



**SELINUS UNIVERSITY**  
OF SCIENCES AND LITERATURE

**Unveiling Engineering Capabilities:  
A Strategic Approach to Profiling and Enhancing  
Engineers' Competencies in Innovation Management**

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# Abstract

In the era of fast-changing technological ecosystems, engineering organizations require innovation as their primary competitive edge. This research investigates how leadership strategies, individual characteristics, organizational structures, cultural traits and team diversity interact to generate innovative results.

This research combines leadership theory with motivation research and team diversity studies through real-world evidence related to organizational psychology and management practices to address real-life problems. This research employs a mixed-methods design, in which there is a survey of 17 engineers working in five countries, followed by comprehensive interviewing of two senior engineering leaders who led groups working across multiple locations.

The study supports the ideas of transformational leadership principles to demonstrate its effectiveness depends on team member diversity and risk-taking freedom within the organization. The presented work discovers a major "confidence-utilization gap" that shows engineers possess self-assurance about their innovative capabilities, yet their organizations block using such skills.

The study reveals that personality type fails to predict innovative behavior effectively because people within the same personality group show greater differences than those between groups. Team innovation increases through cultural diversity when members use structured communication to integrate different perspectives instead of accepting differences passively.

The findings also reveal that the midpoint career professionals produce the most creative work and identify three essential organizational elements of psychological safety, dedicated innovation time and modern technological resources to enable confidence for producing tangible results. The research opposes management methods

based on personality assessments and cultural generalizations by promoting individualized understanding and leadership approaches that enhance team performance.

Additionally, operational guidelines are also presented for handling diverse engineering teams through specific methods to eliminate confidence barriers and establish enduring innovative capabilities in worldwide competitive markets.

Keywords: Engineering Innovation, Transformational Leadership, Team Diversity, Psychological Safety, Confidence-utilization Gap, Multiplier Leadership

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# Introduction

## Background of the Study

In the current arena of dynamic business landscape, the technological innovations are becoming more like a norm. The ability to innovate becomes a make-or-break factor for companies. It's what sets the thriving ones apart from the rest. A recent survey that was conducted by the Boston Consulting Group in 2023 found that 79% of firms have innovation as a top priority. As shown in Figure 1, innovation is designated among the top three by around 80% of participants, and the remaining two-thirds of recipients mention it as a top priority. (Boston Consulting Group, 2023)

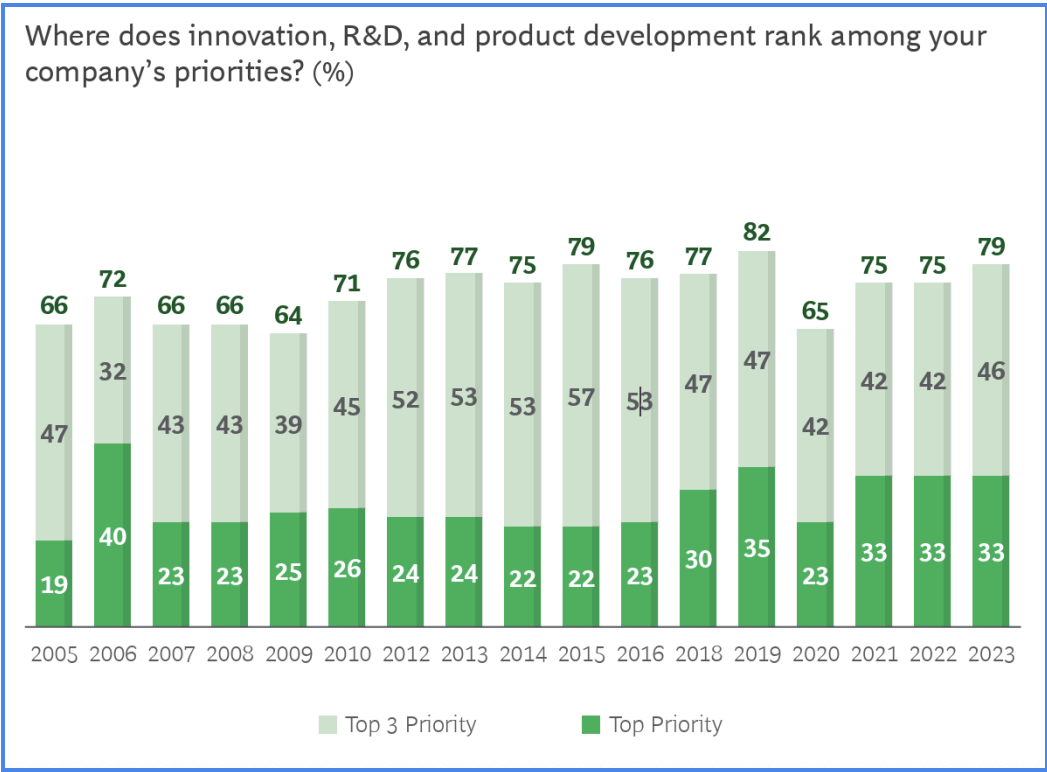


Figure 1: Innovation rank among companies

Source: Boston Consulting Group

But despite this, many organizations struggle to effectively integrate their innovative strategies with their business goals, often falling short of their targets. This research aims to explore the gap for engineering leaders to help them to motivate diverse teams to achieve peak innovative performances while navigating the complexities of diverse personalities, backgrounds, and identities.

In engineering circles, innovation-related competencies have moved from being a nice-to-have perk to a requirement. Recent research on engineering education consistently identifies skills such as creativity, leadership, teamwork, critical thinking, problem solving, communication, multidisciplinary teamwork, lifelong learning and hands-on experimentation as essential for preparing graduates for innovation roles (Beagon et al., 2024). The current market requires engineers who possess innovative thinking abilities, teamwork skills and project leadership competencies to advance innovation. The way organizations lead their teams determines how innovation develops through their chosen leadership approaches. Research shows transformational leadership methods function as innovation boosters because they create spaces where team members feel comfortable in sharing their ideas. The implementation of autocratic or transactional leadership styles prevents innovation from happening because it restricts creative thinking and hinders team collaboration (Cuevas-Vargas et al., 2025).

The engineering field presents unique managerial challenges distinct from other industries. Engineers value autonomy highly, often possess technical expertise exceeding that of their managers, and require careful balance between hands-on technical work and strategic leadership (Hatica, 2023; Zeet, 2024). While these capabilities drive the resolution of complex technical problems, they can complicate leadership efforts to foster innovation, facilitate effective collaboration, and maintain cohesion across diverse teams. Bungay (2011) notes in *The Art of Action* that effective leaders must bridge vision with execution reality, a particularly challenging task in

engineering settings where exacting precision must coexist with the fluid nature of creative innovation.

More businesses now recognize innovation as their key driver for expansion yet they struggle to translate their innovative goals into tangible results. The 2023 Innovation Index from NTT DATA shows that organizations fail to achieve their innovative targets despite 96% of companies making innovation their core growth priority (NTT DATA, 2023). The wide gap between innovation goals and actual results requires better understanding of successful innovation implementation methods for academic research and business operations. The results of organizations depend on their leadership style and workplace environment and the diversity of their workforce regarding personality, gender, experience levels and organizational structure (Thenuwara et al., 2024; Wang and Duan, 2024).

## Statement of the Problem

Engineering organizations face challenges to achieve their innovation targets because they lack effective methods to convert strategic innovation goals into operational results (Cuevas-Vargas et al., 2025). Research shows that leadership style together with team diversity and organizational culture shape innovation performance but engineering organizations need better understanding of these factors' interactions (Wang & Duan, 2024). The current research investigates these variables separately which results in restricted knowledge about their collective impact (Zhou and Li, 2024). The engineering sector requires both exact technical work and creative thinking which produces unique leadership obstacles (Thenuwara et al., 2024) yet current management systems depend on personality tests and cultural stereotypes that simplify employee behavior and restrict their innovative abilities (Chatzi et al., 2022).

Three essential research areas need immediate exploration. The effectiveness of transformational leadership in various engineering environments remains unclear because researchers have not studied its relationship with team diversity characteristics (Wang & Duan, 2024). Research needs to establish how personal characteristics including personality traits and work experience and cultural origins affect the connection between leadership and innovation (Zell & Lesick, 2022). Research must establish the specific organizational elements which support or restrict engineers from showing innovative behavior (Edmondson & Lei, 2014; Frazier et al., 2017). Research indicates that engineers demonstrate self-assurance about their creative abilities yet their organizations prevent them from using these skills (Zadow et al., 2023).

The worldwide spread of engineering teams across different time zones and cultural settings through globalization has not solved the practical problems of using diversity to enhance innovation (Stahl & Maznevski, 2021). Engineering leaders require research-backed methods to build diverse teams and develop communication strategies and inclusive spaces which convert diversity into innovation benefits (Jones et al., 2020). The research investigates leadership methods and personal traits and organizational design and team diversity elements which produce innovative results in engineering settings to create operational solutions for innovation implementation.

## Research Objective/Aim

The primary aim of this research is to investigate how leadership strategies, individual characteristics, organizational structures, cultural traits, and team diversity interact to generate innovative outcomes in engineering organizations. This research seeks to bridge the gap between theoretical frameworks and practical implementation by developing evidence-based recommendations that engineering leaders can apply to enhance innovation performance in diverse team environments. The study aims to move beyond categorical approaches to diversity management by examining the

nuanced ways in which various factors combine to enable or constrain innovation capabilities.

The research investigates these connections through established data analysis to achieve two primary objectives which involve deepening knowledge about leadership and innovation, and creating practical strategies for engineering organizations to achieve their innovative targets.

## Specific Objectives

- To achieve the primary research aim, the following specific objectives guide this investigation:
- To examine the relationship between different leadership styles, particularly transformational leadership, and innovative performance in engineering environments, identifying the specific leadership behaviors and practices that most effectively promote innovation.
- To investigate how individual differences, including personality characteristics, gender, and experience levels, moderate or mediate the relationship between leadership approaches and innovation outcomes in engineering teams.
- To analyze the role of cultural diversity in engineering innovation, examining how cultural intelligence and structured communication practices can transform cultural differences into innovation advantages.
- To identify organizational factors, including psychological safety, dedicated innovation time, and resource availability, that enable or impede engineering professionals from deploying their innovative competencies.
- To explore the "confidence-utilization gap" in engineering innovation, understanding why engineers with confidence in their innovative capabilities may find organizational barriers preventing the application of these skills.
- To examine the relationship between experience levels and innovative performance, with particular attention to the role of mid-career professionals and

the mechanisms for effective knowledge transfer between junior and senior engineers.

- To develop practical, evidence-based recommendations and operational guidelines for engineering leaders seeking to enhance innovation performance through effective management of diverse teams and creation of innovation-enabling organizational environments.

## Research Questions

The research investigates how engineering leadership together with personal elements and environmental conditions influences innovation development in engineering companies. The research investigates these dynamics by asking particular questions which seek to identify their characteristics.

### **Primary Research Question:**

*How do leadership strategies, individual characteristics, organizational structures, cultural traits, and team diversity interact to generate innovative outcomes in engineering organizations?*

### **Subsidiary Research Questions:**

1. How might different leadership styles shape innovative performance in engineering environments? and what specific leadership behaviors are most strongly associated with innovation outcomes?

2. In what ways and to what degree do differences such as different personalities, gender, and differing experience levels serve as moderators or mediators of this relationship?
3. In what ways do cultural fabric and organizational mechanisms either empower or impede engineering professionals from deploying their innovative competencies?

## Significance of the Study

The research findings create substantial value for engineering leadership and innovation management and team diversity fields through theoretical and practical applications. The research findings create multiple layers of significance because they fill essential knowledge gaps in current literature while delivering useful recommendations for engineering organizations.

## Theoretical Contributions

The research investigates how leadership methods interact with personal traits and business environment elements to produce innovation results. The research combines different elements to show how transformational leadership success depends on team diversity aspects and organizational settings which expands leadership knowledge through detailed contingency factor analysis.

The research opposes personality-based management because it shows that personality frameworks fail to predict innovative behavior effectively since team members show more variation than what exists between different groups. The research promotes a transition from group-based management to personalized methods for

handling engineering personnel which affects how organizations select talent and construct teams and evaluate performance.

The research introduces a new concept which explains why organizations with skilled engineers fail to execute innovation because their systems and structures create obstacles instead of individual performance issues.

## Practical Contributions

The research offers evidence-based leadership methods which help engineering leaders create innovation through defined recommendations about their actions and team organization and communication systems and organizational backing systems.

Organizations need to establish enabling conditions which include psychological safety, dedicated innovation time and proper resource allocation according to the research while showing methods to convert demographic advantages into business benefits through effective diversity management.

The research establishes essential competencies for engineers which include creativity and collaboration and communication and adaptability to guide educational curriculum development and professional training and mentorship and career advancement programs.

## Broader Impact

Organizations need to develop effective methods for managing diverse engineering teams because globalization and technological complexity continue to rise. The research develops essential capabilities for innovation-based markets while supporting initiatives that promote fair work environments for all engineers to succeed. The

research design combines quantitative and qualitative methods to establish a framework which future studies can use for comprehensive analysis.

## Scope of the Study

This research focuses on innovation in engineering teams within technology and engineering organizations, examining the intersection of leadership, diversity, and organizational factors in shaping innovation outcomes. The study's scope is defined by several key parameters that establish the boundaries of the investigation while ensuring sufficient depth and relevance.

## Research Context and Setting

The research investigates software engineering, technical infrastructure management and digital innovation within technology sectors that employ engineering professionals. The research includes multinational corporations that operate in different geographic locations because engineering work exists on a worldwide scale.

## Participant Profile

The research includes two participant groups:

1. Survey component with 17 engineering professionals who work in different roles at their organizations such as team members, engineering leads, product owners, project managers, data analysts, business analysts and site reliability engineers from five different countries with experience ranging from new graduates to more than thirty years.

2. Interview component with two senior engineering leaders who have experience leading teams across different time zones and geographic areas.

The research design combines two evaluation methods to understand how engineers face innovation obstacles while senior leaders explain the essential factors for success.

## Key Variables and Dimensions

The research examines three sets of variables which include:

1. Diversity dimensions: including personality, gender, experience, cultural backgrounds and geographic distribution.
2. Leadership approaches: including transformational leadership, empowering leadership, autonomy support, psychological safety creation and innovation encouragement.
3. Organizational factors: including psychological safety, innovation time allocation, resource availability, communication systems and structural support.

## Methodological Scope

The research design uses an explanatory sequential mixed-methods approach which combines quantitative survey data with qualitative interview results to achieve triangulation and reveal statistical patterns together with contextual understanding.

## Limitations and Boundaries

The research investigates contemporary practices through a non-chronological approach. The study's qualitative data analysis is sufficient but the small sample size

restricts the ability to generalize quantitative results. The research investigates leadership elements and organizational aspects of innovation instead of technical aspects while studying multiple settings without attempting to study all possible cases. The research concentrates on practical elements which leaders can modify through their actions and organizational decisions to enhance innovation results while upholding academic standards.

## Organization of the Study

This thesis is structured to provide a comprehensive examination of leadership, diversity, and innovation in engineering organizations, progressing logically from theoretical foundations through empirical investigation to practical implications and recommendations.

- **Chapter 1 (Introduction):** establishes the research foundation by presenting the background, research problem, objectives and questions, research significance, scope, and thesis organization. This chapter contextualizes the research within engineering innovation challenges and establishes its importance for theoretical advancement and practical application.
- **Chapter 2 (Literature Review):** provides comprehensive examination of existing theoretical and empirical research. The chapter explores theoretical foundations of engineering leadership (transformational leadership, Self-Determination Theory, Multipliers leadership, psychological safety), cultural dimensions and global engineering teams, personality diversity and innovation performance, gender diversity in engineering, experience levels and knowledge transfer, and organizational factors supporting innovation. This review identifies gaps in existing knowledge and establishes the theoretical framework guiding the investigation.

- **Chapter 3 (Methodology):** details the research design and methods, articulating the research philosophy, explanatory sequential mixed-methods design, sampling procedures, survey instruments and interview protocols, data collection procedures, analytical approaches, research challenges and limitations, and ethical considerations. This transparency enables readers to evaluate the research rigor and findings credibility.
- **Chapter 4 (Findings and Analysis):** presents results from both survey and interview components. The chapter presents quantitative findings from the engineering professional survey and qualitative findings from senior engineering leader interviews, organized thematically to address research questions. It integrates both data sources to provide comprehensive answers examining leadership effects on innovation, individual differences, organizational factors, and the confidence-utilization gap, with supporting evidence on personality diversity, cultural intelligence, experience levels, and innovation enablers.
- **Chapter 5 (Discussion):** interprets findings in light of existing theory and research. The chapter synthesizes key findings, relates them to theoretical frameworks, discusses unexpected results and explanations, examines practical implications for engineering leaders and organizations, identifies theoretical contributions, and acknowledges limitations and their impact on interpretation, transforming findings into actionable insights while maintaining scholarly rigor.
- **Chapter 6 (Conclusion and Recommendations):** provides comprehensive conclusion, summarizing key findings and significance, presenting evidence-based recommendations for engineering leaders, offering operational guidelines for managing engineering teams, discussing implications for organizational policies, suggesting future research directions, and reflecting on broader implications for engineering management and innovation in technology organizations.
- **Appendices** provide supporting materials including the complete survey instrument, detailed survey results with charts and graphics, interview protocol, full interview transcripts with participant consent, and supplementary data

analyses, enabling detailed examination of research instruments and data for transparency and potential replication.

# Literature Review

## Theoretical Foundations of Engineering Leadership

Leadership theory provides the foundation to select appropriate engineering team management approaches which result in successful innovation. The four elements of transformational leadership which Bass and Riggio (2006) identified, enable organizations to achieve innovation through inspirational motivation, intellectual stimulation, individualized consideration and idealized influence. The research conducted by Gumusluoğlu and İlsev (2009) demonstrates that transformational leadership produces positive results in followers who demonstrate innovative behavior and creative work. Research indicates that leader-member exchange relationships with employees generate small to moderate creativity effects but these effects become stronger when leaders promote intellectual exploration and risk-taking activities (Wang, Z., 2022; Wu, H. and Lv, H., 2024). The performance of innovative tasks by engineering teams during challenging projects depends on the leadership approaches which their leaders implement.

The Self-Determination Theory (SDT) framework offers an alternative perspective explaining how intrinsic motivation leads to creative behavior. SDT emphasizes that intrinsic motivation and engagement depend on three essential psychological needs: autonomy, competence, and relatedness, meeting these needs is critical to promoting positive work attitudes and motivation (Guo and Chelliah, 2024). Organizations with leaders who practice autonomy support create environments enabling their team members to become more innovative. This idea is supported by recent research demonstrating that work autonomy serves as a critical success factor for innovative work behavior, with job autonomy being necessary for employee innovation as a frequently occurring outcome (Hernaus et al., 2024; Amoozegar et al., 2025). Staff members who experience autonomy and competence perform experimental and

innovative work, which engineering needs because problem-solving stands as its core requirement.

The workplace behavior of leaders establishes particular relationships with employee creativity based on practitioner-based models. Wiseman (2010) introduces Multipliers as a leadership method which helps leaders increase team member abilities through empowering behaviors. The concept shares similarities with academic theories that include empowering leadership and leader humility. Zhang and Bartol (2010) discovered through their study that empowering leadership which combined authority delegation with initiative encouragement and developmental support delivery which resulted in higher employee creativity and innovation. Leaders who establish psychological safety and clear expectations and empower their teams create actual pathways for better creative results according to these concepts.

