

# EVALUATING SAP IMPLEMENTATION AS A SUPPLY CHAIN MANAGEMENT SYSTEM AT PT ADHI KARYA: A CASE STUDY OF PROCUREMENT EFFICIENCY IN CONSTRUCTION PROJECTS

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**Abstract.** Procurement activities play a critical role in determining the success of construction projects in terms of time, cost, and quality performance. PT Adhi Karya (Persero) Tbk. has implemented SAP as part of its supply chain digitalization strategy, particularly through the Material Management (MM) and Project System (PS) modules. However, in practice, several procurement activities are still conducted manually and remain insufficiently integrated, especially in tendering and contract issuance processes. This study aims to evaluate the effectiveness of SAP implementation in supporting procurement efficiency and quality within construction projects at PT Adhi Karya. A descriptive quantitative approach was employed, utilizing primary data collected through questionnaires and secondary data derived from procurement cycle time records in 2025. The results indicate that most procurement processes require more than 10 days from the e-Auction stage to contract issuance, which significantly exceeds the international benchmark of an ideal cycle time of  $\leq 5$  days. These findings reveal gaps in system integration that may adversely affect procurement efficiency. The study recommends strengthening the integration between SAP and the e-Procurement platform, as well as accelerating the digitalization of post-auction procurement stages to enhance overall procurement performance.

**Keywords:** Construction Projects; E-Procurement; Procurement Efficiency; SAP; Supply Chain Management.

## 1. INTRODUCTION

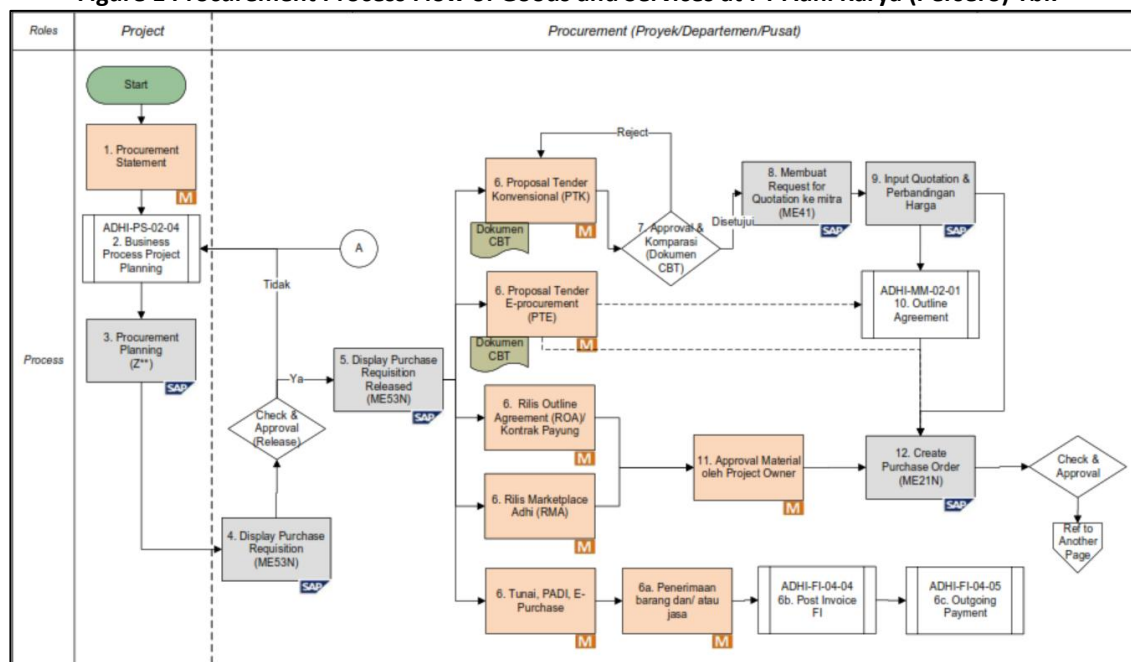
The construction industry is a highly complex and dynamic sector, particularly in terms of supply chain management, with supply chain management being a key area that involves acquiring materials, managing logistics, and working with various stakeholders. Accuracy and speed in procurement processes are critical factors in ensuring the success of construction projects in terms of cost, time, and quality performance. In the era of Industry 4.0, digital transformation through the utilization of information technology has become a fundamental foundation for companies to achieve operational excellence and improve efficiency.

