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The Influence of Project Management Knowledge and Leadership Style on the Success of Groundwater Drilling Projects at PT SII

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ABSTRACT

The role of project management knowledge (PMK) and leadership style (LS) is crucial in determining the success of a project. This study aims to identify the influence of PMK and LS on the success of drilling well projects at PT SII (Project Success or PS). The research method used is quantitative, with data analysis conducted using multiple linear regression through SPSS software. Data were obtained through questionnaires distributed to 56 employees involved in drilling well projects. The results show that PMK positively and significantly affects PS. Similarly, LS also positively and significantly impacts PS. These findings suggest that enhancing PMK and adopting effective LS can improve the success rate of projects at PT SII.

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Introduction

Clean water is a fundamental human necessity for sustaining life, health, and development [1]. In many regions of Indonesia, particularly those not yet covered by centralized water utility networks, access to clean and safe water remains limited. In such

contexts, groundwater drilling emerges as a strategic solution to meet the demand for potable water sources [2], [3]. One of the national contractor companies, PT SII, provides groundwater drilling and geotechnical services, playing a critical role in supporting sustainable water provision through projects across the country.

In 2024, PT SII recorded a significant increase in the number of projects. Based on collected contract data, the company managed at least nine groundwater drilling and related service projects spread across various locations, including Sumatra, Obi Island, East Nusa Tenggara, Malang, Cibitung, and Banyuwangi. Furthermore, PT SII secured several high-value contracts with national and multinational entities. The scope of work includes engineering, procurement, and construction (EPC), maintenance, and hydrological and hydrogeological studies, with contract values reaching millions of U.S. dollars.

However, the increase in project quantity does not always correlate with the quality and effectiveness of implementation. Internal observations indicate that several projects experienced delays from the planned schedule and cost overruns, impacting the company's efficiency and reputation. These challenges highlight the need for a more structured project management system grounded in adequate PMK [4].

PMK comprises a set of principles, techniques, and best practices used in project planning, execution, monitoring, and completion [5]. Core components include scope, time, cost, risk, quality, and communication management. Drilling projects often involve high levels of uncertainty, ranging from unpredictable geological conditions to operational challenges in the field. In such contexts, PMK provides a critical foundation to keep projects on track [6].

Beyond technical considerations, leadership also plays a central role in project success. Project managers' leadership style significantly influences team performance, problem-solving capacity, and individual motivation [7]. Transformational, transactional, and laissez-faire leadership styles offer distinct approaches to directing and managing project teams. Choosing the appropriate style determines how teams respond to challenges, complete tasks on time, and maintain the quality of project outputs [8].

This study aims to analyze the influence of Project Management Knowledge and leadership style on the success of groundwater drilling projects at PT SII. Specifically, it assesses the extent to which the understanding and application of PMK and the LS employed address project challenges and promote more efficient, timely, and budget-compliant project execution. The findings are expected to serve as a managerial reference and provide practical contributions to improving project management quality within PT SII and the broader industry.

Literature Review

This literature review focuses on three main variables: PMK as variable X_1, LS as variable X_2, and PS as variable Y. These variables interact to determine the overall effectiveness of groundwater drilling projects, particularly within the context of project implementation at PT SII. Each of these variables has been studied in prior research and applied in various industries, and together they provide a valuable framework for understanding project outcomes. The following discussion presents each variable in greater detail, drawing on relevant theories and empirical findings.

A. Project Management Knowledge (PMK)

Project Management Knowledge refers to knowledge, skills, tools, and techniques systematically applied to manage project activities and achieve project requirements. PMK is widely recognized as the foundation of effective project implementation, providing structured approaches for dealing with the inherent complexities of project work. According to the Project Management Institute, PMK encompasses ten knowledge areas and five process groups, each supported by inputs, tools, and outputs that guide project execution [4]. In groundwater drilling projects, three specific areas of PMK are particularly relevant: project planning, risk management, and organization and resource management.

Project planning is one of the most critical phases of PMK because it lays the foundation for all subsequent activities. In drilling projects, planning activities include the preparation of geological studies, the securing of necessary permits, the selection of appropriate drilling methods, the estimation of project budgets, and the development of project schedules. Projects will likely face delays, technical errors, or cost overruns without comprehensive planning. Research emphasizes that robust planning processes allow project teams to anticipate potential obstacles, align resources with objectives, and minimize inefficiencies that might arise during implementation [9].

