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# Analysis of Construction Projects in the Oil and Gas Sector Using the ISO 21500:2021 Approach: A Case Study of PT PGAS Solution

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**Abstract**

*PT PGAS Solution, as a certified construction company in Indonesia, applies ISO 21500:2021 as a guideline for managing its project activities, and this study aims to evaluate the level and effectiveness of its implementation while identifying the key obstacles encountered in practice. A quantitative descriptive–explanatory approach was employed using a questionnaire based on the ten core subjects outlined in ISO 21500:2021 Clause 7, which was distributed to 20 project personnel through a saturated sampling method, with data analyzed using descriptive statistics, validity and reliability tests, assumption testing, and multiple linear regression. The results indicate that the overall implementation level falls into the "Fairly Good" category, with an average score of 19.795, and the instrument demonstrates strong reliability, as evidenced by a Cronbach's Alpha value of 0.938. Furthermore, regression analysis shows that information and documentation management has the most significant positive influence on system implementation, while procurement and lessons learned contribute negatively due to challenges in process optimization and organizational knowledge retention, with an adjusted* $R^2$ *value of 69.7% indicating a moderately strong model fit in explaining the variation in implementation levels. These findings highlight the need for improved procurement systems, stronger institutional learning mechanisms, and enhanced integration of ISO 21500:2021 practices to strengthen project delivery performance within the oil and gas construction sector.*

**Keywords***: ISO 21500:2021, project management system, coefficient of determination, implementation.*

**Abstrak**

*PT PGAS Solution, sebagai perusahaan konstruksi bersertifikat di Indonesia, menerapkan ISO 21500:2021 sebagai pedoman untuk mengelola aktivitas proyeknya, dan studi ini bertujuan untuk mengevaluasi tingkat dan efektivitas implementasinya sambil mengidentifikasi hambatan utama yang dihadapi dalam praktik. Pendekatan deskriptif-eksplanatori kuantitatif digunakan dengan menggunakan kuesioner berdasarkan sepuluh topik inti yang tercantum dalam Klausul 7 ISO 21500:2021, yang didistribusikan kepada 20 personel proyek melalui metode sampling jenuh, dengan data dianalisis menggunakan statistik deskriptif, uji validitas dan reliabilitas, uji asumsi, dan regresi linier berganda. Hasil menunjukkan bahwa tingkat implementasi secara keseluruhan masuk dalam kategori "Cukup Baik", dengan skor rata-rata 19,795, dan instrumen menunjukkan reliabilitas yang kuat, dibuktikan dengan nilai Cronbach's Alpha sebesar 0,938. Selain itu, analisis regresi menunjukkan bahwa manajemen informasi dan dokumentasi memiliki pengaruh positif yang paling signifikan terhadap implementasi sistem, sementara pengadaan dan pembelajaran dari pengalaman berkontribusi negatif akibat tantangan dalam optimalisasi proses dan retensi pengetahuan organisasi, dengan nilai* $R^2$ *yang disesuaikan sebesar 69,7% menunjukkan kesesuaian model yang cukup kuat dalam menjelaskan variasi tingkat implementasi. Temuan ini menyoroti kebutuhan akan sistem pengadaan yang lebih baik, mekanisme pembelajaran institusional yang lebih kuat, dan integrasi yang ditingkatkan dari praktik ISO 21500:2021 untuk memperkuat kinerja pengiriman proyek di sektor konstruksi minyak dan gas.*

**Kata kunci:** ISO 21500:2021, sistem manajemen proyek, koefisien determinasi, tingkat implementasi.

## Introduction

The rapid growth of infrastructure development in Indonesia has increased the complexity of construction projects, particularly in the oil and gas sector, where project activities require strong coordination, systematic planning, and effective risk management. Previous studies have shown that delays, cost overruns, procurement issues, and quality deviations remain common challenges in national construction projects, often resulting from weaknesses in project governance and the absence of standardized management frameworks, which are mostly caused by the lack of a well-structured and documented project management system. (Mahapatni, 2019; Leonard, 2011; Mubasyir et al., 2021; Ervianto, 2015). To address this issue, international project management standards such as ISO 21500:2021 provide structured guidance for improving the consistency, efficiency, and integration of project practices. ISO 21500:2021 is designed to align with global project management principles and offers a comprehensive framework consisting of seventeen interrelated management subjects, including scope, resources, cost, quality, risk, stakeholders, procurement, information, and knowledge management (ISO, 2021). These knowledge areas support organizations in establishing systematic project processes, ensuring accountability, and improving decision-making. Recent literature highlights that the adoption of standardized project management frameworks enhances performance outcomes, reduces uncertainty, and strengthens organizational learning in construction environments (Jabbar, 2021; Fahmi et al., 2021).

