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Leadership in Geo –Technical Engineering in USA: Assessing Effective Management of Deep Foundation Testing Project and the Challenges

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Abstract: The study was carried out to assess leadership in geo –technical engineering in USA and its effectiveness in the management of deep foundation testing project and the challenges. In this study, an Ex Post Facto design was adopted. The study was carried out in USA. The targeted population for the study comprised civil engineers, project manager and project management consultants in USA. A stratified random sampling technique was used to select 10 respondents from 6 different types of geo-technical engineering services in USA such as Foundation Engineering, Earthquake Engineering, Geo-environmental Engineering, Geo-technical Hazard Mitigation, Geo-technical Instrumentation and Monitoring as well as Geo-synthetics and Geo-technical Materials. This was done by selecting 8 civil engineers, 1 project manager and 1 project management consultants which gave a total of 60 respondents used for the study. A stratified random sampling technique was used to select 10 respondents from 6 different types of geo-technical engineering in USA. The instrument used for data collection was a structured questionnaire titled “Deep Foundation Testing Leadership Project Questionnaire (DFTLPQ)”. Face and content validation of the instrument was carried out by an expert in project management and one expert in quantitative analysis in order to ensure that the instrument has the accuracy, appropriateness, and completeness for the study under consideration. The reliability coefficient obtained was 0.85, and this was high enough to justify the use of the instrument. The researcher subjected the data generated for this study to appropriate statistical technique such as a descriptive statistical analysis (percentage analysis). The study found out that Clear Vision and Direction” with the frequency of 37(12) and percentage of 19.68 was rated as the highest effects of leadership in geo-technical engineering on effective management of foundation testing. It was also observed that the greatest challenge faced by Geo-Technical Engineering Companies in their operations in USA is “Site and Soil Variability” with the frequency of 39(12) and the percentage of 20. Finally, there is significant effect of leadership in geo-technical engineering on effective management of foundation testing in USA at 0.05 alpha level with 58 degree of freedom (calculated as 0.90 and R-critical as 0.214. One of the recommendations made was that leaders should encourage their team members to pursue certifications, attend relevant workshops and conferences, and encourage continuous education and training in the latest geo-technical engineering techniques and technologies.

Keywords: Geo-Technical Engineering, Management, Deep Foundation Testing Project, Challenges and USA.

Introduction

Geotechnical engineering is a critical field within civil engineering that focuses on the behaviour of earth materials and their interaction with constructed structures. It plays a pivotal role in the design and construction of foundations, slopes, retaining walls, tunnels, and other subsurface structures. Among the various aspects of geotechnical engineering, deep foundation testing is particularly significant due to its complexity and the crucial role it plays in ensuring the stability and safety of large-scale infrastructure projects.

Deep foundation testing involves evaluating the capacity and performance of foundations that extend deep into the ground, often passing through multiple soil layers and sometimes into bedrock (ASTM International, 2010). These tests are essential for verifying design assumptions, ensuring compliance with safety standards, and mitigating risks associated with subsurface uncertainties. Given the high stakes involved, effective management of deep foundation testing projects is paramount to the successful completion of construction projects.

Leadership in geotechnical engineering encompasses a unique set of skills and competencies required to navigate the technical, logistical, and human challenges inherent in these projects. Effective leadership ensures that projects are completed on time, within budget, and to the highest standards of quality and safety. It involves not only technical expertise but also strong project management, communication, and problem-solving abilities.

The importance of leadership in the management of deep foundation testing projects cannot be overstated. Project managers and engineers must coordinate diverse teams, manage complex workflows, and address unforeseen challenges promptly and efficiently. This paper explores the critical aspects of leadership in geotechnical engineering, with a focus on the effective management of deep foundation testing projects (Smith, 2012). Through a review of existing literature and best practices, it aims to provide a comprehensive understanding of how leadership can drive success in this specialised field.