One form of such transformation is the adoption of integrated Enterprise Resource Planning (ERP) systems that are capable of managing all business functions in a comprehensive manner. ERP systems enable organizations to reduce inefficiencies, minimize manual errors, and overcome the lack of real-time data that commonly occurs in conventional management systems (More et al., 2024). SAP is a leading ERP platform that is widely used across many industries, including construction. In particular, SAP Material Management (MM) has been proven to accelerate procurement and material management activities, resulting in significant time and cost efficiencies (Patare & Minde, 2016). The system provides essential modules such as Material Management (MM) and Project System (PS), which are essential for supporting procurement processes and managing construction projects effectively.

By implementing SAP, PT Adhi Karya (Persero) Tbk. seeks to improve data integration, increase transparency in procurement, and strengthen internal controls during project execution. However, in practice, the current SAP system has not yet fully accommodated all Procurement of Goods and Services (PBJ) procedures applied within the company. A notable limitation is the absence of integration between vendor selection processes and tendering or e-procurement systems within the SAP platform, especially in the MM and PS modules that form the core of material and project management. In fact, vendor selection and tendering are critical stages in construction procurement, as they significantly affect project quality and efficiency and require an integrated and well-documented system (Khairnar & Desai, 2019).

This condition is reflected in ADHI's internal procurement flowchart, which shows that several key activities—such as tender proposal preparation, price comparison evaluation, and material approval—are still conducted manually (indicated by the symbol “M”) and have not yet been automated within SAP (see Figure 1). This situation highlights the limited integration between SAP and the company's actual procurement practices, thereby creating opportunities for system enhancement or additional integration to bridge the existing gaps.

**Figure 1 Procurement Process Flow of Goods and Services at PT Adhi Karya (Persero) Tbk**

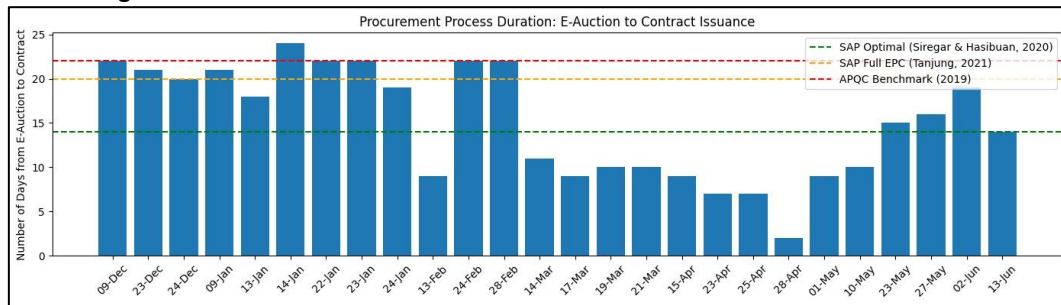


Source: PT Adhi Karya, 2023

In order to evaluate the real effectiveness of the procurement process, an analysis was carried out on the time span between the date the e-Auction was conducted and the date contracts were issued for different procurement packages in 2025. The results indicate that most procurement processes required more than 10 days, with several cases extending beyond 20 to 30 days. The average lead time was recorded at approximately 12.6 days.

For comparison, the American Productivity & Quality Center (APQC, 2019) states that top-performing organizations typically achieve an average procurement-to-purchase order (PO) cycle time of around 22 working days. According to Tanjung (2021), procurement processes in EPC companies usually take between 25 to 40 working days; however, this period can be shortened to 15–20 working days with the complete adoption of SAP MM. Additionally, a study by Siregar and Hasibuan (2020) highlights notable improvements in efficiency, as the time taken for procurement from negotiation to PO issuance was reduced from 26 days to 14 working days after implementing SAP comprehensively.