The development of psychological safety represents a vital factor which supports this process. Amy Edmondson (1999) states that team members can achieve innovative results through psychological safety which enables them to take risks with each other. Team members will practice creative problem solving when they work in a protected space that enables them to share their thoughts and concerns without facing any adverse reactions. Organizations that want to innovate need to evaluate their leadership approaches and methods. Leaders who want to build an innovative organizational culture need to use transformational leadership methods together with autonomy support and empowering actions.

The engineering sector will need adaptive leadership approaches which foster innovation because its operational complexity will continue to rise. Future research must investigate how different leadership elements interact with each other while creating methods to leverage these interactions for engineering innovation development. Research studies that analyze the extended impact of these leadership approaches on team results and organizational achievement will help us comprehend the intricate relationship between leadership and team success.

## Cultural Dimensions and Global Engineering Teams

The assessment of multinational engineering teams receives backing from existing cross-cultural theoretical frameworks. Research conducted on IT and engineering project teams during the last few years demonstrates that team performance and management success, communication systems and innovation abilities depend on cultural dimensions including power distance, individualism and uncertainty avoidance (Mazur et al., 2025; Eyiah et al., 2025). Research findings indicate that cultural frameworks should not function as individual prediction tools because cultural models work best as decision-making tools rather than fixed rules and national cultures display multiple individual personality types (Liao and Thomas, 2025).

People who have cultural intelligence (CQ) succeed in different cultural settings which affects how diverse teams create innovative solutions through their work output. Research shows that teams and leaders with high CQ levels produce superior results by transforming cultural variations into innovation because they excel at exchanging knowledge and communicating effectively (Ang et al., 2007; Iskhakova and Ott, 2020; Kistyanto et al., 2022). The research indicates that team members need to develop CQ competencies because these skills enable them to handle cultural variations which leads to innovative solutions.

Research findings show that CQ or team CQ develops organizational systems which enable international team collaboration to enhance innovation results through diverse cultural perspectives. Research findings validate this concept by showing that teams with high CQ levels create collaborative environments which combine different viewpoints to develop innovative solutions (Garamvölgyi and Rudnák, 2023). A workplace becomes more inclusive when teams implement formal communication systems and defined feedback processes which enable members to share their thoughts freely without worrying about negative consequences.

Research on multinational engineering teams shows that suitable communication systems combined with decision-making frameworks and leadership approaches enable diverse teams to produce better innovation results. Research on multinational teams indicates that effective cultural diversity management leads to enhanced innovative results but cultural differences can lead to negative outcomes through team conflicts, performance discrepancies and organizational power dynamics (Stahl and Maznevski, 2021). Leadership functions remain essential because transformational leaders create spaces where trust and teamwork thrive which stops miscommunication conflicts from occurring (Ali et al., 2021).

Decision-making systems which are both specific and complete enable teams with diverse cultural backgrounds to achieve their best results. Research on software development teams shows that diverse teams with inclusive practices generate higher innovation outputs because team members experience freedom to share their ideas which leads to enhanced decision-making, creativity and innovation (Kohl and Prikladnicki, 2022). The success of diverse teams in innovation development requires organizations to implement management strategies which support inclusive teamwork and open information sharing.

The evaluation of multinational team dynamics requires knowledge that cultural dimension frameworks provide useful information but do not explain all international team behaviors. Organizations can transform cultural obstacles into team collaboration benefits through cultural intelligence training and establish communication systems and leadership methods that demonstrate the creative strength of diverse teams.

## Personality Diversity and Innovation Performance

Research shows that engineering teams with diverse personalities create better innovative results but the relationship between personality diversity and innovative performance remains complex. The Big Five personality model which includes

openness to experience, conscientiousness, extraversion, agreeableness and neuroticism, enables researchers to study how personal characteristics affect team innovative results (Kang et al., 2023). Research studies using meta-analysis show that personality traits link to innovation behavior differently depending on team makeup, work difficulty and assessment methods while organizational settings produce distinct impact sizes (Zare and Flinchbaugh, 2019; Zell and Lesick, 2022).

Research shows that openness to experience stands as the personality trait which creates the strongest link to innovation and creative thinking. Multiple studies using meta-analytic methods show openness creates positive relationships with individual innovativeness, creative output, innovative behavior and entrepreneurship across different cultural groups (Grajzel et al., 2023; Jirásek and Sudzina, 2020). People who score high in openness show curiosity and accept new ideas while handling uncertain situations which are vital for creating innovative solutions to complicated engineering problems. The trait of openness appears more prevalent among entrepreneurs and managers who work in innovative environments than among operational staff members, which enables them to develop creative ideas and strategic thinking for breakthrough innovations (Kang et al., 2023). Research on engineering teams shows that team openness to experience functions as a vital resource which boosts teams to handle challenges better while improving learning and enabling improvisation for successful innovation in changing environments (Mitchell et al., 2024; Sacramento et al., 2023).

Research studies have shown that conscientiousness produces different results for engineering innovation based on specific situations. Multiple studies have shown that conscientiousness leads to positive outcomes for individual innovativeness, creative production, innovative behavior and entrepreneurial character. The research shows that conscientiousness creates negative effects on creativity and innovative behavior in different studies (Zare and Flinchbaugh, 2019). The two opposing aspects of conscientiousness exist because people who are highly conscientious will complete innovation projects but their focus on perfection might block essential experimental work for revolutionary innovation (Kichuk and Wiesner, 1997). Research on agile software

development teams shows that conscientiousness creates positive relationships with task-oriented climate factors but team climate for innovation suffers when there is too much diversity in conscientiousness levels (Chatzi et al., 2022).

Research about extraversion in innovation environments shows that traditional team composition theories need revision. Research shows that extraverted people excel at knowledge sharing, starting conversations and team communication but their extraversion does not guarantee the creativity in all situations (Zare and Flinchbaugh, 2019). Research indicates that teams with balanced introverted and extroverted members achieve better results because members who can adjust their communication style according to situations create both collaborative ideas and focused analytical work (Grant, 2013). Research on engineering teams shows that teams with high openness and high extraversion levels generate innovation but openness stands as the essential factor instead of extraversion (Cangialosi et al., 2025).

The connection between innovation performance, agreeableness and neuroticism traits shows complex patterns. The combination of high agreeableness with team members creates better trust relationships and psychological safety which enables them to share ideas freely without fear of failure (Sacramento et al., 2023). Research shows that agreeableness creates positive relationships with team climate elements in agile teams but excessive agreeableness produces groupthink which decreases innovation quality (Guimarães et al., 2024). Team emotional stability diversity shows negative relationships with team innovation implementation according to research which indicates that different levels of neuroticism create interpersonal conflicts that decrease team performance (Chatzi et al., 2022; Zare and Flinchbaugh, 2019).

Research shows that team success with personality diversity depends heavily on how teams handle their differences. Wang and Duan (2024) show that innovation outcomes result from both positive and negative effects of generational and personality diversity which leadership methods and conflict resolution strategies determine. Research shows that different personality combinations lead to high innovation when teams include

openness with conscientiousness, extraversion and openness with extraversion, low agreeableness and openness with agreeableness and emotional stability but openness remains essential for all successful team configurations (Cangialosi et al., 2025). Teams that maintain equal diversity between openness and conscientiousness levels achieve superior creativity and adaptability but excessive neuroticism diversity leads to interpersonal conflicts that decrease team performance (Chatzi et al., 2022).

Research shows that organizations achieve their best innovation results through purposeful diversity management which combines beneficial traits with effective conflict resolution. Engineering organizations should build diverse teams by acknowledging different personalities and making them central to innovation work instead of searching for particular personality types. Research shows that personality traits explain less than 15% of the variation in team climate and innovation results which indicates that team processes and leadership methods and organizational elements have a greater impact than individual personality characteristics (Sacramento et al., 2023).

## Gender Dynamics in Engineering Innovation

The engineering industry continues to struggle with gender diversity because women represent only 10-20% of the worldwide engineering workforce according to UNESCO (2023) and the Society of Women Engineers (2024). The absence of women in engineering and related fields produces two essential obstacles because it restricts the number of available solutions and decreases innovation potential. Research indicates that teams consisting of male and female members outperform single-gender groups when tackling complex problems. The study by Woolley et al. (2010) shows that organizations which adopt gender-inclusive practices for cognitive diversity achieve superior results through team collaboration. The engineering sector needs this approach because engineers must solve problems by uniting knowledge from various disciplines and multiple perspectives.

Research findings about innovation performance show that organizations which promote full employee participation through gender diversity initiatives achieve superior results. Østergaard et al. (2011) studied numerous organizations to find that businesses with diverse workforces achieve higher innovation levels than organizations with less diverse teams. The innovation benefits from gender diversity become apparent when organizations create environments which enable all employees to participate freely and feel secure (Nielsen et al., 2018; Yang et al., 2022). Tokenistic representation in underinclusive environments leads to worse teamwork because it creates poor collaboration and elevated conflict levels.

Women in engineering face multiple barriers because of their cultural background and the way they experience their workplace environment. Research on intersectionality shows that women encounter distinct obstacles because of their specific social position. The combination of collectivist and high power-distance cultural environments creates stronger organizational barriers which restrict employee movement and power distribution (Nielsen et al., 2018). Western societies encounter two primary types of challenges which include difficulties in managing work, personal life and hidden discriminatory practices. The research by Eagly and Carli (2007) revealed three distinct gender-based biases which affect women through work devaluation and technical skill stereotypes.

The established institutional frameworks operate as biases which function independently from personal prejudices. The educational system and professional development environment in engineering maintain gender inequalities through unintentional systems which push women to leave their engineering careers. Educational institutions should develop curricula which teach students about teamwork and inclusivity because these skills need proper educational development to reach their full potential. The National Academies of Sciences, Engineering, and Medicine (2020) demonstrate that women need specific recruitment and retention strategies to enter STEM fields while organizations must establish welcoming spaces that foster diversity and inclusion.

Organizations must adopt inclusive leadership practices because these methods enable them to extract innovation value from their gender diverse workforce. Leaders must establish structural changes which surpass diversity quotas through the development of mentorship programs and flexible work arrangements and performance assessment systems. A leader who includes others establishes an environment which gives all team members equal value and power to contribute their ideas for achieving maximum gender diversity (Nielsen et al., 2018).

Organizations should track their diversity statistics while building environments which enable staff members to lead inclusion program success initiatives. Organizations which show their gender diversity achievements together with innovative results will build trust with their staff members and external supporters.

The lack of female representation in engineering presents significant obstacles yet organizations can enhance their innovation and problem-solving capabilities through proper gender diversity management. Sustainable progress requires organizations to tackle multiple fronts by implementing educational changes and building inclusive work environments and active policy development. The public sector and private sector must recognize that gender diversity delivers two sets of advantages which support social advancement and business success in today's complex world.

## Experience Levels and Knowledge Transfer

Research indicates that experience leads to a curved relationship between creativity because domain-specific knowledge expands through experience yet deep experience leads to mental stiffness which limits adaptability (Dane, 2010; Simonton, 1997). The specific impact exists only within particular environments because organizations must maintain their ability to adapt and innovate quickly. The work environment of established professionals leads to cognitive entrenchment which occurs when deep expertise creates rigid thinking patterns that block creative thinking (Dane, 2010; Mannucci and

Yong, 2018). Research shows that experienced professionals retain their fundamental problem-solving abilities yet their mental rigidity and opposition to fresh ideas restrict their ability to innovate (Audia and Goncalo, 2007; Dane, 2010).

Research shows that professionals at their career midpoint achieve major innovations because they combine deep knowledge with an open mind for new ideas (Simonton, 1997; Mannucci and Yong, 2018). Their combination of experienced knowledge and flexible thinking enables them to tackle complex problems while maintaining their curiosity about new solutions. Their combination of learned experience and willingness to learn enables them to create an environment which successfully merges established methods with innovative approaches.

The successful deployment of innovative practices depends on knowledge exchange between junior and senior engineers because it supports both new employee growth and experienced staff skill preservation. Nonaka and Takeuchi (1995) developed the SECI model which described how experience lead to the development of tacit knowledge through multiple stages. The model shows that social interaction and shared experiences enable people to transform their tacit understanding into explicit knowledge, which becomes easier to share.

Research indicates that organizations which create mentorship programs for particular practice communities achieve faster learning results and better practice execution (Swap et al.,2001). The mentorship program enables experienced team members to teach their skills to their less experienced colleagues through a knowledge transfer process. Organizations need both structured mentorship systems and spontaneous social learning systems to achieve successful knowledge transfer according to research findings.

The practice of reverse mentoring which allows younger staff members to teach their senior colleagues about new technologies and modern business methods has become popular in engineering and technology businesses (Murphy, 2012; Chaudhuri and

Ghosh, 2012). The system gives junior staff members tools for empowerment yet senior staff members get access to modern industry knowledge and cutting-edge technological advancements. Research shows that reverse mentoring programs help organizations connect different age groups for technology adoption while increasing employee involvement and knowledge exchange between organizational levels (Chaudhuri and Ghosh, 2012; Harvey et al.,2019). Organizations can maintain their innovative power through knowledge sharing between different age groups during times of rapid technological change.

Organizations that enable open communication between staff members achieve superior innovation results. Staff members at organizations which support dialogue between different employee levels get to experience multiple viewpoints and different opinions. The engagement method enables organizations to achieve ambidexterity by creating an active problem-solving space which supports creative thinking according to O'Reilly and Tushman (2013).

Organizations need to achieve innovation through finding the right combination of their experienced staff who maintain established knowledge and their new employees who introduce fresh perspectives. The combination of structured mentorship programs with reverse mentoring strategies and collaborative workspaces provides junior engineers with their most effective learning path to acquire knowledge from senior engineers while senior engineers maintain their knowledge of modern technologies. Organizations need to maintain knowledge sharing between staff members at different experience levels because technological advancement happens quickly to protect their innovative engineering practices.

## Organizational Factors Supporting Engineering Innovation

The development of successful innovative teams requires psychological safety which means team members understand they can share risks with each other without fear

(Edmondson, 1999). Team members who establish psychological safety feel free to express their thoughts and ideas and concerns because they know others will not react negatively. The open environment allows team members to exchange their ideas which leads to creative problem-solving and innovative solution development. The research conducted by Frazier et al. (2017) analyzed 136 independent samples containing more than 22,000 participants and 5,000 groups to establish psychological safety as a vital factor which produces strong connections between safety and creative output and work achievements in various business environments. The engineering and technology sectors need psychological safety to boost team performance because they need fast innovation and successful teamwork success.

Organizations struggle with innovation because they do not have sufficient time to complete their creative tasks. The "20% time" program at Google serves as a well-known example which demonstrates how dedicated innovation time results in successful outcomes. The implemented policies show potential advantages for free innovation time yet they keep specific restrictions in place. Research based on real options theory shows that organizations can enhance their innovation productivity by connecting new activities to their current operational systems through established evaluation and deployment methods (Kogut and Kulatilaka, 2001; McGrath, 1999). The innovation time period serves as a symbolic innovation target indicator because it lacks connections to other organizational components which prevents it from generating actual creative power.

Organizations need to obtain resources and tools to develop their innovation capabilities. The modern workplace operates through three essential advanced infrastructure systems which consist of cloud-based platforms, collaborative design environments and AI-assisted tools. The resources enable staff members to perform experiments while they develop new solutions. Resource availability does not lead to innovation automatically according to Leonard-Barton (1995) because organizations need to create psychological safety. Organizations need to train their staff members for

effective tool usage because this training approach produces the best innovation outcomes (Fountaine et al.,2019).

Leadership must maintain continuous efforts to develop workplaces which promote psychological safety and innovation. Leaders establish protected spaces for their team members to attempt risks through the development of safety protocols. Leaders who reveal their weaknesses and openness establish spaces for team members to exchange thoughts and provide feedback because they experience safety from negative outcomes (Edmondson and Lei, 2014; Frazier et al.,2017). Organizations need to establish open dialogue spaces which maintain active feedback systems to extract knowledge from their successful and unsuccessful experiences.

Team innovation depends on psychological safety as its core foundation because it enables creative work and performance enhancement and open communication channels. Organizations need to establish specific innovation periods in their operations while providing employees with required resources and training to build environments which promote creative thinking. Organizations need to create an integrated system which unites psychological safety with current policies and accessible resources to reach their maximum innovation potential.

# Methodology

## Research Philosophy and Design

The research uses pragmatist philosophy to study engineering innovation management by recognizing both physical facts and personal views about the subject (Creswell and Clark, 2017). Leadership theory through pragmatism matches engineering practice because it understands that leadership and innovation stem from social systems which engineers learn about through their hands-on work experience. The philosophical base allows researchers to perform mixed methods studies which unite quantitative data collection with qualitative analysis to generate meaningful results.

The research design employs an “explanatory sequential mixed-methods”. This approach performs the quantitative survey data collection which is followed by analysis and then moves to qualitative interview data collection (Tashakkori and Teddlie, 2010). The sequence allows the qualitative phase to provide additional information about quantitative results by showing the specific elements which generate statistical patterns. Survey results guide the development of interview protocols at various stages of integration while the combined data from surveys and interviews forms the basis of the framework.

From the researcher’s point of view, it is decided to use a qualitative multi-method approach. Surveys and qualitative interviews. Both methods are explained below.

Interviews are conducted in order to learn more about engineering leadership from the industry leaders themselves to know their experiences and attempt to identify patterns or common behaviors, which would lead the researcher to achieve the objective of this research, which is learning about the technology and engineering leadership styles and best practices, and as a result, providing recommendations for current and future

leaders in terms of the aspects that need to be taken into consideration when leading software engineers and professionals.

The survey collects information about industrial trends and practices through distribution to engineering professionals. The survey uses Google Forms to provide simple online access for participants from different professional backgrounds. The survey contains questions which evaluated participants' work experiences and their professional choices and difficulties in their current roles. The survey design makes it simple for participants to finish their responses quickly. The survey method delivers both high participant engagement and useful data for analysis. The survey collects diverse opinions to identify crucial industry patterns which will help shape future engineering practices for sector advancement.

## Sampling Frame

To conduct this research, a survey is created to collect feedback from professionals in the engineering community and it is shared on social media. The responses are collected anonymously and the target of this survey are team members who are engineering leads, product owners, project managers, data analysis, business analysts, production and the site reliability engineers. The responses are collected anonymously as the researcher focused on receiving candid feedback where engineering professionals feel comfortable to share their thoughts, experiences and recommendations from their own point of view.

In addition, as part of this research two interviews are conducted with engineering leaders having over 30 years of experience in engineering leadership. Open-ended questions are prepared by the researcher in advance and the focus is past experiences and best practices from their own point of view, given their vast experience in the tech field and with managing software engineers, developers and other professionals within the industry.

## Research Challenges

One of the research challenges is to find the right candidates for interviews, and scheduling interviews, and getting them to speak candidly about their experience. Following steps are taken to make the process easier, such as:

- Creating interview questions in advance.
- Developing an interview protocol.
- Conducting mock interviews with colleagues to test out the questions.

## Ethical Research

In any research endeavor, it is critical to apply proper ethical norms. Because of the in-depth nature of the research process, ethical questions have a special resonance in qualitative studies. Concerns about ethical difficulties become more obvious when doing a face-to-face interview with participants who could have a negative impact by the publication of particular data or because they are approached carelessly, for example. While ethical considerations are relevant in all fields of study, they are more important in qualitative research. The authors of this research strongly believe that it is the researcher's obligation to ensure that participants have the ability to choose whether or not to participate in the study, to protect participants' identities throughout the recruiting and dissemination process, and to promote clear and honest research reporting. (Cheron et al., 2022)

It is recommended that the researcher keep in mind that his research purpose, theoretical-analytical framework and information created have a tight relationship with the methods and procedures he will utilize. In addition to this care, even though the interview is described as a social, intersubjective, and interactive encounter, it is

necessary for the researcher to record the information produced, not only to form the research corpus but also to document it in accordance with scientific knowledge criteria.