Risk management is another central component of PMK and is particularly important in groundwater drilling projects due to the high levels of uncertainty involved. Subsurface geological data are often incomplete or unpredictable, resulting in technical difficulties and unanticipated costs. Organizations that possess effective mechanisms for identifying, analyzing, and responding to risks are more capable of delivering successful project outcomes [10]. By incorporating systematic risk assessments and mitigation strategies, project managers can better prepare for operational challenges, reduce exposure to unforeseen events, and protect project timelines and budgets.

The third relevant component of PMK is organization and resource management. Drilling projects require coordinating human resources, specialized equipment, and financial assets, all of which must be carefully managed to maintain productivity and efficiency. Effective

allocation of resources helps ensure that personnel and equipment are used optimally, reducing idle time and avoiding cost wastage [11]. Strong resource management practices also create a more collaborative project environment, motivating teams to achieve common goals. Previous studies consistently highlight that robust project knowledge significantly enhances performance in complex technical undertakings such as drilling and large-scale infrastructure development [12]. Therefore, PMK represents a fundamental determinant of successful project outcomes in groundwater drilling projects.

B. Leadership Style (LS)

Leadership can be defined as the ability to influence, direct, and coordinate individuals or groups to achieve shared goals. In projects that involve multidisciplinary teams, such as groundwater drilling, LS plays a decisive role in shaping work dynamics, maintaining team stability, and fostering motivation among project members. LS is not a one-size-fits-all concept but varies depending on context, organizational culture, and the nature of project challenges. This study focuses on three key LS identified in the literature as particularly influential in technical and project-based environments: transformational leadership, transactional leadership, and laissez-faire leadership.

Transformational leadership emphasizes the ability of leaders to inspire and motivate their teams through vision, charisma, and individualized consideration. Transformational leaders foster a culture of trust and empowerment, encouraging team members to develop their skills and take initiative. Research shows this style is particularly effective in complex and innovation-driven projects, where adaptability and creativity are required to navigate uncertainty [7], [13]. In groundwater drilling, transformational leadership can enhance problem-solving capacity, promote collaboration across diverse disciplines, and increase team resilience when unexpected challenges arise.

Transactional leadership, on the other hand, is rooted in structured systems of rewards and punishments. This style suits projects requiring clear workflows, measurable outputs, and strict adherence to established procedures. Transactional leaders maintain discipline and efficiency by closely monitoring performance and ensuring compliance with project plans. While this style has proven effective for maintaining order and efficiency, its rigid structure may limit flexibility and hinder creativity when novel solutions are required [8]. In the drilling sector, transactional leadership may effectively maintain operational safety and ensure deadlines are met, but it may fall short when innovation is essential.

The third style, laissez-faire leadership, is characterized by minimal intervention from the leader. Team members are granted high autonomy and expected to manage their work with limited supervision. This style can be effective when teams are highly skilled, motivated, and

capable of independent decision-making [6]. However, when teams require more direction, laissez-faire leadership may lead to confusion, lack of coordination, and diminished performance. Studies in the construction and drilling sectors indicate that LS must be carefully adapted to the specific demands of the project environment. Context-appropriate leadership has been shown to enhance motivation, efficiency, and overall outcomes, while transformational leadership has demonstrated strong positive effects on productivity and efficiency [14].

C. Project Success (PS)

Project success represents the primary benchmark for evaluating the effectiveness of project implementation. Traditionally, PS has been measured through the three dimensions of the so-called triple constraint: time, cost, and quality [4]. This framework, sometimes called the iron triangle of project management, remains highly relevant in technical projects such as groundwater drilling. Each of these dimensions reflects a different aspect of project performance and collectively provides an integrated view of project outcomes.

The first dimension, time, measures the ability of the project to meet its scheduled completion date. Timeliness is critical in groundwater drilling because delays increase costs, reduce client satisfaction, and damage organizational credibility. Research shows that projects that fail to adhere to timelines often face additional financial burdens and strained stakeholder relationships [15].

The second dimension, cost, refers to the ability of a project to remain within its allocated budget. Cost overruns are frequently cited as indicators of weak planning and insufficient control mechanisms [16]. In groundwater drilling projects, operational costs can escalate quickly due to technical complications; maintaining budget discipline is essential to achieving profitability and sustaining client trust.

The third dimension, quality, represents the degree to which project outcomes meet technical specifications, environmental standards, and client expectations. Quality is especially critical in drilling projects, where success is not only defined by the completion of drilling activities but also by the capacity of the well to deliver sufficient water yields. A project may meet its time and budget goals but cannot be considered successful if it fails to produce usable results.

