Impact of Human Resources and Technology Support on Management Performance and Product Quality

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DOI: https://doi.org/10.31284/j.jtm.2025.v6i2.7909
Received June 29th 2025; Received in revised July 9th 2025; Accepted July 15th 2025; Available online July 31st 2025

Abstract

Gas turbines are internal combustion engines used as a primary energy source in Gas Power Plants (PLTG). To ensure the reliability and quality of gas turbine repair outcomes, effective project management supported by employee capability and technological infrastructure is essential. This study aims to analyze the influence of employee capability and technological support on project management performance and its subsequent impact on product quality at PT Nusantara Turbin dan Propulsi. A quantitative approach was employed using a descriptive and verification research design, involving 80 research samples. The sample consisted of employees from the operations, marketing, and finance divisions involved in the FT8 gas turbine repair project. Data were collected through Likert-scale questionnaires and analyzed using classical assumption tests, path analysis, t-tests, and F-tests. The results indicate that employee capability and technological support have a positive and significant effect on project management performance (Adjusted R^2 = 61.6%). Furthermore, the three variables—employee capability, technological support, and project management performance—also significantly influence product quality (Adjusted R^2 = 80%). Project management performance is proven to be a partial mediator in the relationship between internal capabilities and product quality. These findings emphasize the importance of integrated management of human resources and technological support in project execution to achieve high-quality products.

Keywords: *management, employee capability, technological support, project management, product quality*

Abstrak

Gas turbin merupakan mesin pembakaran internal yang digunakan sebagai sumber energi utama dalam Pembangkit Listrik Tenaga Gas (PLTG). Untuk memastikan keandalan dan kualitas produk perbaikan gas turbin, diperlukan pengelolaan proyek yang baik yang didukung oleh kapabilitas karyawan dan teknologi. Penelitian ini bertujuan untuk menganalisis pengaruh kapabilitas karyawan dan dukungan teknologi terhadap kinerja manajemen proyek serta pengaruhnya terhadap kualitas produk di PT. Nusantara Turbin dan Propulsi. Penelitian ini menggunakan pendekatan kuantitatif dengan desain deskriptif dan verifikatif. Sampel penelitian terdiri dari 80 karyawan divisi operasi, pemasaran, dan keuangan yang terlibat dalam perbaikan gas turbin FT8. Data dikumpulkan melalui kuesioner dengan skala Likert dan dianalisis menggunakan uji asumsi klasik, analisis jalur, uji t, dan uji F. Hasil penelitian menunjukkan bahwa kapabilitas karyawan dan dukungan teknologi berpengaruh positif dan signifikan terhadap kinerja manajemen (Adjusted R^2 = 61,6%). Selanjutnya, ketiga variabel tersebut (kapabilitas karyawan, dukungan teknologi, dan kinerja manajemen) juga secara signifikan berpengaruh terhadap kualitas produk (Adjusted R^2 = 80%). Kinerja manajemen proyek terbukti sebagai mediator parsial antara kapabilitas internal dan kualitas produk. Temuan ini menegaskan pentingnya pengelolaan karyawan dan dukungan teknologi secara terintegrasi dalam manajemen proyek untuk menghasilkan produk berkualitas tinggi.

Kata kunci: *manajemen, kapabilitas karyawan, dukungan teknologi, manajemen proyek, kualitas produk*

1. Introduction

Gas turbines are internal combustion engines that convert energy from combustion into mechanical energy through a high-pressure combustion process. One of the primary uses of gas turbines in Indonesia is as a Gas-Fired Power Plant (PLTG). In operating gas turbines, operators are required to follow the manual instructions, perform regular maintenance, and conduct overhauls to ensure optimal operation. Gas turbine performance may vary over time, a phenomenon known as the gas turbine transient process. These transients can last a few seconds for aero engines or several hours for heavy-duty gas turbines [1], [2].

One mandatory preventive maintenance activity is borescope inspection, which aims to visually examine internal gas turbine components, including rotors and stationary parts. Common findings from borescope inspections include cracks in components such as the Combustion Chamber Outer Duct (CCOD), Combustion Chamber (CC), and Nozzle Guide Vanes (NGV) that exceed allowable limits, requiring immediate repair. Optimal gas turbine operation requires effective management involving both human resources and technological support [1].

The alignment between workforce management and technological capability is a critical component of performance in companies operating in the Maintenance, Repair, and Overhaul (MRO) sector. Technology resource management plays a significant role in successful technology governance. If a company fails to match its systems with adequate technological capabilities, its organizational objectives may not be optimally achieved [3], [4]. Moreover, skilled human resources can make sound decisions, coordinate teams effectively, and resolve issues during execution. On the other hand, the use of technology in management is known to enhance effectiveness and efficiency in various functions [5], [6].

