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Decision Making in Determining Priorities for Procurement of Goods and Services using AHP-TOPSIS Method in Oil and Gas Company

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ABSTRACT

The upstream oil and gas industry has a significant contribution to the national economy; however, in practice, it often faces challenges in the procurement process of goods and services, particularly due to the high volume of requests and limited human resources. This study aims to develop a structured and objective procurement prioritization system using the Analytical Hierarchy Process (AHP) and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) methods to help procurement teams determine which procurement packages should be prioritized in an objective and structured manner. Through the identification and validation of five main procurement criteria, the AHP method found the highest criteria weights in sequence: procurement that related of HSSE, production, work execution time, budget source, and process complexity. The TOPSIS method identified the procurement package priorities from the list of procurement requests at PT. XYZ – Zone A. The results of the procurement package ranking based on primary data from experts and secondary data from the company are expected to improve the efficiency and effectiveness of the procurement process and support the smooth operation of field activities.

Keywords: Upstream Oil and Gas Industry, Procurement Process, Analytical Hierarchy Process (AHP),

INTRODUCTION

Crude oil and natural gas commodities (oil and gas) are among the most important commodities for Indonesia's economy (Amuda et al., 2023; Batten et al., 2017; Indupurnahayu et al., 2021; Meher et al., 2020; Nyga-Łukaszewska & Aruga, 2020; Rizvi et al., 2022). Indonesia was once recorded as a global exporter of crude oil and a member of the Organization of the Petroleum Exporting Countries (OPEC). However, as natural oil reserves decline and domestic oil consumption increases, Indonesia is no longer an exporter of crude oil and has even become a net importer of crude oil up to the present day (fadhilah, 2022; Nibras & Widyastutik, 2020; Tampubolon et al., 2022).

This is due to Indonesia's heavy dependence on the use of oil and gas as an energy source (Ahdiat, 2023). According to the Ministry of Energy and Mineral Resources (*ESDM*) report, coal and crude oil still dominate Indonesia's energy mix. In 2023, the share of crude oil was 30.18%. Meanwhile, natural gas contributed 16.28%. From this data, it can be said that the upstream oil and gas industry has a significant contribution to Indonesia's economy, as the national economic growth in 2023 reached 5.31 percent, according to data from the Central Statistics Agency (*BPS*). This has led to increasing pressure to operate efficiently and on time, making the procurement process for goods and services increasingly important.

The oil and gas industry itself has a procurement process that is numerous, complex, and high-value. However, in practice, the procurement process in this sector often faces challenges, particularly due to the high volume of procurement requests from various departments and the limited human resources handling these procurements (AlHashmi et al., 2021; Dachyar & Sanjiwo, 2018; Jo et al., 2018; Twaliwi et al., 2022; Yi et al., 2019). Research by Mohammed et al. (2019) shows that this condition causes an imbalanced workload for the procurement committee, often resulting in delays in tender processing that could potentially hinder operational and production activities. John Rolfe et al. (2011) explore how the scale of priority significantly impacts the efficiency of tender processing. Larger-scale tenders, which encompass broader geographic areas and multiple industries, can enhance efficiency by attracting a wider range of proposals, thereby increasing the likelihood of selecting cost-effective options. Until now, the determination of procurement priorities has been carried out subjectively without a structured basis, which can lead to suboptimal decision-making. This situation results in an imbalanced workload for the procurement committee, frequently causing delays in tender processing that could hinder operational and production activities. Ineffective procurement can directly impact operational efficiency, cause project delays, and lead to cost overruns. Furthermore, inaccuracies in the procurement process for goods and services can also affect production performance due to delays in machinery repairs or the replacement of worn-out components (Gultom et al., 2025).

PT. XYZ, as the parent company of several oil and gas entities in Eastern Indonesia operating in Zone A with 7 working areas, including ADK, Cepu, Randugunting, Sukowati, Tuban, Poleng, and West Madura Offshore, faces specific challenges in its procurement process. A common issue is the large number of procurement requests from various departments for different goods and services that arrive simultaneously. This causes the procurement committee to experience an overload in carrying out the procurement process. Some solutions, such as adding personnel to the procurement committee or reducing the number of procurements, are not feasible in the near future due to bureaucracy and the need for extensive re-planning, which consumes a significant amount of time. This has led to the creation of a simpler solution, which is to establish a priority scale for procurement packages that need to be processed urgently, taking into account business considerations and potential risks. However, there is currently no structured criteria in place to determine the priority scale of the procurement process.

