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Article

Key Competencies among Engineering Leaders in The Malaysian Construction Industry

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Abstract: In the rapidly evolving field of engineering, effective leadership is essential for the successful completion of complex projects. However, engineers often hesitate to take on leadership roles and are underrepresented in leadership positions. While there is a growing body of literature on engineering leadership, much of it lacks empirical rigor and tends to focus on managing engineers rather than leadership competencies. Moreover, research specific to engineering leadership, particularly in Malaysia, is limited. This study addresses these gaps by exploring the key competencies required for engineering leaders in Malaysia's construction industry. Using a qualitative research design, data was collected through in-depth interviews with 17 engineering leaders. Purposive sampling was employed to select participants based on specific criteria. Constant comparative analysis revealed three primary competencies: (1) the ability to establish and work toward a set vision, (2) the ability to frame and address engineering project issues, and (3) the ability to manage resources effectively. This study contributes valuable insights into the competencies that define effective engineering leaders, offering practical implications for leadership development and engineering management practices. By cultivating these competencies, organizations can enhance leadership capabilities and improve project outcomes. The findings suggest that focusing on strategic vision, problem-solving, and resource management can help foster better leadership in engineering projects. Ultimately, this research lays the foundation for further exploration into engineering leadership, particularly in non-Western contexts, and provides a model for leadership development tailored to the engineering domain.

Keywords: Engineering leadership; talent management; leadership development; competency; organizational behavior

Introduction

The engineering sector in Malaysia has been a crucial driver of the country's economic growth and development over the past few decades. Malaysia's economy has undergone a significant transformation, shifting from a predominantly agricultural-based system to a rapidly expanding manufacturing-based, as the nation aspires to achieve its goal of becoming a fully industrialized country. This shift has brought to the fore the need for a large pool of talent, especially engineers, with a strong base in science and technology, and the government has embarked on various programmes to address this demand. This transformation emphasizes the critical need for leadership among engineers. The construction industry in Malaysia often faces challenges related to workforce availability and skill gaps (Dehdasht et. Al, 2022). Leaders must play an essential role in attracting, retaining, and developing talent in the industry. Malaysia is still facing with a shortage of engineers, affecting both employability and retention within the engineering sector (Wan Sharuzi, 2020). According to Wan Sharuzi (2020), several factors contribute to this issue such as some engineers leave the profession, many

local engineers opt to work abroad, and there is often a mismatch between the expectations of engineering graduates and employers, leading to unemployment. These dynamics create difficulties in identifying and retaining qualified engineering leaders who can effectively navigate the complexities of the construction industry's evolving landscape. Leadership among engineering leaders involves not only technical training but also ensuring team dynamics, supportive organizational culture and positive social interaction in fostering a collaborative work environment (Bagga et. al., 2023).

According to Liu et al. (2022), not all professions are equally receptive to different leadership styles. This study focuses on engineers since it has been demonstrated that those who undertake intellectually demanding work are far more receptive to leadership style than those who perform repetitive or administrative tasks. The need for engineers to possess leadership abilities has been a topic of discussion since the 1990s. National Academy of Engineering (NAE) emphasises that engineering graduates must understand the leadership principles and be able to apply them in increasing proportions as their careers progress.

In engineering, complex projects often require cross-functional teams that work together to solve problems. From the perspective of Social Science, specifically on Organizational Behavior (OB) theories related to group dynamics, team effectiveness, and collaboration can help engineering leaders understand how to work effectively within teams. OB theories on leadership enhance understanding to engineers on how to adapt their leadership styles depending on team needs and project phases. Understanding leadership can help engineers motivate their teams, communicate effectively, and manage resources efficiently.

In addition to traditional leadership theories, a growing body of Social Science literature highlights the importance of leadership styles that emphasize human aspects, such as Transformational Leadership and Servant Leadership. These theories focus on the leader's role in inspiring and empowering their teams. In the context of engineering, these approaches are particularly relevant as engineering leaders must not only guide technical processes but also foster teamwork, innovation, and organizational culture.