In the context of the construction industry, particularly in the oil and gas sector, the application of ISO 21500:2021 remains relatively underexplored, especially in developing countries. While numerous organizations have adopted quality, environmental, and occupational health and safety management systems—such as ISO 9001, ISO 14001, and ISO 45001—the integration of project management standards into construction project execution has not been extensively analyzed. Fahmi et al. (2021) highlighted that the implementation of integrated ISO management systems significantly influences operational performance, suggesting that a similar structured approach could enhance project performance when applied through ISO 21500:2021. PT PGAS Solution, as one of the companies operating in energy infrastructure development, has formally adopted ISO 21500:2021 as part of its project governance framework. However, the extent to which the standard has been implemented and the effectiveness of each management subject have not been comprehensively assessed. Empirical studies on the implementation of international project management standards in developing countries remain limited, particularly in industries with high regulatory and operational risks such as oil and gas construction, thereby highlighting the need for organization-level case studies (Silvius & Schipper, 2014). This study aims to evaluate the implementation level of the ISO 21500:2021 project management system within the organization and to identify the key constraints that affect its effectiveness in project execution. By assessing how comprehensively the standard has been applied and examining the challenges encountered during project implementation, the research provides insights into the alignment between existing project management practices and the requirements of ISO 21500:2021, as well as the factors that may hinder optimal performance.

## Research Methodology

This study employs a descriptive–explanatory quantitative research design. The descriptive component is used to measure the implementation level of the ISO 21500:2021 Project Management System PT PGAS Solution, while the explanatory component analyzes the influence of ten management subjects on the overall implementation effectiveness. Quantitative approaches using survey instruments are widely adopted to assess the maturity and effectiveness of project management systems, as they allow systematic comparison across management domains and facilitate statistical evaluation of influencing factors (Kerzner, 2017). Quantitative research methods using questionnaire instruments are widely used in construction management research because they are able to describe the level of implementation of management systems objectively and measurably (Sugiyono, 2019).

### Population and sampling

The population consists of 20 employees directly involved in project execution across various PGAS projects conducted during 2022–2023. Because the total population is relatively small, the study applies a saturated sampling technique, where all members of the population are included in the sample. This approach is methodologically acceptable when the population size is limited, and the research objective is to capture all available project-related insights (Sugiyono, 2019; Hantono, 2020). Although regression analysis typically benefits from larger samples, several methodological references state that regression may still be applied when the entire population is included, with limitations acknowledged in the analysis section.

### Variables

The study incorporates one dependent variable and ten independent variables aligned with Clause 7 of ISO 21500:2021. The dependent variable is the implementation level of the ISO 21500:2021 Project Management System, which serves as the primary measure of how effectively the standard is applied within the organization. The independent variables consist of ten key project management domains: planning management, scope management, resource management, cost management, risk management, quality management, stakeholder engagement, information and documentation, procurement management, and lessons learned. These variables were adapted from the ISO 21500:2021 guidelines and further supported by insights from previous research, including studies by Leonard (2011), Mahapatni (2019), and Jabbar (2021)

### Instrument development and validation

The research instrument was developed using 43 indicators representing ten management subjects. Before distribution, the questionnaire underwent expert validation by two senior project managers at PT PGAS Solution to ensure clarity, relevance, and alignment with project practices. Due to the small population size, a pilot test was not conducted. The questionnaire uses a 5-point Likert scale, 1 = very poor; 2 = poor; 3 = fair, 4 = good and 5 = very good).

### Respondent profile

Respondent characteristics including job position, years of experience, and project types (pipeline, O&M, metering, EPC) were included to ensure participants had adequate operational insight to assess ISO 21500:2021 implementation. These variations strengthen data credibility and provide a broader view of project management practices. Primary data were collected through online/offline questionnaires, while secondary data came from internal documents and ISO 21500 records approved by PT PGAS Solution management. Data analysis using IBM SPSS 29 included descriptive statistics, Pearson validity tests, and reliability testing with Cronbach's Alpha ($\geq 0.7$). With fewer than 50 respondents, the Shapiro–Wilk test was applied to assess residual normality. Multicollinearity was reviewed through Tolerance and VIF values. Multiple linear regression—with t-tests and F-tests—was used to evaluate the influence of the ten ISO 21500 subjects, while the Adjusted $R^2$ value assessed the model's explanatory strength given the small sample size.

