Volume 2 Issue 1 (2026) Page. 19 - 38

ISSN: 3110-1119

Journal of Project Management Research

Journal Homepage: https://journalpmresearch.com/jpmr

Risk analysis to improve procurement time performance of the construction services project of Air Traffic Control (ATC) tower and supporting facilities

Bagus Adi Prabowo [1)], Wisnu Isvara [2)], Titi Sari Nurul Rachmawati [3)]

[1), 2), 3)] Civil Engineering Department, Universitas Indonesia

Corresponding author, e-mail: bagusprabowo.adi@gmail.com

ABSTRACT

The implementation of the procurement process for the construction services of the ATC Tower and Supporting Facilities at Perum XYZ is expected to be completed on time with the delivery of the ATC Tower infrastructure and Supporting Facilities to support optimal flight navigation services. However, in the period 2016-2023, obstacles occurred at several project locations which caused the benefits of the project development to be delayed. This study aims to analyze the dominant risk factors that affect the performance of the procurement time for the construction services of the ATC Tower and Supporting Facilities at Perum XYZ. Risk identification was carried out through literature studies and then validated by experts. Furthermore, the risks were submitted to respondents who had been involved in the procurement of construction services for the ATC Tower and Supporting Facilities at Perum XYZ and then a risk analysis was carried out by referring to the company's internal regulations related to the Company's Risk Management Policy and Guidelines. From the results of data collection and analysis, it was found that there were 5 dominant risk factors with a high risk level that affected the procurement time performance. The results of this study can be a basis for determining the development of a procurement strategy for the construction services of the ATC Tower and Supporting Facilities at Perum XYZ in improving procurement time performance.

KEYWORDS

Procurement Management, Risk Management, Construction Project, ATC Tower

How to cite: Prabowo, B. A., Isvara, W., & Rachmawati, T. S. N. (2026). Risk analysis to improve procurement time performance of the construction services project of Air Traffic Control (ATC) tower and supporting facilities. *Journal of Project Management Research*, *2*(1), 19–38. https://doi.org/10.65303/journalpmresearch.v2i1.61

1. INTRODUCTION

Apart from being responsible for Air Traffic Management, Perum XYZ is a state-owned company that has the responsibility to modernize the supporting equipment for flight navigation services at 296 airports throughout Indonesia that have reached the end of life, including the rejuvenation of the ATC Tower Building and its supporting facilities. The ATC Tower building is a tall, windowed structure located in the airport area to control the airport environment, especially through visual observation and has an eye level height that allows the Controllers to monitor each end of the runway clearly without obstruction (Peiris et al., 2019). In addition to the age of the building, the need for the construction of a new ATC Tower building generally arises as a follow-up to changes in the master plan for an airport, which if there is a delay in the procurement process, it can have

https://doi.org/10.65303/journalpmresearch.v2i1.61

Received 23 April 2026; Accepted 22 May 2026; Published 31 July 2026

a major impact, mainly due to increasing the risk of flight safety because of visual obstruction from the ATC Controller to the airside area as an impact of airport development.

The time delays that occurred in the procurement of ATC Tower Construction Services and Supporting Facilities at Perum XYZ generally occurred at all stages of the procurement process, namely procurement planning, procurement preparation, procurement implementation, work contracts, work implementation, and handover of work.

Table 1. Delay Occurred in the Procurement Construction Services of the Air Traffic Control (ATC) Tower and Supporting Facilities Project in Perum XYZ

Project Site	Year	Scope of Work	Procurement Preparation Duration (Days)	Conduct Procurement Duration (Tendering) (Days)			Procurement Implementation Duration (Days)			Contract Type	Remark
				Target	Actual	Gap	Target	Actual	Gap		
A	2016	Building Construction	5	24	24	-	210	427	217	Design Bid Build	-
B	2016	Building Construction with Tower Set Equipment	4	64	127	63	270	429	159	Design & Build	-
C	2016										
D	2016										
E	2017	Building Construction with Tower Set Equipment	34	50	81	31	270	547	277	Design & Build	-
F	2017										
G	2017										
H	2017	Building Construction	86	31	50	19	240	352	112	Design Bid Build	-
I	2018	Building Construction	36	42	79	37	225	225	-	Design Bid Build	--
J	2019	Building Construction	120	48	55	7	240	740	253	Design Bid Build	247 days suspended due to pandemic
Average			47.5			31.4			203.6		

Source: Perum XYZ Dashboard Monitoring, Archive Document, E-Procurement, 2016-2023

The National Development & Consultation Institute (LPKN) (2025) stated that procurement preparation takes between 10-14 working days, so that the procurement preparation time in the procurement of ATC Tower Construction Services and Supporting Facilities at Perum XYZ for 10 locations in table 1 experienced an average delay of 33.5 calendar days and the average procurement implementation process (tender process) experienced a delay of 31.4 calendar days. Thus, if the delay time is combined with the average delay that occurs in the work implementation process, which is 203.6 calendar days, then the total delay in the procurement process for ATC Tower Construction Services and Supporting Facilities is 268.5 days. According

to Findy (2012) from the work owner's perspective, delays in completing project work will cause losses to the project's operating time, so that the use of project development results is delayed.

The ATC Tower of an airport is a vital object whose construction process can be influenced by various risk factors, which any mishandling action can lead to the failure of the project to complete. Therefore, careful planning and implementation strategies, along with a risk-based methodology, are required to achieve efficiency and effectiveness (Phuong et al., 2022). This study was conducted to identify the dominant risks in the procurement of ATC Tower Construction Services and Supporting Facilities at Perum XYZ, which affect procurement time performance through the following research questions:

1. What are the existing business processes and activities of the construction services procurement process for the ATC tower construction project and supporting facilities?
2. What are the risks of the procurement process for construction services in the ATC tower construction project and supporting facilities?
3. What are the dominant risks that affect the performance of construction service procurement time for the ATC Tower Development project and supporting facilities?

2. LITERATURE REVIEW

In the procurement planning stage of construction work, Dita et al (2020) stated that the four biggest risks that occur are the lack of coordination between the Project Manager and the Procurement Service Unit resulting in different perceptions of the scope of work due to the lack of maturity of tender preparation, biased specifications due to non-standardized processes, inaccuracy in splitting or merging work packages due to an improper planning process, and incomplete procurement plans resulting in the procurement process not being able to be implemented as soon as possible. In addition, in the procurement preparation stage, according to Sujata et al (2019), as in their research on the Gautam Buddha International Airport construction project, general risks in construction procurement projects at airports including the construction of ATC Towers and supporting facilities include design, specification, estimation, and scheduling issues.