Organizational behavior theories also underscore the importance of leadership in shaping team dynamics, enhancing motivation, and promoting collaboration (Nauman et. al, 2022). These theories provide a valuable lens through which engineering leadership can be understood beyond technical competencies, encompassing the human and social dimensions essential for effective leadership in the construction industry.

Previous studies found that engineers are frequently hesitant to lead (Jamieson & Donald, 2020) and appear to be underrepresented in leadership roles in many areas of society (Schell & Kauffmann, 2016; Jamieson & Donald, 2020). The underrepresentation of engineers in leadership roles can have several implications. It may limit the influence of engineering expertise in policy-making and strategic decision-making processes, potentially impacting technological innovation and infrastructure development. Addressing this gap requires efforts to enhance leadership development opportunities tailored to engineers, emphasizing the integration of managerial and technical skills. In the construction industry, leadership is encountered with even greater challenges, as leaders place a greater emphasis on task completion rather than humanities aspect. As a result, they tend to disregard the needs of followers, their organisation, and the community in which they live (Nawaz Khan et al., 2020).

Previous studies have predominantly focused on leadership in a general context, with limited attention given to the engineering field (Handley & Berdanier, 2019). Despite the growing importance of leadership in engineering, there is a notable lack of rigorous research on engineering leadership, particularly among engineers in Malaysia. Furthermore, prior studies highlight the absence of a comprehensive framework identifying key components of engineering leadership to guide training and development programs for engineers (Maktar et al., 2024). This gap underscores the need for focused research to address these deficiencies and provide actionable insights for enhancing leadership capabilities within the engineering profession. Therefore, this study aims to explore the vital components of engineering leadership by conducting an empirical study among engineering leaders in Malaysia

Literature Review

The study of leadership as a discipline has a long history, dated back to ancient civilizations. Leadership is a complex and multifaceted phenomenon that has been the subject of extensive research across various

disciplines, including psychology, sociology, management, and political science (Northouse, 2019). The study of leadership has evolved over time, with different theoretical perspectives and approaches emerging to understand the nature, characteristics, and impact of leadership.

In the late 19th and early 20th centuries, leadership was primarily studied as a trait, which focuses on the inherent qualities and characteristics of effective leaders (Maktar et al., 2024). This perspective suggests that certain individuals are born with the necessary attributes, such as intelligence, charisma, and decisiveness, to be successful leaders. However, this approach has been criticized for its inability to account for the impact of situational factors on leadership behavior and its failure to provide clear distinctions between leaders and non-leaders (Stanca, 2021). The scholar who pioneered the trait-based perspective was Bernard (Pusiran & King, 2013), who defined leadership as the ability of a superior to influence the behavior of subordinates and the process of influencing individuals and groups to achieve common goals, respectively. Bernard (1938) as cited in Pusiran and King (2013) found that leaders with certain personal attributes, such as determination, intelligence, and integrity, were more likely to be effective in their roles.

In the mid-20th century, the focus shifted to the behavioral-based perspective which highlighted leadership styles. Researchers began to categorize leaders with different styles such as autocratic, democratic, or laissez-faire (Stanca, 2021). This behavioral approach emphasizes the actions and behaviors of leaders, rather than their innate characteristics (Ganzemiller et al., 2021). In the 1960s and 1970s, the field of leadership studies expanded to include contingency theories, which emphasized that the best leadership approach depends on the specific situation (Fiedler, 1967; Hersey & Blanchard, 1969). The scholar who proposed the contingency theory of leadership was Fred Fiedler, who found that the effectiveness of a leader's style depends on the degree to which the situation gives the leader control and influence (Suharyanto & Lestari, 2020).

