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The Effect of Project Management Performance on Machine Operational Readiness at PT GPE (Medion Group)

Evan Nugraha, Dodi Rukmana, Oviyan Patra, Hendy Suryana
Universitas Jenderal Achmad Yani, Indonesia
Email: noe.rievan@gmail.com, dodi.rukmana@gmail.com,
oviyan.patra@lecture.unjani.ac.id, hendies.free@gmail.com

ABSTRACT

This research aims to analyze the influence of project management on machine operational readiness at *PT Gallaria Prospera Eterna* (*PT GPE*). Five variables were examined: integration management, time management, cost management, quality management, and resource management. Previous issues, such as project delays and cost overruns, prompted the need for an evaluation of the project management system. A quantitative method was employed, utilizing the Partial Least Squares Structural Equation Modeling (*PLS-SEM*) approach. The results indicated that integration management (β = 0.245), time management (β = 0.235), and resource management (β = 0.232) had a significant effect on machine operational readiness. Time and resource management also exhibited positive quadratic effects (QE = 0.170 and QE = 0.181), while cost management had a negative quadratic effect (QE = –0.309). Quality management was found to be statistically insignificant. The R^2 value of 0.689 and Q^2 value of 0.567 indicate that the model has strong explanatory and predictive power. The implementation of strategies based on these findings—such as establishing a *Project Management Office* (*PMO*), digitalizing project tracking, and strengthening human resources—has successfully improved the execution of the second-phase fermenter machine procurement project, delivering it on time, within budget, and fully operational.

Keywords: *Project Management, Machine Operational Readiness, Integration, Time, Resources, PLS-SEM, PT GPE*

INTRODUCTION

Business development today is characterized by increasingly fierce competition, driven by constantly evolving economic conditions and the emergence of new competitors (Porter, 2023). In such an environment, especially within technology sectors, companies must continually innovate and evolve to remain viable in both national and global markets (Vărzaru, 2024). A strong culture of innovation and dynamic capabilities enables firms to adapt more effectively to external shocks and sustain a competitive edge (Garrido-Moreno et al., 2024; Teece et al., 1997). However, many organizations lack the managerial resilience and innovation infrastructure needed to cope with mounting pressures—this opacity often culminates in organizational decline or failure (Probst & Raisch, 2005). Without effective management and adaptive strategies, companies risk eroding their competitive position and incurring significant losses (Amankwah-Amoah, 2019).

This study demonstrates that various aspects of project management significantly influence the operational readiness of machinery at PT Gallaria Prospera Eterna. Notably, integration management has a statistically significant direct effect, followed closely by time and resource management (Hornstein, 2015). The presence of positive quadratic effects for both time and resource management indicates that operational readiness improves with increasing management intensity (Kalaitzi et al., 2022). Conversely, the observed negative quadratic effect of cost management aligns with evidence that excessive cost-cutting can have detrimental operational consequences (PMI, n.d.). The model's strength is underscored by

robust predictive metrics—R^2 and Q^2 values in similar SEM studies often approach high explanatory power (Yusif et al., 2021). Furthermore, successful implementation in a fermenter machine project—with near-budget realization and timely commissioning—is consistent with best practices that link structured integration and readiness planning to project success (PMI, 2022; Progesys case, 2023).

PT Gallaria Prospera Eterna, an *EPC* (*Engineering Procurement Construction*) company and a subsidiary of *MEDION GRUP*, has been authorized to carry out internal projects for *MEDION GRUP* in the development of production facilities, utilities, and production equipment and machinery. In 2019, *PT GPE* was entrusted with the expansion of production facilities due to high market demand, resulting in existing machine utilization exceeding 80% (company policy), which necessitated the addition of new machines. These machines are used to separate solid bacteria from unnecessary liquids, converting the solids into a concentrated bacterial solution known as *bulk* or *semi-finished material*, which serves as raw material for vaccines. Physically, the project is 100% complete; however, an internal audit revealed that the project's achievements have not fully met management's expectations. In terms of time, the project is three months behind schedule. In terms of cost, there has been a 10% increase over the initial budget. Additionally, the final project results show some discrepancies with the quality standards expected by the end-users, thereby affecting user satisfaction levels.

Previous research has explored various aspects of project management and its impact on operational outcomes. For instance, Miguel (2009) emphasized the importance of integration management in aligning cross-functional teams, yet his study lacked empirical validation in high-stakes industrial settings like *PT GPE*. Similarly, *PMI* (2008a) outlined best practices in time and cost management but did not address the quadratic effects of these variables on operational readiness, leaving a gap in understanding their nonlinear relationships. These studies also overlooked the specific challenges of resource management in multicultural or high-pressure environments, as noted by Robbins & Coulter (2016). This study fills these gaps by empirically examining how integration, time, cost, quality, and resource management influence machine operational readiness at *PT GPE*. Using *PLS-SEM*, the research quantifies both direct and quadratic effects, providing actionable insights for improving project execution. By addressing the limitations of prior work and validating findings in a real-world industrial context, this study contributes to both theoretical and practical advancements in project management.