## Deductive and clockwise research process

A specific challenge motivates research efforts. They can be either intellectual or practical, or both. Furthermore, the research challenge underpins the entire research process, which can be divided into four components: Idea, Support, Implication and Contribution. (Svensson, 2009)

The four components are depicted in Figure 2. The research process traditionally begins with a concept that is developed and made explicit through the research objective. One or more research questions are developed in order to contribute to the achievement of the study objective. (Svensson, 2009)

As part of the research phase, support for the proposal is acquired. It is initially based on research literature. It is followed by the collection of empirical data. Theoretical and/or managerial implications are articulated. (Svensson, 2009)

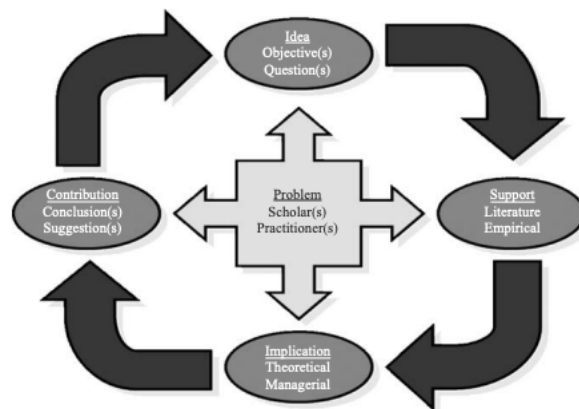


Figure 2: The research process

Source: (Svensson, 2009)

This research is conducted to study the factors that should be considered in order to unveil engineering capabilities within the technology sector, the initial factors that are considered by the researcher are seniority level, origin, culture, gender, personality type (introvert, extrovert or ambivert). The overall research plan is presented in figure 3 below:

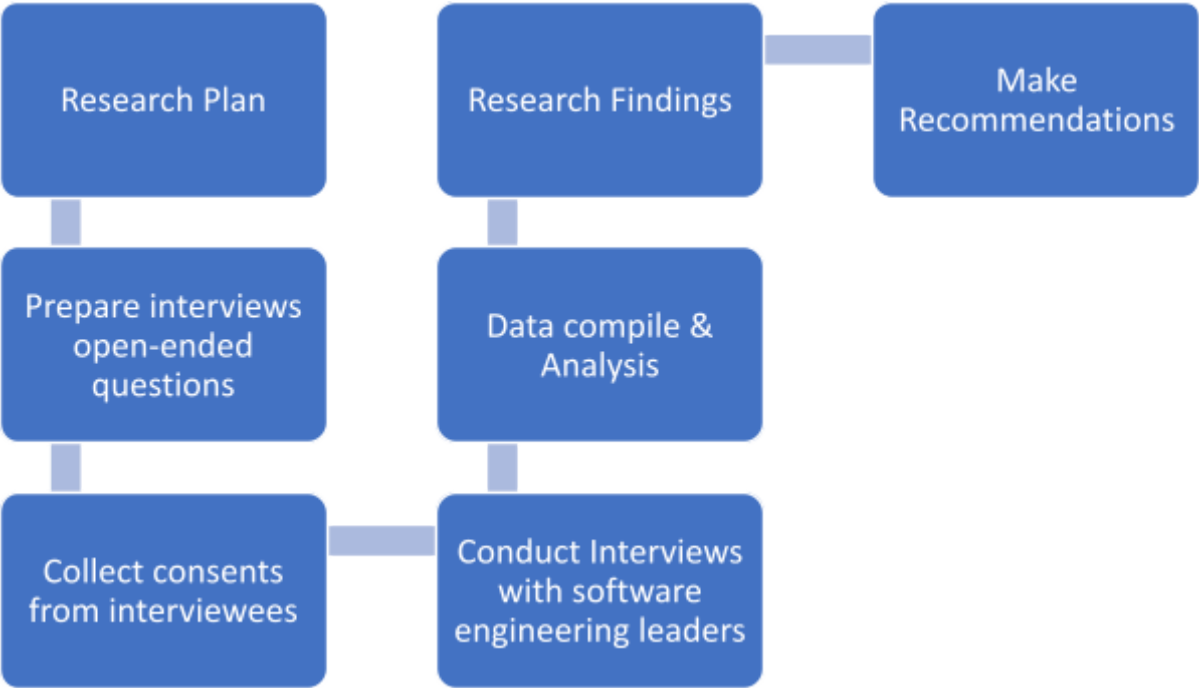


Figure 3: Research plan diagram

Source: researcher's own construct

## Primary Research Instrument

The primary research methods, which are semi-structured interviews and surveys are explained below.

### Primary Research – Qualitative Interviews

The interview, in administration as well as other fields of applied social sciences and humanities in general, is intersubjective, allowing participants - whether interviewers or interviewees - to discuss their interpretations of the world and express how they perceive situations based on their uniqueness. According to the viewpoint supported in this article, the interview consists of dynamic 'interviews,' that is, an exchange of views between two or more persons on a topic in which they share some interest (Kvale, 1996). As a result, the interview is viewed as a dynamic and relational tool. (Cheron, 2022)

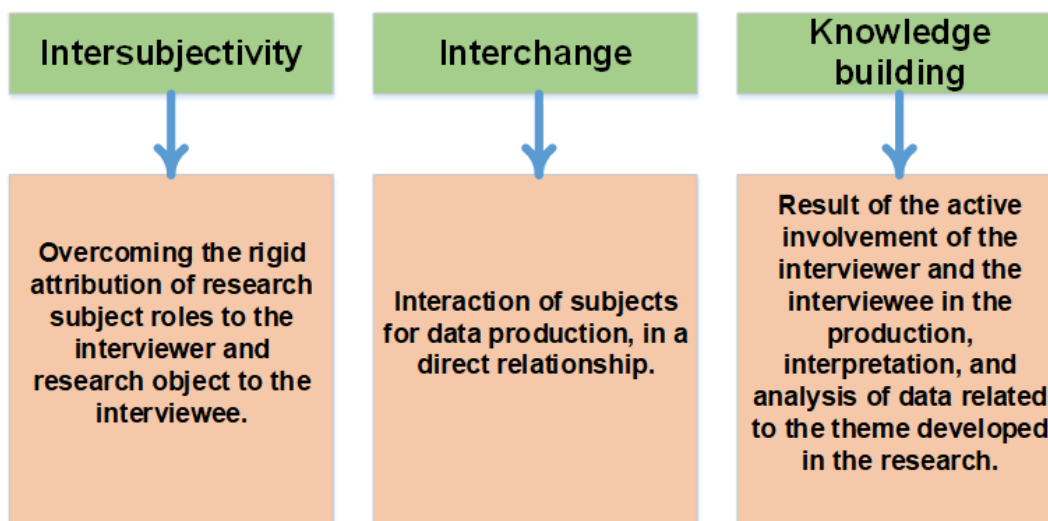


Figure 4: Essential aspects of the qualitative approach interview as a research method in administration

Source: (Cheron et al., 2022)

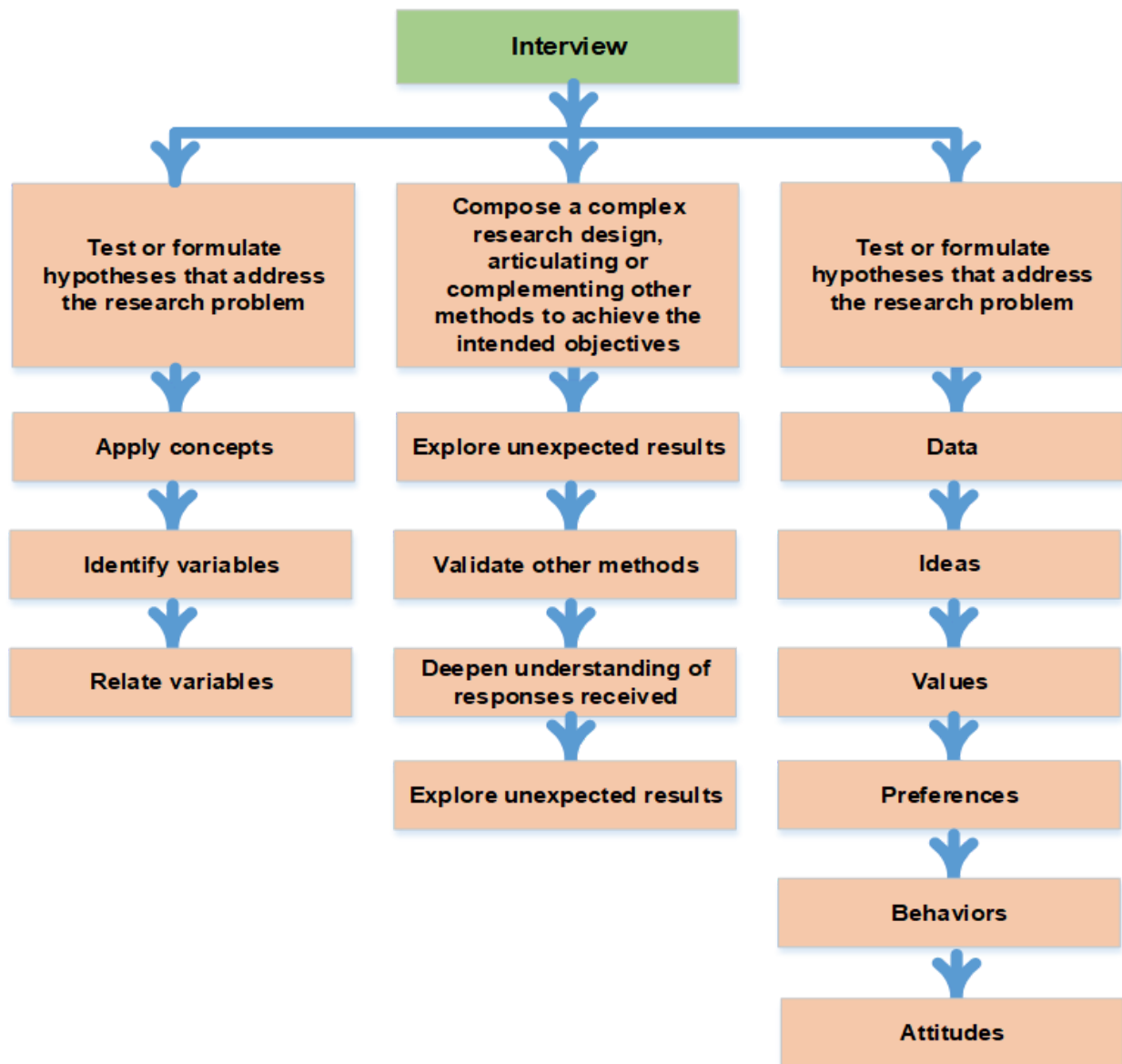


Figure 5: Purposes of using the interview in administration, according to the researcher's perspective.

Source: (Cheron et al., 2022)

In administration, as in other fields of knowledge, the interview can help the researcher in a variety of ways, depending on the disciplinary setting, the subjects under consideration, the theoretical framework, and the empirical universe. Table 1 highlights some of the different scenarios in which the interview is strategically valuable for administrative research. (Cheron et al., 2022)

According to Patton (Patton 1980), there are various sorts of interviews in qualitative or mixed research methodologies that might provide benefits and drawbacks for the researcher, as outlined in Table 2.

In practice, the distinction between interview kinds is based on the degree of structure of the questions, which reflects the goals for which it is meant and, hence, the research objectives. The selection of one or more types of interviews will inevitably be dependent on the adoption of a consistent theoretical framework that supports the problem construction and research objectives.

Reference to the above, Semi-structured, semi-open, or semi-directive interview type is selected as it can be used to explore the research topic or to get a general understanding of the participant's thoughts and feelings on engineering leadership styles and practices.

Semi-directive interviews are designed to answer specific questions or explore a particular area of interest. The interviewer will have an idea of what they want to ask about before the interview begins, but they will not know what the participant will say in response.

Table 1. Situations in which an interview could be strategically valuable for administrative research. Source: Adapted from (Cheron et al., 2022)

Research subjects	What does the researcher seek with the use of the interview? (Examples of possibilities)
Aspects of human and social behavior	Understanding knowledge, values, beliefs, or decision-making processes of stakeholders
Social and organizational contexts	Instead of simply reporting behaviors or categorizing respondents, investigate the contextual experience, activities, and connections during the interview process. From the interviewee's perspective, comprehend the scenario of the relationships between the components and members of specific organizations or groups. Recognize specific interactions involving more than one group.
Specific cases, singular or in a comparative perspective	Recognize a trajectory, an incident, or a specific or illustrative method for the study problem. Create a biography, a life history report, or a historical investigation. Learn about specific people's perspectives.
Changes and transformations	Consider the circumstances under which the educational context can be modified or reformed. Examine the consistency of a given theory in the context of a changing scenario. Provide administrative problem-solving suggestions. Based on activities

	or interventions, assess changes or transformations in a specific organizational situation.
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Table 2. Types of interviews according to the questions structure, possibilities of use, requirements for the researcher, potential advantages and disadvantages. Adapted from (Cheron et al., 2022)

Unstructured, open, or non-directive interview	
Features	It is a more casual dialogue with no predefined question script: the questions are suggested based on the aspects that developed throughout the conversation.
Use	<ul style="list-style-type: none"> <li>● When the researcher wants to learn more about the investigated topic but has not yet defined the specific points of investigation.</li> <li>● Generally used to describe individual cases, understand cultural specificities for certain groups, and compare different cases.</li> <li>● Study strategy aimed at addressing realities not yet explored by the researcher or offering an approximate view of the researched problem.</li> <li>● Strategy to deepen unexpected research results; It is also used with groups of people that shared a common experience (for example, attending the same meeting, seeing a specific incident, or participating in a specific event).</li> </ul>

<p>Requirements</p>	<ul style="list-style-type: none"> <li>● It may be important for the researcher to have considerable theoretical knowledge on the research issue in order to create the relevant questions or identify the themes to be deepened during the conversation.</li> <li>● It is necessary for the researcher to have good communication skills in order to boost the interviewee's speech and instill trust in him (rapport).</li> <li>● It necessitates that the interviewer actively listen to the interviewee's words, recognizing material pertinent to the investigation's objectives.</li> <li>● as well as preventing emphasis shifts that jeopardize the interview's usefulness.</li> <li>● It necessitates additional care on the part of the researcher to ensure that the senses and interpretations that the interviewee associates to their testimonies are accurate.</li> <li>● are respected in information interpretation and analysis.</li> <li>● Interviewees must take the time to engage in a productive dialogue.</li> </ul>
<p>Advantages</p>	<ul style="list-style-type: none"> <li>● More flexibility to conduct the interview based on the emerging elements; Increases the relevance and pertinence of the questions developed during the meeting and emerging from observations.</li> <li>● The interview can be personalized, corresponding to individuals and circumstances.</li> </ul>

	<ul style="list-style-type: none"> <li>● Makes the interviewee more comfortable, allowing for more spontaneous (less calculated) responses.</li> <li>● Increases the researcher's potential to add knowledge.</li> </ul>
Disadvantages	<ul style="list-style-type: none"> <li>● Different information gathered from different persons with different queries leads to less systematization, making it difficult to analyze, organize and examine.</li> <li>● The achievement of research objectives is highly dependent on the unexpected appearance of important questions and information.</li> <li>● More sensitive to the bias of research subjects.</li> <li>● Takes more time.</li> </ul>
Semi-structured, semi-open, or semi-directive interview	
Features	<ul style="list-style-type: none"> <li>● In advance, the subjects and questions to be addressed are established in the form of a screenplay with essential questions based on theories.</li> <li>● as well as hypotheses relevant to the research problem, supplemented with other queries arising from the current situation interview.</li> <li>● During the interview, the researcher blends open and closed questions and chooses on their sequence and convenience: questions can be opened or closed, be changed, added, or removed.</li> </ul>

<p>Use</p>	<ul style="list-style-type: none"> <li>● When the researcher seeks to limit the amount of material produced during the interview in order to acquire a stronger focus on the issue, interfering to ensure the attainment of the study objectives;</li> <li>● When a researcher raises questions from a phenomenological theoretical framework in order to maximize the understanding of a specific social reality.</li> <li>● When a researcher attempts to establish causalities or explanations for social phenomena and develops questions based on a historical structural (dialectical) theoretical framework.</li> </ul>
<p>Requirements</p>	<ul style="list-style-type: none"> <li>● In addition to the open interview criteria, the interviewer must be alert to lead the discussion to the previously identified relevant issues at the appropriate time, or to bring the conversation back to the suggested emphasis.</li> <li>● Relative understanding of the theoretical and empirical universes under consideration.</li> </ul>
<p>Advantages</p>	<ul style="list-style-type: none"> <li>● It enables the interviewee freedom of expression while also allowing the interviewer to maintain focus.</li> <li>● It provides access to the unobservable, causing the interviewee to reflect, as well as current representations, including those of past occurrences.</li> <li>● Allows for the identification of unobservable factors and their relationship to other aspects pertinent to the inquiry.</li> </ul>

	<ul style="list-style-type: none"> <li>● It enables analyzing the coherence or incoherence of the information collected, as well as performing methods that strengthen its validity and dependability, such as source triangulation;</li> <li>● Enables improved systematization of information generated during an unstructured interview, simplifying interpretation and analysis;</li> <li>● Allows for the anticipation and resolution of potential gaps.</li> </ul>
Disadvantages	<ul style="list-style-type: none"> <li>● Topics relevant to an investigation may be excluded inadvertently.</li> <li>● The interviewer's flexibility in questioning can result in significantly varied responses, decreasing their comparability.</li> </ul>
Structured, closed, or directive interview	
Features	<ul style="list-style-type: none"> <li>● The exact wording and sequence of questions are predetermined.</li> <li>● All respondents are asked the same fundamental questions in the same order.</li> </ul>
Use	<ul style="list-style-type: none"> <li>● When the researcher wants to know the interviewee's points of view and circumstances in a comparative context, based on previously defined specific information.</li> <li>● When the researcher wishes to interview a larger number of people, the perspectives and situations of whom will be classified and compared.</li> </ul>

<p>Requirements</p>	<ul style="list-style-type: none"> <li>● Prior knowledge of the empirical universe, to ensure that the subjects and questions have all of the ingredients required to meet the research objectives.</li> <li>● Question language that is clear and understandable to all responses.</li> </ul>
<p>Advantages</p>	<ul style="list-style-type: none"> <li>● It enables for responses to differ based on the factors explored, the interviewee's opinions, and situations, rather than answering different questions.</li> <li>● Improves response comparability in comparison to the semi-structured interview.</li> <li>● Allows for the participation of a larger number of respondents in the investigation.</li> <li>● By pre-defining the subjects and categories covered by the questions, the potential for a posteriori bias in the information built is reduced.</li> <li>● Allows the researcher to delegate the conduct of interviews to additional interviewers at the same time, minimizing the time required.</li> </ul>
<p>Disadvantages</p>	<ul style="list-style-type: none"> <li>● Increases the possibility of skewed information being generated by encouraging responses from the subjects and categories covered by the questions.</li> </ul>

	<ul style="list-style-type: none"><li>• Less flexibility, as it does not allow for the analysis of unexpected comments from respondents that suggest potentially important issues.</li></ul>
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### Primary Research – Qualitative Surveys

Qualitative surveys act as the most logical tool to know about feelings of participants, their real-life experiences, and the way they conduct any task. The surveys are designed to collect responses of targeted participants using detailed questionnaires. Such kind of questionnaires are designed to be open-ended to collect most realistic responses in true letter and spirit. Qualitative research methods are mostly employed in multiple fields of life. For example, health, education, and sociology. This method is also applied to investigate the human experiences, most of which are quite complicated to understand by any quantitative approach (Fuzzell et al., 2020).