The contribution of this research is to provide a data-driven approach in developing a procurement package prioritization scale in oil and gas companies that can improve the effectiveness of the procurement team and support smooth operations in the field.

METHOD

The research method focused on several stages with a case study at the oil and gas company PT. XYZ – Zone A to analyze the decision-making process in determining the priority of procurement packages for goods and services. The identification of procurement package criteria was done by gathering information from various sources, such as the procurement committee and common practices followed in the procurement function. To determine the initial criteria, a survey was conducted with respondents from eleven experts who have experience and are involved in the tender process at the oil and gas company, either as tender committee members or other stakeholders. The survey was conducted online using Google Forms, considering that the respondents are distributed across various regions in Indonesia.

The results of the questionnaire were compiled and presented back to the respondents, who are high-level managers and decision-makers, to obtain validation. This validation aims to ensure whether the criteria with the highest weights are appropriate and relevant according to practitioners in the field. From the total of 14 criteria proposed through the initial questionnaire, criteria selection was carried out through a Focus Group Discussion (*FGD*) together with the Procurement Manager. The *FGD* discussed the criteria obtained previously from the questionnaire, sorting and establishing the final criteria that align with actual conditions.

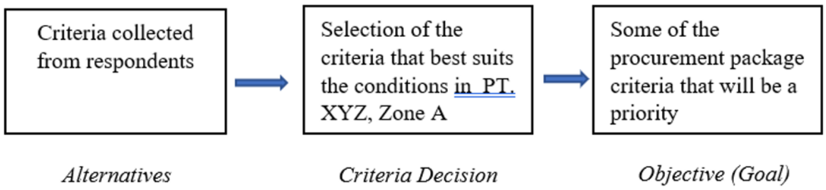

Figure 1. Scenario of FGD

The results of the Focus Group Discussion (FGD) identified 5 criteria's that were considered the most important and representative for further analysis.
The verified criteria are as follows:

Table 1. Verified Criteria from FGD

Code	Criteria
C1	Production rate
C2	Budget Source (ABI)
C3	Process Complexity
C4	HSSE
C5	Execution Time

The five verified and validated criteria were then used as the basis for developing the second questionnaire. The purpose of this questionnaire was to gather data on the respondents' perceptions of the compared criteria. Respondents this time were only senior procurement analysts and managers, considering that they have extensive experience and a deep understanding of procurement problems.

The data collected from this second survey was then evaluated using the AHP method to determine the relative importance of each criterion based on the respondents' perceptions. The results of the AHP process provided the weight of each criterion. After the AHP weights were determined, the next step was to re-validate them with the high-level manager as the decision-maker for the ranking of each criterion.

Once validation of the criteria weights was obtained, the next step was to collect data containing a list of procurement alternatives that the company has prepared since 2024. The oil and gas company PT. XYZ – Zone A has 42 alternatives in the company's procurement assessment. The following are the verified alternatives:

