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STUDY OF THE INFLUENCE OF E-PROCUREMENT SYSTEM ON THE ACHIEVEMENT OF PROJECT PROGRESS PERFORMANCE IN CONSTRUCTION PROJECTS WITHIN THE EPC DIVISION - PT. PP PERSERO Tbk

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ABSTRACT

Amid increasingly fierce competition in the construction industry due to the growing number of service providers and limited market share, achieving optimal cost performance, timely delivery, quality compliance, and zero workplace fatalities has become more challenging. To monitor project performance effectively, companies must establish Key Performance Indicators (KPIs) as benchmarks for project evaluation. One internal factor within PT. PP Persero Tbk is the centralized e-procurement system, which plays a crucial role, especially in EPC (Engineering, Procurement, and Construction) projects. Data from 2020–2022 indicates delays across centralized e-procurement processes in all projects, with procurement delayed in 7 out of 10 required steps: technical clarification, price negotiation, required negotiation evaluation documents, negotiation evaluation, objection period, contract draft review, and final contract wet signatures leading up to contract release. This highlights a suboptimal e-procurement progress performance. This study involved a survey comprising 61 variables related to the potential impact of e-procurement on progress performance, distributed among internal and external stakeholders. Validity and reliability tests were conducted prior to analysis using principal component analysis (PCA). A total of 43 respondents completed the survey. The results of the validity and reliability tests confirmed that all 61 variables were valid and reliable. PCA results identified 16 principal components, with 25 variables exhibiting positive loadings in Component 1, 18 variables in Component 2, and the remaining variables distributed across Components 3–6. The study indicates that focusing on Components 1–6 can serve as a priority framework for addressing variables to significantly improve e-procurement progress performance.

KEYWORDS e-procurement, key performance indicator, progress performance, mponent analysis.

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INTRODUCTION

Projects as an activity are temporary and unique because each project has its own characteristics and problems, both technical and non-technical. In the midst of increasingly fierce competition in the construction industry due to the large number of service providers and limited market share, the challenge of achieving good cost performance, on time, fulfilled quality, and zero work accidents (*Zero Fatality*) getting heavier. In addition, the tightening cost budget and project implementation time also add to the existing challenges. To monitor the performance of the project, the company needs to establish *Key Performance Indicators* (KPI) as a reference for project performance evaluation (Gabcanova, 2012). This KPI is an indicator of whether the project is running according to the set targets (*on the track*). With the construction industry's increasingly difficult conditions and the need to achieve KPI targets, evaluation of factors that affect project performance, especially internal factors, is very important.

KPIs are used to measure how well a company, project, or individual is achieving a predetermined strategic goal (Warren, 2011). This performance is measured based on certain standards that describe the actual conditions of the various sizes that have been agreed. With KPIs, management and stakeholders can track progress and ensure the organization is on track (Permenter, 2007). KPIs include different indicators that are set according to the needs and strategies of the respective companies, aiming to achieve the desired results.

Especially in construction projects, KPIs such as time performance, quality, cost, and safety are essential to ensure work efficiency and safety. Performance progress refers to the proximity of actual performance to the planned schedule and aims to ensure that the entire process runs as planned without unnecessary delays. Therefore, KPIs allow companies to identify bottlenecks and make the necessary adjustments so that projects can be completed on time (Banerjee & Bueti, 2012).

An internal factor that is commonly studied regarding its influence on project performance is the managerial ability of the project team, such as *Team Work*, leadership, problem solving, communication, decision-making, stakeholder management, personnel competence, and supervision; This is a fundamental area in evaluating the success and failure of project performance (D. S. Santoso & Gallage, 2019). These factors reflect the project management capabilities of the project team itself, but there are other internal factors that involve the company more broadly, such as internal business flows or processes that support the project, for example *Centralized e-procurement*. Evaluation of these internal business processes is important to assess their impact on the success or failure of project performance achievements, so that the company can take anticipatory steps and improvements in the future so that the process truly supports the project targets. The problem is that often the internal factors that affect project performance are not thoroughly identified, so an evaluation is needed not only on the managerial capabilities of the project team, but also on the company's business processes and their effect on project performance.

The internal factors studied here will be more specific related to company management (company business processes) that have been carried out within PT.

