a system should work under ideal conditions)	4.62	8	.518

Table 21 below shows the ten highest ranked skills and competencies for an engineering leader from the perception of senior engineers based on the mean ranking of the results collected. Again, communication is ranked highest among senior engineers. This finding underscores the critical role of effective communication in conveying information, aligning team members' efforts, and fostering a collaborative work environment conducive to innovation and success. Beyond simply relaying messages, effective communication empowers engineering leaders to articulate visions, clarify goals, and inspire their teams toward shared objectives. It also facilitates the exchange of ideas, enabling diverse perspectives to be considered and integrated into problem-solving processes.

From the perspective of senior engineers, the skill of active listening holds significant importance for engineering leaders. Senior engineers understand that effective leadership requires more than just giving instructions or making decisions; it involves truly understanding team members' and stakeholders' needs, concerns, and perspectives. Active listening allows leaders to engage with others meaningfully, demonstrating respect, empathy, and openness to diverse viewpoints.

Table 21 - Mean table for senior-level engineers' perceptions of the ten highest rank skills and competencies

Years of experience as an Engineer Senior Level (>7 years)			
	Mean	N	Std. Deviation
Communication (talking to convey information effectively)	4.68	25	.476
Active Listening (listening to what other people are saying and asking appropriate questions)	4.60	25	.577
Critical Thinker (using logic and analysis to identify the strengths and weaknesses of different approaches)	4.56	25	.651
Read comprehension (understanding written sentences and paragraphs in work related documents)	4.52	25	.586
Leadership - Make decisions ethically and understanding ethical responsibilities	4.48	25	.586
Interpersonal skill - empowering employees so that they can conduct their responsibilities effectively	4.44	25	.712
Interpersonal skill - managing people	4.44	25	.583
Leadership - Communicate direction including a shared understanding of the direction	4.44	25	.583
Interpersonal skill - being able to have tough conversations	4.44	25	.507
Problem Identification (identifying the nature of problems)	4.44	25	.712

Table 22 below shows the ten highest ranked skills and competencies for an engineering leader from the engineering manager/leaders based on the mean ranking of the results collected. The highest-ranked skill was critical thinking, an essential skill as an engineering leader as they typically need to solve issues in an organisation with current resources. Active listening is essential for engineering leaders as they need to engage with their teams, understand their perspectives, and foster a collaborative and inclusive work environment. Active listening also enables us to build strong relationships, inspire trust and drive success. Again, as seen with the juniors, intermediates, and seniors, communication is ranked highly, showing the importance of communication for engineering leaders.

Active learning is a skill that does not appear among the highly-ranked skills from the perspective of junior, intermediate or senior engineers. Active learning is a crucial skill for

engineering leaders as it enables them to stay current with industry advancements, expand their knowledge base and adapt to evolving technologies and practices. Active learning demonstrates a commitment to personal and professional growth, continuously seeking opportunities to enhance their skills, expertise and leadership capabilities. This fosters a culture of innovation and continuous improvement within organisations.

Finally, problem identification is essential for engineering leaders as it allows them to anticipate, recognise and address challenges with their teams and projects. Engineering leaders who excel in problem identification possess a keen ability to analyse complex situations, identify underlying issues, and prioritize areas for improvement.

Table 22 - Mean table for management/leader level engineer's ten best highest ranked skills and competencies

Years of experience as an Engineer			
Engineering Management/leader (>10 years)			
	Mean	N	Std. Deviation
Critical Thinker (using logic and analysis to identify the strengths and weaknesses of different approaches)	4.66	32	.545
Active Listening (listening to what other people are saying and asking appropriate questions)	4.62	32	.554
Communication (talking to convey information effectively)	4.56	32	.564
Active learning (working with new information to grasp its implications)	4.47	32	.671
Problem Identification (identifying the nature of problems)	4.44	32	.564
Interpersonal skill - being able to have tough conversations	4.38	32	.707
Identification of key causes (identifying the things that must be changed to achieve a goal)	4.28	32	.634
Leadership - Communicate direction including a shared understanding of the direction	4.28	32	.581
Business - Set direction including establishing a strategy	4.28	32	.634
Leadership - Make decisions ethically and understanding ethical responsibilities	4.25	32	.762

6.3 Research Question Three – Ranking of Leadership Pillars

Table 23 shows the general mean ranking of the four leadership skills. These results provide insights into how the mean ratings of various skills and competencies change across different experience levels as an engineer, specifically focusing on cognitive, interpersonal, business, strategic, and other skills.

1. **Cognitive Skills:**
    - The average mean ranking was higher than the other skill groups provided.
    - The mean ratings for cognitive skills generally increase with experience, with the highest mean rating observed in the intermediate level (4 - 6 years) category.
    - The perception to cognitive skills for engineering leaders remains high through the various career stages, showing that cognitive skills remain critical for an engineering leader from any career stage.
2. **Interpersonal Skills:**
    - Similar to cognitive skills, the mean ratings for interpersonal skills also increase with experience, peaking in the senior level (> seven years) category.
    - The increasing perception of the importance of interpersonal skills for engineering leaders suggests the critical role these skills play as leaders advance in their careers. Effective communication, collaboration, and interaction with others become increasingly vital for engineering leaders as they navigate complex projects and teams.
3. **Business Skills:**
    - The mean ratings for business skills show some variation across experience levels but generally remain consistent.

- While there is a slight increase in mean ratings from junior to intermediate levels, there is a slight decrease in the senior level before returning to a similar level in the engineering management/leader category.
- This indicates that engineering leaders need to have a solid understanding of business-related skills, such as resource management and operational analysis, early in their careers, with fluctuations as they progress into leadership roles.

4. **Strategic Skills:**
    - The mean ratings for strategic skills exhibit a similar pattern to cognitive and interpersonal skills, increasing with experience and peaking in the intermediate and senior levels.
    - This indicates that engineers perceive strategic skills as crucial for engineering leaders, underscoring the necessity for leaders to provide strategic direction and vision to guide engineering teams effectively.
5. **Other Skills:**
    - The mean ratings for other skills show some variability across experience levels, with the highest mean rating observed in the junior-level category.
    - This category likely encompasses additional skills not specifically categorized under cognitive, interpersonal, business, or strategic skills, and the variability may reflect the diverse nature of skills developed by engineers at different career stages.

Table 23 - Mean Ranking of Leadership Skill Pillars across engineer's experience

Report

Mean

	Years of experience as an Engineer			
	Junior Level (0 - 3 years)	Intermediate Level (4 - 6 years)	Senior Level (>7 years)	Engineering Management/leader (>10 years)
Cognitive Skills Mean	4.36	4.65	4.49	4.43
Interpersonal Skills Mean	3.75	4.00	4.12	3.90

Report

Mean

	Years of experience as an Engineer			
	Junior Level (0 - 3 years)	Intermediate Level (4 - 6 years)	Senior Level (>7 years)	Engineering Management/leader (>10 years)
Business Skills Mean	3.99	4.10	3.88	3.98
Strategic Skills Mean	3.98	4.25	4.04	4.06
Other Skills Mean	4.15	4.06	3.90	4.09

6.4 Kruskal-Wallis H test discussion

The Kruskal-Wallis test results as seen in Table 24 below, reveal significant differences in perception the mean rating of skills and competencies for engineering leaders among groups based on years of experience as an engineer for several vital skills: project management, interpersonal skills (specifically, the ability to have tough conversations), reading comprehension, and leadership ability to influence others.

Project Management Skills: The significant p-value of .000 indicates statistically meaningful differences in project management skills for engineering leaders from the perception engineers to engineering leaders. This suggests that the experience level influences an engineer's perception to project management skills.

Interpersonal Skills - Having Tough Conversations: The p-value of .018 indicates significant differences engineering leaders have in the ability to have tough conversations across different experience levels. Engineers with varying years of experience may exhibit different proficiency levels in handling challenging interpersonal situations.

Reading Comprehension: The p-value of .036 suggests significant differences for engineering leaders for the perception of reading comprehension skills among engineers with different experience levels. This implies that the ability to understand written documents related to work varies across experience levels.

Leadership - Ability to Influence Others: With a p-value of .039, there are statistically significant differences in leadership skills, particularly the ability to influence others, based on years of experience. This indicates that engineers' effectiveness in leadership roles may be influenced by their experience level.

Table 24 - Kruskal-Wallis H Test results - significant values only

Test Statistics[a,b]

	Kruskal-Wallis H	df	Asymp. Sig.
Project Management skills	20.207	3	.000
Interpersonal skill - being able to have tough conversations	10.012	3	.018
Read comprehension (understanding written sentences and paragraphs in work related documents)	8.549	3	.036
Leadership - Ability to influence others	8.362	3	.039