Table 2. Procurement list alternative PT. XYZ – Zona A

Code	Alternative
A1	Accommodation Work Barge (AWB).
A2	Stimulation dan Fracturing Services.
A3	Provision of Storage Tank Inspection Maintenance & Repair (IMR).
A4	Well Intervention Well Service Support
A5	Tug boat and utility boat Tuban Marine Terminal.
A6	Rig Unit Maintenance and Repair Services.
A7	Supply of Rig and Operation Rig With a Capacity 250 HP.
A8	Operational, Monitoring and Reporting of Oil and Gas Operational & Production Activities Services.
A9	Electrical & Instrumentation Onshore Facilities Maintenance Services.
A10	Early Production Facility (EPF) Sumur 1-A.
A11	Operation, Repair and Respecification Work of Electric Submersible Pump (ESP) Alliance.
A12	Charter Temporary FSO Tuban Marine Terminal .
A13	Downhole Isolation Valve Supply and Operation Services.
A14	Wellhead Maintenance & Well Integrity
A15	Instrument Protection System Facility Maintenance Services.
A16	Provision of Security Services for Field Operations
A17	Light Passenger Vehicles Including Labor
A18	Provision of Chemical Supply and Services
A19	Lifting Production Services Using Call Out Equipment Roadtank Truck.
A20	HSSE Operational Excellence Implementation Services.
A21	Labuh FSO “Cinta Natomas”.
A22	Jasa Upgrading Fire Protection System SP-3, SP-4 .
A23	Construction of Fire Water Tank.
A24	Instrument Control System Maintenance Services.
A25	Procurement of Iron Catalyst (Fe) Chemicals for Sulfur Recovery Unit (SRU).
A26	Clean Fresh Water and Balong Water Provision Services with Road Tank.
A27	Cathodic Protection and Internal Corrosion Monitoring Services
A28	Lifting and Scaffolding Operation Technical Assistance & Assurance
A29	Purchase of Anti Pollutant & Safety Petal (MBC) Marine Breakaway Coupling 12 Inch.
A30	VSD Repair and Re-specification Services.
A31	Travel Management Services.
A32	Local Area Network (LAN) and Internet Network Rental and Maintenance Services.
A33	Production Transportation Services using Road Tanks.
A34	Provision of Downhole Equipment and its Installation.
A35	Electrical & Instrumentation Facilities Installation & Maintenance Services.
A36	Provision of Complete Liner Hanger Installation Services with Materials and Personnel for Drilling Wells.
A37	Production Facility Housekeeping Services.
A38	Provision Of Technical Services for Reliability Management.
A39	Procurement of Back-Up Transfer and Injection Pump.
A40	Sucker Rod Pump Repair and Maintenance Services.
A41	Procurement of Gas Detector
A42	Provision of Handling, Transportation and Management of Sulfur Services.

The data containing the 42 alternatives was distributed to experts with the goal of obtaining a comparison matrix value. This value is then analyzed using the TOPSIS method to determine the preference ranking of procurement alternatives based on the ideal solution. As a result, the decision-making process will be objective and systematic in determining the best alternative.

RESULT AND DISCUSSION

AHP Calculation Result

1. Pairwise Comparison Matrix of Criteria

Table 3. Pairwise Comparison Matrix

	C1	C2	C3	C4	C5
C1	1	3	5	1	3
C2	1/3	1	5	1/5	1
C3	1/5	1/5	1	1/7	1/5
C4	1	5	7	1	3
C5	1/3	1	5	1/3	1

Source: primary data

After completing the pairwise comparison matrix, the next step is to convert the values into decimal form for normalization. This step is essential to eliminate the scale and ensure that all values are comparable across criteria.

Table 4. Pairwise Comparison Matrix

	C1	C2	C3	C4	C5
C1	1	3	5	1	3
C2	0,33	1	5	0,20	1
C3	0,20	0,20	1	0,14	0,20
C4	1	5	7	1	3
C5	0,33	1	5	0,33	1
total	2,87	10,20	23	2,68	8,20

Source: primary data

2. Normalization

In this stage, the comparison is made by dividing each value by the sum of the respective column. For example, the values 1, 0.33, 0.20, 1, and 0.33 are divided by 2.87, and so on. The results of the normalization are shown in Table 5.

Table 5. Normalization Matrix

	C1	C2	C3	C4	C5
C1	0,35	0,29	0,22	0,37	0,37
C2	0,12	0,10	0,22	0,07	0,12
C3	0,07	0,02	0,04	0,05	0,02
C4	0,35	0,49	0,30	0,37	0,37
C5	0,12	0,10	0,22	0,12	0,12

Source: primary data

After the normalization results are obtained, the next step is to calculate the priority vector and weights.

3. Determination of the Priority Vector and Weights

The priority vector is obtained by summing each row, while the weights are calculated by dividing the results of the priority vector by the total of the matrix. In this study, the matrix consists of 5 criteria: C1, C2, C3, C4, and C5. The results of the priority vector and weight calculations are shown in Table 6.