Some of the main issues identified include: 1) suboptimal cross-functional coordination; 2) design changes during implementation; 3) rework due to design and implementation discrepancies; 4) delays in the procurement of goods and services; and 5) poor work quality. Management wants to evaluate how project management performed in the next machine procurement project to address issues from the previous project. From January 2024 to June 2025, the production department requires additional machines in the form of fermenters to cultivate bacteria. This machine procurement project has been implemented by project management and used as a case study, with the previous project serving as a comparison. The company's expectations for the machine procurement project encompass three main aspects: 1) timely project completion in accordance with the planned schedule; 2) cost realization not exceeding 105% of the allocated budget; and 3) end-user satisfaction with the quality of the

final product in accordance with technical specifications. This study aims to examine the relationship between project management and machine readiness. Using quantitative methods and *Structural Equation Modeling* (*SEM*) analysis techniques based on *Partial Least Square* (*PLS*), this study will empirically test how project management can influence machine readiness.

METHOD

This study uses a quantitative approach with a causal associative research design, aiming to analyze the influence of project management on machine operational readiness. The study was conducted on a fermenter machine procurement project that took place from January 2024 to June 2025. Data were collected through a survey using a closed-ended questionnaire with a 5-point *Likert* scale, as well as project documentation. The research population consisted of 132 people, including Engineering Staff, QA Staff, User Staff, and the project management team. The sampling technique used was random sampling, with a sample size of 100 respondents selected proportionally.

The variables studied include integration management, time, cost, quality, and resources, as well as machine operational readiness as the dependent variable. The analysis was conducted using *SmartPLS* software, with tests including convergent and discriminant validity, construct reliability, coefficient of determination (R^2), predictive relevance (Q^2), and tests for the significance of direct relationships and quadratic effects.

The variables in this study consist of:

- X1 (*Integration Management*): Measures the extent to which coordination between project departments is effective.
- X2 (*Time/Schedule Management*): Assesses the effectiveness of planning and controlling the project implementation schedule.
- X3 (*Cost Management*): Examines how budget efficiency impacts machine readiness.
- X4 (*Quality Management*): Assesses whether the quality of work and results meet technical standards.
- X5 (*Resource Management*): Covers the adequacy and readiness of human resources, materials, and equipment during project implementation.
- Y (*Machine Operational Readiness*): Measured by the technical, administrative, and operational readiness of the machine after the project is completed.

Data analysis was conducted using the *Partial Least Squares*-based *Structural Equation Modeling* (*SEM-PLS*) method with the assistance of *SmartPLS* version 4 software. The analysis steps include testing the measurement model (*outer model*), structural testing (*inner model*), and evaluating goodness of fit through *SRMR* values (<0.08), R^2, Q^2, and bootstrap significance testing of 5000 subsamples (Hair et al., 2020; Ghozali & Latan, 2015).

RESULTS AND DISCUSSION

Data analysis was conducted using the Partial Least Squares-based Structural Equation Modeling (SEM–PLS) method with SmartPLS 4 software. The model tested the influence of project management on machine operational readiness.

A. Validation and Reliability Tests

Validity tests of the indicators were conducted through outer loading measurements. All indicators had loading values above 0.708, which is the minimum threshold recommended for convergent validity in reflective models (Hair et al., 2021). The average outer loading values for the six constructs ranged from 0.85 to 0.94.

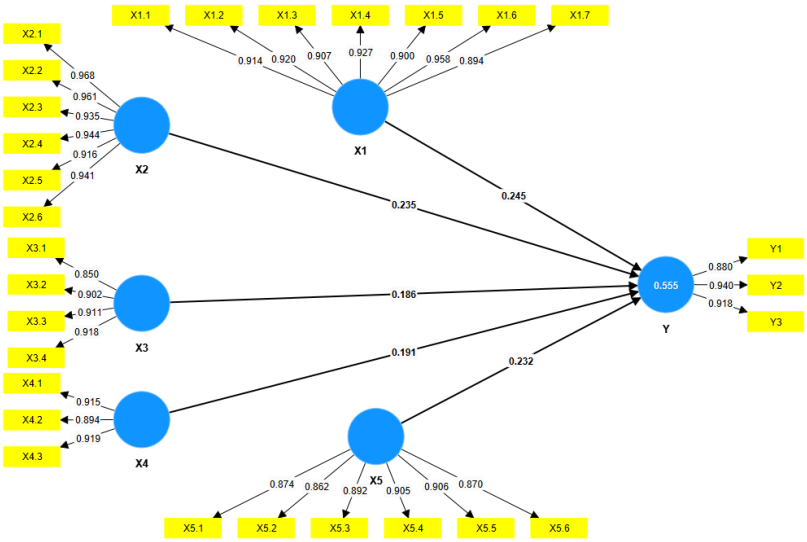

Figure 1. PLS-SEM Test Results

Source: data processing results

Figure 1 shows that all constructs have met the criteria for measuring their respective latent variables. Thus, all indicators in the model are convergent valid and can be used in the structural estimation process.