At the tender implementation stage, the lack of interest of participants to bid (Dinda et al, 2024), the duration of the clarification meeting being too short (Dita, 2020), and no participants passing the technical evaluation (Karyasa, 2014) are some of the risks that may occur in the tender implementation. Meanwhile, after the tender winner is obtained, at the work engagement stage which includes the contractual agreement between the project owner and the contractor, there is a significant influence on the procurement time performance. Having a clear and detailed contract can help set expectations, establish schedules, and identify potential risks that could affect project duration. Oyegoke et al. (2019) concluded that risks associated with project time management issues are often caused by inadequate planning and risk assessment during the contract drafting stage.

At the work implementation stage, Towhid and Amiruddin (2011) stated that the main causes of delays in procurement of construction projects are poor management and supervision, delays in payment of work progress by the owner, changes in orders during construction, ineffective preparation of plans and schedules by the contractor, financial problems faced by the contractor, slow decision-making process by the owner, delays in producing design documents, late review and approval of design documents by the owner, poor contract management by the consultant, and problems with subcontractors can also occur as happened in the procurement of Construction Services of ATC Tower and Supporting Facilities project at Perum XYZ. At the end of the process, the handover stage significantly affects the performance of construction projects by ensuring that all contractual obligations are fulfilled and project documentation is archived for future reference, as concluded by Razkallah Hanane and Bendjama Rachida (2022) that effective

work handover can facilitate the process of evaluating supplier performance and identifying lessons learned that are useful for improving the procurement process in the future.

According to Banaitiene and Banaitis (2012), the lack of a risk management strategy in the construction services procurement process is the main cause of delays in completing work from the predetermined schedule. Therefore, an analysis is needed to identify what risk factors are influencing in the procurement of Construction Services of ATC Tower and Supporting Facilities project at Perum XYZ.

3. METHODOLOGY

3.1. Research Process

This research begins by examining the business process of procurement of construction services for the Air Traffic Control (ATC) Tower and supporting facilities at Perum XYZ through literature studies on both the company's internal archives and previous studies and then identifying risk factors before validation with experts to answer the first and second research questions.

After obtaining validation of existing business processes and activities, a questionnaire was then set to be sent to respondents who had been involved in the procurement of construction services for the ATC Tower and Supporting Facilities at Perum XYZ either as a Technical Specification Unit, Procurement Unit, Procurement Committee, Contract Implementation Officer, Construction Supervision Officer, or Work Results Inspector. The questionnaire was made with a Likert scale with the following criteria:

Table 2. Impact Scale

Scale	Rating	Description
1	Insignificant	Has no significant impact on procurement time performance (Investment delays of <3 months)
2	Minor	Has a minor impact on procurement time performance (Investment delays of >3 to 6 months)
3	Moderate	Has a moderate impact on procurement time performance (Investment delays of >6 months to 1 year)
4	Major	Has a significant impact on procurement time performance (Investment delays of >1 to 2 years)
5	Catasthropic	Has a fatal impact on procurement time performance (Investment delays of >2 years)

Source: Perum XYZ Regulations of Corporate Risk Managemen Policy and Guidline, 2018

Table 3. Frequency Scale

Scale	Occurence	Description
1	Rare	Likely to occur only under abnormal conditions (Probability < 20%)
2	Low	Likely to occur some of the time (probability 20% to 40%)
3	Moderate	Likely to occur some of the time (probability 40% to 60%)
4	High	Likely to occur in many circumstances (probability 60% to 80%)

5	Almost Certain	Likely to occur in many circumstances (probability 80% to 99%)

Source: Perum XYZ Regulations of Corporate Risk Managemen Policy and Guidline, 2018

The results of data collection from the questionnaire are then processed through the following four steps:

1. Conducting Statistical Tests in the form of Homogeneity Tests, Validity Tests, and Reliability Tests
2. Conduct a risk assessment by multiplying the frequency score by the impact score.
3. Ranking risk scores from highest to lowest
4. Determine the risk with the highest risk score as per table 4 and conduct a Pearson correlation test to determine the strength and direction of the relationship between the dominant risk and procurement time performance.

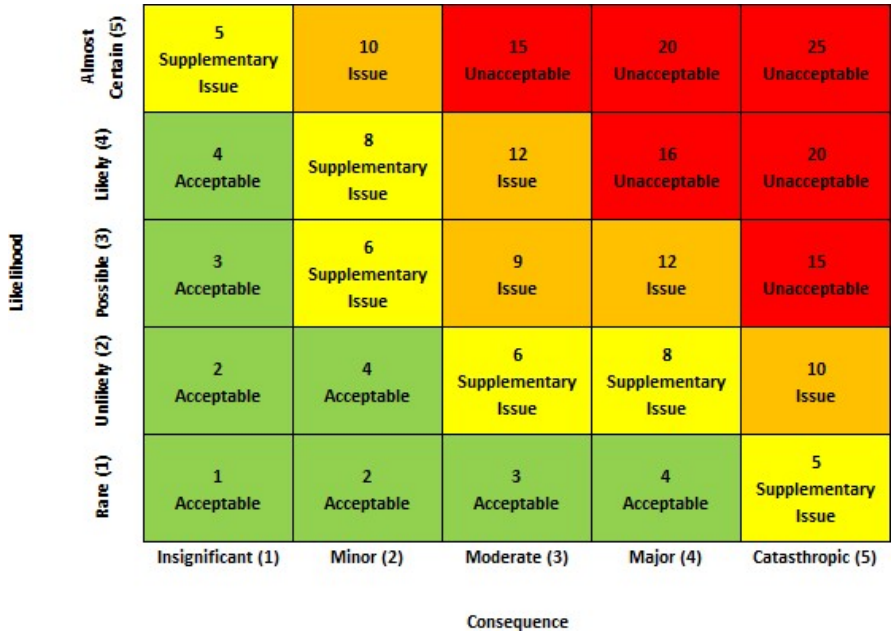

Figure 1. Probability and Impact Matrix

Table 4. Risk Level

No	Risk Level		Range
1	Extreme	Unacceptable	$15 \leq x \leq 25$
2	High	Issue	$9 \leq x < 15$
3	Medium	Supplementary Issue	$5 \leq x < 9$
4	Low	Acceptable	$1 \leq x < 5$

Source: Perum XYZ Regulations of Corporate Risk Managemen Policy and Guidline, 2018

From Table 4, it can be further explained that for an Unacceptable risk level, immediate action is required to manage the risk, for the Issue risk level, action is required to manage the risk, meanwhile for Supplementary Issue, action is recommended if resources are available, and Acceptable risk level does not require any action.