Table 6. Priority Vector and Weights Result

	PV	Weight
C1	1,600	0,320
C2	0,628	0,126
C3	0,211	0,042
C4	1,883	0,377
C5	0,678	0,136

Source: primary data

4. Determining Eigen Value

The Eigen Value (EV) can be obtained by multiplying the weight by the total of the comparison matrix (Table 6). For example, to fill in row C1, it is known that the total for column C1 is 2.87, and the weight for row C1 is 0.320. The resulting eigen vector is as follows:

Table 7. Eiger Value Result

	Eiger Vector
C1	0,917
C2	1,282
C3	0,969
C4	1,008
C5	1,112

Source: primary data

5. Determining CI dan CR

a) Sum of all eigen vectors = 5,288

b) Calculating CI

$$CI = \frac{(5{,}288 - 5)}{5 - 1} = 0{,}072$$

c) Calculating CR

To calculate the CR (Consistency Ratio), you must first know the IR (Random Index) value. Since the matrix consists of 5 criteria, the IR is 1.12 (Table 4).

$$CR = \frac{0{,}072}{1{,}12} = 0{,}064$$

Since the CR value is 0.064 < 0.1, the matrix is considered consistent.

TOPSIS Calculation Result

1. Determining Criteria and Criteria Weights for Each Alternative

The criteria weights are obtained from the results of the questionnaire recap, based on the criteria that were defined and asked to the respondents.

2. Normalization

After the criteria weights are known, the next step is to construct the normalized decision matrix. Then, the weighted normalized decision matrix is constructed. After that, the weighted normalized decision matrix is obtained by multiplying the normalized matrix by the weights assigned to each criteria. The results of the weighted normalized decision matrix (Y) can be seen in Table 8.

Table 8. Normalized Decision Matrix

Alternative	C1	C2	C3	C4	C5
A1	0.175	0.197	0.272	0.183	0.184
A2	0.140	0.118	0.163	0.110	0.110
A3	0.175	0.118	0.163	0.146	0.147
A4	0.175	0.197	0.163	0.146	0.147
A5	0.175	0.118	0.163	0.183	0.184
A6	0.175	0.197	0.109	0.183	0.147
A7	0.175	0.197	0.109	0.146	0.184
A8	0.105	0.118	0.054	0.146	0.184
A9	0.140	0.118	0.054	0.110	0.110
A10	0.175	0.197	0.163	0.146	0.184
A11	0.175	0.157	0.109	0.146	0.147
A12	0.175	0.118	0.054	0.183	0.110
A13	0.175	0.197	0.218	0.183	0.184
A14	0.140	0.157	0.163	0.183	0.110
A15	0.175	0.118	0.054	0.183	0.110
A16	0.140	0.157	0.163	0.183	0.184
A17	0.105	0.197	0.163	0.110	0.184
A18	0.175	0.118	0.272	0.110	0.184
A19	0.175	0.197	0.054	0.110	0.110
A20	0.175	0.197	0.163	0.183	0.184
A21	0.175	0.197	0.054	0.183	0.110
A22	0.175	0.157	0.054	0.183	0.147
A23	0.140	0.118	0.054	0.183	0.110
A24	0.105	0.118	0.163	0.110	0.110
A25	0.175	0.118	0.272	0.146	0.184
A26	0.105	0.118	0.054	0.183	0.110
A27	0.140	0.118	0.163	0.183	0.184
A28	0.140	0.118	0.163	0.183	0.147
A29	0.175	0.197	0.272	0.183	0.184
A30	0.105	0.118	0.054	0.110	0.110
A31	0.035	0.118	0.054	0.037	0.037
A32	0.175	0.118	0.054	0.110	0.184
A33	0.175	0.197	0.054	0.110	0.110
A34	0.175	0.197	0.218	0.183	0.184
A35	0.140	0.118	0.054	0.110	0.110
A36	0.175	0.197	0.163	0.183	0.184
A37	0.105	0.118	0.054	0.146	0.184
A38	0.140	0.118	0.163	0.110	0.184
A39	0.105	0.118	0.163	0.110	0.037
A40	0.175	0.197	0.163	0.110	0.184
A41	0.175	0.118	0.163	0.183	0.184
A42	0.105	0.118	0.272	0.183	0.184

Source: secondary data

3. Determining the Positive Ideal Solution (A+) and Negative Ideal Solution (A-)

The criteria are based on the weighted rankings in the formula. In other words A+ the most desirable solution, while A− is the least desirable solution.