The emergence of transformational and transactional leadership theories has further enriched the understanding of leadership (Burns, 1978; Bass, 1985). Transformational leaders inspire and motivate followers to achieve higher levels of performance, while transactional leaders focus on the exchange of rewards and punishments between leaders and followers (Yeganegi & Zadeh, 2018). Contemporary theories, such as transformational and servant leadership, focus on inspiring and serving followers. Transformational leadership, as described by Bass (1985), emphasizes the leader's ability to motivate and inspire followers to achieve extraordinary outcomes, while servant leadership, as proposed by Greenleaf (1977), prioritizes the leader's role in serving and empowering followers to reach their full potential (Nurtjahjani et al., 2021).

In recent years, the study of leadership has continued to evolve, with a focus on more nuanced and context-specific approaches to leadership. Contemporary research often integrates multiple theories and approaches to better understand the complex and dynamic nature of leadership. The existing leadership theories remain significant gaps, particularly in their application to engineering leadership. These theories often fall short in addressing the specific demands and complexities inherent in the engineering field (Maktar et al., 2024). To bridge this gap, further exploration is demanded. The history of leadership studies demonstrates a continuous pursuit of understanding the complex and multi-faceted nature of effective leadership. Taking this idea into consideration, it is crucial to understand the nature of leadership on specific profession, such as engineer. While the study exclusively focussed on engineers, it is important to note that research in other professions has revealed occupationally specific adjustments to leadership theory as well (Rottmann et al., 2022; Zhu et al., 2021).

The study draws on contingency leadership theories as the analytical lens, with a focus on transformational leadership and behavioral leadership. These theories provided the foundation for understanding and analyzing the leadership competencies in the context of engineering leadership in Malaysia.

Methodology

The study employed a qualitative research design, which is well-suited to capture the complexity of engineering leadership. Qualitative methods provide an in-depth understanding of engineers' experiences, perspectives, and behaviors, aspects that are often difficult to explore through quantitative approaches (Zhu et al., 2021). An inductive research approach is adopted in this study to facilitate the development of engineering leadership model from the collected data. The inductive approach is beneficial because it allows for the

emergence of new insights and theories based on the data, rather than testing pre-existing hypotheses (Makri, & Neely, 2021). This approach is particularly useful in areas where existing theories may not fully capture the complexity of the phenomena being studied. By using an inductive approach, the study aims to generate a grounded understanding of engineering leadership in the Malaysian construction industry, developing a model that are closely aligned with the lived experiences of the engineering leaders.

1. Sampling and Participant Selection

A purposive sampling technique was used to select participants for this study. This approach ensured that the sample comprised individuals who possess relevant expertise and experience in engineering leadership within the construction industry. Specifically, 17 engineering leaders were selected from both public and private organizations across Malaysia, based on their roles in leading engineering projects and managing teams in construction industry. These leaders were chosen to provide a diverse set of insights from varying organizational contexts.

Potential biases in the selection process were mitigated by ensuring the sample included leaders from a range of organizations, differing in size, sector, and geographical location. While purposive sampling inherently involves some degree of subjectivity, this diverse representation aimed to reduce any systematic bias that might influence the findings.

Table 1. Interview participant's detail

Interview Participant	Work experience	Engineering expertise	Job position
EL 1	12	Mechanical/Electrical	Managing Director
EL 2	20	Civil	Managing Director
EL 3	25	Civil	Senior Engineer
EL 4	20	Civil	Senior Project Manager
EL 5	17	Civil	Senior Project Manager
EL 6	18	Mechanical/Electrical	Senior Assistant Director
EL 7	30	Mechanical/Electrical	Senior Project Manager
EL 8	30	Mechanical/Electrical	Managing Director
EL 9	10	Civil	Project Manager
EL 10	15	Civil	Senior Engineer
EL 11	23	Civil	Deputy General Manager
EL 12	24	Civil	Deputy General Manager
EL 13	20	Mechanical/Electrical	Senior Engineer
EL 14	25	Civil	Senior Project Manager
EL 15	27	Civil	Project Manager
EL 16	20	Civil	Project Manager
EL 17	20	Civil	Managing Director

EL – Engineering Leader

2. Data Collection Procedures

Seventeen semi-structured interviews were conducted with the selected engineering leaders. Each interview lasted between 45 minutes to an hour, allowing for in-depth discussions. Prior to the interviews, participants were informed about the purpose of the study and provided with consent forms, ensuring ethical standards related to confidentiality and voluntary participation were upheld throughout the research. All participants were assured that their responses would remain anonymous, and data was securely stored to maintain confidentiality.