a) Kruskal Wallis Test

b) Grouping Variable: Years of experience as an Engineer

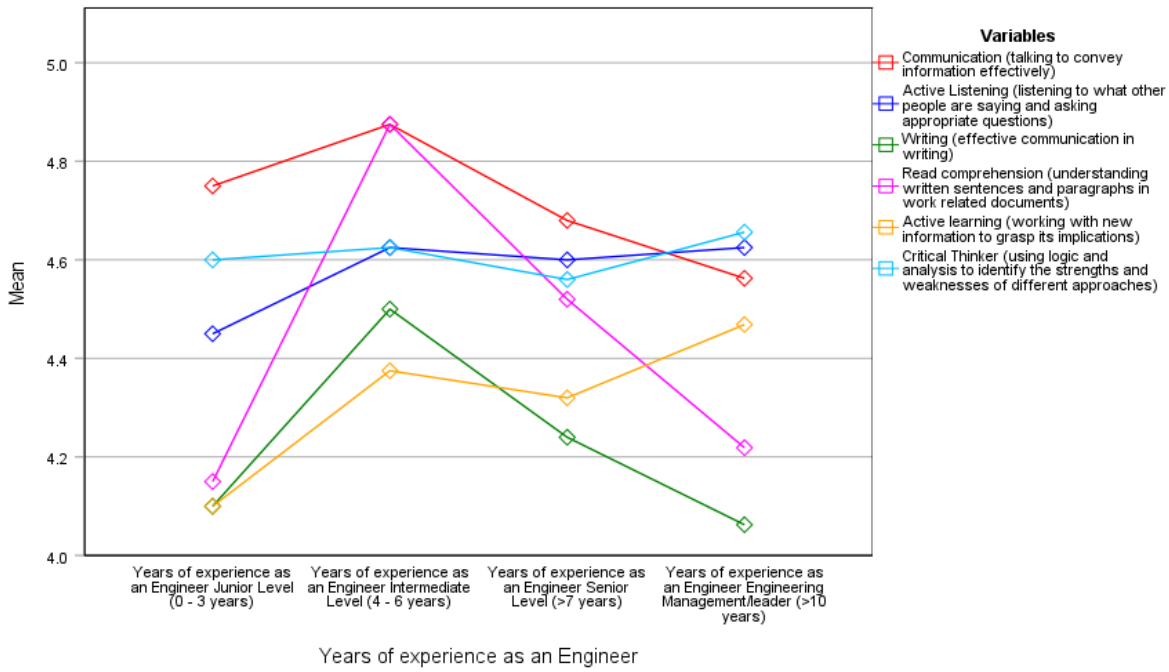

Figure 3 - Mean vs Engineer's Experience for Cognitive Skills

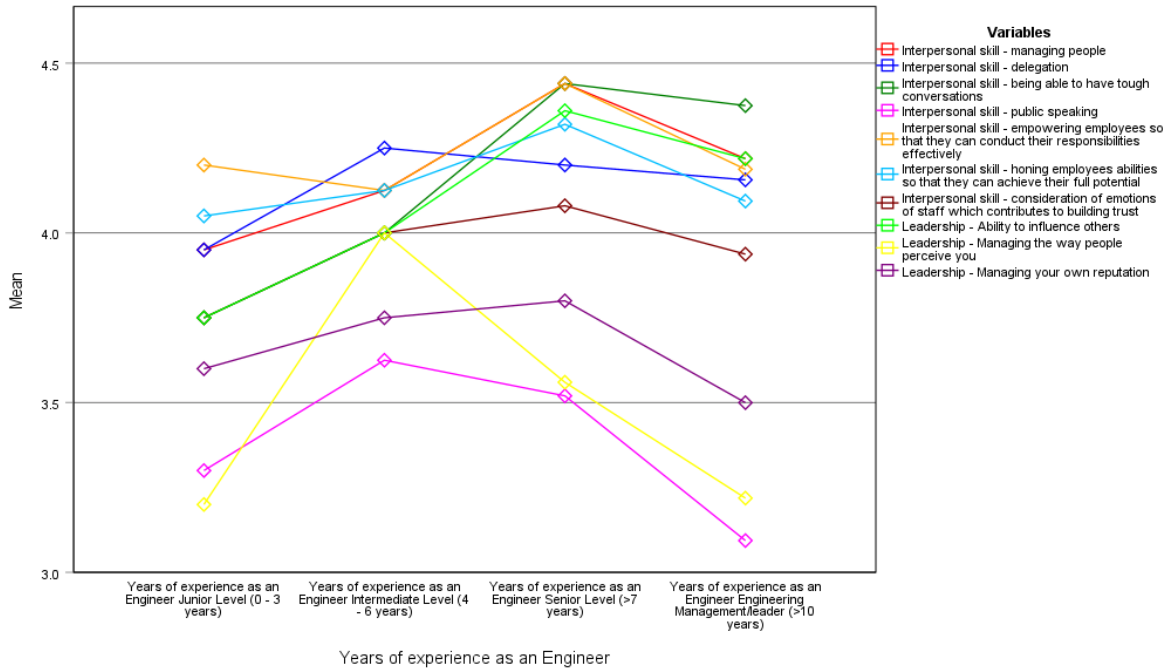

Figure 4 - Mean vs Engineer's Experience for Interpersonal Skills

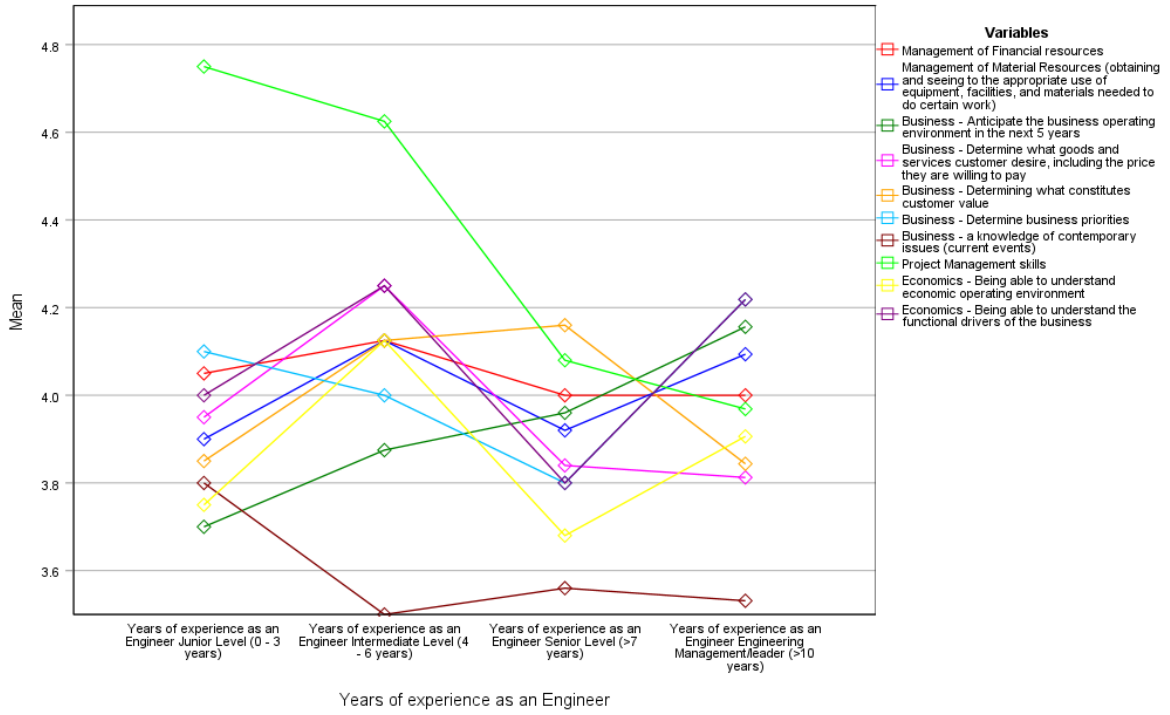

Figure 5 - Mean vs Engineer's Experience for Business Skills

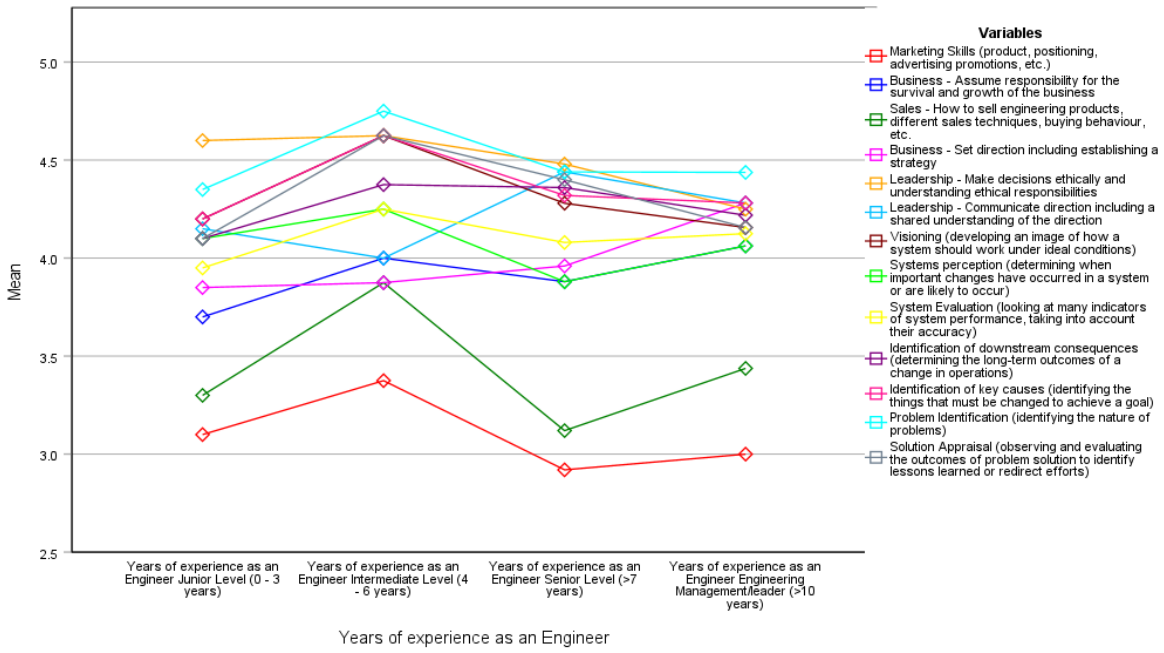

Figure 6 - Mean vs Engineer's Experience for Strategic Skills

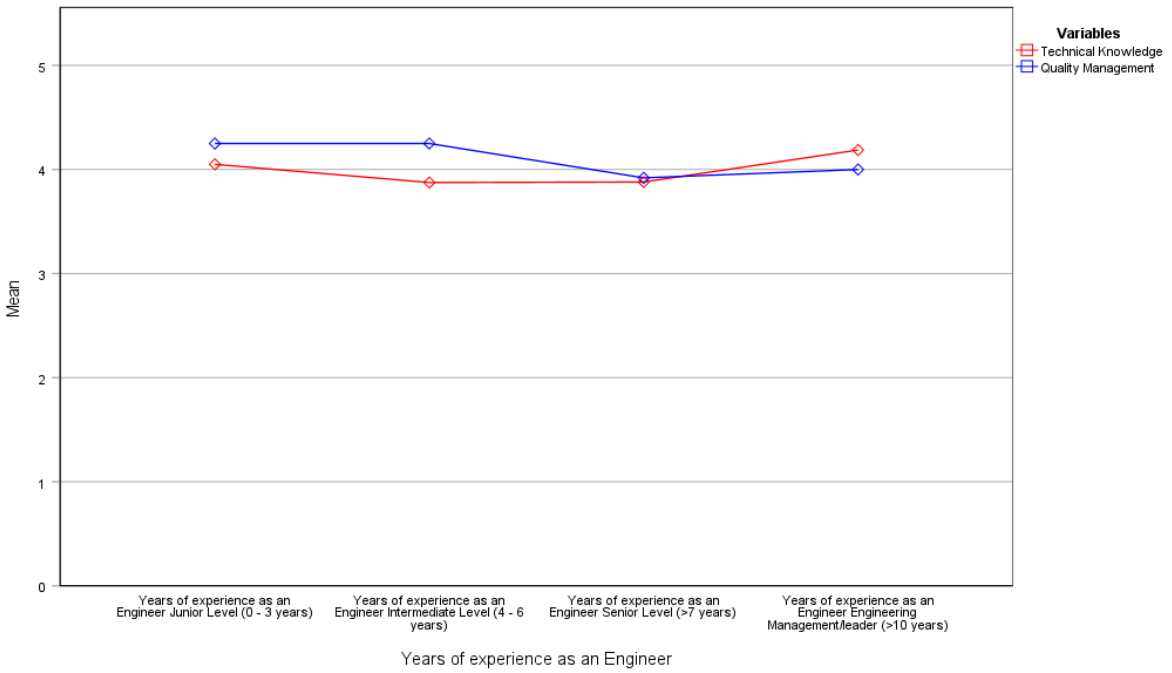

Figure 7 - Mean vs Engineer's Experience for Other Skills

Figure 3, Figure 4, Figure 5, Figure 6 and Figure 7 show the average mean rating of each skill and competency in their respective category against the years of experience as an engineer. Most skills are rated equally from a junior engineer to an engineering leader, except for reading comprehension, having tough conversations, project management skills, and the ability to influence others. This shows the significant difference in perception of these skills over the experience range. Accumulated Experience and Skill Development: Engineers typically gain practical experience and develop their skill sets as they progress. More experienced engineers may have encountered a broader range of project management scenarios, challenging interpersonal situations, and leadership opportunities, allowing them to refine their skills over time.

Exposure to Diverse Situations: Engineers with different experience levels may have been exposed to varying complexity and diversity in their work environments. This exposure can significantly impact their ability to manage projects, engage in challenging conversations, comprehend written materials, and influence others effectively.

Learning and Adaptation: With increasing experience, engineers learn from past experiences, adapt to new challenges, and refine their approaches to project management, interpersonal interactions, reading comprehension, and leadership. This continual learning process contributes to the observed differences in skill proficiency across experience levels.

Mentorship and Guidance: Junior engineers may have limited exposure to mentorship and guidance compared to more experienced engineers who have benefitted from years of working alongside seasoned professionals. Mentorship can be crucial in developing essential skills such as project management, interpersonal communication, reading comprehension, and leadership.

Responsibility and Decision-Making Authority: Engineers at different experience levels may have varying levels of responsibility and decision-making authority within their roles. More experienced engineers often hold leadership positions where they are required to exert influence,

make critical decisions, manage complex projects, and engage in challenging conversations, leading to differences in skill proficiency compared to junior engineers.

These findings suggest that discussions surrounding skill development, training, and mentorship programs within engineering teams should consider the varying skill levels associated with different experience levels. Strategies for enhancing project management, interpersonal skills, reading comprehension, and leadership abilities may need to be tailored to address the specific needs of engineers at different stages of their careers. Additionally, these results may prompt further exploration into the factors contributing to skill disparities among engineers with varying experience levels and inform efforts to promote professional growth and development within the engineering field.

7. Conclusions and Recommendations

In this comprehensive exploration of leadership skills and competencies within the engineering domain, this analysis has provided invaluable insights into the multifaceted nature of effective leadership across different experience levels. By delving into the perceptions of engineers at various career stages and conducting statistical analyses, this study has illuminated critical areas of strength and areas for improvement in leadership development.

7.1 Conclusion to Research Question One

The analysis of skills and competencies among engineers provides valuable insights into the strengths and areas for development within the engineering leadership landscape. By examining the highest and lowest-ranked skills, we gain a comprehensive understanding of the multifaceted role of engineering leaders and the challenges they face in today's dynamic work environment.

At the forefront of effective leadership in engineering is the importance of strong communication skills, critical thinking, ethical decision-making, adaptability, and problem-solving abilities. These foundational skills enable leaders to navigate complex projects, empower teams, and uphold ethical standards, all essential for driving organisational success in the rapidly evolving technological landscape.

However, our analysis also highlights areas where engineering leaders may fall short, particularly in skills such as marketing, public speaking, sales, and interpersonal dynamics. Often, these skills are undervalued or overlooked in favour of technical expertise, leading to missed opportunities for effective leadership and organisational growth.

To address these gaps, engineering leaders must recognize the significance of these overlooked skills and actively seek development opportunities. By prioritising professional growth in marketing, public speaking, and sales, leaders can enhance their effectiveness, improve team dynamics, and drive innovation within their organisations.

Furthermore, organisations must support leadership development initiatives that focus on technical and soft skills, fostering a culture of continuous learning and professional growth. By investing in developing well-rounded engineering leaders, organisations can position themselves for long-term success in an increasingly competitive and complex business landscape.