3.2. Data Collection and Analysis

Data collection in stage 1 was carried out by validating the existing business processes and activities of the construction services procurement process for the ATC Tower and Supporting Facilities Development project and the risk factors of each activity obtained from literature studies and previous research. Validation was carried out on 5 experts from Perum XYZ's internal organizations who represented each stage in the procurement process and were directly involved in the ATC Tower and Supporting Facilities construction project with profiles as shown in Table 5.

In accordance with their respective roles and responsibilities, the VP of Procurement Services is involved in procurement implementation, while the VP of Procurement Planning is responsible for procurement preparation. The Project Delivery Specialist and the VP of Support Management are engaged in contract implementation, whereas the AVP of Building and Landscape Planning participates in the procurement planning stage.

Table 5. The Experts Profile

No	Expert	Position	Work Experience (years)	Recent education
1	E1	VP of Procurement Services	31	Bachelor Degree
2	E2	VP of Procurement Planning	22	Bachelor Degree
3	E3	Project Delivery Specialist	30	Bachelor Degree
4	E4	VP of Support Management	24	Master's Degree
5	E5	AVP of Building and Landscape Planning	14	Bachelor Degree

Source: Primary data processed, 2025

The results of expert validation of activities in the business process and existing activities of the procurement of construction services and the risks in the ATC Tower Construction and Supporting Facilities project proposed by the author are as shown in Table 6.

Table 6. Business Process and existing activities with risk factors

No	Activity	Code	Risk Factors
X1	**Procurement Planning**		
X1.1	Determining Procurement Strategy		
	Work packaging	X1.1.1	Risk of the project being too large/complex
		X1.1.2	The risk of documents that do not comply with location conditions or document planning.
	Work Integration	X1.1.3	Risk of inaccuracy in Work integration
	Selection of procurement method and/or selection method	X1.1.4	The risk that the chosen method does not match the complexity and cost of the procurement
	Determination of packages that require a Procurement Steering Team	X1.1.5	Risk of Lack of Relevant Skills and Experience
	Determination of Procurement Priorities	X1.1.6	The risk of sudden requests for work procurement that require immediate completion
X1.2	Determination of Procurement Implementation Location		

No	Activity	Code	Risk Factors
	Propose a list of procurement packages and determine the location for procurement implementation to the Board of Directors	X1.2.1	Risk of difficulties in the process of monitoring contract implementation and the quality of goods/services
		X1.2.2	Risk of increased costs for supervision and personnel requirements
X1.3	Determination of the Procurement Committee and Procurement Support Team		
	Determination of the Procurement Committee	X1.3.1	The risk of having procurement committee members who lack of expertise and experience in the procurement field (e.g., technical, legal, financial)
		X1.3.2	The risk of the procurement committee carrying out procurement for several procurement packages simultaneously
	Submitting a Procurement Support Team for determination by the Board of Directors	X1.3.3	The risk of having support team members who do not understand company regulations regarding procurement
X2	**Procurement Preparation**		
X2.1	Procurement Preparation by User		
	Preparing URS and KAK for Procurement	X2.1.1	Risk of incomplete deliverables and acceptance criteria requirements
X2.2	Procurement Preparation by Technical Specification Unit		
	Compiling Technical Documents with reference to *the User Requirement Specification* (URS) and the procurement Terms of Reference (TOR)	X2.2.1	Risk of unclear technical specifications/TOR/ identification of needs/scope of work for tender documents
		X2.2.2	The risk of drafting Technical Specifications lead to particular brand or supplier.
	Creating a Quantity List	X2.2.3	Risk of Inaccurate Work Volumes and Unclear or Ambiguous Work Item Descriptions
	Performing Engineer's Estimate (EE) calculations	X2.2.4	The risk of Engineer's Estimate (EE) being set too low
		X2.2.5	The risk of Engineer's Estimate (EE) being set too high and unreasonable
X2.3	Preparation of Technical Documents		

No	Activity	Code	Risk Factors
	Compiling Technical Documents, Bill of Quantities and Engineer Estimate (EE) calculations based on: a. Expert or consultant; b. Prices in the market (RFI (Request for Information), market surveys, and published prices); c. Unit costs are determined by either the authorized institution or the relevant organization; d. Price list from the manufacturer; and/or e. Previous audited Contract Costs.	X.2.3.1	Risks of unavailability of data and information, errors in techniques and methods used, low estimator skills
		X.2.3.2	The risk of preparing an unaccompanied Engineer's Estimate (EE) by accountable supporting data.
		X.2.3.3	Risk of discrepancies between technical documents and Bill of Quantity (BOQ)
X.2.4	Submission of tender request		
	Letter submission completed with Technical Documents, *Bill of Quantity* (List of Quantities), *Engineer Estimate* (EE), Procurement Requisition Letter and attachments	X2.4.1	Risk of design, specification, estimation and scheduling errors
X3	**Procurement Implementation**		
X3.1	Tender Preparation		
	Drafting a contract	X3.1.1	Risk of ambiguity regarding payment terms, implementation duration, or administrative and legal errors
	Preparation of OE and determined as an estimate of the fair price of goods/services	X3.1.2	Risk of error in setting Owner's Estimate (OE)
		X3.1.3	Legal risks in preparing OE which can lead to expensive prices
	Determine the tender implementation plan (Submission Method, Qualification, Technical and Price Requirements, and Number of Winners)	X3.1.4	Risk of errors in determining qualification and technical requirements
	Preparation of Tender documents, which contain information including: a. Invitation/Announcement b. Instructions to Participants c. Total OE cost d. Provisions regarding Contracts e. Bill of Quantity (List of Quantities and Prices) f. Technical Documents (with drawings) g. Terms of the Bidding Document, which includes the Technical Bidding Document and the Price Bidding Document. h. Warranty Terms i. Examples of other forms that are deemed necessary to be filled in (if any)	X3.1.5	Risk of unclear/biased tender documents
X3.2	Tender Implementation		