3. Data Analysis

The interview data was analyzed using thematic analysis with the support of ATLAS.ti software. The constant comparative method was employed to identify recurring patterns and themes across the interviews. The data

was coded inductively, meaning that themes emerged from the data itself, rather than being predefined. Themes were identified through an iterative process, where initial codes were refined and categorized into broader themes that reflected key aspects of engineering leadership.

To ensure the reliability of the coding process, an inter-coder reliability check was performed. Two researchers independently coded a subset of the interviews, and discrepancies in coding were discussed and resolved through consensus. This process helped to enhance the accuracy and credibility of the thematic analysis.

Findings and Discussion

Based on the interview data, three significant themes emerged as behavioral components crucial to engineering leadership: the ability to establish and work toward a set vision, the ability to scan and scaffold engineering project issues, and the ability to manage resources for engineering projects. These themes highlight the multifaceted nature of effective engineering leadership and provide valuable insights for current and aspiring leaders in the field.

1. The Ability to Establish and Work toward a Set Vision

In the context of an engineering project, a shared vision refers to a common understanding and agreement among all project stakeholders (including team members, management, clients, and other relevant parties) about the project's goals, objectives, and desired outcomes. This shared vision serves as a guiding principle that aligns everyone's efforts, decisions, and actions towards achieving the project's success.

During the interviews, all the interview participants agreed that the ability to establish and work toward a set vision goes beyond simply creating a goal. The interview participants emphasized the importance of articulating the vision in a way that resonates with their team members on a personal level as follows:

> *"Establishing a vision is not just about setting goals; it's about creating a shared sense of direction that everyone can rally around. When the entire team is on the same page, we can tackle even the most daunting challenges with a cohesive strategy and determination."*
>
> (Engineering Leader 1, Managing Director)

Moreover, the interviews revealed that engineering leaders employ various strategies to ensure that the set vision remains at the forefront of their team's efforts. These strategies often involve regular and transparent communication, continuous alignment of goals with the vision, and empowering team members to contribute towards its realization. It was clear from the discussions that a compelling and well-communicated vision serves as a foundation for engineering leaders to inspire and motivate their teams, ultimately driving success in the engineering landscape. A few of the participants explained:

> *"Through regular discussions and updates, we ensure that our vision remains a central theme in all our endeavors. This approach keeps our team inspired and committed to achieving our goals."*
>
> (Engineering Leader 1, Managing Director)

> *"A compelling and well-communicated vision serves as the foundation of our leadership strategy. It inspires and motivates our team, driving us toward success in the competitive Malaysian engineering landscape."*
>
> (Engineering Leader 2, Managing Director)

As the interviews explored deeper into the strategies employed by engineering leaders, it became apparent that the establishment and maintenance of a shared vision requires a multi-faceted approach. One key aspect highlighted by the interviewees was the importance of fostering open and transparent communication channels within the team. By creating an environment where team members feel heard and valued, engineering leaders pave the way for a shared vision to take root and flourish. One participant envisioned the following:

"Regular and transparent communication is key to keeping our vision alive and at the forefront of our team's efforts. It ensures everyone is aligned and moving in the same direction."

(Engineering Leader 3, Senior Engineer)

Furthermore, the study discovered the significance of continuous alignment of goals with the established vision. Engineering leaders emphasized the need for regular assessments and realignments to ensure that the team's efforts remained in sync with the overarching vision. This iterative process of goal alignment was noted to be crucial in adapting to the evolving needs of the project or organization, thereby maintaining the relevance and impact of the shared vision. Some participants noted:

"In the rapidly evolving field of engineering, having a clear and compelling vision is paramount. It guides our team through complex projects and technological innovations. When every member understands and aligns with this vision, it fosters a sense of purpose and unity, driving collective efforts toward achieving our goals. As one of our senior engineers aptly put it, 'A well-defined vision transforms uncertainty into a roadmap, empowering us to navigate challenges with confidence and creativity.' This commitment to a shared vision not only enhances productivity but also ignites passion and motivation, crucial elements for sustained success in our industry."