In conclusion, the analysis of skills and competencies among engineers underscores the importance of a balanced skill set and continuous development for effective leadership in the engineering domain. By addressing areas of weakness and building upon strengths, engineering leaders can better navigate challenges, inspire innovation, and drive organisational success in today's fast-paced and ever-changing world.

7.2 Conclusion to Research Question Two

Exploring skills and competencies from the perspectives of engineers at different experience levels provides valuable insights into the evolving demands and priorities within the engineering leadership landscape. By examining the perceptions of junior, intermediate, senior-engineers and engineering managers/leaders, we gain a nuanced understanding of the skills deemed most critical for effective leadership in the field of engineering.

Across all experience levels, effective communication emerges as a consistent top-ranking skill for engineering leaders. This underscores the importance of clear and concise communication in conveying information, aligning team efforts, and fostering collaboration. Additionally, active listening is highlighted as essential, enabling leaders to engage with their teams, understand diverse perspectives, and cultivate inclusive work environments conducive to innovation and success.

Furthermore, critical thinking is universally recognized as a fundamental competency for engineering leaders. This skill empowers leaders to analyse complex problems, devise innovative solutions, and navigate evolving challenges effectively. From problem identification to project

management, engineering leaders must demonstrate critical thinking abilities to guide their teams and organisations toward success.

While specific skills, such as active learning, may not be highly ranked among engineers at all experience levels, they emerge as crucial for engineering managers and leaders. Active learning enables leaders to stay abreast of industry advancements, expand their knowledge base, and adapt to evolving technologies and practices, fostering a culture of innovation and continuous improvement within organisations.

In conclusion, the varying perspectives on skills and competencies underscore the dynamic nature of engineering leadership and the need for leaders to develop and adapt their skill sets continuously. By prioritizing effective communication, active listening, critical thinking, and a commitment to ongoing learning, engineering leaders can navigate challenges, inspire innovation, and drive organisational success in today's rapidly evolving engineering landscape.

7.3 Conclusion to Research Question Three

Analysing leadership skill pillars across different experience levels among engineers' perceptions offers valuable insights into the evolving skill development trajectory. By examining cognitive, interpersonal, business, strategic, and other skills, we understand how engineers' competencies evolve as they progress in their careers.

1. Cognitive Skills:

The data reveals a consistent trend of increasing mean ratings for cognitive skills with experience, peaking at the intermediate level (4 - 6 years) before slightly tapering off at the senior level (> seven years). This trend underscores the progressive development of vital cognitive abilities such as critical thinking, problem-solving, and decision-making as engineers gain more experience. It suggests that engineers become more adept at analysing complex issues and devising practical solutions over time.

2. Interpersonal Skills:

Similar to cognitive skills, interpersonal skills also exhibit an upward trend in mean ratings with experience, reaching their peak at the senior level (> seven years). This indicates that engineers tend to enhance their ability to communicate, collaborate, and interact effectively with others as they advance in their careers. It underscores the importance of strong interpersonal skills in fostering productive relationships and teamwork within engineering environments.

3. Business Skills:

While the mean ratings for business skills show some variation across experience levels, they generally remain consistent, with slight fluctuations observed. This suggests that engineers may develop a solid understanding of business-related skills early in their careers, with fluctuations occurring as they progress into more senior roles. It underscores the importance of engineers acquiring skills in resource management, operational analysis, and strategic planning to complement their technical expertise.

4. Strategic Skills:

The data indicates a consistent increase in mean ratings for strategic skills with experience, peaking at the intermediate and senior levels. This reflects engineers' growing proficiency in strategic thinking, including visioning and system evaluation, as they gain more experience and assume leadership positions. It underscores the significance of strategic acumen in guiding organisational decision-making and driving long-term success.

5. Other Skills:

The variability in mean ratings for other skills across experience levels reflects the diverse nature of skills developed by engineers at different career stages. While the highest mean rating is observed in the junior-level category, indicating early skill acquisition, there is some fluctuation in

subsequent levels. This suggests that engineers continue to refine and expand their skill sets beyond the core pillars of cognitive, interpersonal, business, and strategic skills, reflecting the dynamic nature of the engineering profession.

In conclusion, the analysis underscores the positive trend of skill development and enhancement across experience levels among engineers. It highlights the importance of continuous learning, professional growth, and skill diversification in meeting the evolving demands of the engineering profession and driving innovation and success in today's complex technological landscape.