Statement of problem

The problem in the context of leadership in geotechnical engineering, particularly concerning the management of deep foundation testing projects globally just like in the USA, lies in the challenges to effective coordination, communication, and decision-making among multidisciplinary teams, clear vision and direction, efficient resource management and many others due to the fact that work nature is more or less earth materials solving technical issues in deep construction. In this case these projects require precise technical expertise, rigorous safety standards, and timely execution, all of which depend heavily on strong leadership. However, there is often a gap in leadership skills among project managers, leading to inefficiencies, increased risks, cost overruns, and compromised project quality. This study aims to assess the current leadership practices in managing deep foundation testing projects and identify strategies to enhance leadership effectiveness to improve project outcomes and ensure safety and compliance with engineering standards through mitigation of such challenges as site and soil variability, environmental regulations and compliance and many more.

LITERATURE REVIEW

Concept of Leadership

The practice of influencing people's behaviour so they voluntarily and actively work towards the accomplishment of group goals is known as leadership. It is the process of directing or overseeing a team of individuals or an organisation. Klingborg, Moore, and Hammond (2006) emphasised that leadership requires insight and self-awareness, organisation, ongoing communication and reinforcement, the ability to catalyse a shared future vision, and the successful recruitment of followers motivated to action. Instead of having a predetermined thematic list of personal qualities, effective leaders perform exceptionally well while handling organisational task challenges and take people's interpersonal relationships into consideration.

Furthermore, Roseri (2019) defined leadership as an influenced relationship among leaders and followers who intend real changes that reflect their mutual purpose. It happens when one member of the group alters the abilities or motivation of other members of the group. Silva (2016), citing Tannenbaum, Weschler, and Massarik (1961), added that leadership is the interpersonal influence exercised in a situation and directed, through the communication process, towards the attainment of a specific goal or goals. Leadership is an interaction between two or more members of a group that often involves the structuring or restructuring of the situation, perceptions, and expectations of the members (Lanier, 2021).

Being a leader is not only about having certain traits. Influence is what defines it; not just the leader's influence over followers, but also the interactional influence between the leader and followers. It implies that leaders collaborate with their followers to accomplish common goals. It emphasises the process of supporting both individual and group efforts to achieve common goals as well as persuading others to comprehend and concur on what must be done and how to do it.

Concept of Effective Management

Management is an interactive and continuous process, and this process aims to mobilise collective and individual efforts to achieve the comm*on desired goals by utilising the available resources effectively and efficiently (Omar, 2023). A successful business's key to success is effective management. In order to accomplish organisational objectives, it entails the planning, arranging, directing, and control of resources, including people, money, and materials. According to Najar (2020), effective management is defined as the efficiency with which an association is able to meet its objectives in the organisational environment. This refers to an organisation that generates the intended result or one that is waste-free in its productivity. Following morality or best practices is key to effective management.

Moreover, managing well involves more than just keeping an eye on things. It necessitates both the capacity to encourage and inspire staff members as well as a thorough comprehension of the organization's objectives, core values, and culture. It is critical to recognise that efficient use of authority to lead a team or company towards success is what makes for effective management, not holding a position of power per se. Agwu (1990), cited by Achie and Kurah (2015), saw it as a process of combining and utilising or allocating organisational inputs (men, material, money, and machines) by planning, directing, controlling, and organising for the purpose of producing the output desired by customers so that the organisation's objectives are accomplished. It is the capability of the management to achieve the desired targets in the specified time.

Concept of Geo-Technical Engineering

The area of civil engineering that studies the engineering behaviour of earth materials is called geo-technical engineering. It solves its technical issues by applying the concepts of rock and soil mechanics. According to Eslami and MolaAbasi (2020), geo-technical engineering is the systematic application of techniques that allow construction on, in, or with geomaterials, which are soil and rock. The science that describes the mechanics of soil and rock and its applications to the advancement of civilization is another definition or term for geotechnical engineering. On the other hand, geotechnical engineers utilise their expertise to ascertain the physical, mechanical, and chemical characteristics of rock and soil in order to build retaining walls, foundations, and earthworks. Geotechnical engineering is vital because it helps prevent damage to other buildings and structures caused by subsurface conditions, even though offshore geotechnical engineering is concerned with structures that are located away from the shore, such as oil platforms, wind turbine structures, artificial islands, and subsea pipelines.