Performance data from the FT8 gas turbine at PT. Nusantara Turbin dan Propulsi in 2023 indicated delays in gas turbine repair activities. The management performance involved four key components: human resources, technological support, project management performance, and product quality. The influence of human resources and technological support on management performance directly impacts final product quality. Therefore, further research is conducted to examine whether an increase in the human resource population affects the influence of human resources and technological support on project management performance.

2. Methodology

Research Design and Variables

This study employs a descriptive and verification research design. The factors contributing to the success of gas turbine repair projects are categorized into four main variables: (1) employee capability (X1) and Technological Support (X2) as independent variables, (2) management performance (Y) as the intervening variable, and (3) product quality (Z) as the dependent variable. The research variable paradigm is illustrated in Figure 1.

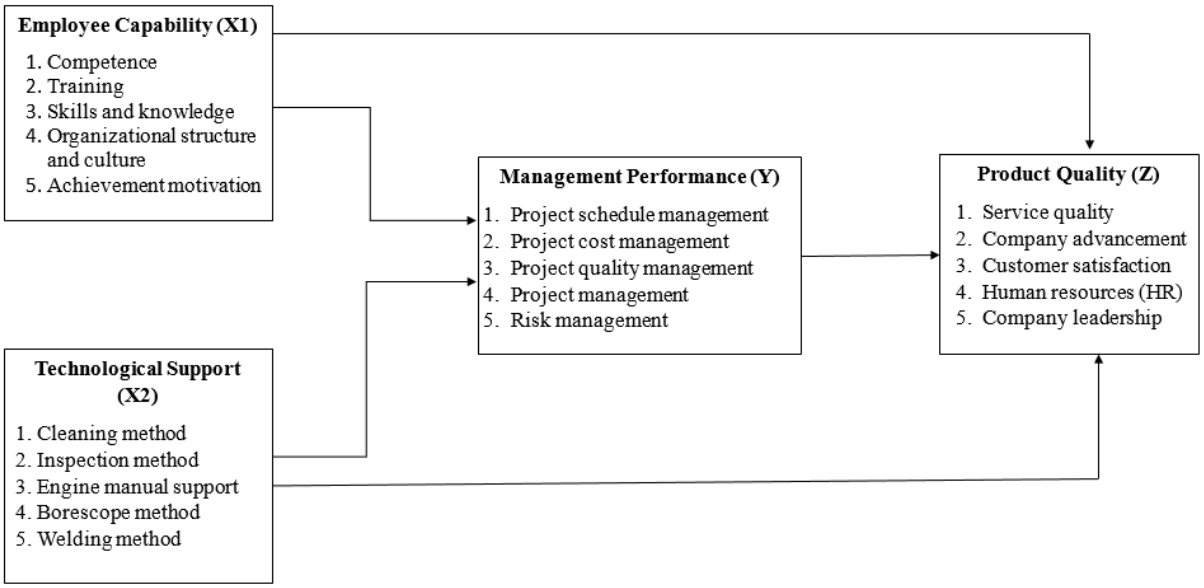

Figure 1. Research Paradigm

Research Location and Sample

This research was conducted at PT Nusantara Turbin dan Propulsi, Bandung, West Java, from November 2024 to June 2025. The sample population consists of employees of PT Nusantara Turbin dan Propulsi who meet the following inclusion criteria: (1) employees working in the operations, marketing, and finance divisions, and (2) employees aged between 18 and 60 years. The exclusion criterion was: (1) employees who did not complete the research questionnaire.