7.4 Conclusion to Research Question Four

In conclusion, the findings from the Kruskal-Wallis H test emphasize the importance of considering experience levels when designing skill development, training, and mentorship programs within engineering teams. Organisations can better support their engineering talent's professional growth and development by acknowledging and addressing the varying skill levels associated with different experience levels. Moreover, further exploration into the underlying factors contributing to skill variations among engineers with differing experience levels can guide efforts to foster a culture of continuous learning and advancement within the engineering profession.

The findings underscore the critical importance of a diverse skill set for engineering leaders, encompassing cognitive, interpersonal, business, strategic, and other essential skills. Communication is a cornerstone skill for conveying information effectively, articulating visions, and fostering collaboration among team members. Critical thinking, ethical decision-making, and problem-solving abilities are highlighted as indispensable traits for navigating the complexities of engineering projects and organisational dynamics.

Furthermore, our analysis reveals significant differences in skill perceptions across different experience levels, emphasising the need for tailored approaches to skill development and training.

While junior engineers prioritise foundational skills such as communication and project management, senior leaders emphasise active listening and strategic thinking.

Engineering organisations must prioritise cultivating these skills through tailored development programs, mentorship initiatives, and a culture of continuous learning. By promoting soft skills alongside technical expertise and fostering cross-functional collaboration, organisations can nurture a pipeline of skilled leaders capable of driving innovation, fostering collaboration, and achieving sustainable success in today's dynamic business environment.

However, it is essential to recognise that leadership development is an ongoing journey requiring commitment, investment, and adaptability. As the engineering landscape evolves, leaders must remain agile, open to new perspectives, and dedicated to personal and professional growth.

In conclusion, this study provides a roadmap for enhancing leadership effectiveness within the engineering domain, empowering individuals to navigate challenges, inspire innovation, and drive organisational growth. Engineering organisations can thrive in an ever-changing world by embracing the principles of effective leadership and fostering a culture of continuous improvement.

7.5 Recommendations:

Tailored Skill Development Programs: Engineering organisations should design and implement tailored skill development programs that address the specific needs of engineers at different experience levels. These programs should enhance communication, critical thinking, project management, and interpersonal skills to empower engineers to thrive in leadership roles.

Mentorship and Coaching: Establishing mentorship and coaching programs can facilitate knowledge transfer and skill development among engineers. Experienced engineering leaders can mentor junior colleagues, providing guidance, support, and opportunities for professional growth.

Continuous Learning: Encouraging a culture of continuous learning and professional development is essential for engineering organisations. Engineers should be encouraged to pursue

further education, attend workshops and seminars, and engage in self-directed learning to stay abreast of industry advancements and emerging technologies.

Promotion of Soft Skills: Engineering organisations should prioritize promoting soft skills such as public speaking, sales, and interpersonal communication alongside technical expertise. Recognising the importance of these skills in driving project success and team cohesion can help cultivate well-rounded engineering leaders.

Cross-Functional Collaboration: Facilitating cross-functional collaboration between engineering teams and other departments, such as marketing, sales, and business development, can broaden engineers' perspectives and enhance their understanding of the broader organisational context. This collaboration can foster innovation and drive business growth.

In conclusion, by addressing the identified skill gaps and promoting a culture of continuous learning and collaboration, engineering organisations can cultivate a diverse pipeline of skilled leaders capable of navigating the complexities of today's dynamic technological landscape and driving sustainable organisational success.

Future research could explore the significant differences in the four skills and competencies that changed over the years of experience as an engineer. What are the initiating factors for engineers transitioning from technical positions to general management? Explore how cultural factors influence the perception and development of leadership skills among engineers in different regions or countries. Cross-cultural studies can provide valuable insights into the universality of specific leadership skills and the cultural nuances that shape leadership practices and behaviours within engineering organisations. Explore the role of gender and diversity in engineering leadership, including the representation of women and underrepresented groups in leadership positions, the impact of diversity on team performance and innovation, and strategies for promoting inclusivity and equity within engineering organisations.

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Annexures

a. Annexure A – Engineering responses

'Figure 8 - People reporting to respondents' results

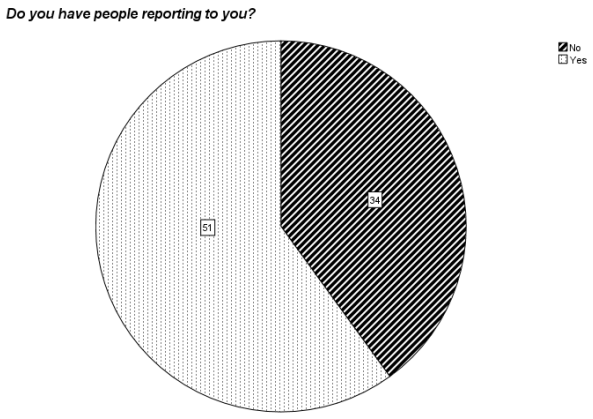


Figure 9 - Managers reporting to respondent's results

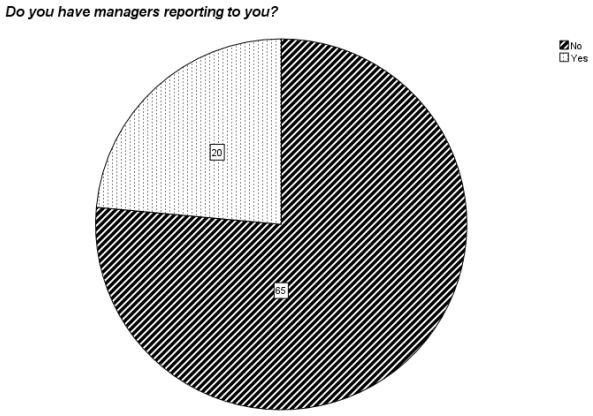
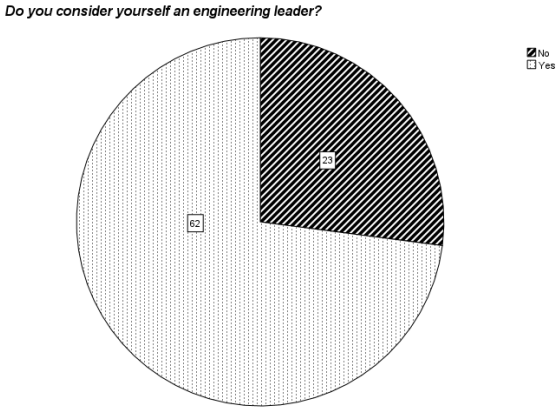


Figure 10 - Results of respondents to being an engineering leader



b. Annexure B – Research Proposal and Proposal Results

Gordon Institute of Business Science
University of Pretoria

Leadership skills for engineering leaders: the followers' perspective

10005146

A research proposal submitted to the Gordon Institute of Business Science, University of Pretoria, in partial fulfilment of the requirements for the degree of Master of Business Administration.

Table of Contents

1. Definition of Problem and Purpose

1.1. Research Problem

Engineers are professionals who are problem-solvers who use their knowledge of science, technology, engineering and mathematics (STEM) to design, build and test equipment, structures and systems. Engineers work to meet the functional requirements of their respective projects while considering practicality, regulation, safety and cost limitations.

Schell et al. (2022) recognise engineers in various fields require the need to develop into more than technical experts but also technical leaders. Technical leaders will be essential for driving innovation and helping organisations stay ahead of the competition.

Rottmann et al. (2015) show that engineers are reluctant to be engineering leaders. Hirudayaraj et al. (2021) define soft skills are not skills or competencies, but rather amalgamations of interpersonal skills and personal attributes that complement technical skills traditionally required for engineering success. These soft skills are not a fixed list of skills and competencies, they range from social skills, personal traits and even self-management skills. Hirudayaraj et al. (2021) also noted that the soft skills required for engineering leaders are not the same as soft skills for regular technical engineers at various stages of their respective careers.

Schuhmann (2010) considers the study of leadership to be a well-defined and mature field of study but engineering leadership is still an imprecise field of study. In the field of engineering leadership education, Didiano et al. (2022) provide educational approaches used to develop engineering students' leadership development. This research compares these skills elaborated and analyses the perception of engineers (graduate level to senior level) of the importance of these skills and competencies for engineering. Then examining the perception of engineering leaders regarding the same skills and competencies.

1.2. Research Purpose

The purpose of this research is to provide insight into the skill and competencies required for engineering leaders from the perspective of the followers. The main objective is to identify the key skills and competencies and determine the rankings of the most important from the perceptions of various level engineers.

The purpose of this research could have positive implications for the development of engineering leaders which could lead to the overall success of engineering teams and organisations. Finally, also develop strategies to narrow the gap between the perception of engineers and engineering leaders for skills and competencies for engineering leader positions.

1.3. Research Questions

Q1: What skills and competencies should an engineering leader have from the perception of engineering followers?

From soft skills, technical skills and business competencies, proficiency in different skills will be compared from the perception of an engineer. This will be completed in by conducting research looking for keywords; such as leadership, engineering leader, technical leaders, leadership skills and engineering management.

Q2: To determine the ranking of various skills and competencies for engineering leaders from the perception of various levels of engineers

The research question aims to rank the skills and competencies essential for a successful engineering leader. To achieve this, data collection will be conducted through a survey. The survey will seek to gather perceptions and opinions from participants, allowing them to rank the identified skills and competencies based on their perceived importance in an engineering leadership role.

Q3: Determine possible relationships between the perceptions of various level engineers and engineering leaders can be discovered?

Through statistical analysis of the data collected from questionnaires, this research aims to explore the relationship between engineers' perceptions and the experience of engineering leaders. By examining how engineers rank the identified skills and competencies for successful leadership, the study seeks to bridge the gap and provide valuable insights to support engineers transitioning into management positions.

2. Literature Review

2.1. Introduction

The literature review aims to get an improved understanding of leadership and leadership skills.