Furthermore, soil mechanics, rock mechanics, and foundation engineering are the three fundamental subfields of geotechnical engineering. These are the main facets of the testing, sampling, and site inspection. Dhir, Ghataora, and Lynn (2017) explained that geotechnical engineering encompasses a whole host of application types, including foundation design, earthworks (excavating and filling), ground improvement, slope stabilisation, and retaining wall construction. Moreover, a wide range of industries can benefit from the use of geotechnical engineering, including dredging, oil and gas, construction, agriculture, water utilities, oil and gas, landfills, coastal restoration, and many more. Additionally, by comprehending and reducing soil-related dangers, geotechnical engineering guarantees the stability and safety of constructions. In addition, it entails the planning, designing, and building of slopes, retaining walls, tunnels, embankments, and other systems that are composed of or supported by rock or soil.

Fig. 1: Geo-Technical Engineering work

Source: https://www.istockphoto.com

Concept of Deep-Foundation Testing Project

In order to guarantee the lifespan, stability, and safety of structures constructed on difficult soil conditions, deep foundation testing is an essential procedure in the construction business. It entails assessing the stability and load-bearing capability of deep foundation systems—piles, drilled shafts, and micropiles—that sustain large, weighty constructions like transmission towers, skyscrapers, and bridges. An array of testing techniques used to evaluate the integrity and load capability of deep foundation systems is referred to as Deep Foundation Testing Solutions (DFTS). Heavy structures like buildings, bridges, and gearbox towers that need to have their foundations buried far below the surface of the earth are usually supported by deep foundations.

The purpose of a deep foundation inspection or test is to evaluate the deep foundation's strength, durability, and overall quality. Visual inspections, lateral load tests, integrity tests, and Osterberg cell load tests are a few examples of deep foundation test types. Likins, Robinson, and Piscsalko (2012) mentioned that the ultimate strength of a deep foundation must satisfy both structural and geotechnical limits for the foundation to perform as desired. Thus, testing of the deep foundation project is required. In a deep-foundation testing project, the integrity and load-bearing capability of drilled shafts and piles—deep foundations that are essential to the stability of massive structures—are evaluated. Bypassing weaker surface soils, these foundations shift building loads to deeper, more stable soil layers or bedrock. Testing these foundations is essential to ensuring their performance meets design specifications and safety standards (Zhou et al., 2017).

Static load testing, dynamic load testing, and non-destructive testing procedures are the main approaches used in deep foundation testing. The most dependable type of load testing is static load testing, which involves placing a predetermined stress on the foundation and observing how it responds. In dynamic load testing, the foundation is subjected to force using a hammer, and the stress waves that emerge are measured. Non-destructive methods, such as ultrasonic or sonic echo tests, evaluate the foundation's condition without causing damage (Likins et al., 2019). Deep-foundation testing is now much more accurate and efficient thanks to technological developments. With the use of fiber-optic sensors and other contemporary methods like cross-hole sonic logging, data can be collected and analysed in real time, giving more precise insights into the behaviour of the foundation under load. These technologies enable engineers to detect potential issues early, reducing the risk of structural failures (Samui & Kim, 2014).

Interpreting test data is a crucial part of a deep-foundation testing endeavour. To properly evaluate the performance of the foundation, engineers need to be knowledgeable about material qualities, load transfer mechanisms, and soil mechanics. The decision-making process for any required corrective measures or design modifications is guided by this interpretation. Proper analysis ensures that the foundation can safely support the intended loads throughout the structure's lifespan (Briaud, 2013). In construction projects, deep-foundation testing is essential, especially for offshore constructions, bridges, and high-rise skyscrapers. Thorough testing and analysis are necessary to guarantee the safety and dependability of deep foundations, avert catastrophic collapses, and increase the longevity of these structures. As the demand for more resilient infrastructure grows, the importance of advanced deep-foundation testing methods will continue to increase (Matsumoto & Hirakawa, 2016).