**Figure 2.** Duration of the Procurement Process from e-Auction to Contract Issuance



Source: PT Adhi Karya, 2023

These findings indicate that although e-Auction has been implemented, later administrative steps—especially the process of issuing contracts—still face delays because the e-Procurement system is not well connected with SAP modules. This lack of integration causes longer procurement times and lowers the overall effectiveness of the supply chain in construction projects. Therefore, this research is important to evaluate the adequacy of SAP implementation in supporting supply chain management and procurement processes in construction projects at PT Adhi Karya, to examine its impact on process efficiency and control, and to provide recommendations for the development of supporting systems to address functional gaps that are not yet accommodated within SAP.

This study is expected to contribute to the literature on ERP implementation in the construction sector, particularly in the context of operational procurement practices in Indonesian construction companies

## 2. LITERATURE REVIEW

Digital transformation in supply chain management has become a strategic necessity for the construction industry, which faces intense pressure to improve efficiency in terms of time, cost, and quality (More et al., 2024). One widely adopted form of this transformation is the implementation of Enterprise Resource Planning (ERP) systems, with SAP emerging as one of the most dominant ERP platforms globally (Patara & Minde, 2016). In the construction context, the SAP Material Management (MM) and Project System (PS) modules serve as the core systems supporting procurement and project management activities.

According to the American Productivity & Quality Center (APQC, 2019), procurement efficiency can be assessed through procurement-to-contract or procurement-to-purchase order (PO) cycle time, where world-class organizations achieve an average duration of approximately 22 working days. A study by Tanjung (2021) indicates that full integration of SAP systems can reduce procurement cycle time from 40 days to approximately 15–20 working days. Similar findings were reported by Siregar and Hasibuan (2020), who observed a reduction in negotiation-to-PO duration from 26 days to 14 working days following comprehensive SAP implementation.

On the other hand, system integration continues to pose a significant challenge in construction procurement, especially when e-procurement processes are carried out on platforms that are not fully connected with the ERP system. Khairnar and Desai (2019) highlight the importance of complete integration across all stages, including tendering, vendor evaluation, and purchase order (PO) issuance, within a unified system. This helps to prevent redundant work, reduce administrative delays, and strengthen internal controls.

From the literature reviewed, it can be concluded that the success of ERP implementation, such as SAP, in the construction industry depends on two main factors: the extent to which SAP

modules (MM and PS) are adopted, and how well these systems are integrated with supporting platforms like e-procurement.

Both factors are thought to directly influence the efficiency of the procurement process, which in turn has a significant effect on project outcomes in terms of cost, time, and quality.

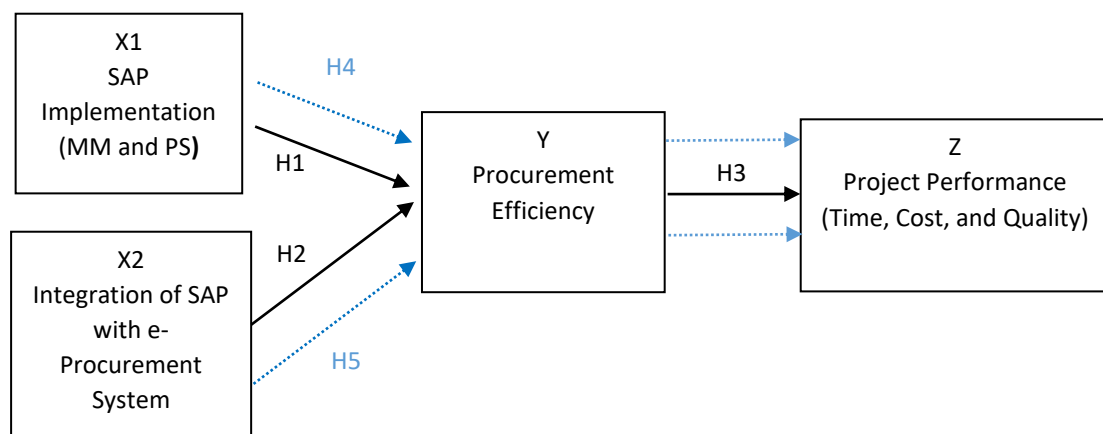
### 2.1 Research Conceptual Framework

The conceptual framework of this study illustrates the relationships among the variables analyzed in this research. The framework is designed to examine how the implementation and integration of SAP systems influence procurement efficiency and, ultimately, project performance in construction projects. The variables in this study are defined as follows:

- X1: SAP Implementation (Material Management and Project System)
- X2: Integration of SAP with e-Procurement Systems
- Y: Procurement Efficiency
- Z: Project Performance (Time, Cost, and Quality)

This conceptual framework assumes that effective implementation of SAP MM and PS modules, as well as their integration with e-procurement platforms, positively affects procurement efficiency. Furthermore, improved procurement efficiency is expected to enhance overall project performance in terms of timely completion, cost control, and quality compliance.