More recent perspectives on PS extend beyond the traditional triple constraint. Scholars argue that modern projects must also account for sustainability, long-term value creation, and alignment with organizational strategic objectives [17], [18]. This expanded view reflects the evolving expectations of stakeholders, who increasingly demand projects that deliver enduring benefits, minimize environmental impact, and support broader organizational missions. In groundwater drilling, PS is therefore not only measured by technical accomplishments but also

by the long-term reliability of water supply, the satisfaction of stakeholders, and the contribution of projects to sustainable development.

Based on this review, the conceptual framework suggests that Project Management Knowledge enhances PS by strengthening planning, risk management, and resource allocation. LS is a mediating factor influencing how teams overcome challenges and meet objectives. Together, these two independent variables shape the success of groundwater drilling projects by ensuring that technical and human factors are addressed in project execution. Understanding their interrelationship enables organizations to formulate more effective planning, implementation, and leadership development strategies, ultimately leading to more efficient and sustainable project outcomes.

Materials and Methods

A. Research Design

This study employs a quantitative research approach using both descriptive and verification methods. A quantitative design is appropriate for measuring and testing the statistical relationships among variables based on numerical data collected through structured instruments. The study's main objective is to examine the influence of PMK and LS on the success of groundwater drilling projects. The descriptive method is applied to present respondents' perceptions regarding the implementation of PMK and the LS adopted in project execution, and PS is evaluated in terms of timeliness, cost efficiency, and quality achievement. The verification method tests the proposed hypotheses regarding the effect of the two independent variables on the dependent variable, both partially and simultaneously.

B. Population and Sample

The research is focused on groundwater drilling projects conducted by a national contractor company, PT SII, with operations spanning multiple regions of Indonesia, including Sumatra, Obi Island, East Nusa Tenggara, and Java. The study population comprises 50 PT SII employees directly involved in project implementation, covering both managerial and technical roles. Considering the relatively small population size, a saturated sampling technique was adopted, including all population members as research respondents. This approach ensures comprehensive coverage of perspectives across different levels of involvement in project execution.

C. Data Collection and Analysis

Data were collected using structured questionnaires designed with a five-point Likert scale to capture respondents' levels of agreement with statements representing each variable indicator. The primary data were obtained directly from survey responses, while secondary data were drawn from company documentation and relevant academic sources. The PMK

variable was measured across three dimensions: project planning, risk management, and resource organization. The LS variable was assessed through transformational, transactional, and laissez-faire dimensions. PS was evaluated using three classical indicators of project management: timeliness, cost efficiency, and quality achievement.

The collected data were analyzed using multiple linear regression to determine the influence of each independent variable on PS, and tested both individually and simultaneously. To ensure the validity of the regression model, classical assumption tests were conducted, including normality, multicollinearity, heteroscedasticity, and autocorrelation tests. Hypothesis testing included the t-test for partial effects and the F-test for simultaneous effects, with the coefficient of determination (R^2) used to measure the model's explanatory power. Instrument validity was examined using Pearson Product-Moment correlation, while reliability was tested with Cronbach's Alpha, with a minimum acceptable threshold of 0.60. All statistical analyses were conducted using SPSS version 22 software.

Results

This study aimed to examine the influence of PMK and LS on the success of groundwater drilling projects at PT SII. Data were collected through questionnaires distributed to 56 respondents, all active field personnel directly involved in project execution. The data analysis employed a quantitative approach using multiple linear regression. Before hypothesis testing, instrument validity and reliability assessments were conducted, along with classical assumption tests, to ensure that the dataset satisfied the requirements for statistical analysis.

A. Data Collection

This study examined the influence of PMK and LS on the success of groundwater drilling projects at PT SII. Data were obtained through questionnaires distributed to 56 respondents, all of whom were active field personnel directly involved in the implementation of projects. The questionnaire was designed to capture perceptions of PMK, LS, and PS, and used structured statements with a five-point Likert scale. The collected responses served as the primary dataset for the subsequent statistical analysis, which employed multiple linear regression. Before hypothesis testing, additional procedures such as instrument validation, reliability assessment, and classical assumption testing were conducted to ensure that the dataset met the quantitative analysis requirements.

B. Instrument Validity

Instrument validity testing was conducted for all questionnaire items corresponding to the three research variables: PMK (X_1), LS (X_2), and PS (Y). Each item was tested using Pearson's product-moment correlation to determine the relationship between individual item scores and the total construct score. The results revealed that all items had correlation coefficients (r-

count) greater than the critical value (r-table) of 0.300, confirming that each item was valid. These findings demonstrate that the questionnaire effectively measured the intended constructs. The detailed validity test results for each indicator are presented in Table 1.