PP Persero Tbk-EPC Division as an example of evaluating how the company's business processes affect the achievement of project performance. The main focus of this research is the *centralized E-procurement* system which has a very important role, especially in EPC projects. This system serves the *procurement* of materials, goods and services where most of the time and cost is spent. If the procurement performance is not good, it will have an impact on the performance of the progress of part or all of the project.

Procurement plays a very important role in the performance of a project, especially for EPC projects where almost 60% of the cost is dominated by the procurement of materials, goods and services. Standardization of *the procurement process* is absolute to ensure that the procurement flow/process is in accordance with the company's GCG (*Good Corporate Governance*) and does not violate existing rules/procedures/WI. Therefore, in order to answer these challenges, the *procurement* system is then made centrally with a clear and strict flow/procedure to ensure the validity and validation of the entire process. With digitalization, the conventional *procurement* system is then replaced by an *E-Procurement* system that involves an internet system through *an online* system, so that information disclosure and ease of access are better. This then needs to be seen as an internal factor (the company's business process) which also affects the project's ability to achieve its productivity performance, to generate cash-in and profit for the company.

Based on empirical data as shown in Figure 1, it was found that the entire *e-procurement* process in each project exceeded the duration on average up to twice the ideal duration, which was 35 days. With the number of work packages varying for each project, *this e-procurement* process causes delays in all project progress at PT PP Persero, Tbk.

In the centralized *e-procurement* process, there are 10 procurement flows of goods or services that must be passed. Not all of these stages were analyzed in this study. Only a few stages of the e-procurement process that cause high average delays are taken as a variable. Result of the calculation of the total service delays at each stage against the data of 253 vendors. It was found that of the 10 stages, 7 stages experienced delays of more than 50% or 127 times for ten projects, namely technical clarification, price negotiation, negotiation evaluation requirements documents, negotiation evaluation, rebuttal period, contract draft review, and wet contract signatures (TTD) until the release contract. These 7 stages cause higher average delays than the average punctuality of e-procurement services.

Previous studies have recognized the importance of project management capabilities in achieving project performance goals. Santoso and Gallage (2019) examined internal factors such as leadership, communication, and stakeholder management, identifying these as key drivers of project success in Indonesia’s construction sector. Similarly, Gunawan et al. (2022) explored how team competence and decision-making affected time and cost performance, concluding that internal human capital plays a significant role in minimizing project risks. However, both studies primarily focused on human-related managerial factors within project teams, leaving a gap in evaluating systemic organizational processes such as centralized digital procurement systems. The present study addresses this gap by analyzing how delays in the centralized e-procurement system at PT. PP Persero Tbk-EPC Division impact project performance. This research expands the scope of internal factor analysis from personnel-centric to process-centric, focusing on business processes that are frequently overlooked but have a significant impact on overall project timelines. Thus, the novelty of this research lies in its specific assessment of procurement workflow delays and their influence on progress performance using real project data.

The objective of this study is to evaluate the influence of internal business processes—particularly the centralized e-procurement system—on project performance at PT. PP Persero Tbk-EPC Division. The research aims to identify the procurement stages most responsible for delays and quantify their impact on overall project timelines. The results are expected to provide actionable insights for EPC contractors to enhance procurement strategies, reduce lead time, and improve project efficiency. Furthermore, this research contributes to academic literature by integrating digital procurement systems as a measurable internal variable affecting project performance, offering a more holistic framework for construction management evaluation.

RESEARCH METHODS

The method used in this study is a quantitative method, namely by distributing questionnaires to the respondents. The respondents selected are parties directly involved in the centralized *e-procurement* system, both from internal parties (employees of PT PP Persero, Tbk), and from external parties (Vendors).

Data collection method

The data collection method in this study will use a questionnaire. The questionnaire is distributed to all Project Managers from the EPC Division who are directly involved in the implementation of the project, the questionnaire answers will be used as primary data.

According to Sugiyono (2013), a questionnaire is a data collection technique that is carried out by giving a set of questions or written statements to respondents to be answered. The questions in the questionnaire must be able to collect the respondents' information needed to produce indicators or meet the tabulation design to be studied (Kamaruzzaman, 2012). The questionnaire is designed based on indicators on internal variables according to Table 1. Each indicator is given a choice of 1 to 5. With a score of 1 strongly disagree, 2 disagree, 3 neutral, 4 agree and 5 strongly agree.