As compared to quantitative surveys, the qualitative surveys are more meaningful to obtain in-depth knowledge about the emotional, motivational, and social thoughts of the audience. This is successfully being attained due to the in-depth contextual nature of the surveys (Kvale and Brinkmann, 2015).

The literature demonstrates the real-time essence of qualitative surveys based on perfectly collected participant's perspectives shared in form of interesting stories (Fuzzell et al., 2020). One of the main factors about qualitative surveys is to create open-interview environment. Such type of environment is necessary to facilitate the participant in their process of openly sharing the true experiences in most elaborated form (Fuzzell et al., 2020).

On the other hand, scientists apply qualitative methods to design theoretical models. The models are then used to translate and investigate the real-time experiences of the participants into result-oriented transcripts.

Inclusivity is one of the main traits of qualitative surveys. These surveys consider the cultural differences closely, and hence the surveyor is able to modify the questionnaire to the most acceptable, yet meaningful form. The inclusivity of all types of populations regardless of their ignored stature in the society makes qualitative surveys highly acceptable (Kvale and Brinkmann, 2015).

The qualitative surveys are designed to collect the participant's information in a logical sequence that allows for better understanding of repetitive patterns. These patterns are then studied to perform thematic analysis. One of the parts of thematic analysis is to assign unique identification codes to different patterns. Such codes are used for simplification to avoid mixing of collected opinions. The simplification leads to realization of considering each participant's input as a part of social narrative (Braun and Clarke, 2006)

There is one key limitation associated to qualitative methods. i.e., biasness of the researcher. As mentioned earlier, the contextual nature of responses needs to be carefully translated into true perceptions of the participants (Kurnaz et al., 2025). Therefore, triangulation is preferred to maintain the validity of the translated responses. The process of triangulation includes the check of translated responses by three types of sources, i.e., multiple sources, methods, and members (Fuzzell et al., 2020).

## Ethical Considerations

This research implements all ethical constraints specified in British Educational Research Association standard (Bryan and Burstow, 2018) . The university review board is asked for prior permission for data collection. The participants are also

informed earlier about the details (methodology, goals, types of surveys, probable risks, probable pros) of the research and then asked for permission to conduct surveys. Furthermore, the participants are also informed about their constitutional right to leave the research at any time they feel inappropriately inconvenient or lead to non-desired consequences.

Moreover, the Data protection is also made possible using GDPR requirements (Ayala-Rivera and Pasquale, 2018), that necessitates the removal of all types of personal identifiers from datasets. Data protection also includes the assignment of pseudonyms to maintain the anonymity of participants. The IP addresses and identification-based metadata are removed with the help of encrypted communication systems. The access to encrypted data is also made safe via use of password-protected encrypted drives to store any type of collected data of participants. It is also committed to maintain the secrecy of the data storage for five years that will be deleted securely thereafter irrespective of any kind of prevailed circumstances.

It is also made sure to protect participants who worked under managers because they may worry about facing job consequences when sharing their true opinions about management methods. The researchers solve these problems through their position as an outside investigator and their commitment to confidentiality and their use of aggregated data.

## Sampling Strategy

The research employs purposive sampling to obtain participants who represent all necessary dimensions which matches the research inquiries. The survey required participants who fulfilled four particular requirements which include working in an engineering role and having at least one year of professional experience and participating in the innovative activities and working within a team-based environment.

The recruitment process relies on professional engineering networks as well as LinkedIn groups and snowball referrals.

The survey sample for the final analysis consists of 17 participants who come from five different countries including Greece, India, the United Kingdom, Jordan and Kenya. The participants had work experience between 1-5 years (33.3%) and more than 20 years (6.7%) and most of them are in the middle of their careers with 11-15 years of experience (46.7%). The gender breakdown of the participants is followed the typical industry distribution with males making up 86.7% and females making up 13.3% of the group. The personality types of the participants include 26.7% introverted and 20% extroverted while 53.3% identified as ambiverted.

Theoretical sampling is employed to choose engineering leaders for qualitative interviews because they require particular knowledge about diversity management practices. The two leaders Andrew Garcia (Senior Engineering Leader Pfizer Digital Operations) and Chris Desiano (Engineering Team Lead Pfizer Digital) together supervise more than 140 engineers who worked in 20+ countries thus offering deep understanding of worldwide team management difficulties.

## Data Collection Instruments

### Survey Development

The survey instrument comprises 24 questions organized into six sections: 1) demographic background, 2) innovation confidence and capability, 3) work preferences and management, 4) team dynamics and collaboration, 5) learning and development, and 6) open-ended challenges/recommendations.

The researchers combined existing measurement tools with new assessment items which they developed based on their literature review and pilot study results.

Most of the researchers use a 5-point Likert scale which is creative self-efficacy scale (Chen et al. 2019) . Work preference items draw from the Basic Psychological Needs Scale (Deci and Ryan, 2000), while team dynamics questions incorporate elements from psychological safety assessment (Edmondson 1999). The instrument shows reliable results (Cronbach's  $\alpha = 0.78$ ) when tested with five engineering professionals during pilot testing.

## Interview Protocol

There are six thematic domains that are considered for semi-structured interviews conducted by designated research teams. The domains are named leadership philosophy and team composition, diversity benefits, personality-based management strategies, cultural competency approaches, experience level management and innovation facilitation practices. Consistent interview procedures are maintained to make possible the uniformity in the research. This consistency ensures the receipt of participant's experiences and perspectives in true form.

Due to the long distant residences of the participants, the mode of contact for interviews is online via video conference. The interviews are conducted for durations ranging from 53 to 63 minutes. A professional conversational method is adopted to conduct interviews. It helps participants to put light on real-life examples and complex workplace scenarios related to their organization's management practices. The validity of the participant's originality is maintained via regular check of official member's email addresses for obtaining requisite data of surveys and also to conduct interviews. These emails are already being communicated earlier. Any other communication via any other email from any participant is not considered in any form in this research.

## Data Analysis Procedures

### Quantitative Analysis

The quantitative analysis of the data collected through surveys is performed on SPSS version 28. SPSS version 28 is further used to do descriptive and inferential statistics. The quantitative analysis begins with estimation of frequency of variables appearance along with the corresponding average values and data distribution. Second, the variables and innovation-based outcomes are analyzed using cross-tabulation techniques. The group comparison is also performed based on small sample size using Mann-Whitney U and Kruskal-Wallis H statistical testing. Mann-Whitney U and Kruskal-Wallis H are categorized as non-parametric tests and are performed as mentioned in literature (Okoye and Hosseini, 2024).

The relationship of management understanding and innovation-based outcomes is also analyzed using correlation analysis (Spearman's rho). For all statistically significant findings surpassing statistical significance, Cohen's d is utilized to determine effect sizes. Listwise deletion is also employed to eradicate the missing data (less than 5%).

### Qualitative Analysis

For quantitative analysis, Braun and Clarke's (2006) six-phase thematic analysis method (Byrne, 2022) is used. This method analyzes the interview transcripts. The sequence of performance of analysis is familiarization followed by initial coding to theme development leading to theme review to theme definition and finally the report production. The initial coding process follows both. The research performs deductive methods (based on interview protocol themes). The research also applies inductive methods to explore new themes. NVivo 12 software is employed for supporting coding and theme management.

## Integration Strategies

Literature (Fetters et al., 2013) reports the integration of obtained and relevant data at different stages. The quantitative data helps to improve the interview protocols. Furthermore, the scrutiny of particular interview topics for additional analysis is performed based on the survey results. The interpretation stage is used quantitative and qualitative data to develop complete explanations about the observed patterns.

The joint displays present quantitative results alongside qualitative data which allow researchers to assess both types of information. The team develops Meta-inferences through discussions about how different data types show convergence and complementarity and divergence. The results show different patterns so researchers conducted extra evaluation to understand the complex relationships that single-method studies could not detect.

# Results

## Quantitative Findings

### Innovation Confidence and Capability Gap

The research findings indicated that engineers displayed greater confidence in their innovative abilities than their actual workplace application of creative competencies. The participants showed high innovation confidence, with an average rating of 4.2 out of 5, and 80% of them expressed being "very confident" or "extremely confident" about their capacity to help with innovation projects. However, employees used creativity the least in their work activities, with only 53.3% of participants demonstrating "considerable" to "extensive" creativity application and an average score of just 3.7 out of 5.

The study finds that this confidence gap exists at the same level for all demographic groups. Experience level does not affect the gap size, showing no meaningful relationship. This suggests that organizational barriers rather than personal growth factors lead to this difference. Personality type also failed to establish any meaningful connection with gap size, as the statistical test showed no significant differences between groups. Both introverted and extraverted engineers encounter equivalent creativity barriers according to the study.

Senior engineers show the biggest gap between their reported creativity usage and their confidence ratings. Engineering Directors use creativity the least, with an average score of 3.0, but show the highest confidence levels at 5.0 out of 5. The research shows that senior engineers with deep knowledge face restricted creative possibilities after they have transitioned into leadership roles.

## Personality and Innovation Approach Preferences

Contrary to stereotypical assumptions, personality type showed weak relationships with innovation approach preferences. Among the four introverted engineers surveyed, they selected three different approaches to innovation: 50% chose collaborative brainstorming, 25% preferred iterative experimentation, and 25% favored independent exploration. This distribution contradicts the common belief that introverted people need to work alone.

Surprisingly, the three extraverted engineers picked structured planning methods instead of collaborative methods, which was an unexpected choice. The eight ambiverted engineers showed the widest range of preferences, with 50% of them preferring iterative experimentation. The research results indicate that personality type fails to predict innovation approach preference because personal differences are more important than the patterns observed between groups.

Statistical testing shows no meaningful relationship between personality type and innovation approach, indicating that using personality stereotypes for management decisions is not effective. The process of innovation requires individual assessment together with flexible accommodation methods to achieve maximum results.

## Cultural Patterns in Innovation Preferences

The research into geographic regions revealed distinct cultural patterns in each area. The four Greek engineers distributed their preferences equally between collaborative brainstorming (50%) and iterative experimentation (50%). The three UK engineers showed a preference for independent work methods at a rate of 33% above other nationalities. The four Indian engineers demonstrated the widest range of preferences because they selected all available innovation approaches.

The patterns show some similarity with Hofstede's cultural dimensions through their individualism-collectivism aspect. However, variation within each culture was substantial, with differences among engineers from the same country often being larger than differences between countries. The research confirms that cultural stereotyping prevention is necessary but cultural awareness should still be preserved.

## Autonomy as Universal Requirement

The survey results demonstrated that autonomy importance remained consistently high, with an average rating of 4.3 out of 5 across all demographic groups, and 93.3% of participants strongly agreed that autonomy was either very important or extremely important. The results showed no meaningful relationships between autonomy importance and experience level, personality type, or cultural background.

The universal value of autonomy supports the essential psychological requirements which self-determination theory has established. Engineering managers need to establish autonomy-supportive practices as core elements because they should not depend on individual traits of their team members. The practice of micromanaging shows no benefit to engineers from any background.

## Management Understanding and Innovation Outcomes

The research established that management knowledge about technical and creative abilities produced different innovation outcomes. Engineers who believed their managers understood their abilities showed moderately strong positive relationships with higher creativity utilization, higher innovation satisfaction, and stronger willingness to share their ideas. All three relationships were statistically significant.

The results of regression analysis showed that management understanding explained 38% of the differences in innovation satisfaction levels among engineers, even after

accounting for experience level and personality type. The research indicates managers need to understand all capabilities that each team member possesses.

## Qualitative Findings

### Theme 1: Individual Assessment Over Categorical Management

The interviewed leaders both agree that traditional diversity management methods based on categories do not work effectively. Andrew Garcia stated that "We use Myers-Briggs assessments but I think you need to learn each person as an individual. An individual who identifies as introverted would require additional social challenges in their interactions with others.

The specific examples demonstrate this point of view. The introverted engineer according to Garcia demonstrates exceptional performance when he receives proper presentation support which proves that introverts do not necessarily shy away from public speaking. Desiano similarly reports that physical indicators do help with identification like in case of extroverts. But these indicators cannot be affixed to a wrong perception that such people cannot work out of their convenience.

The leaders negate the use of categorization systems without proper personality assessments. The experts conclude that observing actual behavior patterns throughout time should take precedence over making changes based on individual responses instead of personality labels.

### Theme 2: Cultural Adaptation Without Stereotyping

Leaders understand cultural competency as essential for global team management but they warned against using cultural stereotypes. Desiano conducts research on cultural

practices but he stays away from making assumptions about them: "Research and understanding are important but you should never be foolish about it. Avoid using greetings in unknown languages since you should learn about different cultures through authentic dialogue and cultural understanding.

Garcia points out functional changes in Greek culture because "In Greece, I see how people tend to stay up late and sleep in late. The team members in India operate at various times to accommodate US time zones while we need to prioritize safety measures especially for female staff members who need to exit sites before 8:00 PM. The cultural adaptations demonstrate understanding of cultural differences yet they prevent the reduction of people to their cultural origins.

Both leaders emphasize that cultural diversity benefits innovation only when actively leveraged. Garcia uses his knowledge of cultural problem-solving methods to distribute work effectively by linking project needs to team member strengths while staying away from preconceived notions about their abilities (Garcia, 1993).

### Theme 3: The Innovation Time Paradox

The research shows that organizations follow a distinct pattern when it comes to time allocation for innovation. Leadership members acknowledge the significance of the program yet they face difficulties when trying to put it into practice. Desiano revealed, "I've tried creating programs like '10% time' for innovation but discovered that even when given permission, high-performing teams that want to do great work for clients don't take that time."

The paradox shows that engineers want to innovate through time yet they fail to use existing time resources which indicates fundamental organizational problems. Desiano achieves this by making innovation a standard part of regular operations through the process of adding innovation tickets to backlogs which product owners would manage.

Garcia defines innovation as a mental approach which differs from unstructured random work activities. I believe that every situation has room for improvement because I always maintain that there exists a superior method no matter how well something performs. The continuous improvement philosophy implements innovation as a standard work practice rather than running it as an independent process.

#### Theme 4: Multiplier Leadership in Practice

The leaders use Multipliers principles from Wiseman's framework although they do not reference the model directly. Garcia bases his management approach on "standards and ownership" which matches the Investor discipline that requires employees to take full responsibility for their assigned work until it reaches completion without passing tasks to additional team members.

The Liberator discipline of Desiano becomes evident through his focus on psychological safety because he believes "My philosophy is based on empathy which involves understanding what makes people tick and what stands in their way. The objective in this case is to understand what the person is thinking rather than feeling sorry for them. The method creates space for innovation because it removes all fear-based restrictions.

Garcia creates the Challenge Maker discipline by continuously working on his development and Desiano develops a training approach for introverted team members through forcing them to conduct workshops even though they felt uneasy. I support them as a leader by recognizing their discomfort while helping them set particular goals."

#### Theme 5: Experience-Level Dynamics

The two leaders recognize separate obstacles which emerge from working with teams containing different age groups. Garcia notices different work approaches among team

members because "Some people will vanish for seven days to work on problems by thinking deeply and conducting thorough analysis. People right away construct teams that bring together resources holding appropriate knowledge to work together on problem-solving."

The level of experience between engineers leads to different work approaches since senior engineers work alone but junior engineers need to work with others. Leaders receive warnings to avoid making assumptions because the group data fails to show the full range of individual differences that people display.

Organizations now face knowledge transfer as their main organizational challenge which they need to solve. Desiano establishes a "safety net" system which enables knowledge receivers to control when they would let go of their support structure: "The performer determines when to remove the safety net in the same way a trapeze artist does. "The person who receives knowledge transfer will decide when they need assistance to be taken away."

The method allows students to learn at their own speed while receiving sufficient help which supports innovation capacity during the time when experienced engineers leave their positions or change jobs.

## Integration of Quantitative and Qualitative Findings

### Convergent Findings

The numerical findings match exactly with the qualitative results which appear in the following sections. Survey results shows that autonomy stands as a vital element for all (93.3% rated it as very/extremely important), which matches exactly with leaders' focus on giving ownership and empowerment to their teams. Garcia demonstrates autonomy-supportive leadership through his approach of giving engineers complete

ownership of their tasks and Desiano achieves this through his establishment of independent work environments.

The quantitative data shows a poor relationship between personality types and innovation preferences which supported the leaders' method of individual assessment instead of group classification. Personality-based management approaches show inferior results when compare to personalized methods that take into account individual preferences which extend past standard personality types.

The leadership teams achieve a positive relationship between their management principle understanding and innovation results ( $r_s=0.62$ ) because they dedicate themselves to learning about their team members in depth. Desiano and Garcia demonstrate that managers must identify team member abilities and work preferences to achieve successful team management.

## Complementary Findings

The different data sources produce additional findings which support each other. The quantitative data shows the confidence-utilization gap but the qualitative data provides reasons for this gap which include organizational barriers, time constraints and role responsibilities that restrict creative work despite employees showing high potential.

Survey results demonstrate that people with various personality types choose different methods for innovation but managers achieve success through flexible work approaches based on interview findings. The authors show effective methods for dealing with different preferences through their use of multiple innovation paths and their method of matching project requirements with individual work approaches.

Senior engineers demonstrate lower creativity utilization according to quantitative results which interview participants supported through their descriptions of career

development obstacles. The quantitative pattern observed by leaders requires them to demonstrate both the reason behind experienced engineers shifting from creative work to administrative tasks and multiple potential solutions.

## Divergent Findings and Explanations

The group members express different views about how cultural diversity affects innovation. Survey participants show that diversity provides restricted benefits since 80% of them believe diversity "somewhat helps" but interviewed leaders demonstrate that diversity leads to substantial advantages when organizations implement proper management of diversity. The two methods operate differently because standard diversity management practices work to keep different groups separate from each other but strategic diversity leverage actively works to harness diverse viewpoints.

The teams show different approaches to how they spend their time for innovation. Survey participants select time as their main obstacle to innovation yet Desiano finds that engineers fail to use the innovation time which has been allocated to them. The paradox demonstrates that time management by itself will not solve the issue because innovation needs to become an essential part of organized work procedures with predefined performance targets.

# Discussion

## Theoretical Contributions

The research units establish leadership models with engineering data to develop original knowledge for this domain. The study confirms transformational leadership theory because it shows that team cultural background and psychological safety influence how the theory affects innovation. Bass and Riggio develop the theory of transformational leadership in their 2006 book, which has become foundational to understanding how leaders inspire and motivate followers. Recent research demonstrates the importance of psychological safety as a mediator between transformational leadership and innovation outcomes, particularly in diverse teams. Gumusluoglu and Ilsev found in 2009 that transformational leadership positively influences organizational innovation, particularly when external support systems are present. The majority of transformational leadership research has concentrated on typical organizational environments, yet this study addresses the current academic need for leadership theory validation in particular settings. Leadership effectiveness evaluation in engineering environments requires separate assessments of operational barriers and operational characteristics that are specific to each setting.

In addition to the leadership framework, this research contributes to theories regarding personality diversity within teams and its correlation with creativity. The findings reveal that traits such as openness substantially enhance team performance. Feist's 1998 meta-analysis demonstrated that openness to experience is a distinguishing feature of creative individuals across both scientific and artistic domains. Additionally, Kaufman and colleagues found in their 2016 study that openness to experience and intellect differentially predict creative achievement, with openness predicting artistic creativity and intellect predicting scientific creativity. The combination of these characteristics allows team members to develop a complete set of skills which boosts their overall

creative abilities. Team members who score high in openness tend to generate innovative ideas and accept new methods, while their diverse skill sets help execute and implement these creative concepts.

Studies from Grant in 2013 showed that ambiverted individuals can be effective in roles requiring a balance between communication and analytical skills, such as sales, because they can switch between introverted and extroverted social behaviors. The new assessment method outperforms traditional individual trait evaluation because it shows how different personality types work together to create innovative solutions for high-tech and engineering tasks.