Fig. 2: Deep-Foundation Testing Project

Source: https://earthengineering.com

Types of Leadership

The ability of a person, team, or organisation to direct, influence, or lead other people, groups, or entire organisations is known as leadership. Gemeda and Lee (2020) mentioned that leadership is crucial for the effective functioning of any organisation, as the fundamental goal of leadership is its persuading power over human resources, the organisation's source of competitive advantage, and the resultant outcomes. The types of leadership are listed below:

Democratic leadership: Participatory leadership is another name for democratic leadership. It includes the group members in the process of making decisions. This method promotes open communication, values group members' opinions, and fosters teamwork. In a democratic leadership style, the potential for weak execution and poor decision-making is high (Khajeh, 2018). However, because their voices are appreciated, democratic leadership is also recognised to inspire workers to perform better.

Autocratic Leadership: An individual leader with considerable authority and the ability to make choices with little or no team member participation is said to exhibit autocratic leadership. Usually, this type of leader gives directions regarding tasks, policies, and processes, and they anticipate that their subordinates will do as they are told. This leadership style is characterised by a rigid structure, stringent regulations, and a top-down communication strategy. But this kind of leadership discourages originality, makes decisions quickly and clearly, and can lower participation and morale among staff members.

Transformational Leadership: A leader that practices transformational leadership inspires and motivates their team members to go above and beyond expectations and realise their greatest potential. This style of leadership is centred on articulating a vision, fostering a positive and encouraging atmosphere, and promoting adjustments and improvements. Burns (1978), cited in Thanh and Quang (2022), explained that transformational leaders are seen as inspirations, motivating employees to be motivated to work with high performance and be able to overcome their previous limits.

Transactional Leadership: Transactional leadership focuses on well-defined goals and well-structured activities, utilising incentives and disincentives to control team output. Thanh and Quang (2022) mentioned that transactional leaders can use punishment when the work is poor or the results are negative but can achieve rewards when the work is positive. But these leaders also establish clear objectives, track advancement, and offer incentives for reaching goals or sanctions for falling short of them. This kind of leadership definitely places a focus on discipline, order, and efficiency.

Laissez-faire Leadership: This type of leadership encourages innovation and creativity and allows for faster decision-making and autonomy to make decisions without waiting for the approval process (Amanchukwu 2015). Even in trying circumstances when a leader is needed, laissez-faire leaders refrain from meddling in their subordinates' decisions because they believe that the workforce makes the last say.

Coaching Leadership: Under this type of leadership, the leaders concentrate on training their staff members and assisting them in enhancing their abilities and performances. This strategy entails leading, coaching, and giving employees constructive criticism in order to foster a positive, growth-oriented work atmosphere. On the other hand, coaching leaders put long-term growth first, motivating team members to establish and meet both personal and professional objectives. This style of leadership fosters empowerment, self-awareness, and learning, which raises engagement and enhances output and job satisfaction.

Effects of Leadership in Geo-technical Engineering on Effective Management of Foundation Testing

The successful administration of foundation testing projects is greatly impacted by the profound and complex consequences of leadership in geotechnical engineering. However, leadership in geo-technical engineering significantly impacts the effective management of foundation testing projects. The effects include the following:

Clear Vision and Direction: Levene (2015) stated that effective visions are credible and responsive to current problems and provide a balance of specificity and ambiguity. Effective leadership ensures that all team members understand their roles and responsibilities in the foundation testing project by setting clear objectives and goals and providing a roadmap or direction for the project.

Efficient Resource Management: Effective leaders distribute resources—people, tools, and materials—to guarantee peak performance. Aside from meticulous budgeting and financial supervision, effective leadership also include preventing cost overruns and making sure the project stays under budget.

Improved Communication: Good leadership promotes open communication, which makes it possible to identify and resolve problems quickly. It also helps team members, stakeholders, and clients communicate in a clear and consistent manner.

Enhanced Team Performance: Coaches and mentors help team members develop their talents, which leads to higher performance and innovation. This inspires and motivates the team and boosts morale and productivity. Han (2024) explained that transformational leadership positively impacts team flexibility and team agility, which positively impact project success, and shows a positive mediating effect between transformational leadership and project success.

Risk Management: Proactively recognising possible risks, putting mitigation plans in place, and acting swiftly on well-informed decisions are all characteristics of effective leaders, and these skills are essential for handling unforeseen difficulties that may arise during foundation testing.