Population and Research Sample

The population used in this study is all key project personnel, ranging from all Project Managers (PM), SEM and internal SAM from PT. PP Persero Tbk – EPC Division which is considered to be involved and uses internal business processes and feels/knows its influence on the performance of their respective projects directly and has the same and relevant characteristics in providing this perception to project performance and is fully responsible for the implementation of construction projects within PT. PP Persero Tbk. Coupled with vendors who are also involved in PT. PP Persero Tbk and felt the process of implementing e-procurement. The determination of the sample in this study will use *the purposive sampling* technique. This approach provides an opportunity for researchers to select respondents who have a deep understanding and sufficient knowledge of the EPC construction business. By selecting individuals with relevant backgrounds and experience, it is hoped that the data obtained will provide rich and detailed insights into the challenges, opportunities, and impacts of implementing EPC business strategies on the performance of state-owned construction companies.

Data Analysis Techniques

The analysis method used in this study is the *principal component analysis* (PCA) method. Before conducting this analysis, the data variables are selected first with validity tests and reliability tests.

Validity Test

Validity test is a measurement of the accuracy of a variable with the total score of the variable's dimensions (S. Santoso, 2012). The hypotheses used are:

- *H0* = The question does not measure the desired aspect
- *H1* = Question measures the desired aspect

How to measure validity using *the Pearson Product Moment* correlation formula is as follows:

$$r = \frac{n\sum xy - \sum x \sum y}{\sqrt{\{[n\sum Xi^2 - (\sum Xi)].[n\sum Yi^2 - (\sum Yi)]\}}} \quad (1)$$

Information:
r : Correlation coefficient
x : Independent variable
y : bound variable
n : Number of respondents

$$t_{hitung} = \frac{r\sqrt{n-2}}{\sqrt{1-r^2}} \quad (2)$$

Information:
r : Correlation coefficient
n : Number of respondents

The rule of decision for distribution (t) for α = 0.05 or 5% is as follows:

- If *the tcount* > *table*, then *Ho* is rejected and *H1* is accepted (valid)
- If *the tcount* < *table*, then *Ho* is accepted and *H1* is rejected (invalid)

Testing was carried out on all variables, where conclusions were drawn by comparing the correlation value (*r calculated*) with the value of the *Pearson Product Moment* table (*r-table*). If r is greater than *r of the table*, then the question has measured the aspect it wants to know (minus *H0*) or it can be said that the question has been significantly used (valid). If variable data is found that does not meet the validity test, then the variable will be omitted or not included in the advanced statistical test.

About this validity test, it can be conveyed as follows:

1. This test is actually to see the feasibility of the question items in the questionnaire in defining a variable
2. This list of questions is generally to support a specific group of variables.
3. The validity test is carried out for each question item. The result is compared to *r table* | *df=n – k* with an error rate of 5%
4. If *r is a table* < *r calculated*, then the question item is valid.

Reliability Tests

Reliability tests measure the level of reliability of variables. High reliability is indicated by a reliability value close to 1. In general, the reliability is considered satisfactory if the value is more than 0.65 – 0.8. Less than 0.5 is considered less reliable. The hypotheses used in the reliability test are:

- *H0* = Questions do not result in consistent measurements
- *H1* = Questions result in consistent measurements

Reliability measurements were measured using the Alpha Cronbach formula because the answer categories were more than 2 (1 – 5). The formula is as follows:

$$\sum ab^2 = \frac{\sum Xi^2 - \frac{(\sum x)^2}{n}}{n} \tag{3}$$

$$at^2 = \frac{\sum y^2 - \frac{(\sum y)^2}{n}}{n} \tag{4}$$

$$r_n = \left(\frac{k}{k-1}\right).\left(1 - \frac{\sum ab^2}{at^2}\right) \tag{5}$$

Information:
Rn : Reliable instruments
k : Number of variable items
Σab2 : Number of variants of the item
AT2 : Total variants
ΣXi : Number of variable scores reviewed

The conclusions for the reliability test were based on a comparison of the alpha values generated with *the Pearson Product Moment* (*r table*). An instrument can be considered reliable if *the rn coefficient is > tableable*.

- About this reliability test can be conveyed as follows:
- To assess the stability of the size and consistency of the respondents in answering the questionnaire.
- Reliability tests are carried out jointly on all questions.
- If *the alpha value* is >0.65, it is considered reliable.