(Engineering Leader 4, Senior Project Manager)

In addition to shared vision, the interview participants highlighted on the empowerment of team members as a pivotal strategy in realizing the established vision. Engineering leaders emphasized the importance of providing opportunities for team members to contribute meaningfully towards the shared vision. This inclusive approach not only enhances the sense of ownership and dedication among team members but also fosters innovation and a collaborative spirit in working towards the set vision. Two interview participants illustrated their experience through these statements:

"Our inclusive approach allows every team member to contribute towards our shared vision. This strategy not only fosters innovation but also strengthens the collaborative spirit within the team."

(Engineering Leader 3, Senior Engineer)

It is evident that a shared vision serves as the foundation for inspiring and motivating teams, ultimately driving success in the engineering landscape. The multi-faceted approach required for the establishment and maintenance of a shared vision, as highlighted in the interviews, emphasizes the significance of fostering a collaborative and inclusive environment where team members feel valued and empowered to contribute meaningfully.

These insights provide valuable guidance for current and aspiring engineering leaders, emphasizing the importance of a compelling vision and the strategies necessary to ensure its integration into the fabric of the team's efforts. As the engineering landscape continues to evolve, these findings underscore the continued relevance and impact of effective engineering leadership practice.

2. The Ability to Scan and Scaffold Engineering Project Issues

The ability to scan and scaffold engineering project issues is crucial for engineering leaders. It involves not only identifying potential challenges and obstacles within a project but also strategically developing a framework to address these issues effectively. During the interviews, it became evident that to be successful engineering leaders must possess a proactive approach to scanning for potential project issues. This involves conducting thorough risk assessments, considering various factors such as technical constraints, resource availability, and external dependencies that could impact the project's progress. A participant explained:

"To be successful, engineering leaders must continually scan for potential issues and conduct detailed risk assessments. This strategy helps us manage external dependencies and maintain project momentum."

(Engineering Leader 8, Managing Director)

Moreover, the ability to scaffold project issues requires engineering leaders to establish a structured framework that allows for proactive problem-solving and mitigation. This framework involves creating clear protocols for issue escalation, defining roles and responsibilities for problem resolution, and fostering a culture of transparency and collaboration when addressing challenges as mentioned by participant below:

> *"We focus on proactive problem-solving by having a structured framework in place. Clear escalation protocols and well-defined roles help us tackle issues swiftly and maintain project momentum,"*
> (Engineering Leader 4, Senior Project Manager)

The interviews highlighted the significance of integrating scanning and scaffolding of project issues into the overall project management process. Engineering leaders must continuously monitor projects, allowing for early detection of potential issues and the implementation of timely interventions to prevent any issues. This approach not only minimizes the impact of challenges on the project but also demonstrates effective leadership in navigating complex engineering projects

Interviewees further emphasized the importance of leveraging cross-functional collaboration as a crucial strategy in effectively scanning and scaffolding engineering project issues. For example, in the development of a sustainable building, architects, engineers, construction teams, and environmental consultants must work closely together. Architects design the building with sustainability in mind, engineers ensure the structural and system integrity meets green standards, construction teams implement these designs with sustainable materials and practices, and environmental consultants provide guidance and oversight. This collaborative approach ensures that the project meets its sustainability goals, regulatory requirements, and client expectations. By involving diverse team members and stakeholders, engineering leaders were able to gather a comprehensive understanding of potential challenges, draw on collective expertise, and develop holistic solutions to address them.