Research Data Instrument

Data for this study were collected through a questionnaire distributed to employees of PT Nusantara Turbin dan Propulsi involved in the FT8 gas turbine repair project. A Likert scale was used to measure respondents' attitudes, opinions, or perceptions toward specific statements. Statements related to Human Resources include; (1) Competence refers to the skills possessed by employees that support the success of project management, (2) Training facilities to enhance employee skills contribute to improved project management performance, (3) Employees with strong skills and knowledge are capable of making sound decisions, (4) A good organizational structure and culture provide the necessary support for efficient management, (5) Achievement motivation is a driving force for continuous improvement in quality and productivity. Statements related to Technological Support include; (1) Cleaning processes are essential steps in both repair and major maintenance (*Overhaul*), (2) Engine components must be inspected visually, dimensionally, and through non-destructive testing as instructed in the manual, (3) *Illustrated part catalog* (IPC) serves as a reference tool for visualizing components within the engine, (4) *Borescope* inspection involves inserting a camera into the engine to detect internal component damage, (5) *Welding* is a process of joining two materials by applying a combination of heat and pressure. Statements related to Management Performance include; (1) Schedule management is the process of estimating the time required to complete tasks, (2) Cost management involves the preparation and control of budgets for project execution, (3) Quality management ensures that the project meets both stated and implied requirements, (4) Project management refers to a series of efforts within a defined period aimed at delivering a product or service, executed through planning, implementation, and control processes, (5) Risk management includes identifying, analyzing, and responding to potential project risks. Statements related to Product Quality include; (1) Service quality is closely related to customer satisfaction, (2) A company's progress is partly influenced by its ability to serve its customers effectively, (3) Customer satisfaction with a product or service depends on factors such as cost, consistency in quality, perceived

risk, and the satisfaction level derived from new products, (4) Human resources are a key factor in supporting business success in the service industry, (5) Company leadership must understand what customers value to achieve optimal performance. Each statement was rated by respondents using a four-point scale: Strongly Agree (SS), Agree (S), Fair (C), and Disagree (KS).

Research Data Analysis

The collected data were analyzed using classical assumption tests to ensure the statistical model's validity. These tests include the normality test, heteroscedasticity test (Glejser test), and multicollinearity test. To assess the direct and indirect effects among variables, path analysis was used with two models: (1) Model 1 evaluates the influence of variables X on Y and (2) Model 2 evaluates the influence of variables X and Y on Z. Hypotheses were tested using t-tests (partial effect) and F-tests (simultaneous effect).

Table 1. Respondent Demography

Category		Frequency	Percentage (%)
Total Respondents		80	100
Gender	Male	73	91.25
	Female	7	8.75
Age	Mean	29.05	-
	Standar Deviation	8.94	-
Education Level	Vocational High School	39	48.75
	Associate Degree (D3)	22	27.50
	Applied Bachelor (D4)	2	2.50
	Bachelor's Degree	15	18.75
	Master's Degree	2	2.50

3. Result and Discussion

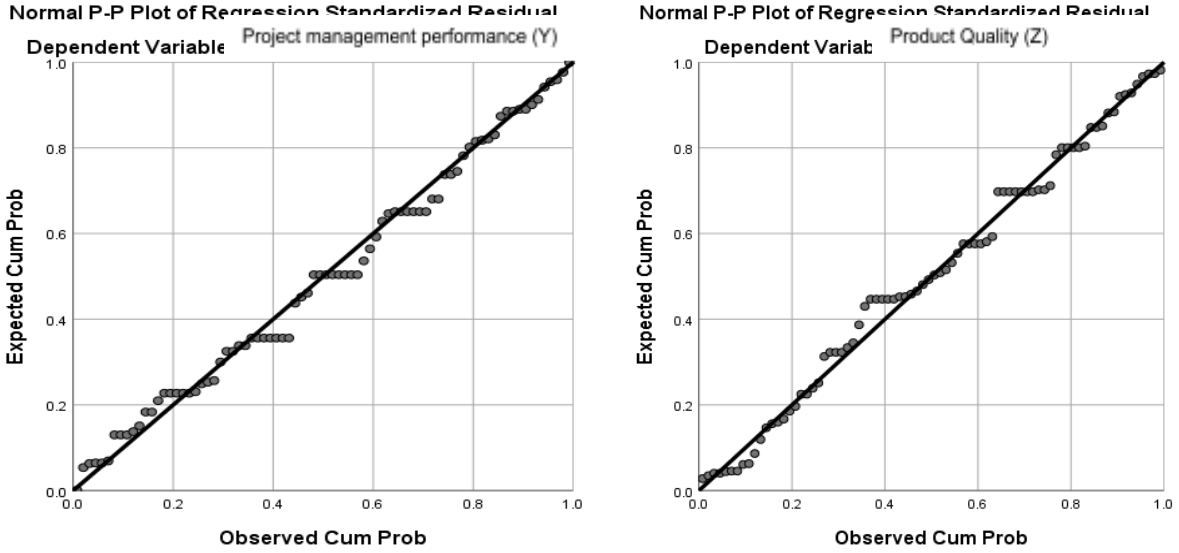

Figure 2. Normal P-P Plot Graphic

A total of 80 employees who met the inclusion criteria and completed the questionnaire were included as research samples. The results of the residual normality test show a significance value of 0.200, indicating that the residuals are normally distributed. The Normal P-P Plot for project management performance demonstrates that all variables influencing project management performance exhibit randomly distributed data that follow a normal distribution. Additionally, the Normal P-P Plot for product

quality also indicates that all variables affecting product quality have randomly distributed data that are normally distributed.