PCA Analysis

PCA aims to reduce the number of original variables that are correlated with each other (Mishra et al., 2017). PCA works by converting the original dataset consisting of many variables into a new dataset referred to as the main component (Pachter, 2014). The main component is a linear combination of the original variable that is determined in such a way that it has maximum variance. In other words, the PCA looks for the directions where the data is spread the most. PCA is performed on variables that meet the validity test and reliability test. This analysis uses the *Google Collaboration*. The determination of important variables is by analyzing the results of eigenvalues greater than 1.

Analysis of the Influence of E-Procurement on Project Progress Performance

After determining the main analysis components, then an analysis of the stages of e-procurement that most affect the performance of project progress can be made. The results of this analysis are used as a basis for the preparation of recommendations for the EPC Division of PT. PP Persero Tbk. This strategy was obtained from the results of a literature review.

RESULTS AND DISCUSSION

From the distribution of the online questionnaire, 46 respondents involved in the centralized e-procurement system with different titles and divisions have been obtained. Eight of them are vendors from companies outside PT. PP Persero Tbk.

Validity Test

Validity test analysis using *the df.corr()* command that is already available in the pandas module. Then, to get the *p-value*, pearson regression *analysis is used.*Analysis The results of the validity test in the study can be seen in Table 2. If the value is close to 1, then the two variables are increasingly correlated. Conversely, if the value is close to -1, then the two variables are not correlated with each other. Variables that have a correlation value with a significant level (*p-value*) of 0.000 < 0.05, then it can be said that the respondent's response to the variable is valid. On the other hand, if the variable has a correlation value with a significant level higher than 0.05, it can be said that the respondent's response to the variable is invalid. From the calculation results, not a single variable is invalid. Therefore, all variables are involved in the PCA analysis.

Table 1. Validity test results

Sub variable	Code	Correlation	Significant	Information
A. Technical Clarification	A1	0,347	0,018	Valid
	A2	0,546	8,830e-05	Valid
	A3	0,593	1,431e-05	Valid
	A4	0,519	0,0002	Valid
	A5	0,615	5,458e-06	Valid
	A6	0,589	1,669e-05	Valid
	A7	0,680	1,963e-07	Valid
	A8	0,683	1,729e-07	Valid
	A9	0,632	2,436e-06	Valid

Sub variable	Code	Correlation	Significant	Information
B. Price Negotiation	B1	0,638	1,890e-06	Valid
	B2	0,700	6,207e-08	Valid
	B3	0,738	4,813e-09	Valid
	B4	0,802	2,149th-11	Valid
	B5	0,620	4,402e-06	Valid
	B6	0,754	1,479e-09	Valid
	B7	0,686	1,417e-07	Valid
	B8	0,666	4,410e-07	Valid
	B9	0,667	4,074e-07	Valid
	B10	0,492	0,0005	Valid
C. Negotiation Evaluation Terms Document	C1	0,611	6,622e-06	Valid
	C2	0,631	2,610e-06	Valid
	C3	0,662	5,426e-07	Valid
	C4	0,741	3,774e-09	Valid
	C5	0,710	3,369e-08	Valid
	C6	0,688	1,281e-07	Valid
	C7	0,721	1,569e-08	Valid
	C8	0,744	3,080e-09	Valid
	C9	0,645	1,325e-06	Valid
D. Negotiation Evaluation	D1	0,551	7,163rd-05	Valid
	D2	0,561	5,002e-05	Valid
	D3	0,572	3,302e-05	Valid
	D4	0,633	2,305e-06	Valid
	D5	0,558	5,589e-05	Valid
E. Period of Objection	E1	0,683	1,735e-07	Valid
	E2	0,650	9,957e-07	Valid
	E3	0,608	7,333e-06	Valid
	E4	0,674	2,815e-07	Valid
	E5	0,689	1,207e-07	Valid
	E6	0,754	1,426e-09	Valid
	E7	0,720	1,735e-08	Valid
	E8	0,730	8,542e-09	Valid
F. Review of the draft Contract	F1	0,751	1,876e-09	Valid
	F2	0,500	0,0004	Valid
	F3	0,711	3,054e-08	Valid
	F4	0,618	4,718e-06	Valid
	F5	0,462	0,0012	Valid
	F6	0,427	0,0031	Valid
	F7	0,640	1,709e-06	Valid
	F8	0,660	6,048e-07	Valid
	F9	0,534	0,00013	Valid
	F10	0,717	2,094e-08	Valid
G. TTD wet Contract to Release Contract	G1	0,520	0,00021	Valid
	G2	0,597	1,197e-05	Valid
	G3	0,710	3,183e-08	Valid
	G4	0,491	0,00052	Valid
	G5	0,718	1,972e-08	Valid