Figure 3. Research Model



### 2.2 Research Hypotheses

- H1: SAP implementation (X1) affects procurement efficiency (Y).
- H2: Integration of SAP with e-Procurement systems (X2) affects procurement efficiency (Y).
- H3: Procurement efficiency (Y) affects project performance (Z).
- H4: SAP implementation (X1) affects project performance (Z) through procurement efficiency (Y).
- H5: Integration of SAP with e-Procurement systems (X2) affects project performance (Z) through procurement efficiency (Y).

## 3. RESEARCH METHODS

### 3.1 Research Design

This study adopts a quantitative descriptive approach to measure and describe the level of efficiency of SAP system implementation in the procurement processes of construction projects at PT Adhi Karya (Persero) Tbk. This method uses quantitative methods, as it provides a systematic and objective way to analyze the relationships between different variables using

statistical methods. This approach allows the study to provide empirical evidence regarding the influence of SAP implementation and system integration on procurement efficiency and overall project performance.

### 3.2 Data Collection Techniques

Primary data were collected through a structured questionnaire distributed to 120 respondents, consisting of permanent employees from operational departments and the head office, as well as project-based personnel at PT Adhi Karya (Persero) Tbk. The respondents were active users of SAP MM, SAP PS, and/or the e-Procurement system, within the age range of 25–45 years. The questionnaire was created with a seven-point Likert scale, ranging from 1 to 7, to assess respondents' views on the research variables.

Secondary data were sourced from internal company documents, specifically procurement lead-time records that covered the time from e-Auction to contract issuance between January and June 2025.

### 3.3 Research Model

This study adopts a causal research model that includes two independent variables (X1 and X2), one mediating variable (Y), and one dependent variable (Z). The model is structured to explore the connections between SAP implementation, system integration, and procurement efficiency, as well as how procurement efficiency influences construction project performance.

### 3.4 Variables and Indicators

Variable	Variable Definition	Dimensions	Indicators	Scale
X1: SAP MM & PS Implementation (Patara & Minde, 2016; Tanjung, 2021)	The extent to which SAP MM and PS modules are implemented and actively used in construction project procurement processes.	1. System utilization	Level of SAP MM and PS application in procurement activities	Likert 1–7
		2. Ease of use	User convenience in operating SAP (user-friendliness)	
		3. Training support	Availability of training and user assistance for SAP usage	
X2: SAP Integration with e-Procurement (APQC, 2019; Tanjung, 2021)	The level of integration and interoperability between the SAP system and the e-Procurement platform in supporting end-to-	1. Process automation	Number of procurement stages that have been automated	Likert 1–7
		2. Data consistency	Frequency of duplicate data entry (double entry)	

	end procurement processes.	3. Data integration	Level of data connectivity and integration across systems	
Y: Procurement Efficiency (Siregar & Hasibuan, 2020; More et al., 2024)	The capability of the system to accelerate procurement processes and reduce inefficient manual activities.	1. Process speed	Average duration from e-Auction to contract issuance	Likert 1–7
		2. System effectiveness	Number of remaining manual stages in the procurement process	
Z: Project Performance (More et al., 2024; APQC, 2019)	The level of project success measured in terms of completion time, cost performance, and quality of work.	1. Timeliness	Compliance with project schedule	Likert 1–7
		2. Project cost	Cost deviation from the approved budget	
		3. Quality performance	Conformity of work quality with technical specifications	

### 3.5 Data Analysis Technique

This study employs Structural Equation Modeling using the Partial Least Squares approach (SEM-PLS), which is analyzed using SmartPLS software. According to Ghazali and Latan (2015), SEM-PLS is appropriate for studies involving complex structural models, relatively small sample sizes, and data that do not require normal distribution assumptions. This method is also suitable for analyzing relationships among latent variables and examining the mediating role of variables within the research model.