No	Activity	Code	Risk Factors
	Announcement	X3.2.1	Risk of a lack of participants
	Registration and Collection of Election Documents	X3.2.2	The risk of minimal supplier interest in bidding
	Clarification Meeting (Aanwijzing)	X3.2.3	The risk of the Clarification Meeting duration being too short and only discussing the fulfillment of administrative requirements
		X3.2.4	The risk of not being given sufficient opportunity and time to participants to ask questions about technical documents
	Submission of Bidding Documents	X3.2.5	Risk of no participants uploading bid documents
	Opening of Bidding Documents	X3.2.6	Risk of incomplete required documents
	Administrative Evaluation, Technical Evaluation and Announcement of Technical Evaluation Results	X3.2.7	The risk that no participants pass the administrative and technical evaluation
	Opening of Price Bidding Documents	X3.2.8	Risk of errors in writing numbers and letters in the offer price
	Price Evaluation	X3.2.9	The risk that the results of the negotiations will not produce the best price or above the OE
	Determination of Tender Winner	X3.2.10	Risk of tender failure/not being awarded the tender winner
	Objection	X3.2.11	Risk of objections arising at the end of the tender process
X4	**Contract**		
X4.1	Supplier Appointment and Contract Signing		
	The authorized official issues the Letter of Award	X4.1.1	Risk of land/location not being ready
	Preparing the contract signing preceded by ensuring the supplier's status on the VMS, the contract drafting finalization, the start date of work implementation, and other necessary matters	X4.1.2	Risk of Contract Clauses Not Complying with Tender Documents or Negotiation Results
		X4.1.3	Risk of awarded supplier withdrawing
		X4.1.4	The risk of changes in the authorized official of one or both of the parties
	Performance Bond submission by supplier	X4.1.5	Risk of delay in submission of Performance Bond
	Signing of the Contract	X4.1.6	Risk of signing the contract not according to the planned schedule
X5	**Implementation of Work (Contract)**		
X5.1	Preparation for the Implementation of the Work		

No	Activity	Code	Risk Factors
	Holding a Preparatory Meeting for the Implementation of the Contract	X5.1.1	The risk of non-compliance between tender agreement commitments and those stated in the contract
		X5.1.2	The risk of work not starting immediately according to the predetermined schedule
		X5.1.3	There is a risk of failure in the implementation of the work because the start of the work implementation begins when the preparatory meeting is being held.
X5.2	Work Execution Control		
	Carry out work supervision and monitoring of work implementation which includes the scope, volume and technical specifications of the work in accordance with the provisions of the Contract.	X5.2.1	The risk of changes in design or specifications/materials during contract implementation
	Carry out control by monitoring and evaluating the implementation of work based on the Contract	X5.2.2	The risk of inaccurate contractor performance reports
		X5.2.3	The risk that the contractor will not be able to carry out the work due to increasing price
	Based on the results of the work implementation monitoring meeting, a proposal can be made to the Authorized Official to issue a Notice Letter or determine the handling of Critical Contract.	X5.2.4	The risk of the work not being completed within the time specified to the contractor
X5.3	Interim Payments		
	Submit a complete payment request by: a. Payment Request Letter issued by the contractor to the Authorized Official, complete with "Invoice", Receipt and Tax Invoice; b. Work Progress Report; c. If there are imported goods, copy of the import documents, proof of paid import duties, import-related taxes, and/or *Certificate of Origin* must be attached. d. Documentation and Reports regarding the work completion process based on the provisions of the Contract; and e. Other documents required in the contract clause.	X5.3.1	Risk of incomplete Payment Request Documents
		X5.3.2	The risk of tax burden if there is a delay in the payment process
X5.4	Changes in Contracts		
	Conduct evaluation and verification if there are changes to the implementation of the work contract and implement changes to the work contract in accordance with the addendum referring to the Minutes of Work Changes.	X5.4.1	Risk of inadequate documentation or misunderstandings regarding changes to project scope, schedule, or costs.
X5.5	Work Completion		

No	Activity	Code	Risk Factors
	Prepare a Work Progress Report containing information that the work has been 100% completed as proof that the work has been carried out and completed according to the Contract implementation duration by the contractor.	X5.5.1	Risk of Progress Not Matching Real Progress
	Create a "Defect List" *to* be attached to the Work Progress Report, the repair of which is the responsibility of the contractor.	X5.5.2	The risk of an incomplete defect list
X6	**Handover**		
X6.1	Project Completion Testing		
	Testing a project competion through a Site Acceptance Test or other tests relevant to *the scope* of work to ensure that the Contract requirements have been met.	X6.1.1	Risk of defects in construction
	The contractor carries out repairs and then carries out re-testing these repairs before the work completion period ends.	X6.1.2	Risk of Incomplete or Unsatisfactory Defect Repair
	Inspector and the contractor prepare a Work Completion Report (BAPP) which contains information that the works carried out confirm its purpose functions as required in the Contract.	X6.1.3	Risks of Preparing BAPP Based on Inaccurate Inspection
X6.2	Handover		
	Submission of project handover request by the contractor	X6.2.1	Risks of Submitting Handover of Unfinished or Non-Conforming Work
	Drafting the Handover Report I (BAST-I) for approval by the Authorized Official	X6.2.2	Risk of Mismatch Between BAST and Actual Work Conditions
	Signing of the Minutes of Handover I (BAST-I) by the Authorized Official and the contractor	X6.2.3	The Risk of Accepting Non-Conforming Work in Specifications or Quality
		X6.2.4	Risks with Internal and External Audits
X6.3	Final Payment		
	The contractor submits a Final Payment "Invoice" with the following attachments: a. Payment Request Letter issued by the contractor to the Authorized Official, complete with a receipt and Tax Invoice; b. Work Completion Report (BAPP); c. Minutes of Handover I (BAST-I); d. If there are imported goods, copy of the import documents, proof of paid import duties, import-related taxes, and/or *Certificate of Origin* must be attached. e. Documentation and Reports regarding the work completion process based on the provisions of the Contract; and f. Other documents required in the contract clause.	X6.3.1	Risk of incomplete Final Payment Request Documents
X6.4	Maintenance		