Sub variable	Code	Correlation	Significant	Information
	G6	0,513	0,00027	Valid
	G7	0,570	3,560e-05	Valid
	G8	0,482	0,0007	Valid
	G9	0,518	0,00022	Valid
	G10	0,487	0,00061	Valid

Reliability Test

Then the reliability test was done using *the cronbach alpha* method. To convert *the cronbach alpha* formula into python, it must create a reliability value calculation method. The results of the reliability test on 61 variables can be seen in Table 2.

Table 2. Reliability test results

Number of variables	Reliability value	Invalid variables
61	0,9740544	-

PCA results

Each variable has a variance value of 1, so the total variance in this study is 61×1 = 61. Then dimension reduction is carried out to summarize the information contained in the origin variable. To do this, use the Main Component Analysis using the *sklearn.decomposition.pca* module. In this step, the PCA will look for *the greatest eigenvalue* of each major component (PC).

Then from the results of the PCA calculation, the variation per main component (PC) is calculated using *pca.explained_variance_ratio*, where the total variance ratio is 1. Then the *eigenvalue* of each PC that has been stored in *the pca.explained_variance_* attribute is calculated. All eigenvalue and variance results are summarized in Table 3. Figure 1 shows the distribution of variance for each PC and its cumulative (*scree plot*).

Table 3. Value *Eigenvalue* and the variance of each PC

PC	Eigenvalue	Variance	Cumulative Variance (%)
PC1	7,344784	15,71	15,71
PC2	3,868441	8,27	23,98
PC3	3,12463	6,68	30,66
PC4	2,642744	5,65	36,31
PC5	2,324362	4,97	41,28
PC6	2,169795	4,64	45,92
PC7	2,127605	4,55	50,47
PC8	1,940701	4,15	54,62
PC9	1,806483	3,86	58,48
PC10	1,634951	3,5	61,98
PC11	1,587678	3,39	65,37
PC12	1,390921	2,97	68,34
PC13	1,261856	2,7	71,04
PC14	1,154601	2,47	73,51

PC	Eigenvalue	Variance	Cumulative Variance (%)
PC15	1,089097	2,33	75,84
PC16	1,050443	2,25	78,09
PC17	0,960344	2,05	80,14
PC18	0,859227	1,84	81,98
PC19	0,819724	1,75	83,73
PC20	0,794849	1,7	85,43
PC21	0,749749	1,6	87,03
PC22	0,703207	1,5	88,53
PC23	0,631648	1,35	89,88
PC24	0,567761	1,21	91,09
PC25	0,514996	1,1	92,19
PC26	0,457702	0,98	93,17
PC27	0,436635	0,93	94,1
PC28	0,354891	0,76	94,86
PC29	0,321627	0,69	95,55
PC30	0,284428	0,61	96,16
PC31	0,244332	0,52	96,68
PC32	0,226779	0,48	97,16
PC33	0,20699	0,44	97,6
PC34	0,184813	0,4	98
PC35	0,168496	0,36	98,36
PC36	0,137555	0,29	98,65
PC37	0,123309	0,26	98,91
PC38	0,116148	0,25	99,16
PC39	0,085549	0,18	99,34
PC40	0,077782	0,17	99,51
PC41	0,072595	0,16	99,67
PC42	0,04628	0,1	99,77
PC43	0,035773	0,08	99,85
PC44	0,028469	0,06	99,91
PC45	0,021555	0,05	99,96
PC46	0,01436	0,03	99,99

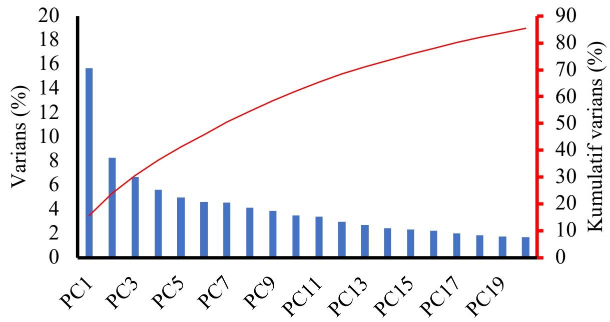

Figure 1. ***Scree plot***

The number of components filtered is determined by the eigenvalue of the component. Components that have an eigenvalue greater than 1.0 are retained in the model. The eigenvalue describes the magnitude of the variation contributed by the component to the 61 variables observed. Based on Table 4, it is known that the eigenvalue greater than 1.0 is the Main Component (PC) 1 to 16 which is blocked in light blue. The cumulative value of variance for the nine components was 78.09%. This means that the 16 main components can explain the correlation between 61 variables by 78.09%.