> *"The complexities of engineering projects, especially in sustainable building development, demand seamless collaboration between different teams. Architects, engineers, construction teams, and environmental consultants need to work together closely to address project issues and achieve our sustainability goals"*
> (Engineering Leader 9, Project Manager)

The ability to scan and scaffold engineering project issues is indeed a multifaceted skill that requires a comprehensive approach. Successful engineering leaders not only possess technical expertise but also demonstrate strategic thinking and strong leadership qualities in this aspect of their role. As the interviews explored deeper into this skill, it became apparent that the impact of effective leadership in scanning and scaffolding project issues goes beyond just problem-solving.

Furthermore, the establishment of a structured framework for scaffolding project issues is crucial in promoting a transparent and collaborative problem-solving environment. Clear protocols for issue escalation and defined roles and responsibilities for problem resolution lay the groundwork for efficient and effective solutions. Additionally, by fostering a culture of transparency and collaboration when addressing challenges, engineering leaders create an environment where team members feel empowered to contribute their expertise and work together towards solutions.

The integration of scanning and scaffolding project issues into the overall project management process emphasizes the proactive and adaptive nature of effective engineering leadership. Continuous monitoring and early detection of potential issues not only highlights the proactive stance of leaders but also demonstrates their ability to navigate the complexities of engineering projects with agility.

3. The Ability to Manage Resource for Engineering Projects

The third theme is the ability to manage resources for engineering projects. Engineering leaders play a crucial role in ensuring the efficient and effective utilization of resources to achieve project goals. The ability to manage resources for engineering projects extends beyond the allocation of finances and materials. It encompasses the strategic management of human resources and the utilization of technology and tools.

Effective resource management begins with a comprehensive understanding of project requirements and constraints. The interview participants emphasized the significance of holistic resource planning, which involves evaluating the skill sets of team members, identifying potential project leaders and team project, and aligning resource allocation with project milestones. By taking a proactive approach to resource planning, engineering leaders can minimize potential gaps in expertise and anticipate resource needs at different stages of the project. This information was represented by a participant:

> *"Effective resource management begins with holistic planning. We assess our team's skill sets, identify potential leaders, and align resources with project milestones. This proactive approach helps us anticipate needs and minimize gaps in expertise."*
>
> (Engineering Leader 12, Deputy General Manager)

Furthermore, the interviews highlighted the role of engineering leaders in talent development and empowerment. Engineering leaders should prioritize the professional growth of their team members, providing opportunities for skill enhancement and knowledge transfer. These include organizing regular training programs to enhance technical and soft skills, establishing mentorship relationships for knowledge transfer, creating personalized career development plans, delegating responsibilities to build confidence and leadership skills, and implementing feedback mechanisms for continuous improvement. For example, in the context of engineering project, a junior engineer can be mentored by a senior engineer, attend specialized training, and be gradually assigned more complex tasks, leading to enhanced skills, confidence, and a more capable project team. This approach not only benefits individual engineers but also contributes to a more efficient, innovative, and resilient team, ultimately improving project outcomes.

> *"For example, in our complex project, we mentored junior engineers by pairing them with senior structural engineers, providing specialized training, and gradually assigning them more complex tasks*"
>
> (Engineering Leader 17, Managing Director)

By fostering a culture of continuous learning and development, leaders not only enhance the capabilities of their team but also cultivate a sense of belongingness, as stated by one participant:

> *"These efforts not only enhance individual skills and confidence but also contribute to a more efficient, innovative, and sense of belongingness, ultimately improving project outcomes."*
>
> (Engineering Leader 15, Project Manager)

In managing resources in engineering projects, adaptability is one of the key components. Adaptability for an engineering leader in engineering projects involve effectively responding to and managing changes and unforeseen challenges that arise during the project. This includes quickly assessing situations such as unexpected site conditions, supply chain disruptions, or weather-related delays, and developing contingency plans to keep the project on track. An adaptable leader embraces new technologies and methods, reallocates resources, and adjusts team structures as needed. This point raised by several participants as follows:

> *"Adaptability for an engineering leader involves effectively responding to and managing changes and unforeseen challenges that arise during the project"*
>
> (Engineering Leader 16, Project Manager)

> *"...There is a lot of experience for an engineer. If in my own organization, engineers are forced or not forced, we cannot use the term forced. I was instructed to manage social affairs together with the engineer participants and I was also instructed to deal with the local authorities for what to settle down regarding the land regarding the budget so for me the experience of an engineer in Malaysia is actually extensive"*
>
> (Engineering Leader 10, Senior Engineer)

Moreover, the integration of technology and tools plays a pivotal role in resource management. Engineering leaders leverage advanced software for project planning, monitoring, and resource tracking. By utilizing technology, engineering leaders gain real-time insights into resource utilization, identify potential inefficiencies, and make data-driven decisions to optimize resource allocation and utilization.

Effective resource management involves collaboration with internal and external stakeholders. Engineering leaders emphasized the importance of transparent communication and collaboration with stakeholders to align resource allocation with project objectives and timelines. By fostering a cohesive relationship with stakeholders, leaders ensure that resource management aligns with the overall project vision and organizational goals. One such example mentioned was:

> *"In Malaysia, where I've led several projects, transparent communication and collaboration with stakeholders have been key to aligning resource allocation with our project objectives and timelines. By building strong relationships with stakeholders, we ensure that our resource management strategy not only meets the project vision but also contributes to our broader organizational goals."*
>
> (Engineering Leader 2, Managing Director)

The ability to manage resources for engineering projects encompasses a multifaceted approach that integrates strategic planning, talent development, adaptability, technology utilization, and stakeholder collaboration. The interview participants recognized the dynamic nature of resource management and employ proactive strategies to optimize resource utilization, ultimately driving project success. As the engineering landscape continues to evolve, these insights emphasizing the critical role of resource management in achieving project objectives and fostering organizational growth.

This study advances engineering leadership theory by offering a culturally relevant model tailored to Malaysian engineers, addressing gaps in prior literature (Handley & Berdanier, 2019). Unlike generic leadership models, which often focus on broad traits, this model emphasizes actionable behaviors specific to engineering contexts, reflecting the demands of Malaysia's construction industry. The findings highlight the importance of setting a clear vision, managing resources, and proactively addressing project issues. This aligns with Zhu et al.'s (2021) emphasis on entrepreneurial thinking and transformational leadership but adds specificity by incorporating practical demands like regulatory compliance (Sadikoglu et al., 2024). The theme's focus on proactive problem-solving as a pre-emptive process advances Handley and Berdanier's (2019) findings on adaptive communication by embedding it in structured leadership strategies.

4. Theoretical Implication of Engineering Leadership Competencies on Society and Organization

Leadership in engineering not only drives project success but also plays a critical role in shaping organizational culture and societal outcomes. Based on the interview findings, engineering leaders who cultivate a strong vision not only improve team cohesion and project outcomes but also contribute to broader organizational goals such as social responsibility and sustainability. This alignment with societal values, such as promoting equity and ethical leadership in engineering, reflects the growing importance of interdisciplinary leadership approaches that combine technical expertise with social and ethical considerations. By fostering a collaborative and inclusive work environment, engineering leaders can contribute to a culture that values diversity, social equity, and long-term societal impact.

In managing human resources, effective leadership is critical for aligning the workforce with the organization's strategic objectives. Leaders who communicate a compelling vision help enhance employee engagement and motivation. As emerged from the interview findings, the ability to set and work toward a clear vision is a core competency in leadership development programs. This theme resonates with theories such as goal-setting theory (Latham et. al., 2020), which suggests that specific and challenging goals, when articulated clearly by leaders, lead to higher performance in teams. From an OB perspective, establishing a shared vision aligns with the concept of transformational leadership (Bass, 1985), where leaders inspire and motivate employees to exceed their own self-interest for the sake of the organization. By fostering an inclusive vision, engineering leaders can build stronger team cohesion and a shared sense of purpose, which has been shown to improve performance and organizational culture.