2.2. Leadership

Leadership has been studied extensively over the years and has taken on much greater importance as the world evolves. Leadership is defined as the ability of an individual to influence and guide followers or members of an organisation, society or team.

Farr et al. (1997) provide nine leadership attributes for effective leaders as found in Figure 1 below.

Figure 1: Nine Leadership Attributes (Farr & Brazil, 2009)

Effective leaders must be big thinkers which is a strategic point of being able to see the bigger picture of the organisation and the main mission of the organisation. A leader needs to have good ethics and be courageous as this will influence the followers and will affect the actions of the followers. Leaders are required to be courageous which includes enduring, remaining ethical and making correct decisions. Leaders need to be adaptive and be able to master change in the ever-changing team, cultural and technology environments. Leaders need to be risk-takers and have the courage to start new projects, make important changes and be ethical. Leaders need to focus on the grand strategy or main mission that matters for the organisation or department. Being committed to the main mission can inspire and motivate followers, it is important that the leader communicates this main mission effectively and get buy-in from followers. Leaders also need to build the correct team to operate at full potential to achieve the main mission.

2.3. Leadership Skills

The ability to acquire and improve leadership skills is influenced by various factors, the individual differences in cognitive capacities, personalities, temperaments, emotion control, identities and values from cultural and personal experiences.

Guzmán et al. (2020) organised leadership skills into four groups: 1) cognitive skills, which are skills that are required to understand the behaviour of patterns, requiring creative thinking, decision making and problem-solving; 2) interpersonal skills, face-to-face interactions, to bring about desired results; 3) business skills, the skills to operate an organisation, financially, personally and operationally; 4) strategic skills, which are skills to achieve organisations' mission and vision.

Table 1 - Four Group of Leadership Skill (Guzmán et al., 2020)

Cognitive Skills	Business Skills	Interpersonal Skills	Strategic Skills
CS1: Speaking CS2: Active Listening CS3: Writing CS4: Reading comprehension CS5: Active Learning CS6: Critical Thinking	BS1: Operations analysis BS2: Management of personnel resources BS3: Management of financial resources BS4 Management of material resources	IS1: Social Perceptiveness IS2: Coordination IS3: Negotiation IS4: Persuasion	SS1: Visioning SS2: Systems perception SS3: System Evaluation SS4: Identification of downstream consequences SS5: Identification of key causes SS6: Problem identification SS7: Solution appraisal

2.4. Engineering Leadership

As engineers climb up the corporate ladder with every increasing responsibility, leadership skills becomes a more essential skills than technical skills. Chetty (2012) shows in Figure 2 below that as an engineer moves with seniority, leadership skills are important to success.

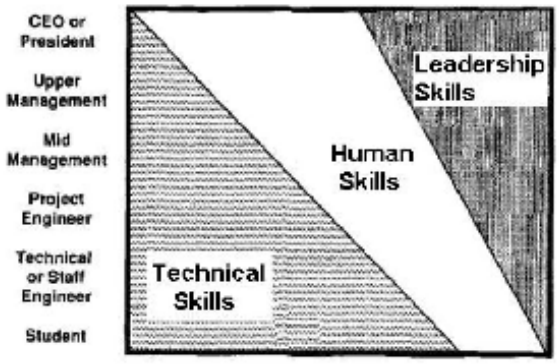


Figure 2: Evolution in skills of a successful engineer (Chetty, 2012)

Schell and Hughes (2022) and Rottmann et al. (2015) found three traits grounded in professional engineers; 1) technical mastery – technical experts willing to mentor others; 2) collaborative optimisation – engineers with the ability to build high-performing teams; 3) organisational innovation – entrepreneurial thinkers who bring engineering solution to market.

Engineering leadership is more complicated than other sectors, to be successful in engineering leadership other additional skills are required, that additional skills are technology leadership and governance. Engineering leaders are employed to lead technology-based companies that focus on a short-term product cycle of weeks instead of years (Farr & Brazil, 2009).

Odusami (2002) listed ten essential skills for project managers;

1) Team Building Skills – the ability to use everyone's strength from various disciplines in an effective team.
2) Leadership Skills – the ability to lead a team and integrate individuals' strengths and weaknesses and lead individuals that will affect performance.
3) Conflict Resolution Skills – the ability to navigate conflicts in a fair and respectful man that will foster a positive work environment.
4) Technical Skills – the ability to manage technological innovation and adoption of solutions.
5) Planning Skills – the ability to prepare the team for projects that require good communication and information-pressing skills
6) Organisational Skills – the ability to understand the hierarchy of an organisation, and the reporting relationships and control within technical departments.

7) Entrepreneurial Skills – the ability to identify and chase objectives that will lead to the success of the project or team, understanding the big picture.
8) Administrative Skills - Project managers need to have strong administrative skills to effectively lead their teams and ensure that projects are completed on time and within budget. Some key administrative skills for project managers include organization, time management, communication, and problem-solving.
9) Management support-building skills – the ability to build strong personal relationships with senior management or directors.
10) Resource Allocation Skills - This involves identifying the resources needed for a project, such as personnel, equipment, and funds, and then allocating them most efficiently and effectively possible.

3. Research Methodology and Design

3.1. Choice of Methodology

The planned method of research will be a single method, which will be quantitative. Which is the collection of categorical or numerical data. Categorical data is data that has been prepared in a descriptive set or arranged in a particular order. Numerical data is the measuring of data using numbers.

3.1.1. Purpose of research design

With the planned research of ranking skill requirements from the perception of various level engineers, the purpose of the research design will be a descriptor-explanatory design. The plan is to use descriptive data to explain relationships and bridge the gap in skills and competencies for engineering leaders.

3.1.2. Research Philosophy

Due to the quantitative nature of the research, the research philosophy will be positivism. Positivism is knowledge acquired by using data and facts unaffected by emotion or human interpretation (Saunders & Lewis, 2017). With this research, the idea is to take an existing theory and develop hypotheses that will expand the theory with new causal relationships from another theory.

3.1.3. Research Approach

The deductive research approach is the assessing of hypotheses using collecting data (Saunders & Lewis, 2017). This research is to find a causal relationship between the skills and competencies from the perception of various levels of engineers

3.1.4. Research Methodology Choice

Mono, firstly as recommended by the GIBS research guide and the time constraints for the research. A mono methodological choice will be used which is a single data collection and analysis, in this case, quantitative data collection and analysis will be completed.

3.1.5. Research Strategy

The strategy to collect data for this research will be electronic surveys. The structured survey employing an electronic questionnaire will provide data and the data will be analysed to determine if the hypothesises are valid or not.

3.1.6. Research Time Horizon

A cross-sectional time horizon will be used as questionnaires will be asked at only one period during the research. The survey is a once-off or "snap-shot". Participants of the questionnaires will only be asked once and the data will be analysed on the collective results of the questionnaires.

3.2. Population

This study aims to target a diverse range of individuals currently employed in the engineering field, including graduates, mid-level engineers, and executive-level professionals across various industries and sectors. The research will focus on engineering leaders and engineers from different disciplines, such as mechanical, chemical, and electronic engineering, to facilitate communication and bridge the gap between them. The objective is to gain a comprehensive understanding of the skills and competencies necessary for engineers to advance in their careers.

3.3. Unit of Analysis

Firstly, doing an in-depth literature review searching for skills and competencies that are required for leaders in other fields of operations compare those skills and competencies

required for an engineering leader as Odusami (2002) and Farr and Brazil (2009). Then from these various types of skills and competencies adapt/develop a standardised questionnaire that will be used to collect data from a respectively large number of respondents via electronic surveying application. The final unit of analysis will be the ranking of skills and competencies for engineering leaders from the perceptions of various levels of engineers.

3.4. Sampling Method and Size

It is crucial to ensure that the data collected for quantitative research is both accurate and representative. To achieve this, careful consideration must be given to the sampling method and size. For the questionnaire used in this research project, a minimum of 150 respondents is necessary. It is also essential to ensure an equal distribution of respondents across the different stages of engineering.

3.5. Measurement Instrument

The instrument used for the selected research will be done employing questionnaires. Firstly, an introduction explaining the research on ranking skills and competencies of engineering leaders will be required. The collection of basic demographics (age, gender, education level, job level and ethnicity) will be collected. To ensure that the correct demographic surveyors are collected, a basic qualifying question will be asked to ensure that engineers are the target population. Closed-ended questions will be asked to rank the various skills and competencies of engineering leaders using Likert scale questions. These close-ended questions need to be unambiguous. A few open-ended questions or areas will be provided to allow respondents to provide extra comments.

3.6. Data Gathering Process

Data collection will be done using questionnaires, where the population will be asked same the closed-end questions to build and collect data. The questionnaires will be based on adapted questions from resources gained for future literature study. Hirudayaraj et al. (2021) conducted quantitative questionnaires on the rating of soft skills required for entry-level engineers. This questionnaire will be modified to better suit engineers of different career levels, with a focus on gathering their perceptions of the skills and competencies necessary to become an engineering leader. Additionally, the same questionnaire will be utilized to gather data on the skills and competencies of current engineering leaders. The questionnaire will be developed on an electronic survey

software for instance Google Form or SurveyMonkey, which allows the respondent to complete the questionnaire at their convenience and these applications assist with the data collection and store the data to analyse at a later stage.

The questionnaire will have a list of closed-end questions, asking the respondents a few category questions to determine if the respondent is an engineering leader or an engineer and also the field of engineering the respondent operates. The main body of the questionnaire will be a rating style (Likert Scale) question to get the opinions of the respondents regarding the skills and competencies required for an engineering leader.

The distribution of the questionnaire will be done electronically, a HTML link to the questionnaire will first be distributed within social networks via various messaging (WhatsApp and Telegram) and professional social media (LinkedIn) applications. Snowballing effect within these various groups to expand the reach of the questionnaire to respondents' various professional social networks in engineering.