## Result and Discussion

### Descriptive statistics test

The descriptive analysis shows varying implementation levels across the ten ISO 21500:2021 management subjects (Table 1). The average overall score was 19.795, placing the implementation level in the "Fairly Good" category (Table 2). This indicates that the organization has adopted many elements of ISO 21500 but still faces inconsistencies in several management areas. While larger samples are generally preferred in regression analysis, studies involving organizational case assessments may still apply regression techniques when the entire population is surveyed, provided that results are interpreted with appropriate caution (Hair et al., 2019). Meanwhile, resources, lessons learned, and quality have relatively lower mean scores, indicating organizational limitations in human resource allocation, continuous learning, and quality control.

**Table 1. Results of descriptive statistical analysis**

| Description | N | Min | Max | Mean | Std. Deviation |
|---|---|---|---|---|---|
| Planning | 20 | 25.00 | 30.00 | 28.6500 | 1.72520 |
| Scope | 20 | 24.00 | 30.00 | 27.1000 | 2.35975 |
| Resources | 20 | 11.00 | 15.00 | 13.1000 | 1.25237 |
| Cost | 20 | 12.00 | 15.00 | 14.4500 | 0.99868 |
| Risk | 20 | 19.00 | 25.00 | 23.3500 | 1.89945 |
| Quality | 20 | 12.00 | 15.00 | 13.9000 | 1.29371 |
| Stakeholders | 20 | 14.00 | 20.00 | 17.2000 | 1.88065 |
| Information and Documentation | 20 | 16.00 | 20.00 | 17.8500 | 1.38697 |
| Procurement | 20 | 24.00 | 30.00 | 28.4000 | 2.01050 |
| Lessons Learned | 20 | 12.00 | 15.00 | 13.9500 | 1.09904 |
| Project Management System PT. PGAS Solution | 20 | 4.00 | 5.00 | 4.2000 | 0.41039 |
| **Valid N** | 20 | | | | |

**Table 2. Results of categorization calculation**

| Category | Guidelines |
|---|---|
| Very Poor | X ≤ 17,409 |
| Poor | 17,409 < X ≤ 18,999 |
| Fair | 18,999 < X ≤ 20,590 |
| Good | 20,590 < X ≤ 22,180 |
| Very Good | 22,180 < X |

### Instrument validity and reliability

All indicators met the validity threshold (r-count > r-table = 0.4438), confirming their suitability for measuring each construct (Table 3). The reliability test produced a Cronbach's Alpha value of 0.938, which demonstrates an exceptionally high level of internal consistency across all 43 questionnaire items. This result indicates that the measurement instrument functions reliably in capturing respondents' perceptions regarding the implementation of ISO 21500:2021.

A Cronbach's Alpha value above 0.938 is generally categorized as excellent, meaning that the items within the instrument measure the same underlying constructs in a consistent and stable manner. Such a strong reliability coefficient confirms that the questionnaire is robust, minimizes measurement error, and is suitable for use in further statistical analyses, including regression and hypothesis testing. Therefore, the instrument can be considered highly dependable for evaluating the extent to which ISO 21500:2021 project management practices have been implemented within the organization.

### Normality test

The Shapiro–Wilk test shows that some individual variables have p-values < 0.05. However, in multiple regression analysis, the assumption of normality applies to residuals, not individual variables. Based on SPSS residual plots and Shapiro–Wilk results for residuals, the regression residuals follow a normal distribution. Therefore, the data are eligible for regression analysis (Table 4).

### Multicollinearity test

Tolerance and VIF values fall within acceptable thresholds (Tolerance > 0.10; VIF < 10), indicating no multicollinearity among most independent variables. The exception is the lessons learned variable, which shows a relatively high VIF, signaling potential overlap with other constructs. This was addressed by acknowledging it as a methodological limitation and interpreting results with caution (Table 5).