Furthermore, SEM-PLS is selected due to its strong predictive capability and flexibility in handling various data characteristics (Hair et al., 2017; Hair et al., 2019).

The data analysis procedure consists of the following stages:

- Measurement model (outer model) evaluation, conducted to assess indicator validity and reliability using outer loadings, composite reliability, and average variance extracted (AVE).
- Structural model (inner model) evaluation, performed to examine the significance of relationships among latent variables using path coefficients, t-statistics, and p-values.
- Assessment of predictive power, indicated by the coefficient of determination (R-square) and effect size ( $f^2$ ).

As a supporting analysis, descriptive statistical analysis is conducted, including mean values, standard deviations, and minimum and maximum scores. The findings are then compared with established benchmarks from APQC (2019), Tanjung (2021), and Siregar and Hasibuan (2020). The results are presented in the form of tables and figures.

### 3.6 Validity and Reliability

The assessment of construct validity and reliability within the SEM-PLS framework follows the criteria proposed by Ghozali and Latan (2015). Convergent validity is assessed using outer loading values and average variance extracted (AVE), while construct reliability is evaluated using Cronbach's Alpha and Composite Reliability (CR). A construct is considered reliable if the values of Cronbach's Alpha and Composite Reliability exceed 0.70.

### 3.7 Research Limitations

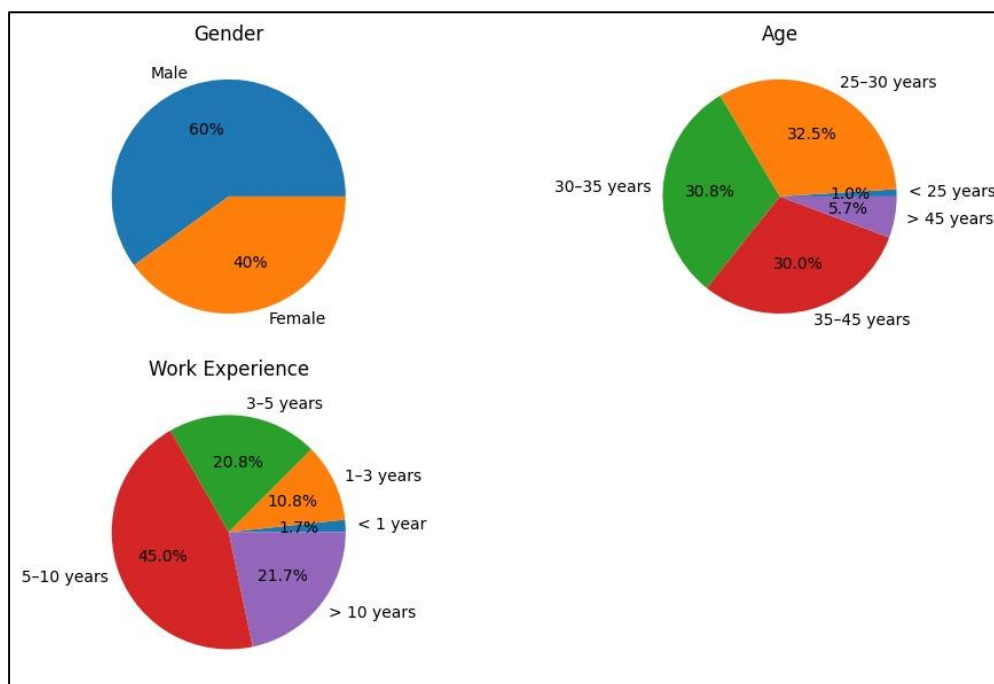
This study has several limitations that should be considered when interpreting the findings. First, the scope of the analysis is limited to the procurement process from the e-Auction stage to contract issuance. Second, procurement activities in the upstream and downstream phases of the supply chain are not examined in depth.

## 4. RESULTS AND DISCUSSION

### 4.1 Respondent Characteristics

This study involved 120 respondents consisting of permanent employees and project staff in a construction company who actively use SAP MM, SAP PS, and e-Procurement systems, aged 25–45 years and directly involved in procurement and project management.