No	Activity	Code	Risk Factors
	Conduct work supervision during the maintenance period	X6.4.1	Risk of the contractor not performing maintenance
		X6.4.2	The risk that the contractor has closed down, bankruptcy or insolvent
	Conduct testing and preparation of Work Maintenance Completion Report (BAPPP) and draft Minutes of Handover II (BAST II) to be carried out for the signing process by the Authorized Official and the contractor.	X6.4.3	Risk of Accepting Maintenance Work that Does Not Meet Specifications or Quality

Source: Literature Study, Primary data processed, 2025

Table 6 presents the activities involved in the business process of the ATC Tower Construction Project and Supporting Facilities at Perum XYZ, as well as the risks associated with each activity, as identified through a review of the literature and input from experts. From the results of data collection stage 1,49 activities were obtained in the business process and existing activities of the procurement of construction services in the ATC Tower Construction project and supporting facilities at Perum XYZ as well as 66 risk factors which became the reference in compiling the questionnaire that will be sent to respondents which preceded by conducting stage 2 in the form of Pilot Survey to 5 respondents candidate. The results of data collection stage 2 showed that the five respondents had understood the risk statements in the questionnaire. In addition, several respondents provided feedbacks to further clarify the statements on the risk factors X1.1.1, X1.1.2, X1.1.5, X1.2.2, X1.3.1, X2.4.1, X3.1.3, X3.2.6, and X6.2.1, which were then analysed and adjusted as shown in Table 7.

Table 7. Risk Factor Statement Correction

No	Activity	Code	Initial	Adjustment
			Risk Factors	**Risk Factors**
X1.1	Determining Procurement Strategy			
	Work packaging	X1.1.1	Risk of Packages Being Too Large/Complex	Risk of the Work Package Scope fo Work Being Too Large/Complex
		X1.1.2	The risk of documents that do not comply with location conditions or document planning.	The risk of documents that do not comply with site conditions or technical document planning.
	Determination of packages that require a Procurement Steering Team	X1.1.5	Risk of Lack of Relevant Skills and Experience	Risk of Lack of Relevant Skills and Experience from the Steering Team
X1.2	Determination of Procurement Implementation Location			
	Propose a list of procurement packages and determine the location for procurement	X1.2.2	Risk of increased costs for supervision and personnel requirements	Risk of increased costs for supervision and the need for additional personnel

No	Activity	Code	Initial	Adjustment
			Risk Factors	**Risk Factors**
	implementation to the Board of Directors			
X1.3	Determination of the Procurement Committee and Procurement Support Team			
	Determination of the Procurement Committee	X1.3.1	The risk of having procurement committee members who lack adequate expertise and experience in the procurement field (e.g., technical, legal, financial)	The risk of having procurement committee members who lack adequate qualifications, expertise and experience in the procurement field (e.g., technical, legal, financial)
X.2.4	Submission of tender request			
	Letter submission completed with Technical Documents, *Bill of Quantity* (List of Quantities), *Engineer Estimate* (EE), Procurement Requisition Letter and attachments	X2.4.1	Risk of design, specification, estimation and scheduling errors	Risk of technical design, specification, estimation and scheduling errors
X3.1	Tender Preparation			
	Preparation of OE and determined as an estimate of the fair price of goods/services	X3.1.3	Legal risks in preparing OE which can lead to expensive prices	There is a risk of legal violations occurring in the OE preparation process, which could result in high prices.
X3.2	Tender Implementation			
	Opening of Bidding Documents	X3.2.6	Risk of incomplete required documents	The risk of incomplete fulfillment of the requirements in the Offer Documents
X6.2	Handover			
	Submission of project handover request by the contractor	X6.2.1	Risks of Submitting Handover of Unfinished or Non-Conforming Work	Risk of Accepting a Handover Application for Unfinished Work or Non-Conforming Work in Specifications or Quality

Source: Primary data processed, 2025

Then, the results of the pilot survey as presented in Table 7 assisted the author in refining the descriptions of the risk factors to enhance their clarity and comprehensibility for respondents. Accordingly, nine risk variables were revised based on the findings of this pilot survey. The adjusted questionnaire according to the results of the Pilot Survey was sent to respondents for conducting stage 3 data collection that were obtained from 30 respondents with profiles as shown in Table 8.

This study employed a purposive sampling technique, considering that the object of the research is situated within the business process scope of Perum XYZ. Accordingly, the target sample consisted of 30 employees within Perum XYZ in a position at a minimum equivalent to Senior Staff,

Specialist, Junior Manager, or Manager, with at least a Diploma III (D3) level of education, selected as respondents based on specific criteria relevant to this study such as a minimum of five years of professional experience and prior involvement as a procurement practitioner in the ATC Tower construction project, serving within the Technical Specification Unit, Procurement Unit, Procurement Committee, Contract Implementation Officer, Construction Supervision Officer, or Work Results Inspector.

Table 8. The Respondents Profile

Respondents	Recent education	Work Experience (years)	Position	Respondents	Recent education	Work Experience (years)	Position	Respondents	Recent education	Work Experience (years)	Position
R1	S2	20	Procurement Specialist	R11	D3	11	Administrative staff	R21	S1	12	Avp of Elec And Mech Planning
R2	S1	20	Procurement Specialist	R12	S1	20	Specialist	R22	S1	21	AVP of Vendor Management
R3	S1	10	Procurement Specialist	R13	S1	10	Procurement Specialist	R23	S1	12	Procurement Specialist
R4	S1	25	Corporate Services Officer	R14	S2	20	Procurement Specialist	R24	S1	57	AVP of Strategic Sourcing
R5	S1	10	Procurement Specialist	R15	S1	10	Procurement Specialist	R25	S1	37	Procurement Specialist
R6	S1	11	Procurement Specialist	R16	D3	11	Data Analyst	R26	S2	20	Project Delivery Specialist
R7	S2	13	Procurement Specialist	R17	S2	25	Procurement Specialist	R27	S2	28	Project Delivery Specialist
R8	S2	8	Procurement Specialist	R18	D3	25	AVP of Electrical & Mechanical	R28	S2	8	Administrative staff