In this analysis, the varimax *rotation procedure is used*, which is a rotation procedure that groups variables that have a positive loading value to the first main component. Then the variables that have not been selected are grouped based on their positive values in the next main component. And so on until each variable has been grouped. The results of the variable loading value for the main component can be seen in Appendix 1.

Based on Appendix 1, it is known that the variables in a component are known by looking at the positive loading value. Variables are inserted into the PC with *a positive loading* value against the main components of the PC. Table 5 shows grouping variables based on the positive loading values on each PC. It was found that 30 variables were on PC 1 and 16 variables were on PC 2. The rest fell on PC 3 to PC 6. It was found that there was no sub-variable of the variable E (Period of Rebuttal) in PC 1. This can be interpreted that variable E is not the main priority on PC 1.

Table 4. Grouping of variables against each PC

Variable	PC1	PC2	PC3	PC4	PC5	PC6
A. Technical clarification	A1	A3				
	A2	A5				
	A4	A8				
	A6	A9				
	A7					
B. Price Negotiation	B2	B3	B1			
	B5	B4				
	B7	B6				
	B10	B9				
C. Negotiation Evaluation Terms Document	C4	C2		C1		
	C5	C3				
	C9	C6				
		C7				
		C8				
D. Negotiation Evaluation	D1			D5		
	D2					
	D3					
	D4					
E. Period of rebuttal		E5		E3	E1	E2
		E7		E4		
		E8		E6		

Variable	PC1	PC2	PC3	PC4	PC5	PC6
F. Draft Contract Review	F1		F4	F3		
	F2		F6	F9		
	F5			F10		
	F7					
	F8					
G. TTD wet Contract to Release Contract	G1		G9			
	G2					
	G3					
	G4					
	G5					
	G6					
	G7					
	G8					
	G10					

In the PCA analysis, the grouping of PCs is sorted by the highest *eigenvalue* and shows that the PC is the most important. Then PC 1 and PC 2 are enough to represent because 46 of the 61 subvariables are present in these two PCs. However, PC 3 – 6 was not just thrown away. Because these 3 PCs still contain the remaining 15 subvariables. The grouping of subvariables on each PC can be interpreted as sequencing in dealing with problems in the *e-procurement system* with PC 1 as the top priority.

Figure 2 shows that as many as 19 respondents contributed positively to PC 1 and PC 2. The other 19 respondents only contributed positively to PC 1 so that a total of 38 respondents or 82.6% contributed positively to PC 1. The other 4 respondents only contributed positively to PC 2 so that a total of 23 respondents or 41.3% contributed positively to PC 2. The remaining 4 respondents or 8.7% contributed negatively to PC 1 and PC 2. This shows that PC 1 is more dominant than PC 2 because the positive contribution of the largest respondents is in PC 1.

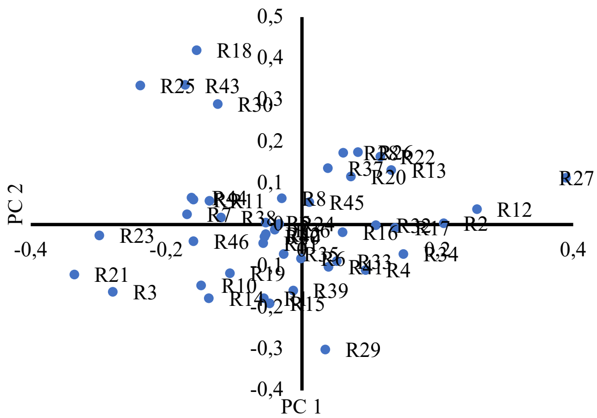

Figure 2. Variable relationship graph on PC 1 and PC 2

Main Component 1 (PC 1)

It was found that PC 1 consisted of 30 selected variables that had a positive loading value. Table 5 shows that out of the 7 variables, variable E is not in the list of PC 1.