Table 9. Ideal Solution Result (A+ dan A-)

Ideal	C1	C2	C3	C4	C5
A+	0.0560	0.0248	0.0114	0.0690	0.0250
A−	0.0112	0.0149	0.0023	0.0138	0.0050

4. Determining the Distance

This step is performed to calculate the Euclidean distance between each alternative and the positive ideal solution (A+) as well as the negative ideal solution (A-).

Table 10. Positive and Negative Ideal Solutions

Alternative	A+	A−	Alternative	A+	A−
A1	0.00000	0.04596	A22	0.01155	0.04350
A2	0.03327	0.03134	A23	0.02018	0.03140
A3	0.01830	0.04275	A24	0.03851	0.02034
A4	0.01538	0.04470	A25	0.01699	0.04406
A5	0.01092	0.04363	A26	0.02799	0.02043
A6	0.00849	0.04467	A27	0.01564	0.03293
A7	0.01542	0.04551	A28	0.01642	0.03175
A8	0.02956	0.02280	A29	0.00000	0.04596
A9	0.03420	0.03140	A30	0.03931	0.02043
A10	0.01454	0.04555	A31	0.07507	0.01142
A11	0.01695	0.04342	A32	0.03073	0.04367
A12	0.01679	0.04248	A33	0.03075	0.04445
A13	0.00229	0.04570	A34	0.00229	0.04570
A14	0.01646	0.03229	A35	0.03420	0.03140
A15	0.01679	0.04248	A36	0.00458	0.04555
A16	0.01307	0.03384	A37	0.02956	0.02280
A17	0.03584	0.02622	A38	0.03173	0.03293
A18	0.02933	0.04406	A39	0.04222	0.02261
A19	0.03075	0.04445	A40	0.02798	0.04555
A20	0.00458	0.04555	A41	0.01092	0.04363
A21	0.01355	0.04445	A42	0.02449	0.02354

5. Calculating Preference Value and Ranking

A high preference value (Psi) indicates that alternative is selected. The final result of the decision-making process is as follows.

In Table 11, based on the calculations above, it can be seen that the top 10 procurement request packages are as follows: Accommodation Work Barge (AWB) Services, Purchase of Anti Pollutant & Safety Petal (MBC) Marine Breakaway Coupling 12 Inch, Downhole Isolation Valve Supply and Operation Services, Downhole Equipment Supply and Installation, HSSE Operational Excellence Services, Liner Hanger Installation Services with Materials and Personnel for Drilling Wells, Tug Boat and Utility Boat for Tuban Marine Terminal, Gas Detector Procurement, Rig Unit Maintenance and Repair Services, and Fire Protection System SP-3 and SP-4 Upgrading Services.

Table 11. Preference Value (Psi)

Alternative	Psi	Rank	Priority Scale	Alternative	Psi	Rank	Priority Scale
A1	1.0000	1		A27	0.6780	21	
A29	1.0000	2		A28	0.6592	22	
A13	0.9523	3		A14	0.6624	23	
A34	0.9523	4		A23	0.6087	24	
A20	0.9087	5	1	A18	0.6003	25	
A36	0.9087	6		A40	0.6194	26	3
A5	0.7998	7		A32	0.5870	27	
A41	0.7998	8		A33	0.5911	28	
A6	0.8403	9		A19	0.5911	29	
A22	0.7902	10		A42	0.4901	30	
A21	0.7663	11		A38	0.5093	31	
A10	0.7580	12		A2	0.4851	32	
A7	0.7470	13		A35	0.4787	33	
A4	0.7441	14		A9	0.4787	34	
A25	0.7217	15	2	A8	0.4355	35	
A16	0.7214	16		A37	0.4355	36	4
A11	0.7192	17		A26	0.4220	37	
A12	0.7167	18		A17	0.4225	38	
A15	0.7167	19		A24	0.3456	39	
A3	0.7003	20		A30	0.3420	40	
				A39	0.3487	41	
				A31	0.1320	42	

These ten procurement packages will be the top priority, with their tender processes starting first to fulfill compliance aspects related to HSSE and also to support production rate activities.