Table 2. Multicollinearity Test Results

Model	*Tolerance*	VIF
Employee Capability (X1)	0,602	1,662
Technological Support (X2)	0,529	1,890
Project Management Performance (Y)	0,374	2,675

Table 3. Heteroscedasticity Test

Model	*p-value*
Employee Capability (X1)	0,310
Technological Support (X2)	0,121
Project Management Performance (Y)	0,086

The results of the multicollinearity test show that all VIF values are less than 10 and tolerance values are greater than 0.1, indicating no significant correlation among the independent variables. The results of the heteroscedasticity test show that the p-values for the variables of employee capability (X1) and technological support (X2) are greater than 0.05, indicating that the residuals have constant variance across all independent variables.

Table 4. Individual Influence Test (t-Test) – Model I

Model	*Unstandardized coefficients Beta*	*p-value*
(Constant)	-0,373	-0,261
Employee Capability (X1)	0,552	0.000
Technological Support (X2)	0,535	0.000

To determine the extent to which employee capability (X1) and technological support (X2) influence project management performance (Y), a t-test for Model I was conducted. Based on Table 3, the regression model for project management performance with the influencing factors is presented as follows:

$$\mathbf{Y = -0.373 + 0.552\ X1 + 0.535\ X2}$$

Based on the regression equation, it was found that the variable employee capability (X1) has a positive regression coefficient, indicating a direct relationship with project management performance (Y). This also implies that employee capability (X1) has a positive effect on project management performance (Y). Similarly, technological support (X2) also shows a positive regression coefficient, indicating that it has a positive effect on project management performance (Y).

Referring to the t-table value of 1.9908, the t-calculated value for X1 is 5.738. This shows that t-calculated > t-table or 5.738 > 1.9908, meaning that employee capability (X1) has a significant influence on project management performance (Y). The t-calculated value for X2 is 6.927, indicating that t-calculated > t-table or 6.927 > 1.9908, thus technological support (X2) also has a significant influence on project management performance (Y).

Referring to DF = N − k − 1, the F-table value or F0.05;77;1 is 3.9651, while the F-calculated value is 64.486. This shows that F-calculated > F-table or 64.486 > 3.9651, which means that there is a significant simultaneous effect of X1 and X2 on project management performance (Y).

This study yields a multiple determination coefficient (adjusted R^2) of 0.616. This indicates that 61.6% of the variance in project management performance (Y) is explained by the independent variables: employee capability (X1) and technological support (X2). The remaining 38.4% is influenced by other variables not included in this research model.

Employee capability within a company can significantly influence organizational management. A study by Kasmawati indicates that the quality of internal resources—particularly employee capability—plays a crucial role in supporting the efficiency and effectiveness of project implementation, especially within organizations characterized by complex structures and systems [7]. Effective employee management is a critical factor in enabling companies to achieve optimal performance. Employees in an organization are considered a primary source of competitive advantage and the most valuable asset in

organizational and business competition [3], [7]. The findings of this study are also supported by Fitroh, who emphasized that human resource management and technological support are essential to the success of a company's products. Another study by Wiyono highlights that Environmental, Social, and Governance (ESG) practices that strengthen employee capacity contribute significantly to organizational performance [3], [8].

Table 5. Individual Influence Test (t-Test) – Model II

Model	*Unstandardized coefficients Beta*	*p-value*
(Constant)	-0,583	0,018
Employee Capability (X1)	0,344	0,000
Technological Support (X2)	0,328	0,000
Project Management Performance (Y)	0,463	0,000

Based on the results of the t-test for Model II in Table 4, the influence of various factors on product quality (Z) is presented as follows:

$$\mathbf{Z = -0.583 + 0.344\ X1 + 0.328\ X2 + 0.463\ Y}$$

Based on the regression equation above, the variable employee capability (X1) has a positive regression coefficient, indicating a direct relationship with product quality (Z). This suggests that employee capability (X1) has a positive influence on product quality (Z). The variable technological support (X2) also has a positive regression coefficient toward product quality (Z), indicating that technological support (X2) has a positive influence on product quality (Z). In addition, the variable management performance (Y) has a positive regression coefficient, indicating a positive influence on product quality (Z).