Quality Control: In order to guarantee the precision and dependability of test results, leadership helps to set and enforce strict guidelines and protocols. Additionally, it promotes a culture of continuous development by continuously looking for ways to improve testing procedures and results.

Stakeholder Satisfaction: Leaders control expectations from stakeholders by communicating openly and providing frequent updates. According to Orieno (2024), the importance of sustainability in project management is underscored by its potential to enhance project outcomes, foster stakeholder engagement, and contribute to the broader goals of sustainable development. Nonetheless, proficient leadership guarantees that project deliverables either surpass or correspond with stakeholder expectations, resulting in contentment and confidence.

Innovation and Adaptability: Innovative solutions are promoted and investigated in an atmosphere that is facilitated by effective leadership. They are flexible and able to change course when needed to meet evolving project demands and conditions.

Types of Geo-Technical Engineering in United State of America (USA)

In the US, geotechnical engineering includes a wide range of specific disciplines that are crucial for disaster relief, environmental preservation, and infrastructure development. Technological developments and shifting environmental requirements have led to the evolution of several significant geotechnical engineering practice types.

Foundation Engineering: When constructing buildings, bridges, and other structures, foundation engineering is still essential. It involves assessing soil conditions to design stable foundations that can withstand loads and environmental stresses (Das, 2016).

Earthquake Engineering: Because earthquakes frequently occur in the United States, earthquake engineering focuses on creating infrastructure and buildings that can withstand seismic activity. Techniques include soil liquefaction analysis and seismic retrofitting (Kramer, 2017).

Geo-environmental Engineering: This field addresses the intersection of geotechnical engineering and environmental science, focusing on issues like groundwater contamination, waste disposal, and environmental remediation (Daniel et al., 2019).

Geo-technical Hazard Mitigation: Given the increasing frequency of natural disasters, geotechnical engineers' work on assessing and mitigating hazards such as landslides, slope stability, and coastal erosion (Stark and Choi, 2018).

Geo-technical Instrumentation and Monitoring: For the purpose of identifying any breakdowns early on, geotechnical infrastructure (such as dams and tunnels) must be continuously monitored. Advances include real-time data acquisition and analysis using sensors and remote monitoring techniques (Zhu and Gong, 2020).

Geo-synthetics and Geo-technical Materials: Geo-synthetics like geo-textiles and geo-membranes are extensively used in infrastructure projects for erosion control, reinforcement, and drainage (Koerner, 2018).

Challenges Faced by Geo-technical Engineering Companies

Numerous obstacles that geotechnical engineering firms must overcome can have an impact on their day-to-day operations, the success of their projects, and their overall performance, (Reddy (2012). Strategic planning, talent and technology investments, efficient risk management, strong coordination, and communication are all need to meet this challenge. Companies may satisfy customer expectations, enhance project outcomes, and keep their competitive advantage in the market by proactively addressing these difficulties. Nonetheless, geotechnical firms encounter several primary challenges, including the following:

Site and Soil Variability: Unexpected difficulties may arise during testing and construction in the engineering industry because to variations in soil qualities and site conditions. It is quite obvious that several soils substantially threaten the road's serviceability and long-term durability.

However, thorough and comprehensive geotechnical investigations are necessary for accurate site assessments, and they can be expensive and time-consuming.

Environmental Regulations and Compliance: Geotechnical businesses have to follow complicated environmental laws that differ greatly from one location to the next. Nevertheless, acquiring the required licences and approvals may result in delays and raise the price of the project.

Technological Advances: Since organisations must constantly invest in new tools, equipment, and engineering training due to the rapid improvements in technology, integrating new technologies into existing workflows can be difficult and may require major adaptations.

Risk and Resource Management: Unexpected geological features, like earthquakes or sinkholes, can put geotechnical engineering firms at serious danger. Additionally, creating and putting into practice sensible risk mitigation techniques is crucial but can be difficult and resource-intensive. Delays and higher expenses can also result from a lack of highly qualified geotechnical engineers and technicians as well as restricted access to specialised equipment.

Project Complexity and Coordination: Coordinating civil, structural, and environmental disciplines is typically necessary for geotechnical projects, which can make project management more difficult for the engineering firm since handling complicated projects with many moving components and stakeholders can be difficult.