**Figure 4.** Respondent Characteristic



Source: Primary data, survey results, 2025

### 4.2 Descriptive Statistical Analysis Results

The descriptive analysis indicates that all variables have mean values that fall within the moderate to high range. System integration is noted to have a relatively high mean, which suggests that there is effective data connectivity between SAP MM, SAP PS, and the e-Procurement system. Procurement efficiency is also shown to have positive results, especially in terms of faster processes and better data accuracy, indicating that the implementation of SAP supports procurement activities within construction projects.

**Table 1.** Descriptive Statistics of Research Variables

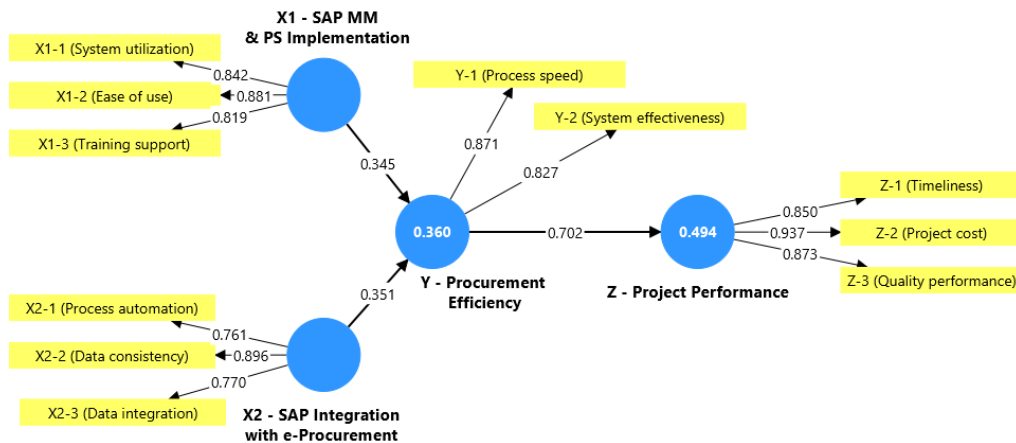
Variable	Mean	Std. Dev	Category
SAP Implementation (X1)	5.46	1.13	High
SAP–e-Procurement Integration (X2)	5.26	1.03	High
Procurement Efficiency (Y)	5.4	0.92	High
Project Performance (Z)	6	0.98	Very High

Source: Primary data processed using PLS-SEM (SmartPLS), 2025

#### 4.3 Measurement Model Evaluation (Outer Model)

The measurement model evaluation was conducted to assess the validity and reliability of the research constructs. Based on the criteria proposed by Ghazali and Latan (2015) and Hair et al. (2019), an indicator is considered to demonstrate adequate convergent validity if it has an outer loading value of  $\geq 0.70$  and an Average Variance Extracted (AVE) value of  $\geq 0.50$ .

**Figure 5.** Validity Test and Indicator Loading Factors



Source: Primary data processed using PLS-SEM (SmartPLS), 2025

Based on Figure 5, the findings show that all indicators in this study have outer loading values above 0.70 and Average Variance Extracted (AVE) values higher than 0.50. These outcomes suggest that each indicator effectively captures its corresponding latent construct and satisfies the standards for convergent validity.

**Table 2.** Outer Loadings

Indicator	X1 – SAP Implementation	X2 – SAP and e-Procurement Integration	Y – Procurement Efficiency	Z – Project Performance
X1-1 (System utilization)	0.842			
X1-2 (Ease of use)	0.881			
X1-3 (Training support)	0.819			
X2-1 (Process automation)		0.761		

X2-2 (Data consistency)		0.896		
X2-3 (Data integration)		0.77		
Y-1 (Process speed)			0.871	
Y-2 (System effectiveness)			0.827	
Z-1 (Schedule adherence)				0.85
Z-2 (Project cost)				0.937
Z-3 (Work quality)				0.873

Source: Primary data processed using PLS-SEM (SmartPLS), 2025

Furthermore, the reliability test shows that the Cronbach's Alpha and Composite Reliability values for all constructs are above 0.70. This suggests that the research tool is reliable and consistent in measuring system quality, data integration, and procurement efficiency.