Respondents	Recent education	Work Experience (years)	Position	Respondents	Recent education	Work Experience (years)	Position	Respondents	Recent education	Work Experience (years)	Position
R9	S1	30	Project Delivery Specialist	R19	D3	10	Readiness Procurement Specialist	R29	D3	8	Administrative staff
R10	S1	16	Project Delivery Specialist	R20	S1	10	Staff	R30	S1	15	Data Analyst

Source: Primary data processed, 2025

3.3. Validity Test

From the data collected from the stage 3 questionnaire, a statistical test was then carried out, namely a validity test using the Pearson Correlation Test where If the calculated R value is higher than the R table and the significance level is 5%, then the validity conditions are met. If the calculated R is lower than the R table, it implies that the statement or question item in the survey does not correlate significantly with the overall score, so the item is invalid. From the results of the validity test, it was found that the variables X1.1.6, X1.3.1, X1.3.2, X3.2.1, X3.2.2, X3.2.10 had R count < R table, so these variables were declared invalid and removed from the list of risk variables.

3.4. Reliability Test

The reliability test was conducted using the Cronbach's Alpha method, with the basis of decision-making being that if the Cronbach's Alpha value is > 0.60, it is reliable, and if the Cronbach's Alpha value is < 0.60, it is unreliable. The results of the reliability test obtained a Cronbach's Alpha value for the Frequency Scale of 0.982 (> 0.6) and for the Impact scale of 0.984 (> 0.6). Thus, the question items in the questionnaire are reliable.

3.5. Homogeneity Test

A Homogeneity Test was conducted using Kruskal-Wallis H by considering that the classification used was more than 2 (two) categories to obtain information regarding the level of differences in understanding of the existing respondent data with the categories as shown in Table 9.

Table 9. The Respondent Categories

No	Recent education	Category	Work Experience (years)	Category	Position	Category
1	D3	1	> 5 years	1	Staff	1
2	S1	2	> 15 years	2	Equivalent to Specialist	2
3	S2	3	> 25 years	3	Managerial	3

Source: Primary data processed, 2025

The following are the hypotheses used in this test:

- Ho = There is no difference in the perceptions of respondents with different positions, work experience and recent education.
- Ha = There is a difference in at least one respondent's perception with different positions, work experience, and recent education.

The guidelines used to accept or reject the proposed null hypothesis (Ho) are:

- Ho is accepted if the p-value in the Asymp. Sig column > level of significance (α) of 0.05.
- Ho is rejected if the p-value in the Asymp. Sig column < level of significance (α) of 0.05.

The results of this test showed that:

1. Based on recent education:
   - There are variables that are rejected on the frequency scale for variables X2.2.1, X3.1.1, X4.1.1, X5.1.2, X5.2.1, X5.2.3, X5.3.1, X6.2.2, X6.2.3, and X6.3.1
   - There are variables that are rejected on the impact scale for variables X2.2.1, X2.2.3, X2.3.1, X3.1.1, and X6.2.2
2. Based on work experience
   - There are variables that are rejected on the frequency scale for variables X2.4.1, X3.1.2, X3.1.4, and X3.1.5
   - There are variables that are rejected on the impact scale for variables X1.1.3, X1.1.5, X2.2.3, X2.4.1, X3.1.4, and X3.2.10
3. By Position
   - There is one variables that is rejected on the frequency scale for variable X1.3.1
   - All variables on the impact scale are accepted.

From the results of the statistical test, elimination was then carried out on the risk variables that were rejected in the homogeneity test and invalid in the validity test so that a total of 42 risk factors were obtained to be continued to perform qualitative risk analysis by multiplying the frequency and impact scores for each risk factor and a risk ranking is arranged from the highest to the lowest score and all risk factors are mapped into the Probability and Impact Matrix with the results as shown in Table 10.

Table 10. Risk Ranking

Variable	Frequency Average	Impact Average	Risks	Ranking	Risk Level	Variable	Frequency Average	Impact Average	Risks	Ranking	Risk Level
X1.1.1	3.33	3.30	11.00	1	High	X.2.3.2	2.10	2.33	4.90	22	Low
X5.2.4	3.10	3.27	10.13	2	High	X4.1.4	1.90	2.57	4.88	23	Low
X1.1.2	2.93	3.30	9.68	3	High	X6.2.1	1.93	2.50	4.83	24	Low
X3.2.5	2.90	3.27	9.47	4	High	X5.1.1	2.00	2.40	4.80	25	Low
X3.2.7	2.90	3.23	9.38	5	High	X6.1.2	2.00	2.40	4.80	25	Low
X3.2.6	2.90	3.10	8.99	6	Medium	X3.2.9	2.07	2.30	4.75	27	Low
X6.2.4	2.90	2.97	8.60	7	Medium	X4.1.2	2.00	2.37	4.73	28	Low
X1.2.1	2.63	3.10	8.16	8	Medium	X6.1.3	2.03	2.27	4.61	29	Low
X.2.3.3	2.70	2.97	8.01	9	Medium	X3.2.8	2.13	2.13	4.55	30	Low
X5.5.1	2.73	2.83	7.74	10	Medium	X3.2.4	2.10	2.13	4.48	31	Low
X5.4.1	2.67	2.90	7.73	11	Medium	X2.2.5	2.07	2.17	4.48	32	Low
X2.1.1	2.73	2.77	7.56	12	Medium	X4.1.3	1.60	2.73	4.37	33	Low
X1.2.2	2.53	2.93	7.43	13	Medium	X6.4.1	1.77	2.37	4.18	34	Low
X1.3.3	2.63	2.63	6.93	14	Medium	X3.2.11	1.67	2.40	4.00	35	Low
X5.2.2	2.43	2.73	6.65	15	Medium	X4.1.6	1.80	2.20	3.96	36	Low
X1.1.4	2.37	2.73	6.47	16	Medium	X3.1.3	1.87	2.07	3.86	37	Low

Variable	Frequency Average	Impact Average	Risks	Ranking	Risk Level	Variable	Frequency Average	Impact Average	Risks	Ranking	Risk Level
X2.2.4	2.23	2.53	5.66	17	Medium	X2.2.2	1.87	2.03	3.80	38	Low
X5.5.2	2.20	2.50	5.50	18	Medium	X6.4.3	1.70	2.20	3.74	39	Low
X5.1.3	2.13	2.57	5.48	19	Medium	X5.3.2	1.83	2.00	3.67	40	Low
X6.1.1	2.03	2.53	5.15	20	Medium	X6.4.2	1.50	2.30	3.45	41	Low
X3.2.3	2.13	2.37	5.05	21	Medium	X4.1.5	1.53	2.10	3.22	42	Low

Source: Primary data processed, 2025

The Pearson correlation test was then conducted on the five high risk factors to determine the strength or weakness of the variables and the direction of the correlation between the high risk factors (X) and procurement time performance (Y) resulted that all variables have results above 0.5 (Table 11) which indicates that there is a strong correlation and those five variables show a correlation - (negative) which indicates that all dominant risk variables (X) have the opposite direction of the relationship with variable Y (time performance). Thus, actions performed to reduce the impact of dominant risks will improve time performance.