Client and Stakeholder Expectations: Effective communication is essential for managing the expectations of clients and stakeholders, but it may be challenging because these parties frequently have high standards for project budgets, schedules, and results.

Safety and health concerns: For the engineering company, worker safety on potentially hazardous and risky sites is a constant issue. Nonetheless, continuing work and resources are needed to comply with health and safety laws and requirements.

Environmental Impact and Sustainability: It is becoming more and more important to minimise the environmental impact of geotechnical work, which calls for meticulous planning and implementation. Furthermore, there is growing demand to implement sustainable practices, which may necessitate early financial outlays and modifications to conventional procedures.

METHODOLOGY

In this study, an Ex-Post Facto design was adopted. The study was carried out in USA. The targeted population for the study comprised civil engineers, project manager and project management consultants in USA. A stratified random sampling technique was used to select 10 respondents from 6 different types of geo-technical engineering services in USA such as Foundation Engineering, Earthquake Engineering, Geo-environmental Engineering, Geo-technical Hazard Mitigation, Geo-technical Instrumentation and Monitoring as well as Geo-synthetics and Geo-technical Materials. This was done by selecting 8 civil engineers, 1 project manager and 1 project management consultants which gave a total of 60 respondents used for the study. The instrument used for data collection was a structured questionnaire titled “Deep Foundation Testing Leadership Project Questionnaire (DFTLPQ)”. Face and content validation of the instrument was carried out by an expert in project management and one expert in quantitative analysis in order to ensure that the instrument has the accuracy, appropriateness, and completeness for the study under consideration. The reliability coefficient obtained was 0.85, and this was high enough to justify the use of the instrument. The researcher subjected the data generated for this study to appropriate statistical technique such as a descriptive statistical analysis (percentage analysis).

RESULTS AND DISCUSSIONS

Research Question 1

The research question sought to find out the effects of leadership in geo-technical engineering on effective management of foundation testing. To answer the research percentage analysis was performed on the data, (see table 1).

Table 1: Percentage analysis of the effects of leadership in geo-technical engineering on effective management of foundation testing.

EFFECTS	Frequency	Frequency in 60	Percentage
Clear Vision and Direction	37	12	19.68**
Efficient Resource Management	33	11	17.53
Improved Communication	28	9	14.89
Enhanced Team Performance	24	8	12.77
Risk Management	22	7	11.70
Quality Control	17	5	9.04
Innovation and Adaptability	12	5	7.98
Innovation and Adaptability	15	4	6.38*
TOTAL	**188**	**60**	**100%**

**** The highest percentage frequency**

*** The least percentage frequency**

SOURCE: Field survey

The above table 1 presents the percentage analysis of the effects of leadership in geo-technical engineering on effective management of foundation testing. From the result of the data analysis, it was observed that the effect of leadership in geo-technical engineering on effective management of foundation testing tagged “Clear Vision and Direction” with the frequency of 37(12) and the percentage of 19.68 was rated as the highest one with 19.68% as the percentage, while “Stakeholder Satisfaction” with the frequency of 15(4) and percentage of 6.38 was rated the least. The result therefore, is in agreement with the research findings of Levene (2015), who noted that effective visions are credible and responsive to current problems and provide a balance of specificity and ambiguity and that effective leadership ensures that all team members understand their roles and responsibilities in the foundation testing project by setting clear objectives and goals and providing a roadmap or direction for the project. Others including efficient resource management, improved communication and many more.

Research Question 2

The research question sought to find out the challenges Faced by Geo-technical Engineering Companies in their operations in USA. To answer the research percentage analysis was performed on the data, (see table 2).

Table 2: Percentage analysis of the challenges Faced by Geo-technical Engineering Companies in their operations in USA.