**Table 3.** Construct Reliability and Validity

	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
X1 - SAP MM_ & PS Implementation	0.805	0.817	0.884	0.719
X2 - SAP Integration_ with e-Procurement	0.74	0.77	0.852	0.658
Y - Procurement_ Efficiency	0.616	0.623	0.838	0.722
Z - Project Performance	0.865	0.866	0.918	0.788

Source: Primary data processed using PLS-SEM (SmartPLS), 2025

The discriminant validity test results also indicate that each construct has distinct characteristics, suggesting no overlap in measurement among the variables. Based on these results, the measurement model is deemed adequate for further evaluation of the structural model.

#### 4.4 Structural Model Evaluation (Inner Model)

##### a. Coefficient of Determination (R-Square)

The coefficient of determination, known as R-square, is utilized to assess how well the structural model explains the endogenous variables. The findings from the evaluation of the inner model are outlined as follows:

**Table 4.** Coefficient of Determination (R-Square)

	R-square	R-square adjusted
Y - Procurement_ Efficiency	0.360	0.349
Z - Project Performance	0.494	0.489

Source: Primary data processed using PLS-SEM (SmartPLS), 2025

The results indicate that SAP implementation and SAP integration with e-Procurement

explain 36% of the variance in procurement efficiency, while procurement efficiency explains 49.4% of the variance in project performance. These R-square values suggest that the predictive power of the model falls within the moderate category for both endogenous constructs, based on SEM-PLS evaluation criteria.

*b. Effect Size ( $f^2$ )*

Effect size analysis is conducted to assess the relative contribution of each independent variable to the dependent variable within the structural model.

**Table 5.** Effect Size ( $f^2$ )

Relationship Between Variables	$f^2$	Category
SAP Implementation (X1) → Procurement Efficiency (Y)	0.143	Small
SAP–e-Procurement Integration (X2) → Procurement Efficiency (Y)	0.148	Small
Procurement Efficiency (Y) → Project Performance (Z)	0.974	Large

Source: Primary data processed using PLS-SEM (SmartPLS), 2025

The analysis of effect size ( $f^2$ ) was carried out to assess how much each exogenous variable influences the endogenous variables. Based on the guidelines from Cohen (1988) and Hair et al. (2019), an  $f^2$  value of 0.02, 0.15, and 0.35 represents a small, medium, and large effect, respectively.

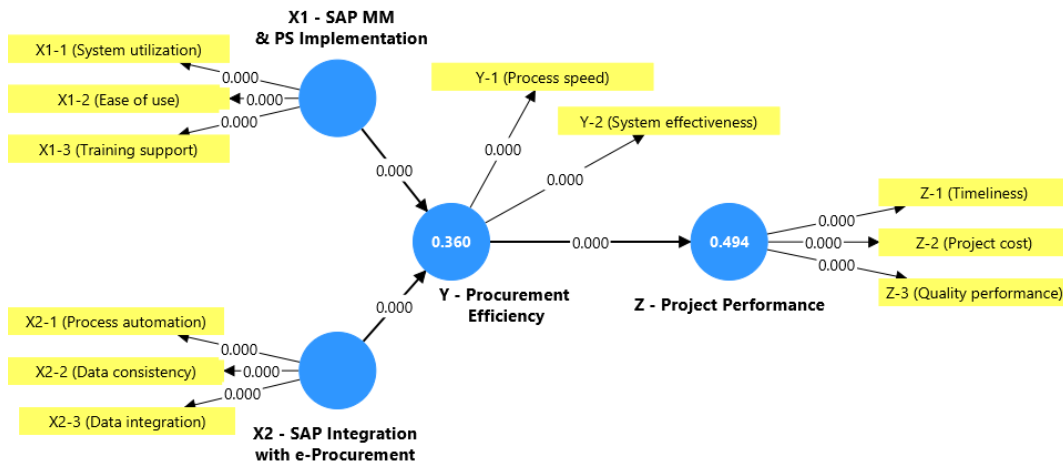
The results show that SAP implementation (X1) and SAP integration with e-Procurement (X2) have small effect sizes on procurement efficiency (Y), suggesting that while both variables are statistically significant, their individual contributions are relatively limited.