Table 11. Pearson Correlation Test For Dominant Risk Factors

Variables		X1.1.1	X1.1.2	X3.2.5	X3.2.7	X5.2.4	Y
X1.1.1	Pearson Correlation	1	0.599**	0.584**	0.617**	0.431*	-0.572**
X1.1.2	Pearson Correlation	0.599**	1	0.398*	0.345	0.538**	-0.531**
X3.2.5	Pearson Correlation	0.584**	0.398*	1	0.804**	0.492**	-0.680**
X3.2.7	Pearson Correlation	0.617**	0.345	0.804**	1	0.471**	-0.552**
X5.2.4	Pearson Correlation	0.431*	0.538**	0.492**	0.471**	1	-0.651**
Y	Pearson Correlation	-0.572**	-0.531**	-0.680**	-0.552**	-0.651**	1

Source: Primary data processed, 2025

Furthermore, after re-validation was carried out with the experts regarding the dominant risk results, it was found that all experts agreed that all five risk factors were the dominant factors that influenced the performance of the procurement time for construction services for the ATC Tower and Supporting Facilities project.

4. RESULTS & DISCUSSION

Based on the results of the risk analysis, five dominant risk factors with high risk levels were identified across specific activities within the business process of construction service procurement for the ATC Tower Construction Project and Supporting Facilities. In detail, two risks were identified at the procurement planning stage, specifically in the activity of Determining Procurement Strategy, two risks were found at the procurement implementation stage, particularly in the Tender Execution activity; and one risk was identified at the work implementation (contractual) stage, namely in the activity of Work Implementation Control.

These five dominant risk factors are likely to occur in particular activities and, if realized, may significantly affect the time performance of construction service procurement in the ATC Tower Construction Project and Supporting Facilities. The identified risks include: the risk of the work package scope being excessively large or complex (X1.1.1), the risk of the work not being completed within the time specified to the contractor (X5.2.4), the risk of documents not complying with site conditions or technical planning documents (X1.1.2), the risk of no

participants uploading bid documents (X3.2.5), and the risk that no participants pass the administrative and technical evaluation (X3.2.7), with further explanations as follows:

4.1. When work is packaged, the scope of work of the project package is too large/complex

Complexity is one of the factors that influence the achievement of project objectives, where complexity is used by several researchers including Luo et al (2017) to explain the causes of cost overruns, schedule delays, and poor project performance. Likewise, in the procurement of construction services for the ATC Tower and Supporting Facilities, if a building construction work is merged with the installation of Tower Set work which has different characteristics, then it will increase the complexity of the scope of work and according to Hossny et al (2021) it will be the main source of project risk that has a significant impact on the overall procurement time performance. These findings are also in line with the results of research by Dita et al (2020) that inaccuracy in the splitting or merging of scope of works in procurement planning resulted in delays in the procurement process. In the procurement of construction services for the ATC Tower and Supporting Facilities, where the scope of ATC Tower building construction work merged with Tower Set equipment work, the complexity of the work will increase in terms of time due to the Tower Set equipment can only be installed after the building construction is completed and the main contractor find difficulties in finding and engaging with limited number of Tower Set equipment suppliers.

4.2. At the time a Notice Letter is issued or a determination to handle the Critical Contract is made by the Authorized Official, the work cannot be completed within the time specified to the Contractor

The issuance of a Notice Letter to the determination of a Critical Contract is carried out when there is a delay of 10% (Standard Operating Procedures for Critical Contracts of the Directorate General of Highways, Indonesia Ministry of Public Works, 2023), where according to Sambasivan and Soon (2007), delays can cause various problems in the construction industry such as legal disputes, increased costs, further project delays, productivity, financial losses, and the contractor's inability to complete the project which leads to contract failure. This resulted in a decrease in the overall performance of construction service procurement time due to loss of efficiency and productivity (Sanni-Annibire et al, 2020). The occurrence of further delays can even lead to contract termination which, if it occurs, will delay the benefits of the project (Arijeloye, 2017), so that in the procurement of construction services for the ATC Tower and Supporting Facilities, the delay in the benefits obtained by this procurement has implications for decreasing the performance of procurement time which is a high risk for air navigation services operation in Perum XYZ.

4.3. When the work was packaged, mismatch was found between the location conditions or the technical document planning and the project package documents

Referring to the archive data of procurement of construction services for the ATC Tower and Supporting Facilities at Perum XYZ in the previous years, apart from merging the construction work of the ATC Tower building with the installation of Tower Set equipment work, work packaging was also carried out on the construction work of the ATC Tower building in several locations combined into one project package. Considering the differences among each location's conditions, the technical documents project package is difficult to standardize and prone to be mismatched with the existing project site conditions. This study are in line with the results of the study by Ebtha et al (2017) where the inconsistency of technical planning documents and work volume with field conditions is the biggest risk in the implementation of construction work.

4.4. At the time of the tender implementation, during the tender document submission process, no participants uploaded the tender documents and if there were participants who uploaded the tender documents, then no participants passed the administrative and technical evaluation.

Bid Document Submission and Bid Document Evaluation activities are critical stages in the construction tender process (Sarker et al, 2021) which can lead to failed tenders, where according to Andreana et al (2023) failed tenders often occur in the procurement process of goods/services in government agencies with one of the highest risk factors being that no participants pass the evaluation of the bid documents. The impact of a failed auction is the delay of the overall procurement timeline, causing disruption to services from an agency. This is also in line with the results of research by Dinda et al (2024) who used the FMEA method that the occurrence of a condition where the contractor is not interested in participating in the tender has a high Risk Priority Number (RPN) value. Thus, the absence of participants uploading bid documents in the tender for the procurement of construction services for the ATC Tower and Supporting Facilities resulted in the need for an extension of the procurement implementation duration to conduct a re-tender.