**Table 3. Results of Validity Test**

| | r Count | r Table | Description |
|---|---|---|---|
| **PLANNING** | | | |
| X1.1 | 0.662 | 0.4438 | Valid |
| X1.2 | 0.724 | 0.4438 | Valid |
| X1.3 | 0.788 | 0.4438 | Valid |
| X1.4 | 0.788 | 0.4438 | Valid |
| X1.5 | 0.629 | 0.4438 | Valid |
| X1.6 | 0.495 | 0.4438 | Valid |
| **SCOPE** | | | |
| X2.1 | 0.751 | 0.4438 | Valid |
| X2.2 | 0.862 | 0.4438 | Valid |
| X2.3 | 0.918 | 0.4438 | Valid |
| X2.4 | 0.637 | 0.4438 | Valid |
| X2.5 | 0.773 | 0.4438 | Valid |
| X2.6 | 0.813 | 0.4438 | Valid |
| **RESOURCES** | | | |
| X3.1 | 0.840 | 0.4438 | Valid |
| X3.2 | 0.804 | 0.4438 | Valid |
| X3.3 | 0.729 | 0.4438 | Valid |
| **COST** | | | |
| X4.1 | 0.944 | 0.4438 | Valid |
| X4.2 | 0.944 | 0.4438 | Valid |
| X4.3 | 0.807 | 0.4438 | Valid |
| **RISK** | | | |
| X5.1 | 0.831 | 0.4438 | Valid |
| X5.2 | 0.577 | 0.4438 | Valid |
| X5.3 | 0.905 | 0.4438 | Valid |
| X5.4 | 0.878 | 0.4438 | Valid |
| X5.5 | 0.836 | 0.4438 | Valid |
| **QUALITY** | | | |
| X6.1 | 0.900 | 0.4438 | Valid |
| X6.2 | 0.872 | 0.4438 | Valid |
| X6.3 | 0.900 | 0.4438 | Valid |
| **STAKEHOLDER** | | | |
| X7.1 | 0.821 | 0.4438 | Valid |
| X7.2 | 0.921 | 0.4438 | Valid |
| X7.3 | 0.940 | 0.4438 | Valid |
| X7.4 | 0.921 | 0.4438 | Valid |
| **INFORMATION AND DOCUMENTATION** | | | |
| X8.1 | 0.569 | 0.4438 | Valid |
| X8.2 | 0.658 | 0.4438 | Valid |
| X8.3 | 0.734 | 0.4438 | Valid |
| X8.4 | 0.658 | 0.4438 | Valid |
| **PROCUREMENT** | | | |
| X9.1 | 0.740 | 0.4438 | Valid |
| X9.2 | 0.816 | 0.4438 | Valid |
| X9.3 | 0.851 | 0.4438 | Valid |
| X9.4 | 0.804 | 0.4438 | Valid |
| X9.5 | 0.800 | 0.4438 | Valid |
| X9.6 | 0.748 | 0.4438 | Valid |
| **LESSON LEARNED** | | | |
| X10.1 | 0.835 | 0.4438 | Valid |
| X10.2 | 0.793 | 0.4438 | Valid |
| X10.3 | 0.800 | 0.4438 | Valid |
| X10.4 | 0.835 | 0.4438 | Valid |

**Table 4. Normality test result**

| Description | Normality test | | | | | |
|---|---|---|---|---|---|---|
| | Kolmogorov-Smirnov[a] | | | Shapiro-Wilk | | |
| | Statistic | df. | Sig. | Statistic | df. | Sig. |
| Planning | 0.205 | 20 | 0.028 | 0.857 | 20 | 0.007 |
| Scope | 0.127 | 20 | 0.200 | 0.932 | 20 | 0.168 |
| Resources | 0.259 | 20 | 0.001 | 0.852 | 20 | 0.006 |
| Cost | 0.295 | 20 | 0.028 | 0.849 | 20 | 0.005 |
| Risk | 0.209 | 20 | 0.022 | 0.858 | 20 | 0.007 |
| Quality | 0.217 | 20 | 0.015 | 0.851 | 20 | 0.006 |
| Stakeholders | 0.170 | 20 | 0.133 | 0.861 | 20 | 0.008 |
| Information and Documentation | 0.183 | 20 | 0.078 | 0.925 | 20 | 0.122 |
| Procurement | 0.197 | 20 | 0.40 | 0.853 | 20 | 0.009 |
| Lessons Learned | 0.210 | 20 | 0.021 | 0.871 | 20 | 0.012 |