Table 1. Correlation Coefficient (r-count) Results

No	r-count
X1.1	0.758
X1.2	0.583
X1.3	0.820
X1.4	0.782
X1.5	0.673
X1.6	0.716
X1.7	0.501
X1.8	0.850
X1.9	0.773
X1.10	0.811

No	r-count
X2.1	0.758
X2.2	0.747
X2.3	0.640
X2.4	0.654
X2.5	0.727
X2.6	0.339
X2.7	0.327
X2.8	0.517
X2.9	0.479

No	r-count
Y.1	0.773
Y.2	0.815
Y.3	0.756
Y.4	0.795
Y.5	0.888
Y.6	0.842
Y.7	0.626

C. Instrument Reliability

After confirming validity, the reliability of the instruments was assessed using the Cronbach's Alpha method. The results showed that all variables exceeded the minimum threshold of 0.600, with values of 0.890 for PMK, 0.794 for LS, and 0.884 for PS. These values indicate that the instruments used in this study are reliable and consistent in measuring each construct. The detailed results are summarized in Table 2.

Table 2. Instrument Reliability Test Results

Variable	Cronbach's Alpha
PMK	0.890
LS	0.794
PS	0.884

D. Classical Assumption Testing

Once the instruments were proven valid and reliable, classical assumption tests were conducted to ensure the appropriateness of the regression model.

1. Multicollinearity Test

   The correlation values among the independent variables were all below 0.8, indicating that multicollinearity was not present (Table 3).

2. Heteroscedasticity Test

   Using the Glejser method, the significance values of all independent variables were 1.000 (> 0.05). Thus, the model does not exhibit heteroscedasticity (Table 4).

Table 3. Multicollinearity Test Results

	PMK	LS
PMK		
Pearson Correlation	1	.782**
Sig. (2-tailed)	–	< .001
N	56	56
LS		
Pearson Correlation	.782**	1
Sig. (2-tailed)	< .001	–
N	56	56

Remark: **Correlation is significant at the 0.01 level (2-tailed).

Table 4. Heteroscedasticity Test (Glejser Method)

Model	Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	t	Sig.
(Constant)	1.01E-12	1.271	–	.000	1.000
PMK	.000	.042	.000	.000	1.000
LS	.000	.054	.000	.000	1.000

Remark: a. Dependent Variable: Standardized Residual

3. Normality Test

Kolmogorov-Smirnov testing showed that the Asymp. Sig. Value was greater than 0.05, confirming that the data were normally distributed (Table 5).

Table 5. Normality Test (Kolmogorov-Smirnov)

	Standardized Residual
N	56
Normal Parameters	
• Mean	.0000000
• Std. Deviation	.98164982
Most Extreme Differences	
• Absolute	.099
• Positive	.046
• Negative	-.099
• Test Statistic	.099
Asymp. Sig. (2-tailed)	.200
Monte Carlo Sig. (2-tailed)	.184
99% Confidence Interval	
• Lower Bound	.174
• Upper Bound	.194

4. Autocorrelation Test

The Durbin-Watson value was 2.126, which falls within the acceptable range (1.604 < DW < 2.396), suggesting no autocorrelation in the regression model (Table 6).

Table 6. Durbin-Watson Autocorrelation Test

R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
.823[a]	.678	.666	208.143	2.126

Notes:
a. Predictors: (Constant), Leadership Style, Project Management Knowledge
b. Dependent Variable: Project Success

E. Multiple Linear Regression Analysis

After confirming that all assumptions were met, multiple linear regression analysis was performed to determine the effect of PMK and LS on PS. The resulting regression equation is:

$$Y=3.722+0.365X1+0.310X2+eY = 3.722 + 0.365X_1 + 0.310X_2 + e$$

This equation indicates that:

- A one-unit increase in PMK (X_1) increases PS by 0.365 units.
- A one-unit increase in LS (X_2) increases PS by 0.310 units.

Both variables positively contribute to PS. The detailed results are presented in Table 7.

Table 7. Multiple Linear Regression Results (Coefficients[a])

	Unstandardized B	Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	Collinearity Tolerance	Statistics VIF
(Contrant)	3.722	2.645		1.407	.165		
PMK	.365	.086	.528	4.223	<.001	.388	2.576
LS	.310	.113	.342	2.733	.009	.388	2.576

a. Dependent Variable: Project Success

F. Coefficient of Determination (R^2)

The coefficient of determination was 0.678, indicating that PMK and LS can explain 67.8% of the variance in PS. The remaining 32.2% is influenced by other factors beyond the model (Table 8).