The research expands self-determination theory through its analysis of how autonomy needs and competence needs and relatedness needs manifest in engineering organizations. Research conducted by Deci and Ryan in 2000 and Demircioglu in 2021 demonstrates that autonomy leads to innovation across different cultural environments. The research shows that autonomy expression and support patterns between high power distance and low power distance cultures show significant differences. Leaders who work in high power distance environments enable autonomy through resource allocation and independent work support but leaders in low power distance cultures give direct decision-making authority to demonstrate autonomy. Human psychological requirements exist in every person but their fulfillment depends on the cultural environment they live in.

Leaders who implement psychological safety methods as described by Edmondson in 1999 and Frazier and colleagues in 2017 create spaces where employees can freely share their ideas. Team members in environments with psychological safety can express their opinions without fear because they receive protection from adverse consequences when they share dissenting views or take risks. Leaders who implement empowerment models as described by Zhang and Bartol in 2010 alongside psychological safety development create conditions for their engineering teams to experiment and take risks. Leadership generates innovative results through two distinct

methods which strengthen current innovation management theories by combining empowerment with psychological safety approaches.

The research presents multiple perspectives about how leadership influences team composition and psychological needs and innovation within engineering teams. Leaders need to recognize specific cultural aspects and environmental conditions which affect team work and innovation because of this. Leaders who create diverse teams and establish psychological safety enable their teams to reach their peak performance which results in innovative practices that benefit personal and organizational success.

## Challenging Conventional Wisdom

Recent findings challenge traditional management theories that simplify team dynamics through personality-based strategies. The assumption that introverted individuals prefer solitary work while extroverts lean towards collaboration lacks robust support from empirical evidence. Research indicates that both introverts and extroverts can be highly effective contributors in team environments when their roles are aligned with their intrinsic strengths. Furthermore, the concept of ambiversion, where individuals display both introverted and extroverted traits, appears to be more prevalent than previously assumed (Grant, 2013; Adeoye et al., 2023). This nuanced understanding prompts managers to reassess how they formulate teams, advocating for a more individualized approach to understanding employee preferences rather than relying on broad stereotypes.

One implication of this research is that managers can foster more effective teams by acknowledging and accommodating the diverse working styles present among their employees. Rather than placing individuals in predefined roles based on personality assumptions, managers can engage in open dialogues to discover employees' preferences and strengths. For instance, introverts may perform optimally in roles that allow for deep focus and individual contributions, while extroverts may excel in positions

that require frequent collaboration and communication. Organizations can enhance both employee satisfaction and performance outcome by aligning tasks and liabilities with individual satisfaction.

Equally crucial is the examination of policies which intends to spur innovation, such as Google's well-known "20% time," which allows employees to dedicate a portion of their work hours to pursue creative projects. However, recent studies suggest that merely providing temporal resources is inadequate in fostering genuine innovation. Innovation thrives most effectively when dedicated time is coupled with systemic structures for idea evaluation, feedback, and support (Birkinshaw et al., 2008). When companies allocate time without accompanying mechanisms for nurturing creative ideas, the result is often a proliferation of symbolic initiatives that fail to translate into substantive innovation. This insight stresses the importance of integrating time with a robust framework that encourages and evaluates creative efforts, thus paving the way for more substantive outcomes.

Moreover, while cultural frameworks like Hofstede's can offer valuable insights into cross-cultural dynamics, their application should not be deterministic. Hofstede's dimensions of culture provide a starting point for understanding how cultural factors might influence workplace behaviors, yet empirical studies reveal considerable variation within cultures that can supersede these broad classifications (Beugelsdijk & Welzel, 2018). This suggests that rather than viewing culture as a fixed variable, it is more productive to consider how team processes, communication strategies, and leadership styles can collectively impact innovation outcomes.

Evidence indicates that team dynamics often play a more significant role in innovation than cultural stereotypes. Effective communication and collaborative leadership are critical in creating an environment conducive to idea sharing and experimentation. Teams that embrace diverse perspectives and foster respectful discourse are more likely to generate innovative solutions, regardless of their cultural background. This

perspective challenges both universalist views, which overlook the relevance of culture and culturalist viewpoints that may overemphasize its impact.

Therefore, organizations must adopt a more sophisticated understanding of team dynamics that incorporates individual strengths, supports innovation through structured frameworks, and recognizes the complexities of cultural influences. Managers should actively cultivate team environments where diverse personalities can thrive, ensure innovation initiatives are bolstered by solid support systems, and adapt strategies that transcend simplistic cultural categorizations. Such an approach can lead to enhanced collaboration, increased creativity, and ultimately, superior organizational performance.

In conclusion, the results are drawn from recent research underscore the importance of individualized management strategies that align with team members' strengths. The interplay of personality, innovation frameworks, and cultural understanding is intricate and requires thoughtful navigation. As organizations adapt to these findings, they will be better positioned to leverage their teams' collective potential to drive meaningful innovation and develop resilient, high-performing work environments.

## The Multiplier Effect in Engineering Contexts

The research supports Wiseman's (2010) Multipliers framework through its application to engineering-specific organizational dynamics. The research supports the concept that leaders who amplify team capabilities can boost performance when teams need to generate innovative solutions. Research by Zhang and Bartol (2010) shows that when leaders empower their teams through autonomy promotion, initiative encouragement, and team development, the teams achieve higher creativity and innovation results. Leaders who demonstrate empowering behaviors in engineering environments enable team members to contribute their unique skills including technical expertise, rapid idea generation, and comprehensive problem resolution, which all drive innovation forward.

Edmondson (1999) first introduced the concept of psychological safety, which described a shared belief held by members of a team that the team is safe for interpersonal risk-taking. This condition is essential for creating an environment which supports open communication and active participation. Research across cultures shows risk-taking behavior differs substantially between cultural groups, yet leaders need to actively reduce team member fear of failure for innovation to succeed (Frazier et al., 2017). Psychological safety has proven effective across multicultural environments, which makes it essential for diverse workplace settings.

The understanding of experience-level impact on multiplier effects serves as a fundamental requirement for effective engineering leadership. Leaders who present challenges as learning experiences deliver the most value to junior engineers who are eager but lack experience. The perspective allows them to understand that failures should be viewed as chances to learn instead of barriers to progress. Senior engineers with deep industry knowledge and experience deliver better results through their work on strategic projects and mentoring activities (Wiseman, 2017; Nonaka & Takeuchi, 1995). Leaders need to modify their multiplier behaviors based on team member career stages because this demonstrates their understanding of the requirement for personalized support at various development stages.

An essential role that leaders must adopt within the innovation framework is that of the "investor." The method follows resource-based management theories which show that leaders must offer resources and show dedicated commitment and determination to achieve innovation project success (Leonard-Barton, 1995). Leaders who function as investors for their teams provide more than financial support because they dedicate themselves to emotional and intellectual development of their teams. Leaders who maintain absolute backing create an environment based on trust which leads to better team collaboration.

The research shows that specific success factors do not stand as the main focus because it reveals the actual operational components which lead to success. The four

essential elements for successful engineering innovation strategies consist of empowerment and psychological safety and structured debate and committed resource allocation. The practice of leading through empowerment enables team members to develop self-governance which allows them to discover new solutions. People can share their thoughts without fear when psychological safety exists which leads to diverse perspectives because of open communication. The process of structured debate helps people develop critical thinking abilities while allowing them to share different viewpoints which leads to innovative answers.

The evaluation of these elements demonstrates that successful engineering leadership demands a sophisticated method which unites the requirements of team members across various career levels with safety standards and employee empowerment. Leaders who apply multipliers' principles will help their teams achieve maximum potential and generate innovative solutions which boost engineering operations while entering new markets.

Leaders need to be flexible and responsive while making a dedication to support their teams throughout different stages of their career growth. Organizations that want to achieve modern engineering success need to run continuous learning programs while dedicating resources and building psychological safety spaces.

## Practical Framework for Managing Engineering Diversity

The findings suggest a practical framework with four levels: individual, team, organizational, and cultural.

At the individual level, effective management requires moving beyond personality stereotypes and demographic categories. Managers should assess engineer's working styles, communication preferences, and career aspirations to tailor support. This aligns

with evidence that group stereotypes often mask significant individual variation within demographic categories (Hyde, 2005).

At the team level, diversity of personality, experience and cultural background enhances innovation only when combined with inclusive processes. Evidence shows that structured turn-taking, clear decision protocols and psychological safety mediate positive effects of diversity (Woolley et al., 2010; Edmondson, 1999).

Organizational practices must integrate innovation into workflows rather than rely on add-on initiatives. Research shows that formal innovation time is most effective when embedded in project structures, supported by recognition and career systems, and complemented by access to modern tools (Birkinshaw et al., 2008; Leonard-Barton, 1995). Without integration, the "confidence–utilization gap" persists as engineers report confidence but lack opportunities to apply it.

At the cultural level, leaders must develop cultural intelligence to leverage global collaboration. Studies show that training, cross-cultural mentoring and explicit collaboration protocols improve team functioning across cultural boundaries (Ang et al., 2007; Presbitero, 2020).

## Addressing the Confidence-Utilization Gap

The research shows engineers feel confident about their innovation abilities but their organizations fail to provide enough support for these skills. Studies have shown this pattern exists throughout various employee innovation capacity surveys, where employees frequently express a higher level of confidence in their innovative skills than the opportunities provided by their organizations to apply these skills. (Dutta et al., 2023, Gavade, 2023)

The current state of dissonance shows that skilled workers encounter a fundamental issue which stems from their professional objectives not aligning with their

organizational structures. Engineers and creative professionals possess the technical skills needed to lead change but their capacity to do so faces limitations because of cultural obstacles within their organizations. The existence of multiple factors results in this knowledge deficit. Senior-level professionals often experience increased administrative burdens that reduce time available for strategic innovation activities (Denti & Hemlin, 2012). Leaders who focus predominantly on management duties create fewer chances for innovative problem-solving. The organization's transition from its core mission established an environment that fails to support innovation which hinders the company from achieving its maximum potential (Amabile et al., 2004).

Risk aversion in organizations prevents both experimental activities and the creation of innovative new ideas (Leonard-Barton, 1992). The fear of failure in traditional corporate environments prevents employees from trying new things because of this widespread anxiety. Organizations that select stability and predictability instead of experimentation prevent the creative process from taking place. The fear of adverse results from their mistakes prevents workers from suggesting innovative concepts and starting new projects. This kind of environment creates conditions which prevent innovative thinking while supporting standardized thinking that contradicts the core principles of innovation (Mueller et al., 2012).

Performance systems create extra difficulties because they focus on delivering short-term results instead of experimental work (Gibson & Birkinshaw, 2004). Organizations that seek fast results force their staff members to rush through their ongoing work instead of enabling them to explore new innovative projects with uncertain outcomes. People become risk-averse in environments that focus on short-term results which prevents them from developing innovative ideas and creative thinking (Baer & Frese, 2003). The gap between employee innovation confidence and organizational support will grow because employees lose their motivation and become disengaged when success metrics fail to recognize creative work and exploratory activities.

The problem requires systemic changes because individual solutions will not resolve the issue. Research shows dual career ladders help organizations maintain technical expertise because they allow creative staff to advance their careers while keeping their technical practice (Allen & Katz, 1986; Weer & Greenhaus, 2010). Organizations need to establish technical positions which maintain engineers and skilled workers in innovation work to stop them from moving into administrative roles that reduce their expertise.

The evaluation process requires innovation metrics to establish an environment which promotes creative thinking (Hamel, 2006). Organizations that formally acknowledge and compensate for innovative work will motivate their staff members to pursue creative activities. The transformation process motivates staff members to generate fresh concepts which proves to the organization that innovation stands as a necessary element for reaching future targets.

Organizations can establish protected innovation time allocation systems through formal processes which create environments for creativity to grow (Amabile et al., 1996). The implementation of innovation-focused time blocks for employees allows them to conduct experiments without facing performance assessments during this time. This approach enables researchers to investigate concepts that produce delayed outcomes which eventually result in significant discoveries (O'Reilly & Tushman, 2013).

Leaders possess the ability to transform senior roles through their practice of combining mentorship duties with technical oversight which stops vital skills from disappearing into administrative tasks (Mumford et al., 2002). Leaders who create mentorship programs and learning opportunities will develop future innovators while maintaining their technical expertise.

Organizations need to work together to establish an environment which supports innovation through strategic business process integration and active organizational support. Organizations need to tackle cultural and structural barriers and systemic

obstacles which block creativity to enable their engineers to achieve their maximum potential and create substantial innovation (Anderson et al., 2014).

## The Innovation Time Paradox Resolution

The problem of engineers who request innovation time yet do not use it effectively shows basic organizational problems that affect engineering workplaces. Organizations show they need innovation yet they create environments which prevent creative thinking from developing. Research indicates that innovation success depends on more than time allocation because it needs psychological safety, supportive organizational systems, and recognition mechanisms (Amabile et al., 1996; Edmondson, 1999).

Organizations face a fundamental problem because of the unofficial cultural indicators which exist within their structures. The practice of rewarding employees who appear busy leads to an environment which restricts their ability to innovate through established formal procedures (Perlow, 1999). The modern workplace requires employees to maintain traditional productivity measures which value speed over innovative ideas. Engineers who work in such an environment will avoid taking risks because they worry about receiving poor performance reviews or losing their jobs when they try new approaches. The difference between innovation targets and actual workplace conduct results in reduced employee participation in innovation programs (Caldwell & O'Reilly, 2003).

Research indicates that innovation time achieves its highest impact when organizations incorporate it into their standard operational processes (Leonard-Barton, 1992). Organizations reach both innovation legitimacy and core objective alignment by implementing innovation within their existing sprint structures, project plans, and collective challenges. Engineers execute their fundamental work responsibilities through established frameworks which enable them to solve problems creatively (Shalley et al., 2004).

Leadership support functions as a key element which enables teams to display innovative behaviors through the establishment of secure spaces for members to present their ideas. Leaders create an innovative workplace through their direct actions which show their dedication to experimental and exploratory approaches (Mumford et al., 2002). Team leaders who reveal their innovative ideas and their mistakes create an environment which allows engineers to present their unconventional solutions. According to Edmondson (1999), psychological safety exists as a shared team belief which enables members to risk sharing with each other for better teamwork and innovative results. Engineers will participate more freely in brainstorming activities and exchange innovative concepts when they work in such an environment.

The development of proper organizational systems which enable innovation stands as a vital requirement. Organizations should create separate innovation teams or cross-functional groups which specialize in new idea development and product or process advancement (West, 2002). The teams function independently to test new concepts through experimental approaches while avoiding operational constraints. The organizational structure enables innovation development because it allows team members with different areas of expertise to exchange knowledge effectively (Hargadon & Sutton, 1997).

Engineers face a paradox because they want innovation time yet they fail to use it properly, which requires organizations to move away from random time allocations toward permanent integration of innovation time. Organizations that integrate innovation into their standard engineering operations will achieve better and more consistent innovation results (O'Reilly & Tushman, 2013). The organization needs to create an environment which supports psychological safety while building supportive systems for innovation and teaching leaders how to demonstrate creative behaviors (Carmeli & Gittell, 2009). Organizations that make innovation a core operational element enable their engineering teams to perform purposeful work that leads to organizational advancement.

## Implications for Engineering Education

The research provides essential educational recommendations for engineering because it shows that current teaching methods need transformation to train students for contemporary engineering systems. Traditional engineering education focuses on developing technical skills through detailed learning of mathematical and physical principles and engineering fundamentals. Traditional leadership development programs use a restricted method which does not create the necessary teamwork abilities and cultural understanding that contemporary teams require (Jamieson & Donald, 2022). Engineering students need to acquire technical competencies together with teamwork abilities to work effectively with multicultural teams because the engineering industry has become global.

Engineering programs need to establish multiple collaboration methods which match different student personality types to solve this problem. The belief that engineering students work best alone prevents students from developing teamwork abilities which are essential for modern professional environments. Educational institutions should implement different collaborative learning activities including team-based projects and peer instruction and intercultural seminars to create a learning environment that supports both technical competence and interpersonal cooperative abilities. Students need to learn how to combine different viewpoints through collaborative work because this skill forms the base for innovation development (Johnson & Johnson, 2009).

Research evidence shows that engineering educational programs require the implementation of cultural intelligence (CQ) development training. Cultural intelligence refers to an individual's capability to function effectively in culturally diverse settings. Research indicates that CQ development happens through particular training programs and international teamwork and self-assessment activities (Ang et al., 2007; Earley & Ang, 2003). Engineering programs need to implement intercultural training through hands-on international projects that students work on with established engineering companies across the globe. Students gain practical experience through these activities

which enables them to use their technical skills while learning about international workplace customs and methods that help them succeed in global engineering teams.

Engineering students need pedagogical methods that focus on autonomy to develop their creative and innovative abilities. Research shows that autonomy leads to better creativity and problem-solving abilities according to Deci and Ryan (2000). The combination of project-based and problem-based learning in the curriculum enables students to become independent learners who solve actual engineering problems from the real world. The system enables students to work independently which leads to deeper understanding of the material while developing their critical thinking abilities and innovation skills for their future work. Students who get to explore and experiment develop work passion which leads to essential lifelong learning habits required for modern engineering fields that experience rapid change.

Research shows that engineering environments demonstrate higher innovation confidence but actual innovative method implementation remains low. Educational systems need to create frameworks which teach students about organizational dynamics of real-world settings because academic settings differ from professional environments (Hamel, 2006). Students show strong belief in their new ideas but struggle to execute them through established corporate frameworks. The solution to this problem requires educational programs to teach essential competencies which include role negotiation and boundary management and creative engagement maintenance under limited conditions (Mumford et al., 2002). Simulation exercises and role-playing scenarios serve as effective teaching methods which enable students to develop organizational skills and present their ideas to different stakeholders.

Students gain advantages through mentorship programs which pair them with industry experts who have experienced comparable professional obstacles. The guidance provides vital information about sustaining innovation throughout a career and developing adaptability for dealing with ongoing workplace challenges (Eby et al., 2013).

The education system for engineers needs to evolve by adding training for teamwork abilities, cultural competence, self-directed work and practical organizational experience. Educational institutions that focus on these areas develop graduates who excel in technical skills and succeed in the diverse global engineering sector.

## Conclusions

### Summary of Key Findings

This research provides insights into how leadership, personality, culture, experience and organisational factors interact to influence innovation in engineering contexts. Several contributions emerge.

First, findings reinforce transformational leadership theory (Bass & Riggio, 2006) by showing that its effects on innovation are moderated by contextual factors including team composition and psychological safety (Edmondson, 1999; Carmeli et al., 2014).

Second, personality diversity contributes positively to team innovation, particularly when openness and conscientiousness are balanced in teams (Feist, 1998; Kaufman et al., 2016). Evidence on ambiversion (Grant, 2013) supports the idea that flexibility in social interaction styles is more valuable than rigid introversion–extraversion dichotomies.

Third, cultural influences on innovation align partly with Hofstede's dimensions but show significant within-culture variation (Hofstede et al., 2010; Beugelsdijk et al., 2018). This suggests that managers must combine cultural awareness with attention to individual variation. Cultural intelligence (Ang et al., 2007) emerges as a critical enabler.

Fourth, experience has a curvilinear relationship with innovation: mid-career engineers often show peak contributions (Simonton, 1997; Ng & Feldman, 2013). Knowledge

transfer mechanisms such as mentorship and reverse mentoring support sustained innovation (Nonaka & Takeuchi, 1995; Murphy, 2012).

Fifth, organisational factors including psychological safety (Frazier et al., 2017), structured innovation time (Birkinshaw et al., 2011) and access to tools (Leonard-Barton, 1995) are decisive for enabling engineers' innovation confidence to translate into outcomes.