3.7. Analysis Approach

The questionnaire will be designed to rank various skills and competencies of a successful engineering leader from the perception of various levels of engineers. The various levels of engineers will form categorical data. The ranking of the various skills and competencies will create ordinal data (Saunders & Lewis, 2017). To ensure consistency and possible omissions of the questionnaires, the final data will be subject to editing and cleaning process.

Determining the average ranking of the ordinal data of each skill and competency will be the first step of the analysis this was followed by Odusami (2002). The categorical data will be put through an allocation phase to allocate numerical data to the categorical data to allow for easier analysis on IBM SPSS.

The data analysis will involve comparing the rankings of skills and competencies among different levels of engineers. To accomplish this, a Kruskal-Wallis H Test will be conducted. This nonparametric test allows us to assess whether there are statistically significant differences between the rankings of skills and competencies for multiple categorical groups (in this case, the various levels of engineers) on a continuous or ordinal dependent variable (the rankings of skills and competencies) (Chetty, 2012). Kruskal-Wallis's test will determine if the means are significantly different in statistics.

3.8. Quality Control

Quality control is important when conducting quantitative research in the survey strategy methodology, to ensure the collected data is accurate, reliable and valid. A few quality control points will be in place; the design of the questionnaire needs to well design, with clear and concise questions that the respondents will be able to understand, also the questionnaire needs to be free of bias or leading language to eliminate influence on the results. Initial testing of the questionnaire needs to be conducted with a group of independent respondents to assist with any issues with the questionnaire design. The correct sample and population should be appropriate for the research and a sufficient number of respondents should be collected to ensure the validity and reliability of the data. Remove insufficient data that has been collected due to incomplete questionnaires. Data analysis will be done using correct statistical methods from IBM SPSS to ensure that the results are valid and reliable. Data analysis should be done or reviewed by an independent expert in statistical analysis. The interpretation of the results needs to be done accurately and clearly without bias or incorrect representation of data, with correct figures and descriptions provided.

3.9. Limitations

For the purposed research, there are a few limitations concerning the selected research methodology. Possible limited response rate; typically, engineers are normally busy individuals which could hinder the response rate to the questionnaires, therefore it is important to ensure the questionnaire is clear and concise to ensure the questionnaire can be completed in a short period. With quantitative research, the depth of information is normally limited and often extra detailed information is required, to limit this an open-end section in the questionnaire will be provided to allow engineers to give additional feedback on the skills and competencies required for engineering leaders.

4. Project Plan

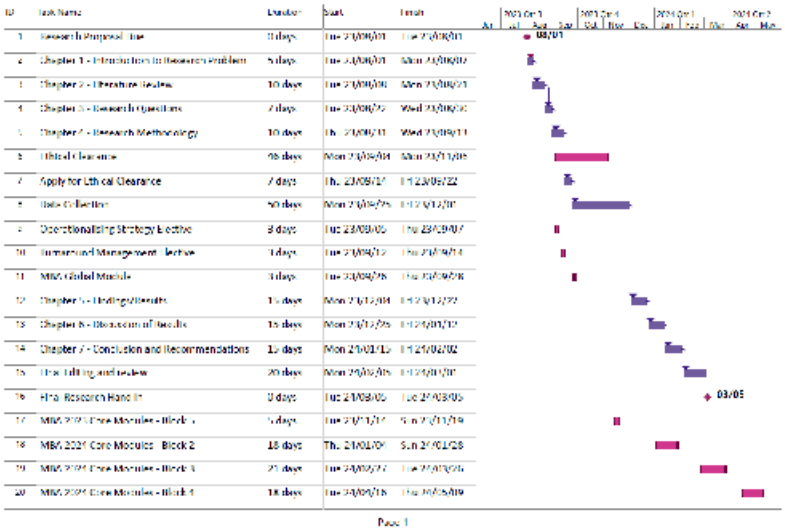


Figure 3 - MBA Project Plan

5. References

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Schuhmann, R. J. (2010). Engineering leadership education–The search for definition and a curricular approach. *Journal of STEM education: Innovations and research*, *11*(3).

Gordon Institute of Business Science
University of Pretoria

Proposal Report

Student Name: Albert Spear
Student No: 10005146
Course Name: Integrated Business Research Project (MBA Intensive) 2023.24
Research Title:

Rubric Criteria Final Feedback — Result: Pass — Symbol: C+ — Final Mark: 65.00 %

Criteria	Result	Feedback
Problem Formulation	14/20	Business and academic rational identified. The need for the research articulated but it is not clear how the research questions will contribute to the gap in research. The problem matches research questions but it is not clear how the various traits, skills of project managers and the groups from Guzman et al (2020) will be employed to in quantitative manner. It feels like too many models are clumped together in order to identify a list in Q1 that will be ranked in Q2 and then utilized to point out a relationship. It is also not clear how this will bridge the gap to support engineers to support the transition to management.
Theory base/Literature review	18/30	The literature supports the research question but is used more descriptive than offering arguments. The evolution of skills in successful engineers proposed by Chetty needs to be integrated with the various traits and skills offered to better support Q3. Literature a mix of dated and recent sources.
Methodology	18/30	Methodology covered in the standard format in a descriptive manner with very little referencing.
Referencing	8/10	Well referenced document with APA rules respected.
Literary style	7/10	Well presented document.

Gordon Institute of Business Science
University of Pretoria

Proposal Report

Student Name: Albert Spear
Student No: 10005146
Course Name: Integrated Business Research Project (MBA Intensive) 2023.24
Research Title:

Rubric Criteria Final Feedback | Result: Pass | Symbol: C+ | Final Mark: 65.00 %

Final Overall Feedback

The majority of the similarity (47%) appears to be from an assignment submitted by the student. The remainder of the similarity is linked to tables and definitions with references.

c. Annexure C – Electronic Survey

Engineering Leaders: Skills and Competencies

I am currently a student at the University of Pretoria's Gordon Institute of Business Science (GIBS-UP), and completing my research in partial fulfilment of an MBA degree.

This online questionnaire is part of a research project aimed at exploring the skills and competencies deemed essential for Engineering Leaders. The study seeks to gather insights from a diverse group of experienced engineers to gain a comprehensive understanding of their perspectives on the subject. Your participation in this survey will greatly contribute to the advancement of knowledge in the field of engineering leadership.

This is a short questionnaire that should take about 10 minutes to complete. Your participation is voluntary, and you can withdraw at any time without penalty. Your participation is anonymous and only aggregated data will be reported. By completing the survey, you indicate that you voluntarily participate in this research. If you have any concerns, please contact my supervisor or me. Our details are provided below:

Researcher Name: Albert Spear Johnstone
Email Address: 10005146@mygibs.co.za
Phone: 082 650 9748

Research Supervisor: Mr. Rhys
Email Address: johnstoneR@gibs.co.za
Phone: 011 771 4000

* Indicates required question

Qualifying Section

1. What engineering qualification do you have? *

Mark only one oval.

- ◯ Technical qualification from a college eg. Diploma, certification (NQF Level 6) *Skip to question 3*
- ◯ Bachelor of Technology in Engineering (BTech Eng) (NQF Level 7) *Skip to question 3*
- ◯ Bachelors of Engineering (BEng) or Bachelors of Science in Engineering (NQF Level 7) *Skip to question 3*
- ◯ Honours Degree in Engineering (BEng Hons) (NQF Level 8) *Skip to question 3*
- ◯ Masters in Engineering (MEng or MSc) (NQF Level 9) *Skip to question 3*
- ◯ Doctorate in Engineering (PhD) (NQF Level 10) *Skip to question 3*
- ◯ None

2. What, if any, business qualification do you have?

_____

Unqualified

We appreciate your interest in participating in the questionnaire; however, it appears that you may not meet the qualifications necessary to proceed with the survey at this time.

Demographic Section

3. Years of experience as an Engineer *

Mark only one oval.

- ◯ Junior Level (0 - 3 years)
- ◯ Intermediate Level (4 - 6 years)
- ◯ Senior Level (>8 years)
- ◯ Engineering Management/leader (>10 years)

4. Do you have people reporting to you? *

Mark only one oval.

- Yes
- No

5. Do you have managers reporting to you? *

Mark only one oval.

- Yes
- No

6. Do you consider yourself an engineering leader? *

Mark only one oval.

- Yes
- No

Skills and Competencies for Engineering Leaders

Engineering Leader - is an individual who holds a key position of authority and responsibility within the field of engineering. This role goes beyond technical expertise and involves guiding, directing, and managing engineering teams and projects. Engineering leaders are responsible for not only the technical aspects of their work but also for overseeing the strategic, managerial, and organizational facets of engineering endeavors.

If you are an Engineering Leader please rate these skills according to how important you think they are.

If not an Engineering Leader please rank skills that you want in an ideal Engineering Leader as a follower.

Please rate your response according to scale below.

Cognitive Skills

7. Communication (talking to convey information effectively) *

Mark only one oval.

- 1 - Not Important at all
- 2 - Somewhat Important
- 3 - Moderately Important
- 4 - Very Important
- 5 - Extremely Important

8. Active Listening (listening to what other people are saying and asking appropriate questions) *

Mark only one oval.

- 1 - Not Important at all
- 2 - Somewhat Important
- 3 - Moderately Important
- 4 - Very Important
- 5 - Extremely Important

9. Writing (effective communication in writing) *

Mark only one oval.

- 1 - Not Important at all
- 2 - Somewhat Important
- 3 - Moderately Important
- 4 - Very Important
- 5 - Extremely Important

10. Read comprehension (understanding written sentences and paragraphs in work related documents) *

Mark only one oval.

- 1 - Not Important at all
- 2 - Somewhat Important
- 3 - Moderately Important
- 4 - Very Important
- 5 - Extremely Important

11. Active learning (working with new information to grasp its implications) *

Mark only one oval.

- 1 - Not Important at all
- 2 - Somewhat Important
- 3 - Moderately Important
- 4 - Very Important
- 5 - Extremely Important

12. Critical Thinker (using logic and analysis to identify the strengths and weaknesses of different approaches) *

Mark only one oval.