Table 8. Coefficient of Determination (R^2)

R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
.823[a]	.678	.666	208.143	2.126

a. Predictors: (Constant), LS, PMK
b. Dependent Variable: PS

G. Hypothesis Testing

The F-test produced an F-calculated value of 55.829, greater than the F-table threshold of 4.0230, with a significance level 0.000. This result confirms that PMK and LS significantly influence PS (Table 9).

Table 9. F-Test Results (ANOVA[a])

	Sum of Squares	df	Mean Square	F	Sig.
Regression	483.742	2	241.871	55.829	<.001[b]
Residual	229.615	53	4.332		
Total	713.357	55			

a. Dependent Variable: PS
b. Predictors: (Constant), LS, PMK

Discussion

The correlation analysis demonstrated a positive relationship between project management knowledge and leadership style ($r = .782$, $p < .001$). This finding suggests that as individuals' project management knowledge increases, their leadership style becomes more effective and aligned with project goals. Previous studies have highlighted similar dynamics, where managerial competencies are often interwoven with leadership effectiveness in shaping project outcomes [19], [20]. In practice, this means that project managers who possess a deep understanding of project methodologies are more capable of adopting leadership styles that promote collaboration, motivation, and adaptability within teams. This result aligns with Müller and Turner [21], who argued that project managers require technical and leadership competencies to ensure project success. Similarly, Pinto and Slevin [20] identified that leadership and knowledge are critical success factors across the project life cycle. Thus, the correlation found in this study reinforces prior evidence that knowledge and leadership are not isolated competencies but complementary drivers of success.

The regression model summary revealed that leadership style and project management knowledge jointly explained 67.8% of the variance in project success ($R^2 = .678$). This indicates that these two variables are highly influential predictors when considered together. Comparable findings have been documented in project management literature, where combinations of soft skills and technical expertise were essential in achieving sustainable project outcomes [12],[22]. Despite the model's strong explanatory power, the individual regression coefficients of both predictors were statistically insignificant ($p > 0.05$). This outcome may be attributable to multicollinearity between the two independent variables, since leadership is often expressed through applying knowledge, while knowledge becomes impactful when executed under effective leadership [23], [24]. Thus, although both predictors are indispensable, their overlapping variance weakens their statistical significance when tested separately. These results suggest that in real project environments, the synergy of leadership style and project management knowledge is more important than either factor alone. As Crawford [25] emphasized, organizations should integrate leadership development with project management training, as separating the two reduces their effectiveness.

The findings of this study offer both theoretical and practical insights. Theoretically, the strong combined explanatory power of leadership style and project management knowledge supports multidimensional models of project success, which emphasize that success results from the interaction of technical, behavioral, and contextual variables rather than a single dimension [26], [27]. This resonates with Gomes et al. [27] multidimensional framework, which argues that project success must be understood beyond efficiency metrics and includes leadership, communication, and knowledge integration.

Practically, the results suggest that organizations should design training and professional development programs that cultivate leadership alongside technical expertise. Le Manh et al. [28] stress that organizations with mature leadership development programs achieve higher project success rates than those focusing solely on technical project management. Furthermore, given that 32.2% of project success variance remains unexplained, future studies should incorporate external variables such as organizational culture, stakeholder involvement, and environmental uncertainty [12].

This study argues that project management knowledge and leadership style are mutually reinforcing competencies. Their joint effect significantly enhances project success, although they may not appear statistically significant individually. This underlines the importance of adopting an integrated competency framework in research and practice.

Conclusion

Based on the findings of this study, it can be concluded that both PMK and LS substantially influence the success of groundwater drilling projects at PT SII. The application of PMK, encompassing project planning, risk management, and resource allocation, has enhanced project execution, particularly regarding timeliness, cost control, and quality outcomes. Meanwhile, the LS adopted by project managers, especially transformational and transactional approaches, plays a pivotal role in fostering motivation, strengthening team collaboration, and addressing challenges during project implementation.

These two variables account for 67.8% of the variance in project success, underscoring the importance of project management competence and leadership quality as critical determinants of performance at PT SII. Accordingly, it is recommended that the company continuously reinforce PMK capabilities while promoting adaptive and participative LS. Such measures will ensure more effective execution of future projects and contribute to the overall sustainability of organizational performance.

Conflict of Interest

The authors declare that there is no conflict of interest.

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