Referring to the t-table value of 1.9908, the t-calculated value for X1 is 4.133, which means that t-calculated > t-table or 4.133 > 1.9908, indicating that employee capability (X1) has a significant influence on product quality (Z). The t-calculated value for X2 is 4.606, which shows that t-calculated > t-table or 4.606 > 1.9908, meaning that technological support (X2) has a significant influence on product quality (Z). The t-calculated value for Y is 5.605, indicating that t-calculated > t-table or 5.605 > 1.9908, which means that management performance (Y) has a significant influence on product quality (Z).

To verify whether the independent variables have a simultaneous effect on the dependent variable, an F-test was conducted. Referring to DF = N − k − 1, the F-table value or $F_{0.05;76;2}$ is 3.1170, and the F-calculated value is 106.147. This shows that F-calculated > F-table or 106.147 > 3.1170, indicating that management performance (Y), employee capability (X1), and technological support (X2) have a simultaneous influence on product quality (Z).

The adjusted coefficient of determination (adjusted R^2) for Model II is 0.800, meaning that 80% of the variation in product quality is explained by the three independent variables: employee capability (X1), technological support (X2), and management performance (Y). The remaining 20% is influenced by other variables not included in the research model.

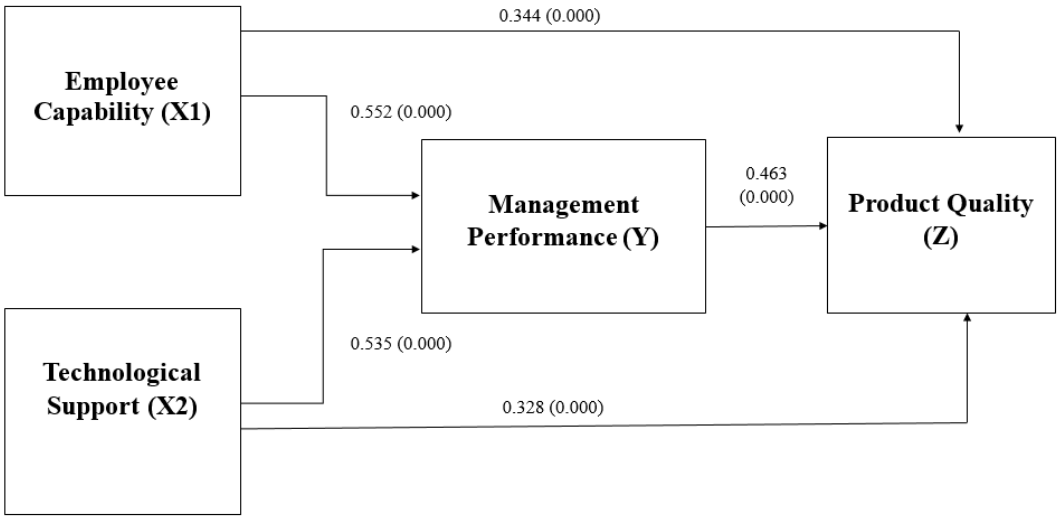

Figure 3. *Path analysis* Result Between X, Y, and Z

Product quality is a key indicator in evaluating a company's production performance. Achieving high-quality products requires attention to several factors, such as the effectiveness of production processes, workforce competence, and production management [4]. Skilled employees are capable of making accurate decisions, managing teams efficiently, and resolving issues that arise during project execution [6], [9]. The findings of this study are consistent with the research conducted by Ochoa Pacheco, which found that effective organizational management can provide the necessary support for efficient project management, thereby leading to high-quality products [10]. Moreover, through effective employee management practices, companies can develop a sustainable competitive advantage [11]. Other factors that may influence product quality, beyond the variables examined in this study, include operational systems, organizational culture, quality management, work environment, organizational leadership, as well as communication and coordination across departments [12], [13].

Based on the research findings and literature review, the researcher suggests that future studies explore additional variables that potentially affect product quality, such as operational systems, organizational culture, quality management, work environment, leadership style, and interdepartmental communication and coordination.

4. Conclusion

Employee capability and technological support have a positive and significant effect on project management performance, indicating that the higher the employee competence and the better the company’s infrastructure, the more effective the project management becomes. Furthermore, employee capability, facility capability, and management performance are also found to have a direct impact on product quality. Project management performance acts as a partial mediator in the relationship between employee capability and product quality, highlighting that optimal resource management through an efficient project management system is essential for delivering high-quality products.

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How to cite this article:

Tulus Doan. Impact of Human Resources and Technology Support on Management Performance and Product Quality. *Jurnal Teknologi dan Manajemen.* 2025 July; 6(2):101-108. DOI: 10.31284/j.jtm.2025.v6i2.7909