- 1 - Not Important at all
- 2 - Somewhat Important
- 3 - Moderately Important
- 4 - Very Important
- 5 - Extremely Important

Interpersonal Skills

13. Interpersonal skill - managing people *

Mark only one oval.

- 1 - Not Important at all
- 2 - Somewhat Important
- 3 - Moderately Important
- 4 - Very Important
- 5 - Extremely Important

14. Interpersonal skill - delegation *

Mark only one oval.

- 1 - Not Important at all
- 2 - Somewhat Important
- 3 - Moderately Important
- 4 - Very Important
- 5 - Extremely Important

15. Interpersonal skill - being able to have tough conversations *

Mark only one oval.

- 1 - Not Important at all
- 2 - Somewhat Important
- 3 - Moderately Important
- 4 - Very Important
- 5 - Extremely Important

16. Interpersonal skill - public speaking *

Mark only one oval.

- 1 - Not Important at all
- 2 - Somewhat Important
- 3 - Moderately Important
- 4 - Very Important
- 5 - Extremely Important

17. Interpersonal skill - empowering employees so that they can conduct their responsibilities effectively *

Mark only one oval.

- 1 - Not Important at all
- 2 - Somewhat Important
- 3 - Moderately Important
- 4 - Very Important
- 5 - Extremely Important

18. Interpersonal skill - honing employees abilities so that they can achieve their full potential *

Mark only one oval.

- 1 - Not Important at all
- 2 - Somewhat Important
- 3 - Moderately Important
- 4 - Very Important
- 5 - Extremely Important

19. Interpersonal skill - consideration of emotions of staff which contributes to building trust *

Mark only one oval.

- 1 - Not Important at all
- 2 - Somewhat Important
- 3 - Moderately Important
- 4 - Very Important
- 5 - Extremely Important

20. Leadership - Ability to influence others *

Mark only one oval.

- 1 - Not Important at all
- 2 - Somewhat Important
- 3 - Moderately Important
- 4 - Very Important
- 5 - Extremely Important

21. Leadership - Managing the way people perceive you *

Mark only one oval.

- 1 - Not Important at all
- 2 - Somewhat Important
- 3 - Moderately Important
- 4 - Very Important
- 5 - Extremely Important

22. Leadership - Managing your own reputation *

Mark only one oval.

- 1 - Not Important at all
- 2 - Somewhat Important
- 3 - Moderately Important
- 4 - Very Important
- 5 - Extremely Important

Business Skills

23. Management of Financial resources *

Mark only one oval.

- 1 - Not Important at all
- 2 - Somewhat Important
- 3 - Moderately Important
- 4 - Very Important
- 5 - Extremely Important

24. Management of Material Resources (obtaining and seeing to the appropriate use of equipment, facilities, and materials needed to do certain work) *

Mark only one oval.

- 1 - Not Important at all
- 2 - Somewhat Important
- 3 - Moderately Important
- 4 - Very Important
- 5 - Extremely Important

25. Business - Anticipate the business operating environment in the next 5 years *

Mark only one oval.

- 1 - Not Important at all
- 2 - Somewhat Important
- 3 - Moderately Important
- 4 - Very Important
- 5 - Extremely Important

26. Business - Determine what goods and services customer desire, including the price they are willing to pay *

Mark only one oval.

- 1 - Not Important at all
- 2 - Somewhat Important
- 3 - Moderately Important
- 4 - Very Important
- 5 - Extremely Important

27. Business - Determining what constitutes customer value *

Mark only one oval.

- 1 - Not Important at all
- 2 - Somewhat Important
- 3 - Moderately Important
- 4 - Very Important
- 5 - Extremely Important

28. Business - Determine business priorities *

Mark only one oval.

- 1 - Not Important at all
- 2 - Somewhat Important
- 3 - Moderately Important
- 4 - Very Important
- 5 - Extremely Important

29. Business - a knowledge of contemporary issues (current events) *

Mark only one oval.

- 1 - Not Important at all
- 2 - Somewhat Important
- 3 - Moderately Important
- 4 - Very Important
- 5 - Extremely Important

30. Project Management skills *

Mark only one oval.

- 1 - Not Important at all
- 2 - Somewhat Important
- 3 - Moderately Important
- 4 - Very Important
- 5 - Extremely Important

31. Economics - Being able to understand economic operating environment *

Mark only one oval.

- 1 - Not Important at all
- 2 - Somewhat Important
- 3 - Moderately Important
- 4 - Very Important
- 5 - Extremely Important

32. Economics - Being able to understand the functional drivers of the business *

Mark only one oval.

- 1 - Not Important at all
- 2 - Somewhat Important
- 3 - Moderately Important
- 4 - Very Important
- 5 - Extremely Important

Strategic Skills

33. Marketing Skills (product, positioning, advertising promotions, etc.) *

Mark only one oval.

- 1 - Not Important at all
- 2 - Somewhat Important
- 3 - Moderately Important
- 4 - Very Important
- 5 - Extremely Important

34. Business - Assume responsibility for the survival and growth of the business *

Mark only one oval.

- 1 - Not Important at all
- 2 - Somewhat Important
- 3 - Moderately Important
- 4 - Very Important
- 5 - Extremely Important

35. Sales - How to sell engineering products, different sales techniques, buying behaviour, etc. *

Mark only one oval.

- 1 - Not Important at all
- 2 - Somewhat Important
- 3 - Moderately Important
- 4 - Very Important
- 5 - Extremely Important

36. Business - Set direction including establishing a strategy *

Mark only one oval.

- 1 - Not Important at all
- 2 - Somewhat Important
- 3 - Moderately Important
- 4 - Very Important
- 5 - Extremely Important

37. Leadership - Make decisions ethically and understanding ethical responsibilities *

Mark only one oval.

- 1 - Not Important at all
- 2 - Somewhat Important
- 3 - Moderately Important
- 4 - Very Important
- 5 - Extremely Important

38. Leadership - Communicate direction including a shared understanding of the direction *

Mark only one oval.

- 1 - Not Important at all
- 2 - Somewhat Important
- 3 - Moderately Important
- 4 - Very Important
- 5 - Extremely Important

39. Visioning (developing an image of how a system should work under ideal conditions) *

Mark only one oval.

- 1 - Not Important at all
- 2 - Somewhat Important
- 3 - Moderately Important
- 4 - Very Important
- 5 - Extremely Important

40. Systems perception (determining when important changes have occurred in a system or are likely to occur) *

Mark only one oval.

- 1 - Not Important at all
- 2 - Somewhat Important
- 3 - Moderately Important
- 4 - Very Important
- 5 - Extremely Important

41. System Evaluation (looking at many indicators of system performance, taking into account their accuracy) *

Mark only one oval.

- 1 - Not Important at all
- 2 - Somewhat Important
- 3 - Moderately Important
- 4 - Very Important
- 5 - Extremely Important

42. Identification of downstream consequences (determining the long-term outcomes of a change in operations) *

Mark only one oval.

- 1 - Not Important at all
- 2 - Somewhat Important
- 3 - Moderately Important
- 4 - Very Important
- 5 - Extremely Important

43. Identification of key causes (identifying the things that must be changed to achieve a goal) *

Mark only one oval.

- 1 - Not Important at all
- 2 - Somewhat Important
- 3 - Moderately Important
- 4 - Very Important
- 5 - Extremely Important

44. Problem Identification (identifying the nature of problems) *

Mark only one oval.

- 1 - Not Important at all
- 2 - Somewhat Important
- 3 - Moderately Important
- 4 - Very Important
- 5 - Extremely Important

45. Solution Appraisal (observing and evaluating the outcomes of problem solution to identify lessons learned or redirect efforts) *

Mark only one oval.

- 1 - Not Important at all
- 2 - Somewhat Important
- 3 - Moderately Important
- 4 - Very Important
- 5 - Extremely Important

Other Skills

46. Technical Knowledge *

Mark only one oval.

- 1 - Not Important at all
- 2 - Somewhat Important
- 3 - Moderately Important
- 4 - Very Important
- 5 - Extremely Important

47. Quality Management *

Mark only one oval.

- 1 - Not Important at all
- 2 - Somewhat Important
- 3 - Moderately Important
- 4 - Very Important
- 5 - Extremely Important

48. Other skills or competencies not mentioned above

_____

d. Annexure D – Ethical Clearance Form and acceptance letter

GIBS ETHICAL CLEARANCE APPLICATION FORM 2023/24

RESEARCH PROJECT INFORMATION

NAME:	Albert Spear
STUDENT NUMBER:	10005146
PHONE NUMBER:	
E-MAIL ADDRESS:	10005146@mygibs.co.za
PROPOSED TITLE OF STUDY:	Attitude for Skills and Competencies Across Experience Levels for Engineering Leaders
RESEARCH SUPERVISOR:	Rhys Johnstone
E-MAIL OF SUPERVISOR:	rhys.johnstone@gmail.com
RESEARCH CO-SUPERVISOR	
E-MAIL OF CO-SUPERVISOR	

The purpose of this Research Ethics process is to ensure that all research conducted under the auspices of GIBS is done so in an ethical manner, in accordance with the University's policy and in such a way that **the rights of all stakeholders** associated with the research are protected.

In order for the GIBS Research Ethics Committee to assess your application, you are required to submit **a description of your Research Methodology** that must contain sufficient detail to ensure that the required steps have been taken to achieve this purpose, in the research design, data collection, analysis and storage of data used in the conduct of this research.