5. CONCLUSION

There are 49 activities in the business process and existing activities of the procurement of construction services in the ATC Tower Construction and Supporting Facilities project at Perum XYZ along with 66 risk factors, where based on the results of questionnaire responses from 30 respondents who had been involved in the procurement of construction services for the ATC Tower Construction and Supporting Facilities project at Perum XYZ and statistical tests were carried out, 42 risk factors were obtained. Of the 42 risk factors, after performing risk analysis, 21 risks were found to have a low risk level, 16 risks to have a medium risk level, and 5 risks to have a high risk level.

5.1. Practical Implication

The five high risks obtained basically represents three main processes of Procurement Management as the risk of the work package scope being too large/complex (X1.1.1) and the risk of documents that do not comply with location conditions or technical document planning (X1.1.2) occurred in the procurement planning stage, the risk of no participants uploading bid documents (X3.2.5) and the risk of no participants passing the administrative and technical evaluation (X3.2.7) shown up at the procurement implementation stage, and the risk of the work not being completed within the time specified to the contractor (X5.2.4) represent the procurement implementation stage.

In order to reduce the risk, a further research can be conducted to develop risk responses based on those five high risk factors by identifying causes, impacts, preventive actions, and corrective actions for each dominant risk factor.

5.2. Limitation and Future Research

To obtain more comprehensive research results, it is advisable to conduct more in-depth research involving external parties to the company such as the contractors, design consultants, and supervisory or construction management consultants, so that a sharper analysis can be carried out based on the views of all parties involved.

6. REFERENCES

Arijeloye, J & S, Gabriel, & Akinola, Joseph & Ade-Ojo, Olubunmi. (2017). Implications of Construction Contract Termination for Infrastructural Development in Ekiti State Local Government Areas, Nigeria. FUTY Journal of the Environment. 11. 2017.

Banaitis, Audrius & Banaitiene, Nerija. (2012). Risk Management in Construction Projects. Risk Management - Current Issues and Challenges, INTECH

Dita, Felisitas & Rohman, Mohammad & Nurcahyo, C. (2020). Risks of Public Procurement for Construction Works . IOP Conference Series: Materials Science and Engineering .

Ebtha, Yuni & Nyoman, Norken & Sudarsana, Dewa & Putu, Adnyana. (2017). Risk Analysis of Tender Documents on the Execution of Private Construction Work at Badung Regency, Bali Province, Indonesia. Journal of Sustainable Development. 10. 130-130. 10.5539/jsd.v10n4p130.

Findy Kamaruzzaman (2012). Studi Keterlambatan Penyelesaian Proyek Konstruksi (Study of Delay in The Completion of Construction Projects). Teknik Sipil Untan, 12(2), 175–190.

Hossny, Hossam & Ibrahim, AH & Elnady, Abeer. (2021). Assessment of Construction Project Complexity. The Open Civil Engineering Journal. 15. 414-423. 10.2174/1874149502115010414.

Janita, Andreana & Hatmoko, Jati & Hermawan, Ferry. (2023). Risk analysis of tender failure in the procurement of construction services. Teknika: Journal of Science and Technology. 19. 54. 10.36055/tjst.v19i1.20059.

Karyasa. (2014). Analysis of Factors Influencing the Failure of Electronic Government Procurement of Goods and Services (E-Procurement) Auctions in Badung Regency. Spektran Journal, Vol 2 No 1.

Kušar J, Rihar L, Zargi U, Starbek M. Extended risk-analysis model for activities of the project. Springerplus. 2013 ;2 (1):227. Published 2013 May 17. doi: 10.1186/2193-1801-2-227

Luo, Lan & He, Qinghua & Xie, Jianxun & Yang, Delei & Guangdong, Wu. (2016). Investigating the Relationship between Project Complexity and Success in Complex Construction Projects. Journal of Management in Engineering. 33. 04016036. 10.1061 /(ASCE)ME.1943-5479.0000471.

Oyegoke, Adekunle & Awodele, Oluwaseyi & Ajayi, Saheed. (2019). Managing construction risks and uncertainties. 10.4324/9780203887059-16.

Peiris, M & Sammandapperuma, Kalani & Kalugaldeniya, Aravinda & Withanage, G. (2019). Design of Air Traffic Control Tower (ATCT) at Hambantota Airport.

Putri, Dinda & Ophiyandri, Taufika & Hidayat, Benny. (2024). Risk Analysis of Contractor Selection in Construction Work Procurement. CIVED. 11. 694-707. 10.24036/cived.v11i2.563.

Hoang, Phuong & Tran, Daniel. (2022). Current State of Practice in Selection and Implementation of Airport Capital Project Delivery Methods. 109-118. 10.1061/9780784483978.012.

PMI.2017. A Guide to Project Management Body of Knowledge . (PMBOK Guide) 6 th Edition . Project Management Institute .

Pourrostam, Towhid & Ismail, Amiruddin. (2012). Causes and Effects of Delay in Iranian Construction Projects . International Journal of Engineering and Technology .

Razkallah, Hanane & Bendjama, Rachida. (2022). The Role of Procurement Management On Project Performance: Case Study A Sample of Construction Projects of the City of Constantine. Finance and Business Economies Review.

Shakya, Sujata & Mishra, Anjay. (2019). Risk Assessment of Gauttam Buddha International Airport. Journal of Advanced Research in Construction & Urban Architecture. 4. 17-34. 10.24321/2456.9925.201903.

Sambasivan M, Soon YW. Causes and effects of delays in Malaysian construction industry. Int J Proj Manage 2007 ;25 (5):517–26

Sanni-Anibire MO, Mohamad Zin R, Olatunji SO. Causes of delays in the global construction industry: a meta analytical review. Int J Constr Manage 2020:1–13

Sarker, Smita & Salah, Mohammad & Chowdury, Mohammad & Deb, Pulok. (2012). Study of Influencing Factors of Tender Evaluation: An Evidential Reasoning Approach. International Journal of Research in Computer Science. 2. 10.7815/ijorcs.25.2012.043