Overall, the findings challenge oversimplified assumptions about personality, culture and leadership, and support integrated frameworks that account for individual, team and organisational levels.

## Theoretical Contributions

This research makes several significant theoretical contributions to engineering management, organizational psychology, and innovation studies literature. First, it extends transformational leadership theory by demonstrating how cultural dimensions and personality diversity moderate leadership-innovative relationships in engineering contexts. The research reveals that transformational leadership dimensions require adaptive application based on team composition rather than universal application.

The identification and empirical validation of the confidence-utilization gap represents a novel theoretical construct with broad implications. This gap highlights a systematic organizational failure to leverage human innovation potential, suggesting that innovation constraints lie primarily in organizational structures rather than individual capabilities. The increasing gap with seniority challenges human capital theory assumptions about experience-performance relationships.

The research contributes to personality psychology by demonstrating the limited predictive validity of introversion-extraversion for professional work preferences. The high prevalence of ambiverts and the weak relationship between personality type and

innovation approaches suggest that personality frameworks require reconceptualization for workplace applications. The finding supports emerging perspectives on personality flexibility rather than fixed traits.

Self-determination theory receives nuanced support through the universal importance of autonomy coupled with cultural variation in its expression. This suggests that basic psychological needs manifest through culturally specific behaviors, requiring expansion of SDT to incorporate cultural moderation effects. The research demonstrates that autonomy support must be culturally calibrated rather than uniformly applied.

## Practical Implications

The research provides actionable guidance for engineering managers, organizational leaders, and human resource professionals. The comprehensive framework for managing diverse engineering teams operates across individual, team, organizational, and cultural levels, providing specific strategies for each.

For engineering managers, the research emphasizes individual assessment over categorical management. Rather than relying on personality tests or cultural stereotypes, managers should invest time in understanding each team member's unique preferences, capabilities, and aspirations. The strong relationship between management understanding and innovative outcomes justifies this investment. Managers should create multiple pathways for innovation participation, accommodating diverse working styles within unified team objectives.

Organizations must address structural factors that create the confidence-utilization gap. This requires redesigning senior engineering roles to maintain creative engagement, implementing dual career tracks that don't equate advancement with management, integrating innovation metrics into performance evaluations, and providing modern tools and infrastructure that enable experimentation. The innovation time paradox resolution

requires embedding innovation into regular workflows through formal processes rather than segregating it as optional activity.

Human resource professionals should reconsider traditional diversity and inclusion approaches. The research suggests that diversity training should emphasize individual variation within groups, cultural sensitivity without stereotyping, and active diversity leverage rather than passive coexistence. Recruitment strategies should seek personality diversity (including ambiverts) rather than specific personality types. Career development programs must maintain innovative engagement across career stages rather than assuming senior engineers prefer administrative work.

For engineering education, the findings suggest curriculum reform to include collaborative competencies for all personality types, cultural intelligence development, and organizational navigation skills. Problem-based learning approaches that grant student autonomy while requiring diverse collaboration better prepare engineers for innovation-focused careers than traditional individual-focused technical training.

## Limitations and Future Research

This research is completed with few limitations that require future exploration.

The sample size studies in this research is  $n=17$  for surveys,  $n=2$  for interviews. This is a small number and does not suit the needs of generalizability. Therefore, there is a need to explore the effects of a comparatively bigger sample size on results of multiple organizations and industries.

The cross-sectional design prevents causal inference about the relationship between management practices and innovation outcomes. Longitudinal research tracking teams over time could establish causality and identify how diversity-innovation relationships evolve. Experimental designs that manipulate specific management practices could isolate causal mechanisms.

The gender imbalance in the sample (86.7% male) reflects industry realities but limits insights into gender dynamics. Future research should oversample women engineers to enable robust gender-based analysis. Intersectional approaches examine how gender interacts with culture, personality, and experience which could reveal additional complexity.

The research focuses on individual and team levels with limited examination of organizational and industry factors. Future research should investigate how organizational culture, industry characteristics, and national innovation systems influence the diversity-innovation relationship. Multi-level modeling could parse variance at individual, team, organizational, and societal levels.

The innovation measures relied on self-report rather than objective innovation metrics. Future research should incorporate patent filings, product launches, process improvements, and other objective innovation indicators. The relationship between subjective innovation experience and objective innovation output warrants investigation.

## Final Recommendations

Based on the comprehensive findings, ten key recommendations emerge for optimizing innovation in diverse engineering teams, each providing a pathway to enhance creativity and effectiveness in the workplace.

1. **Abandon categorical management:** Traditional management practices often rely on rigid categorizations based on personality types, cultural backgrounds, or demographics, which can limit an individual's potential. Instead, fostering a culture of individual assessment and adaptive management strategies allow leaders to recognize the unique strengths and weaknesses of each team member. By focusing on capabilities rather than preconceived notions, teams can harness diverse perspectives and solutions, ultimately driving innovation forward.

2. **Provide universal autonomy support:** Autonomy is a crucial factor in employee motivation and engagement. While all engineers require a sense of autonomy, the expression of that autonomy can vary significantly across cultures. Effective management should calibrate autonomy support to meet individual preferences, acknowledging that some may thrive in a hands-on environment while others excel when given freedom to explore their own ideas. This tailored approach can enhance creativity, leading to novel solutions that align with the team's objectives.
3. **Close the confidence-utilization gap:** Many organizations inadvertently sideline seasoned engineers by relegating them to administrative roles, which can diminish their creative potential. To maintain a vibrant and innovative environment, it is essential to restructure organizations in ways that empower senior engineers to remain actively engaged in creative processes throughout their careers. Encouraging ongoing participation helps leverage their experience and insights, fostering a culture of continuous innovation.
4. **Integrate innovation into regular workflows:** Innovation is often treated as a separate entity, relegated to optional "innovation time" that engineers may not utilize effectively. To combat this, organizations should formalize innovation processes within regular workflows. By embedding innovation practices into daily tasks, teams can continuously seek improvements and creative solutions without feeling the pressure of dedicating separate time blocks to innovation.
5. **Develop deep management understanding:** Strong predictors of innovation outcomes lie in the management's understanding of individual team members' capabilities and preferences. By investing time to learn about each engineer's strengths, weaknesses, and working styles, managers can assign roles and responsibilities that play to these strengths. This personalized approach fosters an environment where individuals feel valued and motivated, which can lead to enhanced creativity and productivity.
6. **Create multiple innovation pathways:** Innovation does not adhere to a one-size-fits-all model; thus, organizations should develop multiple pathways

accommodating various approaches. Some engineers may thrive in collaborative environments, while others may prefer independent or structured methodologies. By recognizing and facilitating diverse pathways to innovation, teams can ensure that all members can contribute effectively, regardless of their personal working style.

7. **Leverage diversity actively:** Diversity is often assumed to be inherently beneficial for innovation, but without explicit strategies, its potential can go untapped. Organizations should implement structured protocols that actively harness diverse perspectives and ideas. This might include brainstorming sessions that encourage input from all team members or interdisciplinary projects that bring together varied expertise. By cultivating an environment where diversity is celebrated and utilized, teams can produce more dynamic and creative solutions.
8. **Implement dual career tracks:** To retain talent and foster innovation, organizations should offer dual career tracks that allow for technical advancement without mandatory management responsibilities. This framework provides engineers the opportunity to grow their expertise and contribute to innovation without being forced into roles that do not align with their interests or strengths. By valuing technical proficiency alongside management skills, organizations can maintain a robust pipeline of innovative thinking.
9. **Invest in modern infrastructure and tools:** Creating an environment conducive to experimentation requires modern infrastructure and tools that facilitate innovation. Organizations should provide up-to-date technology and resources that support engineers in testing new ideas. Additionally, instilling a sense of psychological safety, where failure is viewed as a learning opportunity rather than a setback, encourages creative risk-taking. This approach fosters a culture of resilience and continuous improvement.
10. **Develop cultural intelligence:** Lastly, cultivating cultural intelligence within teams is essential for navigating the complexities of a diverse workforce. Organizations should prioritize training that promotes understanding and

appreciation of different cultural perspectives while avoiding stereotypes that oversimplify individual identities. Recognizing that variation within groups can often exceed differences between groups allows teams to appreciate the unique contributions of each member, fostering an inclusive environment where innovative ideas can thrive.

By implementing these ten recommendations, organizations can create an atmosphere where innovation flourishes, leveraging the strengths of diverse engineering teams to tackle complex challenges and drive progress.

## Conclusion

Engineering innovation in the 21st century requires sophisticated management approaches that transcend traditional categorical thinking about diversity. This research demonstrates that successful innovation management requires recognizing and accommodating individual uniqueness within cultural awareness, personality understanding, and experience appreciation. The systematic gap between what engineers can contribute and what organizations allow them to contribute represents enormous wasted potential that can be recovered through structural and cultural changes.

The future of engineering innovation lies not in finding the "right" type of engineer but in creating organizational environments where all engineers can contribute their unique capabilities. This requires managers who act as multipliers rather than diminishers, organizations that embed innovation into core processes rather than treating it as peripheral, and cultures that genuinely value creative contribution alongside reliable delivery.

As engineering challenges become increasingly complex and global, the ability to leverage diverse talent becomes a strategic imperative rather than a nice-to-have.

Organizations that successfully manage diverse engineering teams for innovation will enjoy competitive advantages in talent attraction, problem-solving capability, and market responsiveness. Those that cling to outdated categorical management approaches will increasingly struggle to compete in innovation-driven markets.

The path forward requires courage to challenge conventional wisdom, wisdom to recognize individual uniqueness, and commitment to creating inclusive innovation environments. The evidence is clear: engineering diversity, properly managed, represents untapped innovation potential. The question is not whether to embrace diversity but how to transform it from demographic statistics into innovation outcomes. This research provides a roadmap for that transformation.

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# Appendices

## Appendix A: Survey Instrument

### Section A: Demographics

1. What is your current job title/role?
2. How many years of professional engineering experience do you have?
3. What is your highest level of education?
4. Which region/country do you primarily work in?
5. What is your gender?
6. How would you describe your personality? (Introverted / Extroverted / Ambivert)

### Section B: Innovation Competencies

7. How confident are you in your ability to contribute to innovation projects? (1 = Not confident, 5 = Highly confident)
8. To what extent do you feel your current role allows you to use your creativity? (1–5 scale)
9. How frequently do you engage in problem-solving that requires novel solutions? (Never / Rarely / Sometimes / Often / Always)
10. Which of the following best describes your preferred approach to innovation? (Structured planning / Iterative experimentation / Collaborative brainstorming / Independent exploration)

### **Section C: Management and Leadership**

11. How important is autonomy in your work performance? (1–5 scale)
12. To what extent do you feel your manager understands your technical and creative capabilities? (1–5 scale)
13. How do you prefer to receive feedback? (Written / Verbal / Collaborative review / Minimal feedback)
14. How supportive do you find your current management in fostering innovation? (1–5 scale)

### **Section D: Team Dynamics and Culture**

15. How often do you collaborate with colleagues from different cultural backgrounds? (Never / Rarely / Sometimes / Often / Always)
16. Do you feel cultural diversity in your team helps or hinders innovation? (Helps / Hinders / No impact / Unsure)
17. How comfortable are you sharing ideas in team settings? (1–5 scale)
18. Which factor most influences your willingness to contribute ideas? (Psychological safety / Recognition / Managerial support / Time availability)

### **Section E: Personal Development and Motivation**

19. How important is continuous learning for your innovation performance? (1–5 scale)
20. What motivates you most in engineering innovation projects? (Personal growth / Solving complex problems / Team success / Recognition / Career advancement)
21. Do you feel your current organization provides sufficient opportunities to develop your innovation competencies? (Yes / No / Unsure)
22. How satisfied are you with your overall capacity to innovate within your current role? (1–5 scale)

### **Section F: Open Feedback**

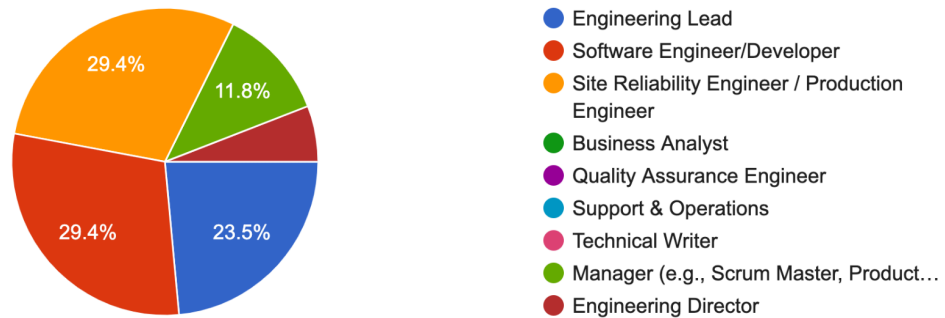
23. What challenges do you face in contributing to innovation? (Open-ended)

24. What would you recommend managers do differently to maximize engineers' innovation potential? (Open-ended)

## Appendix B: Survey Results (charts)

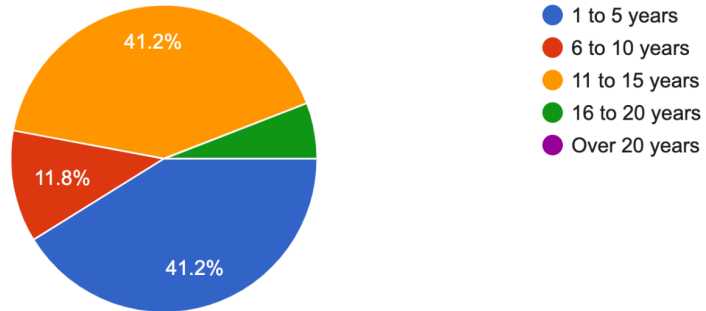
What is your current job title/role?

17 responses



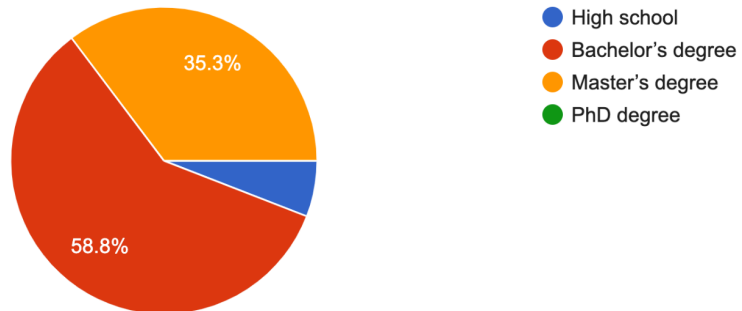
### How many years of professional engineering experience do you have?

17 responses



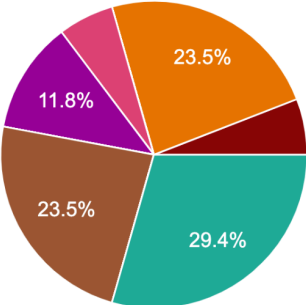
### What is your highest level of education?

17 responses



Which country do you primarily live/work in?

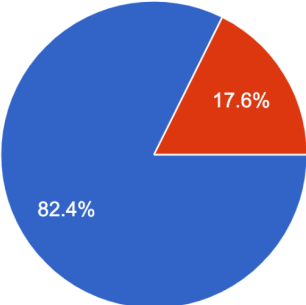
17 responses



- Afghanistan
  - Albania
  - Algeria
  - American Samoa
  - Andorra
  - Angola
  - Anguilla
  - Antarctica
- ▲ 1/27 ▼

What is your gender?

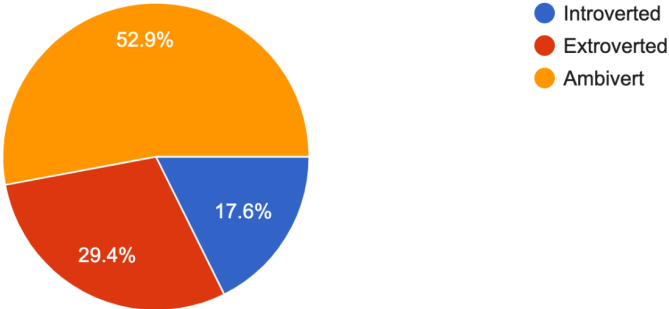
17 responses



- Male
- Female
- Prefer not to say

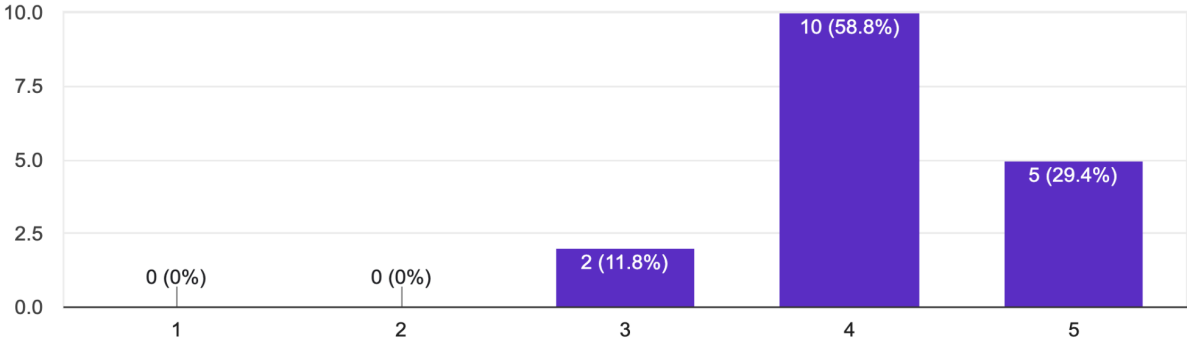
How do you describe your personality?

17 responses



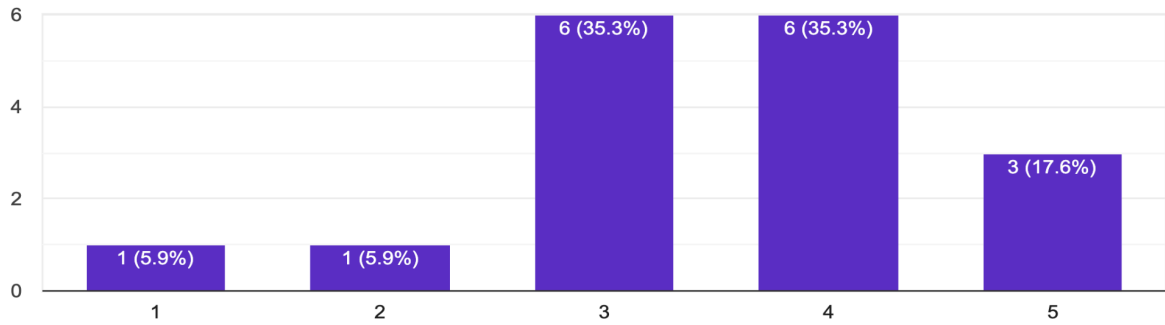
How confident are you in your ability to contribute to innovation projects?

17 responses



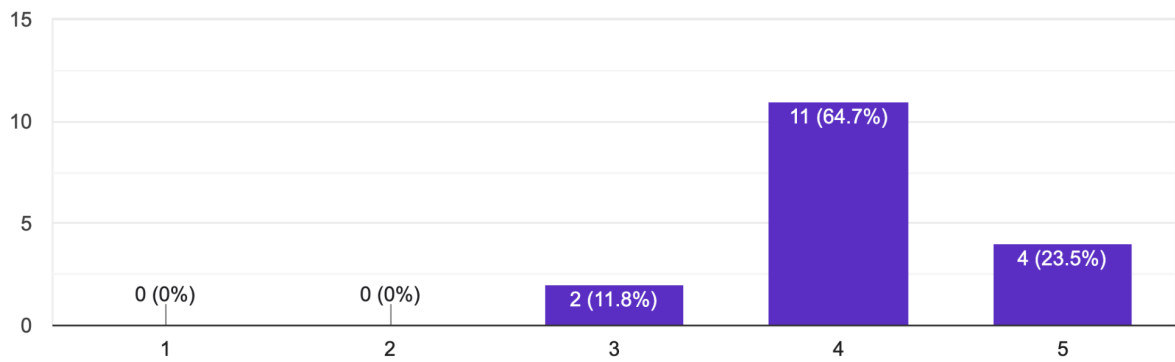
To what extent do you feel your current role allows you to use your creativity?