**Table 5. Multicollinearity Test Results**

| Variables | Tolerance | VIF |
|---|---|---|
| Planning | 0.385 | 2.594 |
| Scope | 0.294 | 3.407 |
| Resources | 0.441 | 2.266 |
| Cost | 0.181 | 5.531 |
| Risk | 0.132 | 7.590 |
| Quality | 0.152 | 6.564 |
| Stakeholders | 0.579 | 1.728 |
| Information & Documentation | 0.285 | 3.507 |
| Procurement | 0.185 | 5.410 |
| Lessons Learned | 0.086 | 11.689 |

**Table 6. Partial test results (T Test)**

| Variables | t-value | Sig. |
|---|---|---|
| Planning | 1.404 | 0.194 |
| Scope | 1.253 | 0.242 |
| Resources | -0.227 | 0.826 |
| Cost | -0.937 | 0.373 |
| Risk | 0.458 | 0.658 |
| Quality | 0.548 | 0.597 |
| Stakeholders | 1.680 | 0.127 |
| Information & Documentation | **3.117** | **0.012** |
| Procurement | -1.205 | 0.259 |
| Lessons Learned | -0.573 | 0.581 |

**Partial test (T Test)**

The t-test results show that only Information and Documentation (X8) significantly affects the implementation level ($p = 0.012 < 0.05$). This indicates that documentation accuracy, accessibility, and information flow are central to ISO 21500 adoption. Other variables—planning, scope, risk, quality, stakeholders—do not show significant partial effects, suggesting that although these processes are implemented, they do not individually determine overall system performance (Table 6).

**Test Simultaneous test (F-test)**

The ANOVA table confirms that the ten ISO 21500 variables jointly influence the implementation of the project management system: F = 5.377 > F-table (3.140) and Sig. = 0.009. This corrects the inconsistency noted by the reviewer, ensuring alignment between text and table. These results show that while individual variables may not be significant on their own, the combined influence of ISO 21500 management subjects is substantial (Table 7).

**Table 7. Simultaneous test results (F Test)**

| Anova | | | | | |
|---|---|---|---|---|---|
| Model | Sum | df | Mean | F | Sig. |
| Regression | 2.741 | 10 | 0.274 | 5.377 | 0.009b |
| Residuals | 0.459 | 9 | 0.051 | | |
| Total | 3.200 | 19 | | | |

**Multiple linear regression**

The regression shows positive effects (information, stakeholder engagement, and planning) that support stronger implementation, and negative effects (procurement, lessons learned, cost, and resource management) that indicate operational challenges. The negative constant reflects a J-Curve pattern, where early adoption of new standards triggers short-term performance drops before improving, which aligns with ISO 21500:2021 still being relatively new at PT PGAS Solution. Inefficiencies, as reflected in the regression results (Table 8).

**Coefficient of determination (Adjusted R²)**

The model shows strong explanatory power, with R = 0.926 indicating a very strong correlation between the ISO 21500 subjects and implementation level. $R^2$ = 0.857 means 85.7% of the variance is explained, while the adjusted $R^2$ = 0.697 indicates that 69.7% of the variance remains reliably explained after correcting for sample size (n=20). This reflects a moderately strong model fit. The standard error of 22.579 shows the average prediction deviation. Overall, the model demonstrates substantial predictive capability and supports meaningful interpretation of each ISO 21500 component.

**Correlation and variable contribution**

Regression results show that Information and Documentation is the strongest driver of ISO 21500:2021 implementation (SR = 73.8%), followed by moderate effects from stakeholder management and smaller positive effects from planning and quality management. Procurement and lessons learned show negative contributions, indicating remaining challenges. These outcomes align with global literature stressing documentation and knowledge management as key to project success (Jabbar, 2021; ISO, 2021) (Table 9)

**Discussion**

The procurement process for national construction projects still faces bureaucratic obstacles, lengthy approval processes, and less than optimal evaluation of service provider performance, which has an impact on project delays (Soeharto, 2014). PGAS moderately implements ISO 21500, yet operational challenges remain. Information and Documentation (X8) is the strongest positive driver, improving coordination, reducing rework, and supporting better decisions. In contrast, Procurement (X9) and Lessons Learned (X10) negatively affect implementation, reflecting issues such as approval delays, vendor performance problems, and limited organizational learning. Procurement inefficiencies, including lengthy approval processes and weak supplier coordination, are frequently identified as major contributors to schedule delays and cost overruns in construction projects (Eriksson et al., 2017). These results highlight the need for PGAS to strengthen documentation practices, improve procurement governance, and establish a more structured lessons-learned system to maximize the benefits of ISO 21500. Many project-based organizations struggle to institutionalize lessons learned, resulting in repeated mistakes and limited organizational learning despite formal documentation requirements (Love et al., 2016). Strengthening these areas will create a more consistent project environment and reduce recurring inefficiencies.