Table 5. List of PC variables 1

Variable	Sub variable	
A. Technical clarification	A1	The technical clarification process takes time due to the inconsistency of the technical specifications of the vendor.
	A2	The time it takes to get a reply or confirmation of technical clarification from the vendor is too long.
	A4	The large number of technical documents that need to be examined slows down the clarification process.
	A6	Repeated revisions of technical specifications due to the lack of agreement with the client/owner cause delays in the clarification process.
	A7	The large number of vendors that need to be clarified separately
B. Price Negotiation	B2	Too long negotiation time due to price disagreements.
	B5	Bureaucracy and the need for internal explanations to relevant parties on a recurring basis that slows down the decision to approve prices by management
	B7	Repetitive/long negotiations because they are related to terms and conditions of payment that have not been agreed.
	B10	The budget value has a difference that is considered too far from the final bid value, so it takes time for the budget revision before the final price negotiations are resumed
C. Negotiation Evaluation Terms Document	C4	Incomplete paperwork from the vendor slows down the evaluation process.
	C5	Lack of automation systems to speed up document checking.
	C9	The need for a complete signature on each document takes a long time (Minutes of Negotiation, CBE (commercial bid evaluation), etc.)
D. Negotiation Evaluation	D1	The approval process for negotiation evaluation takes a long time because many parties need to approve approval online.
	D2	The approval process for negotiation evaluation takes longer for procurement items that have a higher value than the budget plan
	D3	The involvement of many parties and the need for reminders of related parties slowed down the approval of evaluation results.
	D4	Weak monitoring of the approval process of online negotiation evaluation results
F. Draft Contract Review	F1	Repeated revision of the draft contract due to unclearness/disagreement with the articles in the initial draft contract.
	F2	Slow process of checking and approving contracts due to internal bureaucracy.
	F5	Lack of digital collaboration tools to speed up the review and approval of draft contracts
	F7	Lack of standard guidance that leads to longer revisions (including Unclear time limits)

Variable	Sub variable	
	F8	Slow response time from the parties involved in the contract review.
G. TTD wet Contract to Release Contract	G1	Delay in collecting signatures from related parties.
	G2	Manual process of collecting signatures that slows down workflows.
	G3	Delay in contract release due to an error in final verification.
	G4	Slow contract distribution process due to lack of digitalization.
	G5	Absence/absence of interested parties for signature at the specified time.
	G6	Long time to double-check the contract and its attachments before signing.
	G7	Delay in sending physical contracts for signature.
	G8	The large number of parties who have to check and paraphrase/sign, prolongs the process time.
	G10	Repeated revisions to contract attachments extend the process time

In the technical problem variable, the main challenges include the number of technical documents and vendors as well as the non-conformity of technical specifications submitted by vendors. When specifications don't meet company standards, the clarification process requires additional time for adjustments, which is compounded by slow vendor confirmation. As a result, other work that relies on technical clarification is also delayed, hindering the overall progress of the project. The workload is getting heavier with the number of documents to check, and the repetitive revision of specifications due to a lack of agreement with the client also lengthens the process.

On other variables, such as price negotiations and document evaluations, price disagreements and lack of supporting data prolong the process. Document evaluation is hampered by incompleteness of vendor documents, slow manual checking, and large number of signature approvals. In the review of draft contracts, repeated revisions and lack of standard guidance slow down completion, exacerbated by bureaucracy and a lack of digital collaboration tools. The process of signing contracts and releasing them was hampered by delays in collecting signatures, physical distribution, and revising attachments many times, which delayed the execution of the project.

Main Component 2 (PC 1)

It was found that PC 2 consisted of 16 selected variables that had a positive loading value. Table 6 shows that 4 of the 7 variables, namely variables A, B, C and E are included in the list of PC 2. Variable E is starting to be discussed on this PC 2.

Table 6. List of PC 2 variables

Variable	Subvariable	
A. Technical clarification	A3	The lack of technical understanding of the objects purchased from the procurement team caused the clarification discussions to be longer.