Please indicate the nature of the output your research is aimed at producing (mark one box only):

- ☐ ABP Applied Business Project
- ☑ MBA Research Report
- ☐ MBA Project Publish Article
- ☐ MBA Teaching Case Study
- ☐ MBA Entrepreneurship Stream Portfolio
- ☐ MBA Consulting Stream Portfolio/MBA Health Stream
- ☐ MPhil Research Report

GIBS Ethics Policy distinguishes between FOUR main types of data and THREE main types of methodology. Please complete the table for ALL the data types that you plan to use. Note that all applications must be accompanied by a description of the methodology to be used in the study. Initial all sections that apply to your research

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Section of form and type of data or methodology		Attachments – including methodology chapter (please mark that they are included)	
A	**Pre-existing personal records of human subjects,** e.g. performance reviews	☐	Methodology section of proposal
		☐	Description of the nature of the records to be used
		☐	Signed permission letter from appropriately authorised person in the organisation to use the data
B	**New data solicited from human subjects,** e.g. through interviews or surveys	☑	Methodology section of proposal
		☐	Informed consent statement attach proforma (separate for qualitative data collection; as part of survey questionnaire for quantitative data collection)
		☑	Interview guide / survey questionnaire / pre-existing proprietary test instrument / description of intervention
		☑	IF pre-existing proprietary test instrument, letter of permission from the owner/copyright holder (e.g. the MBTI)
C	**Public non-human data,** e.g. World Bank or other databases (no letter needed)	☐	Methodology section of proposal
		☐	Explanation of the nature of the data, how you will source it and how you will use it
D	**Private Organisation-specific non-human data,** e.g. financial statements, marketing or safety records	☐	Methodology section of proposal
		☐	Explanation of the nature of the data, how you will source it and how you will use it
		☐	Permission letter from the owner/organisation to use the data
E	**Indicate which methodology** you will be using. Choose one only	☐	Qualitative
		☑	Quantitative
		☐	Mixed methods

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SECTION A. PRE-EXISTING PERSONAL RECORDS OF HUMAN SUBJECTS

1. Specify the nature of records and how they will be used

2. Confirm that permission has been obtained from an appropriately authorised person to study and report on these records.
Remember to attach permission letter(s).

☐ I confirm

3. Provide the name and job title of the person in the organisation who has authorised the use of the records.

Name: Job Title:

4. How will **confidentiality** (when the identity of the respondent is known to the researcher e.g. when data collection is via interviews) and/or **anonymity** (when the identity of the interviewer is not known to the researcher e.g. when data collection is via surveys) of the respondents and their data be assured?
Mark all that apply – ensure this is included in your methodology chapter.

☐ No names will be requested

☐ No names will be reported

☐ Data will be stored without identifiers

☐ Only aggregated information will be provided

☐ Other. Please specify

SECTION B. NEW DATA OBTAINED FROM HUMAN SUBJECTS

5. Does the nature of your research require you to collect data from respondents who constitute a 'vulnerable population' (defined as those who are particularly susceptible to coercion or undue influence or who have difficulty giving free and informed consent to being the subjects of research)

☑ No

☐ Yes.
IF yes, explain the nature of the population and what measures will be put in place done to reduce or minimise this vulnerability. Ensure this is included in your methodology chapter.

6. Please confirm that no incentive is to be offered to respondents to participate in the study.

☑ I confirm

7. Mark the applicable box(es) to identify the proposed procedure(s) to be carried out to obtain data.

☐ Interview guide Attach if applicable

☑ Survey questionnaire Attach if applicable

☐ Pre-existing proprietary test instrument, e.g. MBTI Attach if applicable
IF a pre-existing proprietary test instrument is used, confirm that permission has been obtained to use it.

☐

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I confirm
Remember to attach permission letter(s) to use proprietary test instrument/s from an appropriately authorised person.

☐ • Intervention, e.g. training or experiment Describe in full in methodology chapter

8. Confirm that the data gathering is accompanied by a consent statement.

☑ I confirm

9. Where is the consent statement found?

☑ As part of the survey questionnaire, if quantitative data collection, in the introduction section of the questionnaire.

☐ As a separate document, if qualitative data collection, remember to attach.

10. Is there a risk that the respondents may not fully understand the nature of the study, or instructions or questions, or their rights as a result of language barriers between themselves and the researcher?

☑ No, there is not a risk

☐ Yes, there is a risk.
IF yes, how will the subjects' full comprehension of the content of the research, including giving consent, be ensured? Please specify, and include in methodology chapter

11. Do any respondents risk possible harm or disadvantage (e.g. financial, legal, reputational or social) by participating in the research?

☑ No

☐ Yes.
IF yes, explain what types of risk and what is done to minimise and mitigate those risks and include in methodology chapter.

12. Are there any aspects of the research about which subjects are not to be informed?

☑ No

☐ Yes.
IF yes, explain why, and how subjects will be debriefed, and include in methodology chapter.

13. Will the audio or video recorded data be transcribed and/or translated by an independent transcriber and/or translator?

☑ No

☐ Yes.
If yes, confirm that the transcriber and/or translator will be required to sign a non-disclosure agreement to protect the respondent's confidentiality, and include in methodology chapter

☐ I confirm. Remember to attach a pro-forma non-disclosure agreement

14. How will **confidentiality** (when the identity of the respondent is known to the researcher e.g. when data collection is via interviews) and/or **anonymity** (when the identity of the interviewer is not known to the researcher e.g. when data collection is via surveys) of the respondents and their data be assured? Include in methodology chapter

☑ No names will be requested, relevant when the identity of the respondent is not known to the researcher

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- ☐ No names of individuals or organisations will be reported, relevant when the identity of the respondent is known to the researcher
- ☐ Only aggregated information will be reported
- ☑ Data will be stored without identifiers
- ☐ Other. Please specify

15. Is the topic of your research and the nature of the interview or survey questions about one or more particular organisations or to be conducted within one or more particular organisations?

- ☑ No
- ☐ Yes. If yes, confirm that appropriately authorised person/s have provided written permission for you to conduct this research
- ☐ I confirm. Remember to attach signed permission letter/s

SECTION C. PUBLIC NON-HUMAN DATA

16. Specify the nature of records to be used: Explain how they will be selected, where the data will be sourced and how the data will be used, and include in methodology chapter:

17. Confirm that this pre-existing non-human data is in the public domain, is legally accessible and is free of any copyright.

- ☐ I confirm

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SECTION D. PRIVATE ORGANISATION-SPECIFIC NON-HUMAN DATA

18. Specify the nature of records (e.g. financial reports, marketing reports or safety records) and how they will be used.

19. Confirm that permission has been obtained to study and report on these records.

☐ I confirm. Remember to attach a signed permission letter(s).

20. Provide the name and job title of the person in the organisation who has authorised the use of the records.

Name: Job Title:

21. Do companies risk possible harm or disadvantage (e.g. financial, legal, reputational or social) by participating in the research?

☐ No

☐ Yes. Explain what types of risk and what is done to minimise and mitigate those risks. Include explanation in methodology chapter

22. How will **confidentiality** (when the identity of the respondent is known to the researcher e.g. when data collection is via interviews) and/or **anonymity** (when the identity of the interviewer is not known to the researcher e.g. when data collection is via surveys) of the respondents and their data be assured? Include in methodology chapter

☐ No names will be requested, relevant when the identity of the respondent is not known to the researcher

☐ No names of individuals or organisations will be reported, relevant when the identity of the respondent is known to the researcher

☐ - Only aggregated information will be reported

☐ - Data will be stored without identifiers

☐ Other. Please specify

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ALL APPLICANTS MUST COMPLETE SECTIONS E AND F

E. CONFIDENTIALITY OF RESEARCH REPORT SUBMITTED FOR EXAMINATION OR PUBLICATION

23. Please select the relevant option relating to the confidentiality of the research report you will submit for examination:

- ☑ Free access, i.e. report not embargoed
- ☐ No access for a period of two years after research report is submitted for examination
  Note that in exceptional circumstances, GIBS, being the copyright holder of the published research, may consent to an embargo of the report submitted for examination for a period of no more than two years. If you wish to apply for such an embargo, please provide reasons for this in a separate attachment.
- ☐ No access under any circumstance for an undetermined period.
  A letter of permission from the Vice- principal: Research and Postgraduate Studies at the University of Pretoria must be obtained prior to making this application – and attached to this application for ethical clearance.

F. DATA STORAGE AND DISSEMINATION OF RESEARCH REPORT SUBMITTED FOR EXAMINATION

24. Please conform that you will use appropriate methods to ensure your data is safely stored in an accessible format for a minimum period of 10 years

- ☑ I confirm

25. Confirm that the details of your data storage method are set out in your attached methodology chapter

- ☑ I confirm

26. It is a goal of GIBS to make research available as broadly as possible. Mark the boxes below for the medium/media in which you do NOT wish results to be made available.

Academic dissemination	**Popular dissemination**
☐ Research report	☐ TV
☐ Scientific article	☐ Radio
☐ Conference paper	☐ Lay article
☐ Book	☐ Podcast
	☐ Book

Provide reasons for any limitation on publication marked above

27. Confirm that the consent obtained reason from participant in the research is aligned with the extent of dissemination, specified in question 26. For example, consent if you are planning to use the research to launch a consulting career will be more comprehensive than in the case of research that is intended only for a scientific audience.

- ☑ I confirm

28. IF you wish to describe any other information which may be of value to the committee in reviewing your application

- ☑ No
- ☐ Yes. Provide details in a separate sheet attached to this application

GIBS ETHICAL CLEARANCE APPLICATION FORM 2023/24

G. APPROVALS FOR/OF THIS APPLICATION

When the applicant is a student of GIBS, the applicant must please ensure that the supervisor and co-supervisor (where relevant) has signed the form before submission

STUDENT RESEARCHER/APPLICANT:

29. I affirm that all relevant information has been provided in this form and its attachments and that all statements made are correct.

Student Researcher's Name in capital letters:	ALBERT NEALE SPEAR
Date:	08 Oct 2023
Supervisor Name in capital letters:	RHYS JOHNSTONE
Date:	15 Oct 2023
Co-supervisor Name in capital letters:	
Date:	08 Oct 2023

Note: GIBS shall do everything in its power to protect the personal information supplied herein, in accordance to its company privacy policies as well the Protection of Personal Information Act, 2013. Access to all of the above provided personal information is restricted, only employees who need the information to perform a specific job are granted access to this information.

Decision:

Approved

REC comments:

Thank you. Good luck with your research.

Date: 17 Oct 2023