The ability to identify potential issues and establish a framework for addressing them is crucial in leadership, reflecting proactive problem-solving and risk management practices in HRM and OB. In HRM, leaders are expected to manage both technical and human resources effectively. The concept of scaffolding can be seen in HRM practices such as competency mapping and workforce planning, where leaders anticipate skill gaps and resource needs. Leaders who are adept at scanning for issues are often better at talent management and succession planning, as they can identify challenges before they become critical and align the right people to address them. Furthermore, the ability to anticipate and mitigate problems reflects the principles of strategic leadership. Leaders who engage in continuous scanning for potential challenges embody systems thinking (Reese, 2020), which emphasizes understanding the interconnections within an organization or project. This proactive approach helps to manage complexity and align leadership efforts with organizational goals, ultimately improving decision-making processes and outcomes.

The third theme highlights the leaders' ability to manage not only financial and material resources but also human capital. This theme is strongly connected to HRM practices and OB theories. Resource management is a core competency, especially in terms of talent development and performance management. Engineering leaders who focus on developing their team members align with human capital theory (Becker, 1964), which emphasizes investing in people to improve organizational performance. By providing opportunities for learning and development, these leaders foster a culture of continuous improvement, which is critical for retaining talent and enhancing team productivity. From an OB perspective, team dynamics and the effective use of human resources are essential for project success. Leaders who manage resources well often exhibit strong emotional intelligence (Goleman, 2021), understanding the emotional and interpersonal needs of their team members. Effective resource management also supports team empowerment and collaborative problem-solving, which are key drivers of high-performance teams in organizational settings.

The third theme highlights engineering leaders' ability to manage financial, material, and human resources, a competency deeply rooted in Human Resource Management (HRM) practices and Organizational Behavior (OB) theories. This aligns with Human Capital Theory (Becker, 1964), which underscores the importance of investing in employees as key assets to improve organizational outcomes. By focusing on talent development and providing opportunities for learning, engineering leaders enhance their team's skills and foster a culture of continuous improvement, directly contributing to productivity and talent retention. From an OB perspective, effective resource management ties into Emotional Intelligence Theory (Goleman, 2021), where leaders' awareness of emotional and interpersonal dynamics enables them to address team needs effectively, build trust, and maintain high morale. Moreover, these practices reflect the principles of Transformational Leadership Theory (Bass, 1985), as leaders empower their teams, foster collaborative problem-solving, and drive team performance beyond expectations. This integration of resource management with human capital development and team dynamics demonstrates how engineering leaders utilize a strategic blend of theories to navigate the complexities of leadership in their field.

Conclusion

The findings from this study highlight the key behavioral components that define effective engineering leadership, identifying three critical competencies: setting and working toward a clear vision, scanning and scaffolding project challenges, and managing resources effectively. These competencies not only drive project success but also contribute to broader organizational growth. More than just practical insights, these results deepen our understanding of how engineering leaders navigate complex environments, offering a framework that blends strategic foresight, inclusive leadership, proactive problem-solving, and adaptability.

The broader implications suggest that these leadership behaviors are pivotal not only in the engineering field but may also resonate across other technical and managerial domains. This framework can inform leadership development programs, enabling organizations to cultivate leaders capable of managing dynamic challenges in an evolving engineering landscape.

The integration of social science perspectives, such as Organizational Behavior and Human Resource Management, is essential in expanding the scope of engineering leadership. These interdisciplinary insights help address the human aspects of leadership, enabling engineering leaders to foster team dynamics, enhance

motivation, and contribute to societal goals. By combining technical and social competencies, engineering leadership can achieve a more holistic approach that not only improves project outcomes but also supports organizational and societal progress.

Future research should explore the application of these findings across different industries, employing larger and more diverse samples to examine the generalizability of the leadership competencies identified. Additionally, quantitative studies could validate these behavioral components and test their impact on specific organizational outcomes, further refining our understanding of leadership effectiveness in complex project environments.

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