Variable	Subvariable	
	A5	Scheduling technical clarification meetings is difficult to arrange due to the time constraints of the relevant parties.
	A8	The absence of clear standards for technical assessments causes the clarification process to take longer.
	A9	Less effective communication between the technical team and vendors led to delays in clarification.
B. Price Negotiation	B3	Vendor price changes due to price quote validity limits that require renegotiation.
	B4	Lack of preparation of supporting data leads to a longer price decision-making process.
	B6	Lack of capacity of negotiators to resolve price discussions quickly.
	B9	Price negotiations cannot be finalized immediately because there are still differences in specifications to what is required
C. Negotiation Evaluation Terms Document	C2	Delays in document verification due to a long data collection process.
	C3	Ambiguity/Ambiguity of document requirements that cause repetitive/incomplete revisions.
	C6	Scattered collection of documents that take longer.
	C7	Delays in the delivery of documents from vendors due to lack of coordination.
	C8	Errors in documents that require additional time for re-repair
E. Period of rebuttal	E5	Too many rebuttals slow down the entire process.
	E7	Documentation of rebuttals that require lengthy verification.
	E8	Delay in notification of the decision to the vendor regarding the rebuttal.

The technical clarification process often faces obstacles due to the procurement team's lack of understanding of the technical aspects of the goods or services purchased. This makes clarification discussions take longer because teams have to understand the technical specifications of the vendors, which risks delaying the entire project timeline. Scheduling clarification meetings is also a challenge, as many parties are involved with limited time, causing meetings to be often delayed and prolonging the procurement process. The absence of a clear technical assessment standard also adds to the duration of clarification, as each vendor may have different interpretations, thus complicating the decision-making process. At its core, the team's lack of understanding, productivity and professionalism *E-procurement* In carrying out procurement, the main focus is in improving progress performance (Mahamid, 2016).

The price negotiation stage is often extended by a variety of factors, such as price changes due to the expiration of the validity of the offer and the lack of supporting data that slows down the decision. In addition, the capacity of less qualified negotiators extends the duration of price discussions, and additional negotiations are often required to adjust to differences in specifications. In document evaluation, delays in data collection from various sources cause obstacles to project approval. Another challenge occurs during the rebuttal period, where many rebuttals from vendors require lengthy verification, which can delay the entire procurement process as well as the final decision on the project.

Solutions

From the results of the discussion, it was found that PC 1 and PC 2 have collected 46 out of 61 subvariables that must be prioritized to be improved to improve the progress performance of *centralized e-procurement*. Appendix 2 and Appendix 3 show solutions from various sources that can be used as a reference to improve progress performance. In applying this solution, priority scaling can be done by solving the problem on PC 1 first because the *eigenvalue* is the highest eigenvalue which indicates that PC 1 is the most important component before PC 2.

In essence, the role of automation technology in the centralized *e-procurement system* needs to be improved considering that all procurement activities of goods and services are carried out in an integrated manner. Automation is particularly relevant in speeding up the scheduling and monitoring of the negotiation and approval process of contracts, which usually involve multiple parties. With automated systems, automated reminders and notifications can be integrated to speed up the approval flow, ensuring no party is left behind or hindering the process. A digital system capable of automatically managing documents also allows for efficient collection, verification, and distribution of documents, which greatly helps reduce problems related to document delays or revisions. Integrating automation solutions into *the e-procurement* process not only increases speed, but also ensures transparency and accountability to achieve KPIs and optimal performance in procurement. This system requires parties who understand procurement SOPs, integrated technology, and field implementers to overcome the problems that have been mentioned.

CONCLUSION

Based on the analysis of key components in the centralized e-procurement system at PT. PP Persero, Tbk, this study concludes that six out of ten procurement stages—namely technical clarification, price negotiation, negotiation evaluation requirements documents, negotiation evaluation, contract draft review, and contract wet signatures to release contracts—exhibit performance deficiencies that significantly hinder the achievement of project Key Performance Indicators (KPIs), especially in project progress. These delays are primarily driven by insufficient technical comprehension among procurement personnel, weak interdepartmental communication, inadequate standardization of technical and documentation procedures, and inefficiencies in negotiation and approval workflows. Further contributing factors include limited technological support, inconsistent coordination mechanisms, and the lack of capacity-building for negotiators. This research proposes actionable solutions, including the implementation of automated verification systems, the adoption of standardized e-procurement workflows, and structured training programs to enhance team competencies. It also recommends the utilization of integrated digital collaboration tools to improve communication and decision-making speed. Future research is suggested to focus on measuring the long-term impact of such digital transformation initiatives and to explore predictive models for identifying potential bottlenecks in procurement before they impact overall project timelines. Additionally, comparative studies across different EPC companies can help generalize the effectiveness of centralized e-procurement interventions in improving project performance.

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