From the weighting results of the five criteria that were validated with procurement experts, the procurement related to HSSE (Health, Safety, Security, and Environment) has a weight of 0.377, and procurement related to production has a weight of 0.320. The weights of these two highest criteria are not too far apart because both are very important, especially in the oil and gas industry. HSSE is a non-negotiable aspect in the oil and gas industry because it is directly related to human safety, asset protection, and operational sustainability. Negligence in procuring personal protective equipment (PPE), fire protection systems, gas detection tools, or environmental security could lead to fatal accidents, pollution, facility shutdowns, and even legal litigation. Therefore, procurement related to HSSE must be processed first, without compromise. On the other hand, production is the primary activity that generates revenue. Delays in production procurement can lead to failed lifting, loss of output, and economic losses. However, compared to HSSE, production has a bit more flexibility as it can be rescheduled or managed through workload adjustments.

The criteria related to execution time has a weight of 0.136. This criteria assesses how quickly the work must begin after the tender is completed. The sooner the work starts, the higher the priority of the tender. However, in practice, this urgency can still be compensated by internal acceleration or project management. This is different from HSSE and production, which have direct and critical risks. In many cases, some urgent tasks that are not directly related to production and HSSE can be renegotiated between the user, vendor, and project management. This provides flexibility compared to HSSE (which cannot be postponed) and production (which directly impacts revenue).

Although important in terms of budget sources (Opex/Capex), there is a new policy where tenders can still proceed even if the budget disbursement comes later so its weight is placed in the middle at 0.126. Meanwhile, tenders that are complex, which have the lowest weight of 0.042, can be planned earlier or supported by experts and project management teams who are usually aware of the tender timeline and have prepared contingency time for the tender process. This criteria is understandably placed in the last priority.

From the ranking results using the TOPSIS method, it can be seen that the following 10 procurements have the highest preference values compared to other alternatives, including: Accommodation Work Barge (AWB) Services, Purchase of Anti Pollutant & Safety Petal (MBC) Marine Breakaway Coupling 12 Inch, Downhole Isolation Valve Supply and Operation Services, Downhole Equipment Supply and Installation, HSSE Operational Excellence Services, Liner Hanger Installation Services with Materials and Personnel for Drilling Wells, Tug Boat and Utility Boat for Tuban Marine Terminal, Gas Detector Procurement, Rig Unit Maintenance and Repair Services, and Fire Protection System SP-3 and SP-4 Upgrading Services. If these procurements are not carried out immediately, it will pose risks to workplace safety, environmental pollution, and the security of work activities, which could result in fatal consequences and financial losses for both workers and the company.

CONCLUSION

Analysis of the criteria for determining the priority of procurement requests for goods and services shows that the combination of AHP and TOPSIS methods provides a structured and objective solution in determining the priority of procurement packages for an oil and gas company, particularly in the case study of PT. XYZ – Zone A. After collecting open questionnaire data and validating the selection of criteria with experts, the criteria used for determining priorities were obtained, namely HSSE, production rate, execution time, source of budget, and tender process complexity. The weighting results indicate that HSSE is the most dominant criterion, with the highest weight of 0.377. This reflects the importance of workplace safety and regulatory compliance in the procurement process, especially in high-risk environments such as the oil and gas industry. The AHP method provides a consistent weight structure ($CR = 0.064 < 0.1$), while the TOPSIS method is able to rank 42 procurement alternatives based on their proximity to the ideal solution. The TOPSIS results identify the top ten highest priority procurements, such as Accommodation Work Barge (*AWB*) services, Anti Pollutant & Safety Petal Marine Breakaway Coupling, Downhole Isolation Valve Supply and Operation Services, HSSE Operational Excellence Services, Liner Hanger Installation Services with materials and personnel for drilling wells, which are generally related to HSSE aspects and production continuity. This indicates that the quantitative approach not only clarifies the urgency of procurement but also supports more efficient decision-making aligned with operational needs. Additionally, the highest-ranked procurement alternatives obtained through TOPSIS show that procurements with a direct impact on workplace safety and production continuity should be processed first. Therefore, the implementation of this method is expected to improve efficiency, reduce the risk of delays, and strengthen the operational performance and business sustainability of the company.

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