17 responses



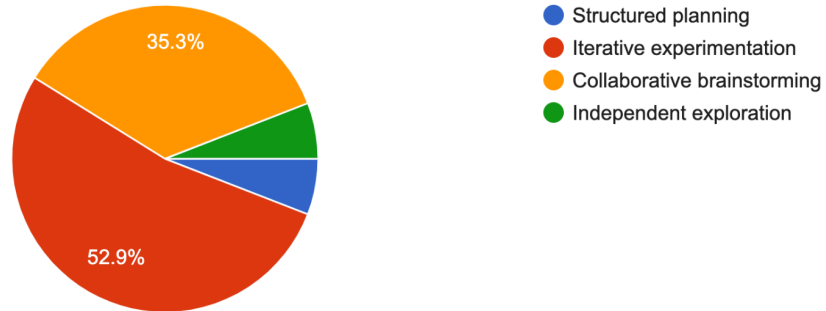
How frequently do you engage in problem-solving that requires novel solutions?

17 responses



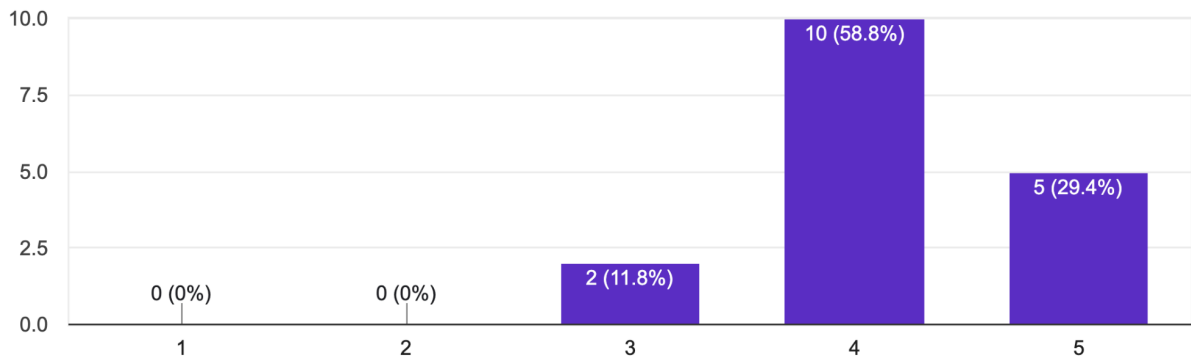
### Which of the following best describes your preferred approach to innovation?

17 responses



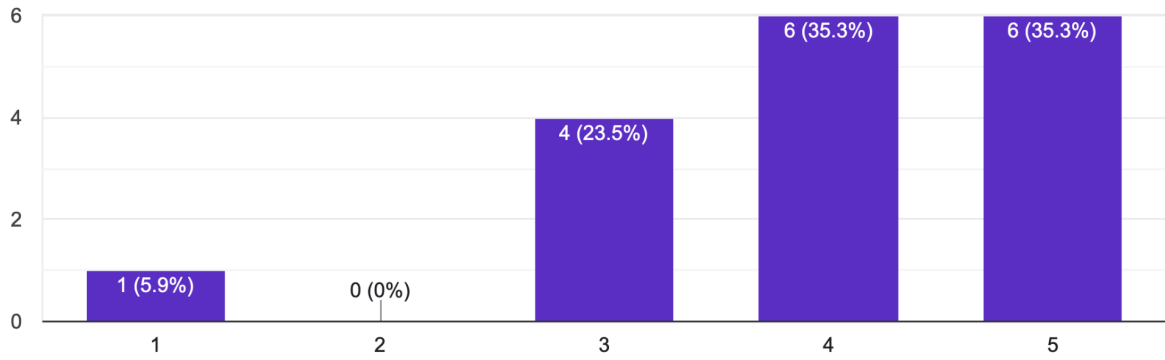
### How important is autonomy in your work performance?

17 responses



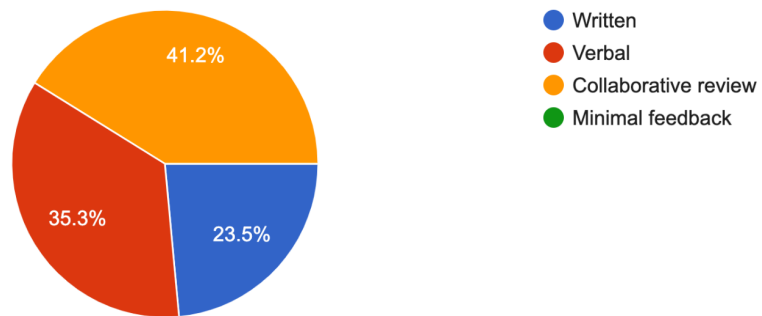
### To what extent do you feel your manager understands your technical and creative capabilities?

17 responses



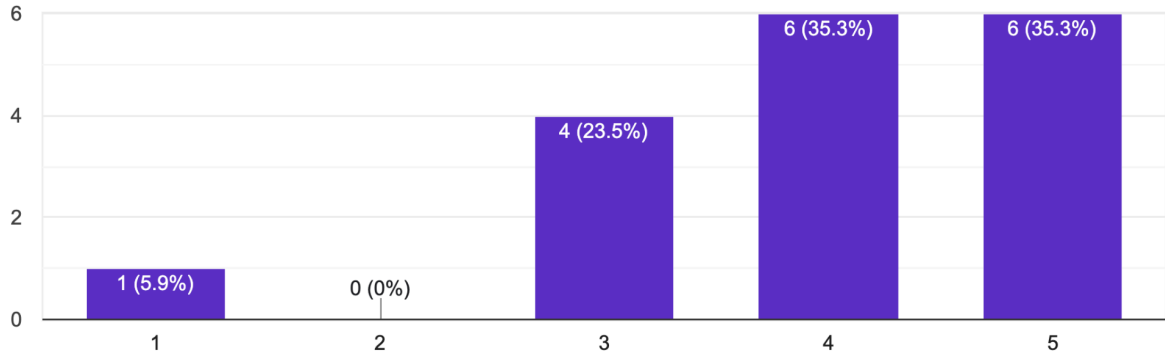
### How do you prefer to receive feedback?

17 responses



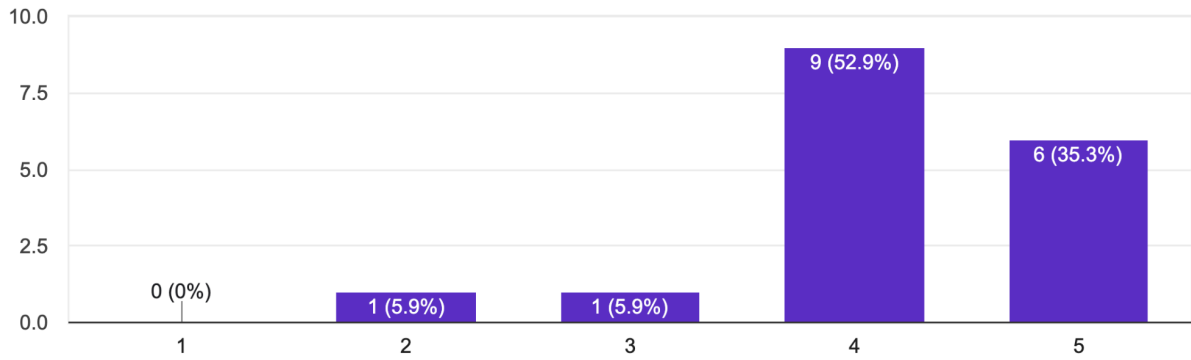
### How supportive do you find your current management in fostering innovation?

17 responses



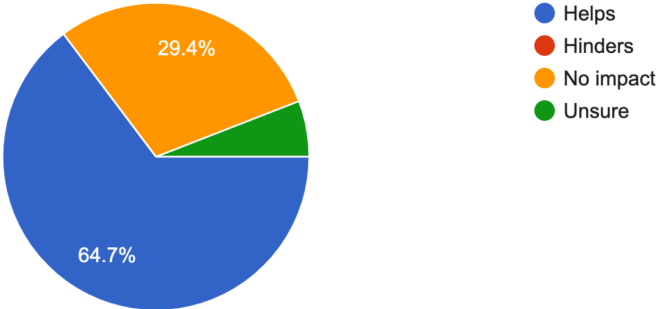
### How often do you collaborate with colleagues from different cultural backgrounds?

17 responses



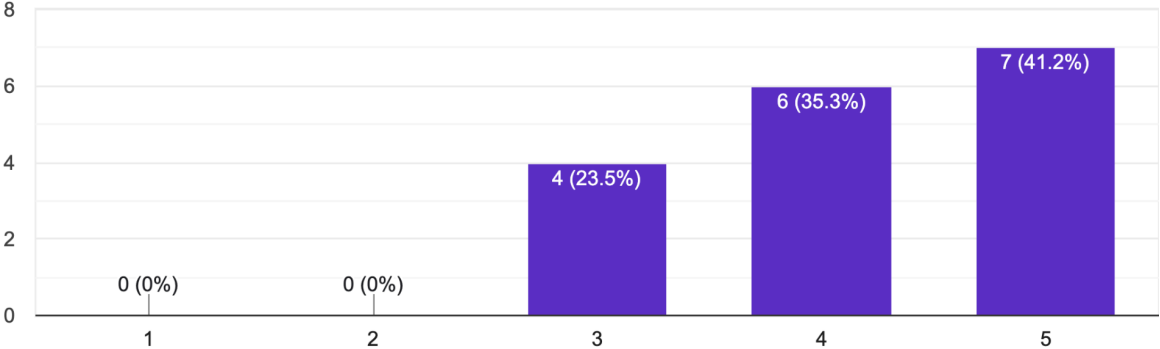
Do you feel cultural diversity in your team helps or hinders innovation?

17 responses



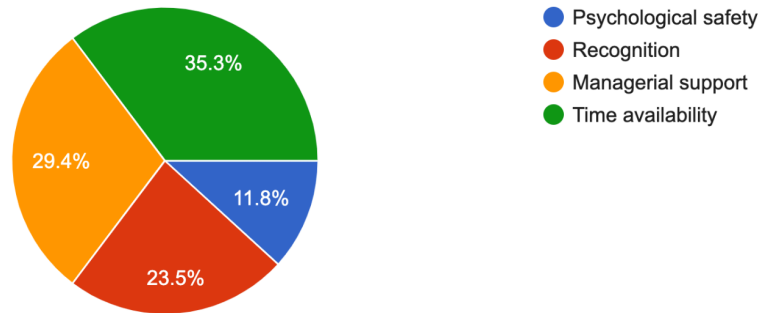
How comfortable are you sharing ideas in team settings?

17 responses



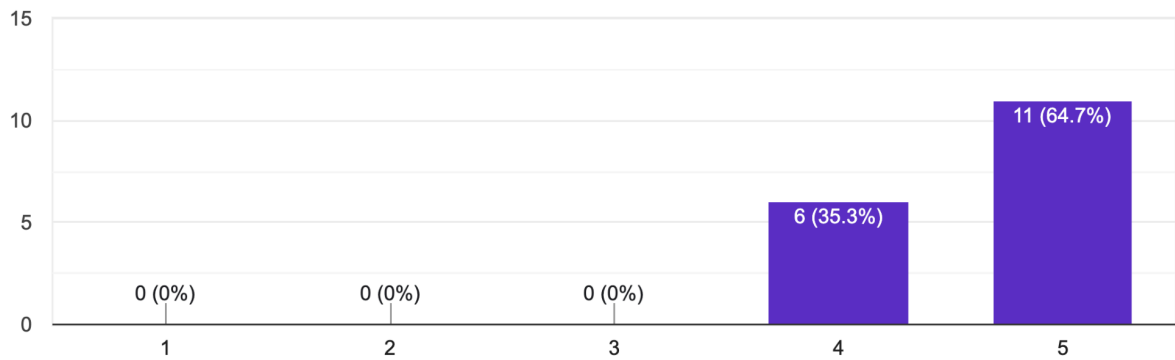
### Which factor most influences your willingness to contribute ideas?

17 responses



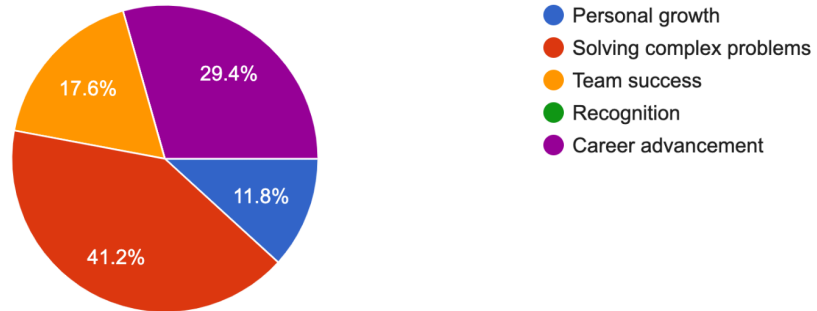
### How important is continuous learning for your innovation performance?

17 responses



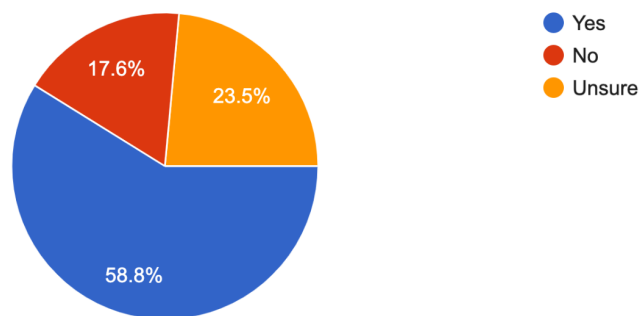
### What motivates you most in engineering innovation projects?

17 responses



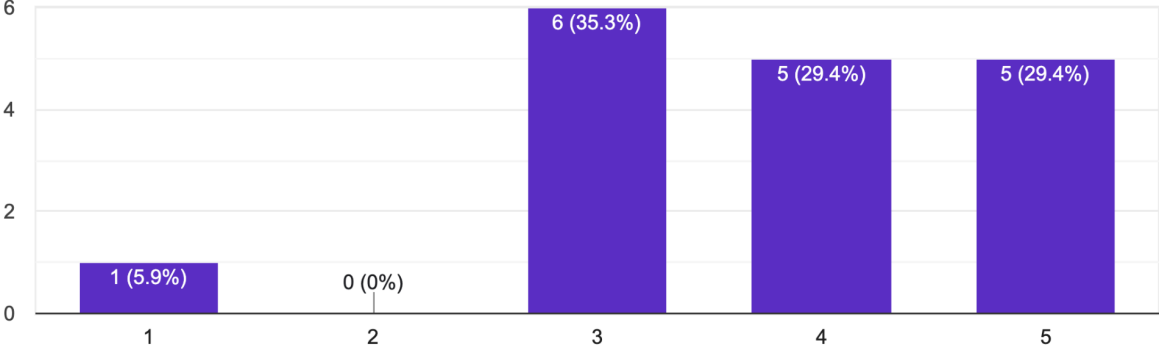
### Do you feel your organisation provides sufficient opportunities to develop your innovation competencies?

17 responses



How satisfied are you with your overall capacity to innovate within your current role?

17 responses



## What challenges do you face in contributing to innovation? 17 responses

1. Able to provide consistent time for learning and experimenting
2. Not really a challenge, but sometimes everyday tasks do not leave much time for innovation
3. The required access is unavailable due to a lengthy and complex approval process, which is time-consuming. Additionally, there has been no salary growth to support motivation.
4. Support from the management team,
5. Allocating sufficient time to develop and implement innovative ideas can be challenging due to competing priorities and existing workloads. Receiving recognition from my employer as most of my work and achievements are for the client rather than directly for company.
6. At the organizational level, there are rapid changes taking place, which means that my innovations become outdated in a short period of time. This fast-paced environment makes it challenging to ensure that my contributions remain relevant and effective for long. As a result, I find it necessary to continually adapt and update my ideas to keep up with the ongoing transformation within the organization.
7. Limited uninterrupted focus time due to frequent context switching
8. Legacy systems and processes
9. The contributing goal could change depending the time frame/project
10. A manager who does not value innovation and discourages contributing ideas, giving the impression of a superficial, fleeting admiration.
11. Time Availability
12. Managing between current roles and responsibilities and giving time for innovation.
13. Quantifying ROI of projects that are innovative as outcome harder to predict
14. Proper infrastructure and tools (e.g., access to LLMs)
15. lack of budget, conservative management, politics

16. Unclear requirements. Red tape in infrastructure matters. Unclear GitHub policies.

17. Time

What would you recommend managers do differently to maximise engineers' innovation potential? 17 responses

1. Once a week one hour to learn and experiment , once in quarter opportunity to showcase the knowledge gained to small group or internal team
2. Maybe dedicate specific sessions that team can brainstorm and innovate
3. Helps to expedite resolution of dependency blockers and enables growth in salary.
4. Support them in all phases of innovation processes, create enabling environment to experiment with different solutions in their business models
5. Set aside dedicated time for brainstorming and experimentation, share available tools/licenses to perform. Show how employee contribution to client projects advance the company overall objectives.
6. We should actively foster innovation by creating psychological safety and encouraging open idea-sharing. They should give engineers autonomy and ownership over their work.
7. Allocating time for experimentation, like hackathons or innovation sprints, is key.
8. Cross-team collaboration should be promoted to spark fresh thinking.
9. Recognize and share learnings from both successful and failed experiments.
10. Empower your engineers and give them more responsibility
11. Matching engineer's goals along with company's is essential
12. At the very least, they should value creativity and encourage effort.
13. Support them

14. Help them assign relevant innovation projects and make sure you provide them necessary time to work on those tasks. Also provide necessary support during process.
15. Break huge projects with uncertain outcomes into smallest possible parts to increase buy in from leadership to allow multiple checkpoints where business can decide whether to continue or hit pause on further iterations
16. Provide the Right Environment & Tools,
17. Give Time & Autonomy,
18. Facilitate Collaboration & Knowledge Sharing,
19. Align Innovation with Impact,
20. create a platform where people can submit and vote ideas anonymously, do a shark tank to pitch for budget and vote for best pocs
21. Get members of the development team to work together with the business to define the requirements of a project/product.
22. Provide professional training.

## Appendix C: Interview Protocol

Semi-structured interview guide was developed to explore themes raised in surveys but with room for participants to raise other insights and contributions. The interviews are meant to facilitate deeper understanding of management styles, challenges, and best practices of managing diverse engineering teams in innovation settings.

### Interview Guide

#### Opening and Introduction

Good morning/afternoon, and thank you for your time during this research interview. As we discussed, the interview is part of my thesis research into managing engineering teams with diversity for innovation. The discussion will be about 45-60 minutes long, and with your permission, I'll be recording the conversation for future analysis.

#### Background and Experience

1. Can you start by telling me about your current role and how long you've been in engineering leadership?
2. What's your background - how did you transition into management/leadership roles?
3. How would you describe your management philosophy, and how has it evolved over your career?