On the other hand, procurement efficiency (Y) has a large effect size on project performance (Z), showing that procurement efficiency is a major factor in explaining the outcomes related to time, cost, and quality in project performance.

*C. Hypothesis Testing Results*

The assessment of the structural model was carried out using the Partial Least Squares Structural Equation Modeling (PLS-SEM) method, incorporating a bootstrapping technique to analyze the significance of the relationships between latent variables. Bootstrapping was used to calculate the path coefficients, t-statistics, and p-values, which form the foundation for testing the hypotheses. The findings from the hypothesis testing are summarized as follows:

Figure 6. PLS Bootstrapping Results



Source: Primary data processed using PLS-SEM (SmartPLS), 2025

Hypothesis testing is conducted to determine whether the proposed hypotheses are accepted or rejected based on the values of path coefficients, t-statistics, and p-values.

Table 6. Path Coefficient, T-Statistic, P-Value

Hypothesis	Relationship Between Variables	Original Sample (O)	Sample Mean (M)	Std. Dev.	T-Statistic	P-Value	Decision
H1	SAP Implementation (X1) → Procurement Efficiency (Y)	0.345	0.345	0.076	4.512	0.00001 (p < 0.001)	Accepted
H2	SAP-e-Procurement Integration (X2) → Procurement Efficiency (Y)	0.351	0.355	0.08	4.418	0.00001 (p < 0.001)	Accepted
H3	Procurement Efficiency (Y) → Project Performance (Z)	0.702	0.701	0.048	14.699	0.00001 (p < 0.001)	Accepted
H4	SAP Implementation (X1) → Project Performance (Z)	0.242	0.243	0.061	3.99	0.00007 (p < 0.001)	Accepted

H5	SAP–e-Procurement Integration (X2) → Project Performance (Z)	0.247	0.25	0.061	4.071	0.00004 (p < 0.001)	Accepted
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Source: Primary data processed using PLS-SEM (SmartPLS), 2025

The significance criteria are T-statistic > 1.96 and P-value < 0.05 (Hair et al., 2019). Based on Table 6, all structural paths show T-statistic values above 1.96 and P-values below 0.05, indicating that all hypothesized relationships are statistically significant.

- **H1.** The results indicate that SAP MM and PS implementation (X1) has a significant effect on procurement efficiency (Y) ( $\beta = 0.345$ ;  $T = 4.512$ ). This suggests that more effective SAP implementation improves procurement efficiency by standardizing processes and reducing manual activities.
- **H2.** SAP–e-Procurement integration (X2) significantly influences procurement efficiency (Y) ( $\beta = 0.351$ ;  $T = 4.418$ ). Integrated systems support end-to-end procurement processes, reduce data duplication, and enhance information accuracy.
- **H3.** Procurement efficiency (Y) has a strong and significant effect on project performance (Z) ( $\beta = 0.702$ ;  $T = 14.699$ ), highlighting its critical role in achieving time, cost, and quality performance.
- **H4.** SAP implementation (X1) has a significant effect on project performance (Z) ( $\beta = 0.242$ ;  $T = 3.990$ ). Procurement efficiency partially mediates this relationship, indicating that SAP contributes to project performance both directly and indirectly.
- **H5.** SAP–e-Procurement integration (X2) significantly affects project performance (Z) ( $\beta = 0.247$ ;  $T = 4.071$ ). Procurement efficiency acts as a partial mediator in this relationship.

The study shows that implementing SAP and integrating systems have a major effect on how efficiently procurement is done. Efficient procurement, in turn, is very important for improving the performance of construction projects. These findings suggest that project performance is affected not just by directly using technology, but also by better procurement processes that result from increased efficiency.

## CONCLUSION

This study demonstrates that using SAP MM and SAP PS, combined with integrating SAP with e-Procurement systems, plays an important role in making procurement more efficient in construction projects. When these systems are well-integrated, they are not just tools for daily operations but also key factors that help speed up procurement processes, reduce unnecessary manual tasks, and improve the accuracy and transparency of data. Procurement efficiency is shown to be a major factor in improving overall project performance, especially in terms of following schedules, controlling costs, and ensuring work quality.

Furthermore, the findings indicate that procurement efficiency acts as a bridge between the implementation and integration of systems and the overall performance of a project.

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