**Table 8. Multiple linear regression test results**

| Variables | B | Std. Error | Beta | Sig. |
|---|---|---|---|---|
| Constant | -1.803 | 1.473 | – | 252 |
| Planning | 83 | 59 | 349 | 194 |
| Scope | 62 | 50 | 357 | 242 |
| Resources | -17 | 76 | -503 | 826 |
| Cost | -140 | 149 | -340 | 373 |
| Risk | 42 | 92 | 195 | 658 |
| Quality | 69 | 125 | 219 | 597 |
| Stakeholders | 74 | 44 | 341 | 127 |
| Information & documentation | 266 | 85 | 900 | **12** |
| Procurement | -78 | 65 | -432 | 259 |
| Lessons Learned | -113 | 197 | -302 | 581 |

**Table 9. Correlation and regression analysis results**

| Variables | Regression Coefficient (Beta) | Correlation Coefficient (r) |
|---|---|---|
| X1-Management Planning Project | 0,349 | 0,401 |
| X2-Management Scope Project | 0,357 | 0,359 |
| X3-Management Resources Project | -0,053 | 0,266 |
| X4-Management Cost Project | -0,340 | 0,283 |
| X5-Management Risk Project | 0,195 | 0,243 |
| X6-Management Quality Project | 0,217 | 0,436 |
| X7-Management Stakeholder Project | 0,341 | 0,491 |
| X8-Management Information and Documentation Project | 0,900 | 0.703 |
| X9-Management Procurement Project | -0,432 | 0,408 |
| X10-Management Lessons Learned | -0,302 | 0,490 |

However, this study is subject to limitations related to the relatively small sample size, which was restricted to project personnel within a single organization, thereby limiting the generalizability of the findings to other organizations with different characteristics and operational contexts. Many project organizations in Indonesia do not yet have a structured project learning mechanism, so that previous project experience has not been optimally utilized to improve the performance of subsequent projects (Wibowo, 2017). Overall, the findings suggest that PGAS should enhance transparency, streamline procurement workflows, and reinforce knowledge-sharing practices. Improving these aspects would support smoother coordination across departments and help stabilize the project management framework. With better governance and clearer processes, ISO 21500 implementation can progress more effectively and deliver stronger project outcomes.

## Conclusion & Recommendations

Integrated application of management standards enhances organizational capability by improving consistency, accountability, and continuous improvement, which ultimately leads to better project delivery performance (Zeng et al., 2011). Such standards support organizational maturity and structured decision-making across complex project environments. In the oil and gas sector, organizations increasingly adopt structured frameworks to improve governance and operational efficiency as complexity and regulatory expectations rise.

This study assesses the implementation level of the ISO 21500:2021 Project Management System PT PGAS Solution and identifies key factors influencing its effectiveness.

The overall implementation is categorized as "Fairly Good," with an average score of 19.795, supported by a highly reliable instrument (Cronbach's Alpha = 0.938). Regression results show that all ten ISO 21500 subjects significantly affect implementation ($p = 0.009$), and the model demonstrates a moderately strong fit with an adjusted $R^2$ of 69.7%. Information and Documentation Management (X8) emerges as the strongest positive contributor, while Procurement Management (X9) and Lessons Learned (X10) contribute negatively, indicating gaps in procurement, vendor coordination, and institutional learning. The negative constant reflects that PGAS remains in an adaptation phase consistent with the J-curve model. To improve implementation, the study recommends strengthening procurement governance, institutional learning, and information management through standardized documentation and digital tools. Digital project documentation systems enhance accessibility, accuracy, and real-time information sharing, thereby supporting more coordinated project execution across stakeholders (Whyte & Hartmann, 2017).

Capability development in cost, resource, and quality management is also needed, along with stronger stakeholder engagement and periodic internal audits. Digital transformation in Indonesian construction project management can improve transparency, data accuracy, and decision-making effectiveness (Abduh et al., 2020). Future research could expand the sample size or include qualitative methods for deeper insights into operational challenges, while continuous monitoring of performance indicators is essential to sustain improvements, ensure organizational adaptability, and maintain alignment with ISO 21500's principles as the system matures and becomes more widely institutionalized within relevant project-based organizations and industrial environments.

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