#### Team Composition and Diversity

4. Can you please describe your team's composition today? How much experience variations, cultural and personality diversity do you notice?
5. How would you build and structure varied engineering teams?
6. What benefits have you experienced from having multicultural team blends?

7. What difficulties have you faced in working with diverse teams, and how have you handled them?

#### Personality-Based Management

8. How do you identify different personality types on your team (introverted, extroverted, ambivert)?
9. Do you adapt your management style based on individual personality characteristics? Can you give me some examples?
10. What strategies have you found effective for managing introverted team members specifically?
11. How do you ensure that both introverted and extroverted team members can contribute effectively in team settings?
12. Have you noticed differences in how different personality types approach innovation and problem-solving?

#### Multi-Cultural and Global Teams

13. What experience do you have managing culturally diverse or geographically distributed teams?
14. How do you adapt your communication and management approaches for different cultural backgrounds?
15. What strategies have you found effective for building cohesion across cultural differences?
16. How do you leverage cultural diversity as an asset for innovation rather than just managing it as a challenge?
17. Can you share an example where cultural diversity specifically contributed to a better solution or innovation outcome?

## Experience Level Management

18. How do you approach managing teams with mixed experience levels - from junior to senior engineers?
19. What strategies do you use to facilitate knowledge transfer between different experience levels?
20. How do you keep senior engineers engaged in hands-on innovation while also leveraging their mentorship capabilities?
21. What approaches have you found effective for developing junior engineers' innovation capabilities?
22. How do you handle situations where experience level differences create tension or communication challenges?

## Innovation Management Practices

23. What specific practices do you use to foster innovation across your diverse team?
24. How do you allocate time and resources for innovation activities versus day-to-day operational work?
25. How do you measure and recognize innovation contributions from team members with different backgrounds and working styles?
26. What role does psychological safety play in your innovation management approach?
27. Can you describe a successful innovation project and how you managed the diverse team through that process?

## Challenges and Solutions

28. What are the most significant challenges you face in managing diverse engineering teams for innovation?
29. Can you share an example of a management approach that didn't work well initially and how you adapted?

30. What organizational factors help or hinder your ability to manage diverse teams effectively?
31. How do you handle conflicts or disagreements that arise from cultural differences or different working styles?

#### Recommendations

32. What advice would you give to other engineering managers who are new to managing diverse teams?
33. What organizational changes or support systems would help you be more effective in managing diverse teams?
34. If you were designing an ideal innovation management framework for diverse engineering teams, what would be the key elements?
35. What trends do you see in engineering team management, and how are you preparing for future challenges?

#### Closing

36. Is there anything important about managing diverse engineering teams that we haven't discussed?
37. Do you have any questions about the research or would like clarification on anything we've discussed?

Thank you so much for your time and consideration. I'll be comparing all of the interview data and survey results to provide actionable recommendations for engineering leaders. If you'd like, I can send you the final results.

## Appendix D: Transcript – Interview with Chris Desiano

*Note: The following transcript is reproduced with participant consent. Minor edits (e.g., filler words, pauses) were made for clarity without altering meaning.*

**Date:** September 1, 2025

**Duration:** 62 minutes, 46 seconds

**Position:** Engineering Team Lead, Pfizer Digital

### Background and Experience

**Interviewer:** Can you tell me about your current role and experience in engineering leadership?

**Desiano:** I'm Chris Desiano, and I've worked at Pfizer for 22 years. I currently lead the Franklin team, which has responsibility across all of Pfizer to manage technical infrastructure and tooling for publishing, monitoring, and modifying externally-facing websites and mobile applications. This is substantial - we manage approximately 2,700 websites and 200+ mobile applications.

My background begins with my father, who was a high school math teacher who transitioned to become our school district's computer coordinator. This sparked my interest in technology. I earned a Bachelor of Science in Computer Science and Applied Mathematics with minors in Theater and Music.

I started as a programmer in 1997 and worked in that role for several years. I realized that my theatrical training allowed me to convey ideas, problem-solve, and empathize with people managing technology better than my attention deficit allowed me to focus on syntax. I was better at solving problems and facilitating conversations than creating technology, so I transitioned into management, leading both delivery teams and engineering teams before reaching my current role.

## Management Philosophy

**Interviewer:** How would you describe your management philosophy?

**Desiano:** My philosophy centers on empathy - understanding what drives and motivates people, and comprehending their hurdles. This isn't about feeling sorry for someone, but genuinely understanding their perspective.

For example, when releases don't go well, instead of asking "How did you mess this up?" I recognize that the person probably worked hard and is more disappointed than defensive. People's pride often serves as a defense mechanism when they feel bad internally about outcomes.

My leadership style is "people first." I believe if you put people first, they'll want to perform and enjoy performing well. When relationships are strong, conversations flow more freely. I love seeing relationship development because strong relationships enable better communication.

## Team Composition and Diversity

**Interviewer:** Can you describe your team's composition and diversity?

**Desiano:** My team consists of about 75 people distributed across 20 different countries, spanning time zones from the West Coast US to India (UTC -8 to UTC +4.5). This isn't people working from Pfizer offices - they're primarily working from home environments, which was our model pre-COVID.

Experience-wise, we have team members with up to 30 years of experience alongside recent college graduates. This creates both challenges and opportunities, particularly for teaching and knowledge development within a diverse experience range.

## Building Diverse Teams

**Interviewer:** How do you approach building and structuring diverse engineering teams?

**Desiano:** Unlike many large companies where teams are simply assigned, we have the advantage of interviewing people who join our team. This allows us to assess both skill sets and personality fit, not just technical experience.

We don't confine ourselves to single vendor sources. Sometimes we bring people recommended by existing team members - having established relationships on teams rather than all strangers makes a significant difference.

For example, we've brought people from the Drupal community who had previous working relationships or knew each other from conferences. This pre-established relationship foundation definitely helps team building.

When building teams, we interview for both skill and personality, asking "Can this person work well with existing team members?" This isn't objective - there's no simple A or B answer. People with certain skills and personalities might oppose each other, but sometimes that opposition creates valuable challenge. However, you need people who challenge respectfully while maintaining respect for what others are trying to achieve.

## Diversity Benefits and Perspectives

**Interviewer:** What benefits have you observed from diverse team compositions?

**Desiano:** I find "diverse team" difficult to quantify because I think every team is inherently diverse. Without diversity, you wouldn't have a team - you'd have a single person.

Think of a sports team: even though a goalkeeper can use hands while others cannot, ultimately everyone's job is ensuring they have more points than the opponent at the

end. Without diverse players and personalities, you'd have 11 goalkeepers instead of defense, offense, and different specialized roles.

Diversity within teams is necessary because it allows multiple approaches to success. Someone who's a strong problem solver but weaker developer fits well as a business analyst. Someone who loves syntax but isn't comfortable with non-technical conversations works well as a developer. Without diversity, you're running individual contributors rather than a team.

## Personality-Based Management

**Interviewer:** How do you identify personality types and adapt your management style?

**Desiano:** I should note that I'm clearly an extrovert, and sometimes it's challenging for extroverts to gauge themselves appropriately for introverts.

Extroverts want to discuss everything - what they're doing, what's happening, their plans. Meetings with introverts require more pulling than pushing. For extroverts, I need to be better at guiding because they can go off on tangents.

Physical indicators help with identification: extroverts generally make more eye contact, even on webcams. When asked personal questions like "How was your weekend?" introverts might give one-word emotional responses ("It was good"), while extroverts provide detailed activity lists.

These are preferences for how people work and interact, but it doesn't mean they cannot occasionally work outside their comfort zones. An introvert might need to facilitate a workshop - it may be uncomfortable, but sometimes necessary. As a leader, I support them by recognizing the discomfort and helping them set objective goals rather than subjective ones like "be more energetic."

## Innovation and Problem-Solving

**Interviewer:** Do you notice differences in how personality types approach innovation or problem-solving?

**Desiano:** Innovation - trying untested approaches, taking risks, attempting new things - seems more comfortable for extroverts. Introverts who need to innovate require permission and objective goals. I might tell them, "You're allowed to skip half your work this week to try something new. If it doesn't work, that's success because you've learned how not to do it."

Both personality types can innovate, but they need different permission sets and approaches. Their leader must communicate that "failure is discovery" rather than failure. I don't think it's inherently a personality trait limitation - both types can do both functions, but they need different approaches or different task breakdowns to reach that point.

## Cultural Competence and Global Teams

**Interviewer:** How do you adapt your communication and management approaches for different cultural backgrounds?

**Desiano:** There are logistical challenges with timing across different time zones. One important principle is that as a leader, I'm always willing to sacrifice convenience. If people can't find meeting times that work across time zones, I'll get up at 5:30 AM rather than inconvenience the team. This demonstrates understanding of their difficulties and willingness to go above and beyond.

When team members see this sacrifice over weeks, they're more willing to accommodate occasional requests for meetings at less convenient times for them. It's leading by example.

Culturally, I research different practices. For example, before a meeting in Korea, I researched proper meeting behavior, learning about two-handed handoffs while maintaining eye contact and bringing appropriate gifts (American candy for everyone attending). When they requested to speak Korean during part of the meeting, rather than insisting on English, we respected their need to express themselves in their natural language.

Research and understanding are important, but you must avoid being silly about it. Don't attempt greetings in languages you don't know well - focus on understanding people's cultures through genuine conversation and respect.

## Experience Level Management

**Interviewer:** How do you approach knowledge transfer between different experience levels?

**Desiano:** I establish what I call a "safety net" approach. Knowledge transfer, whether from someone leaving or onboarding someone new, creates nervousness if people think they've transitioned too early, or annoyance if they think it's taking too long.

Like a trapeze artist, it's not up to the circus manager when the safety net is removed - it's up to the performer. The person receiving knowledge transfer determines when they're ready to have support removed, whether gradually or completely. This establishes that knowledge transfer is designed for their success, which ultimately makes the organization successful.

This gives people doing the knowledge transfer understanding that it won't be forever, while giving recipients freedom to say they're ready or not ready without fear. The safety net might be SOPs, working alongside someone with the recipient taking primary lead while the trainer remains available for support.

## Innovation Management Challenges

**Interviewer:** What are your main challenges in fostering innovation within diverse teams?

**Desiano:** This is particularly difficult. I've tried creating programs like "10% time" for innovation, but discovered that even when given permission, high-performing teams that want to do great work for clients don't take that time.

The challenge is that when you have great people who want to do excellent work, it's hard to get them out of their comfort zone of "what's my next backlog item?" Even when I create permission structures and processes, teams don't utilize them, then report in surveys that they don't have time to innovate.

I believe the issue is that permission from leadership isn't enough - you need buy-in from middle management and well-established processes. You probably need product owners adding innovation tickets to backlogs, making innovation part of the formal process rather than something extra.

For high-performing teams focused on client success, you need to make innovation part of their regular workflow rather than additional time they need to carve out.

## Leadership Advice

**Interviewer:** What advice would you give to other engineering managers new to managing diverse teams?

**Desiano:** The biggest lesson is that just saying "it's okay" as a leader isn't enough, especially with high-performing teams. You need buy-in from team leads and middle management, not just executive permission.

You need well-established processes - you can't just say "go ahead and innovate." Consider creating JIRA boards for innovation attempts, incorporating innovation discussions into stand-ups, or having product owners add innovation tickets to backlogs.

Make innovation part of the regular process rather than something people need to find extra time for. This is especially crucial for high-performing teams that naturally focus on their next assigned task rather than exploring new approaches.

The key is integrating innovation into existing workflows rather than treating it as additional work that requires separate time allocation.

## Appendix E: Transcript – Interview with Andy Garcia

*Note: The following transcript is reproduced with participant consent. Minor edits (e.g., filler words, pauses) were made for clarity without altering meaning.*

**Date:** September 3, 2025

**Duration:** 52 minutes, 30 seconds

**Position:** Senior Engineering Leader, Pfizer Digital Operations

### Background and Experience

**Interviewer:** Can you start by telling me about your current role and how long you've been in engineering leadership?

**Garcia:** In my current role, I lead support and operations for Pfizer in a unique capacity. I oversee all support and operations workstreams across our C4 organization, covering sales, local applications, marketing, corporate solutions, revenue management, and patient services across different global markets. Additionally, I'm leading the AIMS program for Pfizer, which gives me guidance over all support organizations across

digital. We work together to achieve efficiencies, bring in new vendors, and manage various workloads.

My experience managing engineers began in 1990 when I started managing a group of resources while serving in the Air Force. We were designing and managing networking environments - Cisco networking, Novell, and Banyan Vines networks for McGuire Air Force Base and Fort Dix. These were network engineers learning fundamental skills, though they were just beginning to be called "engineers." Over my career spanning 40 years now, I've worked with development teams, support teams, and various engineering groups.

**Interviewer:** How did you transition into management or leadership?

**Garcia:** The transition began during my military service at age 18. In the military, you're placed on an accelerated path where every rank creates a hierarchy of management. As you advance, you start having oversight over other people. It becomes management training by design - once you reach two or three levels up, you immediately manage individuals. However, this is directive management, very different from corporate management.

When I transitioned to the corporate world, the skills I developed in the military - being responsible, thorough situational coverage, and working well with people to accomplish missions - led to consideration for management roles. I joined Pfizer (originally Wyatt) in 1996 as a contractor, working with various teams from a technical perspective. Management often moves technically skilled individuals into leadership roles, which isn't always optimal since some prefer to remain technical specialists.

I discovered I enjoyed both aspects - staying technically involved while doing management work and interfacing with business stakeholders. A critical skill I developed was the ability to translate between technical and business languages, ensuring both sides understand what needs to be accomplished.

## Management Philosophy

**Interviewer:** How would you describe your management philosophy and how has it evolved?

**Garcia:** My philosophy centers on two key elements: standards and ownership. I focus on defining standard operating procedures, models, and processes that establish our consistent way of operating.

Ownership means when you assign work to someone, you expect them to fully own it to completion rather than creating multiple layers of responsibility. The person assigned should take complete ownership, though they can always ask for assistance, understanding, or clarity. This concept relates to principles from the 1800s that remain relevant today - you want people who can accept an assignment, own it, solve the problem, and report back when it's completed, rather than those who pepper you with endless questions.

## Team Composition and Diversity

**Interviewer:** Can you describe your team's composition and diversity in terms of experience levels, cultural backgrounds, and personality types?

**Garcia:** We have approximately 70 members in our organization. From a direct leadership perspective, my immediate team includes diverse backgrounds: two males from Italy and South Africa respectively, one who appears to be white male but has Black heritage and cultural understanding, and myself with Hispanic background from Texas, closely related to both Mexican and Spanish New Mexican communities.

Our backgrounds vary significantly. Some grew up in what I would have considered affluent families with clear educational paths, while others, including myself, came from more challenging circumstances - I started working in cotton fields in Texas at age nine.

Some team members have master's degrees, while I personally don't have a formal degree, having pursued extensive military training and continuing education instead.

Globally, we span multiple countries including Greece, India, China, Japan, and Brazil. This diversity allows us to understand different cultural situations, holidays, and events, which I find to be a joyful aspect of learning about different cultures.

## Diversity Management Approach

**Interviewer:** What benefits have you observed from diverse teams, and what challenges have you encountered?

**Garcia:** I focus primarily on diversity of experience and perspective. Cultural diversity comes into play when scheduling around major holidays, but my main focus is on the diverse experiences individuals bring. When building something, if someone has years of SharePoint experience, they naturally take on SharePoint-related responsibilities.

Assignment distribution depends on logical fit - marketing assignments go to those with marketing expertise, while generic assignments are opened to those wanting new challenges or skill development opportunities.

The main challenge occurs when individuals attempt to leverage their diverse background for preferential treatment, whether based on cultural, historical, or gender differences. My approach is that we hire people because we need help, and once you're part of the team, you're contributing to organizational success regardless of background. Diversity is important in ensuring we have a broad candidate pool, but once hired, everyone is evaluated based on their contributions to accomplishing our mission.

## Personality-Based Management

**Interviewer:** How do you identify personality types within your team and adapt your management style?

**Garcia:** While we use assessments like Myers-Briggs, I believe you must learn your people individually. Someone who identifies as introverted may actually need more challenges in interpersonal situations. You must be considerate of personalities - I wouldn't put someone very shy on a big stage without giving them experience with smaller presentations first.

Whether someone is highly energetic or more reserved, you need to consider whether they communicate our story well. You don't want someone in front of people if they can't effectively communicate our message, regardless of their comfort level with public speaking.

Experience teaches you more than classification testing. You need to know the person, not just their classification.

## Innovation and Problem-Solving Approaches

**Interviewer:** Have you noticed differences in how personality types approach innovation or problem-solving?

**Garcia:** Absolutely. Consider the difference between team-minded versus individual-minded approaches. Some individuals will disappear for a week to solve a problem through deep thinking and detailed analysis. Others immediately build teams around them, gathering resources with relevant knowledge to solve problems collaboratively.

Both approaches are effective in different environments. For enterprise-wide programs, you need someone who can build partnerships across the organization, not someone

who works in isolation. You must be aware of these working styles to assign the right resources to the right type of work.

## Cultural Competence and Communication

**Interviewer:** How do you adapt your communication and management approaches for team members from different cultures?

**Garcia:** I don't necessarily communicate differently with each person, but I try to understand what drives them individually. For example, in Greece, I recognize the cultural tendency toward late evenings and later morning starts. In India, I understand team members work different hours to support US time zones, and we must be mindful of safety considerations, particularly for women who must leave sites by 8:00 PM.

We align cultural understanding with work responsibilities and environmental considerations. Sometimes people take the ownership concept too far, becoming almost dictatorial and pushing outside cultural comfort zones. We coach through these situations, helping people understand individual and community factors while maintaining work accomplishment goals.

## Experience Level Management

**Interviewer:** How do you approach managing teams with mixed experience levels and facilitate knowledge transfer?

**Garcia:** Experience level doesn't necessarily equate to skill level - two people with 25 years each may absorb information at different rates. You still need to know individuals regardless of their background.

I have higher expectations for senior-level individuals in terms of workload management, team leadership, people care, and customer satisfaction. I don't expect junior members to understand financial processes or have the same responsibilities. Senior directors should manage up to their seniority level - if you want senior-level positions, you must accept the accompanying responsibilities.

## Innovation Management Practices

**Interviewer:** What practices do you use to foster innovation across diverse teams?

**Garcia:** I approach innovation as a mindset rather than an intermittent activity. I always say "there's always a better way" - regardless of how smoothly something went, there's always room for improvement. This keeps teams thinking about work from that perspective, focusing on areas with the most impact.

We continuously analyze our workload. We've reduced from almost 700 resources across multiple vendors to just under 500 in our new model, achieving efficiency through resource overlap across capabilities and technologies.

Each individual understands their resource allocation, workload through ticket management, and volume mapping. Understanding your workload, processes, and continuously asking "are we doing this the right way?" drives innovation.

Through our AIMS program, we've established the "School of AIMS" - education from AI Academy and ITIL training. We're implementing Gin Wizard as our agentic framework, training all team members in automation tools and agentic workflows. When team members understand potential technology, workloads clearly, and maintain a "there's always a better way" mindset, they naturally look for improvements.

## Challenges and Leadership Advice

**Interviewer:** What advice would you give other engineering managers new to managing diverse teams?

**Garcia:** Focus on knowing the individual and their culture - be curious and learn about them. These conversations enrich organizational operations and communication. Understanding individuals and cultures within your team brings out much more flavor in how the organization operates.

Everyone's approach to skill development differs. Some people work because they love the technology and build careers around it, while others work primarily for compensation. Both exist in every culture and environment.

Take India as an example - they've done incredible work moving people out of poverty through IT skills training. Many individuals entered IT not from passion but because it was the available opportunity. Understanding whether someone fell in love with technology versus viewing it as a career necessity affects how they approach work, but you need both types in your organization to fill different roles effectively.