CHALLENGES	Frequency	Frequency in 60	Percentage
Site and Soil Variability	39	12	20**
Technological Advances	34	10	17.43
Project Complexity and Coordination	28	9	14.36
Environmental Impact and Sustainability	25	8	12.82
Environmental Regulations and Compliance	21	6	10.77
Risk and Resource Management	19	6	9.74
Client and Stakeholder Expectations	16	5	8.21
Safety and health concerns	13	4	6.67*
TOTAL	**195**	**60**	**100%**

**** The highest percentage frequency**

*** The least percentage frequency**

SOURCE: Field survey

The above table 2 presents the percentage analysis of the challenges Faced by Geo-technical Engineering Companies. From the result of the data analysis, it was observed that the challenge most faced was "Site and Soil Variability" with the frequency of 39(12) and percentage of 20, while "Safety and health concerns" , with the frequency of 13(4) and with the percentage of 6.67 was rated the least. The result therefore is in agreement with the research findings of Reddy (2012), who noted that several soils substantially threaten the road's serviceability and long-term durability and that the challenges include site and soil variability, environmental regulations and compliance, technological advances and many more.

Hypothesis testing

Hypothesis One: The null hypothesis states that there is no significant effect of leadership in geo-technical engineering on effective management of foundation testing in USA. In order to test the hypothesis, simple regression analysis was performed on the data (see table 3)

TABLE 3: Simple Regression Analysis of the effect of leadership in geo-technical engineering on effective management of foundation testing in USA.

Model	R	R-Square	Adjusted R Square	Std. error of the Estimate	R Square Change
1	0.90a	0.81	0.81	0.56	0.81

***Significant at 0.05 level; df= 58; N= 60; critical R-value = 0.214**

The above table 3 shows that the calculated R-value (0.90) was greater than the critical R-value of 0.214 at 0.05 alpha levels with 58 degrees of freedom. The R-Square value of 0.81 predicts 81% of the effect of leadership in geo-technical engineering on effective management of foundation testing in USA, while the remaining 19% was determined by other factors not including leadership. This rate of percentage is highly positive and therefore means that there is significant effect of leadership in geo-technical engineering on effective management of foundation testing in USA. It was also deemed necessary to find out the influence of the variance of each case of independent variable as responded by each respondent (see table 4).

TABLE 4: Analysis of variance of the effect of leadership in geo-technical engineering on effective management of foundation testing in USA

Model	Sum of Squares	Df	Mean Square	F	Sig.
Regression	82.97	1	82.97	261.12	.000b
Residual	18.43	58	0. 32		
Total	101.40	59			

a. Dependent Variable: Management

b. Predictors: (Constant), Leadership Effectiveness

The table 4 presents the calculated F-value as 261.12 and the P-value as .000b. Being that the P-value (.000b) is below the probability level of 0.05, the calculated result (261.12) therefore signifies that there is significant effect exerted by the independent variables i.e. leadership effectiveness on the dependent variable which is effective management. The result therefore means that there is significant effect of leadership in geo-technical engineering on effective management of foundation testing in USA. The result therefore is in agreement with the research findings of Levene (2015) that noted that the effective visions are credible and responsive to current problems and provide a balance of specificity and ambiguity and that effective leadership ensures that all team members understand their roles and responsibilities in the foundation testing project by setting clear objectives and goals and providing a roadmap or direction for the project. The significance of the result caused the null hypotheses to be rejected while the alternative was upheld.

Conclusion

Effective leadership in geo-technical engineering is crucial for the successful management of deep foundation testing projects. Leaders must integrate technical expertise with strong project management skills to address the complexities of foundation testing. Key practices include thorough planning, proactive risk management, and stringent quality control. By fostering clear communication and collaborative problem-solving, leaders can navigate challenges and ensure project success. As the field advances, embracing new technologies and sustainable practices will be essential. Ultimately, strong leadership not only enhances project outcomes but also drives innovation and excellence in geo-technical engineering. Finally, there is significant effect of leadership in geo-technical engineering on effective management of foundation testing in USA

Recommendations

1. Continuous education and training in the latest geo-technical engineering techniques and technologies are essential. Leaders should encourage team members to pursue certifications and attend relevant workshops and conferences.
2. Leverage the latest technologies and tools in geo-technical engineering, such as automated testing equipment, data analytics, and simulation software. This can improve accuracy and efficiency in testing procedures.
3. Establish clear communication channels within the team and with stakeholders. Regular updates, meetings, and transparent reporting practices help in maintaining alignment and addressing issues promptly.

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