B. Structural Model Results and Hypothesis Testing

The path estimation results indicate that all relationships between constructs are significant. A summary of the test results is presented in Table 1.

Table 1 SEM-PLS Path Coefficient Test Results

No	Path Relationship	Beta Coefficient	p-value	Description
1	Integration Management → Operational Readiness of Machinery	0.245	0.046	Accepted
2	Time Management → Machine Operational Readiness	0.235	0.014	Accepted
3	Cost Management → Machine Operational Readiness	0.186	0.039	Accept
4	Quality Management → Machine Operational Readiness	0.191	0.024	Accepted
5	Resource Management → Machine Operational Readiness	0.232	0.005	Accept

Source: data processing results

The analysis results indicate that all project management variables have a significant influence on machine operational readiness. Integration management contributes β = 0.245 with a p-value of 0.046, indicating that coordination and synchronization between project elements have a direct impact on machine readiness. Time management also has a significant effect (β = 0.235; p = 0.014), emphasizing the importance of proper schedule management to

ensure machines operate according to target timelines. Furthermore, cost management shows a positive influence (β = 0.186; p = 0.039), indicating that efficient allocation and control of costs support the availability of important resources for operational preparation. Quality management also has a significant influence (β = 0.191; p = 0.024), reinforcing that the implementation of quality standards at every stage of the project helps improve machine reliability when it begins operation. Lastly, resource management makes an important contribution with a coefficient value of β = 0.232 and a p-value of 0.005, indicating that optimal management of labor, materials, and equipment strongly supports machine operational readiness. Overall, these findings reinforce that improving quality in every aspect of project management directly contributes to machine operational readiness, and this should be a primary focus in project planning and implementation within the company.

C. Model Quality Evaluation

The structural quality of the model is evaluated through the R^2, Q^2, and SRMR values as presented in Table 2.

Table 2 SEM-PLS Model Evaluation

No	Indicator	Value	Description
1	R^2Operational readiness of machinery	0.55	Accept
2	Q^2 Machine operational readiness	0.411	Accept
3	SRMR	0.051	Accepted

Source: data processing results

This research model is deemed feasible and valid based on three main indicators. The R^2 value of 0.555 indicates that the model can explain 55.5% of the variation in machine operational readiness, which is considered fairly strong. Meanwhile, the Q^2 value of 0.411 indicates that the model has good predictive ability. Additionally, the SRMR value of 0.051 is below the threshold of 0.08, indicating that the model has good fit with the data. Therefore, this model can be relied upon to explain and predict machine readiness factors based on project management.

D. Empirical Field Support

These statistical results are reinforced by empirical data from the implementation of a machine separator procurement project that experienced a three-month delay and a 10% cost overrun, along with some quality discrepancies in the machines. In contrast, the machine fermenter procurement project, after the implementation of project management, was successfully completed on time with a cost deviation of only 3.8%. The quality of the machines met the expectations of the users/production team.

Table 3 Comparison of Project Achievements for Separator Machine Procurement and Fermenter Machine Procurement

No	Performance Indicator	Separator	Fermenter (After Intervention)	Description
1	Timeliness	Late (3 months)	On time (*on schedule*)	Improved achievement
2	Cost realization	*Over budget by* 10% of the budget	*Over budget by* 3.8% of the budget	<5% achieved

No	Performance Indicator	Separator	Fermenter (After Intervention)	Description
3	Quality compliance	Does not meet URS	Compliant with standards and passed IQ, OQ tests	Achievement improved

Source: data processing results

CONCLUSION

This study demonstrates that various aspects of project management significantly influence the operational readiness of machinery at PT Gallaria Prospera Eterna. Notably, integration management has a statistically significant direct effect, followed closely by time and resource management (Hornstein, 2015). The presence of positive quadratic effects for both time and resource management indicates that operational readiness improves with increasing management intensity (Kalaitzi et al., 2022). Conversely, the observed negative quadratic effect of cost management aligns with evidence that excessive cost-cutting can have detrimental operational consequences (PMI, n.d.). The model's strength is underscored by robust predictive metrics—R^2 and Q^2 values in similar SEM studies often approach high explanatory power (Yusif et al., 2021). Furthermore, successful implementation in a fermenter machine project—with near-budget realization and timely commissioning—is consistent with best practices that link structured integration and readiness planning to project success (PMI, 2022; Progesys case, 2023).

To operationalize these findings, several strategic recommendations emerge. First, establishing a dedicated *Project Management Office* would institutionalize best practices across all projects. Second, digital tracking systems should be implemented to enable real-time monitoring of schedules and resources. Third, quality assurance processes need strengthening through iterative checks at each project phase. Fourth, targeted training programs should address specific skill gaps in risk management and technical competencies. Finally, while cost efficiency remains important, the negative quadratic effect suggests the need for balanced budgeting that does not sacrifice quality. Future research should explore how leadership styles influence these outcomes and examine the long-term organizational impacts of these project management improvements. These evidence-based recommendations provide *PT GPE* with a clear roadmap to enhance project execution and machine readiness while offering valuable insights for similar industrial operations.

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