Standardization of Technical Specifications and Budget of Charter Rate in Indonesian Oil & Gas Upstream Operation Support Vessel

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Abstract. Special Task Force for Upstream Oil and Gas Business Activities (SKK Migas) is an institution tasked with managing upstream oil and gas business activities based on Production Sharing Contract (PSC). In carrying out technical evaluations and budget recommendations, there are often differences in specifications and budgets between PSC Contractors. In order to reduce the problems mentioned above, it is necessary to standardize technical specifications and charter rates for operations support vessels which will later be used as the basis for evaluating technical specifications and recommendations for charter budgets, for preparing owner estimates as the basis for negotiations in the ship procurement process. The problem-solving methodology adopted in this research is to collect data on operations support vessels in PSC Contractors and then evaluate the data with Multi Criteria Decision Making (MCDM) through the Elimination Et Choix Traduisant la Realite (ELECTRE) method, then the results will be analysed qualitative data, to further develop a standard technical specification and recommendation for vessels charter rates for each type of vessel.

1. Introduction
Oil and gas business activities are divided into two parts, namely upstream oil and gas activities and downstream oil and gas activities. Pudyantoro stated downstream oil and gas activities consist of managing crude oil and gas, storing, distributing and trading them [1]. The scheme for the distribution of Indonesia's oil and gas business processes is shown in Figure 1.

![Figure 1. Upstream & Downstream of Indonesian Oil and Gas Scope](image-url)
Upstream oil and gas business activities are responsible for optimally producing Indonesia's oil and gas for the greatest prosperity of the Indonesian people in accordance with the mandate of the 1945 Constitution Article 33 paragraphs 2 and 3. The allocation of profit sharing funds is regulated based on the location of the oil and gas wellhead [2]. Optimization of upstream oil and gas business activities is shown through efforts to generate the highest revenue for the state through lifting activities, efficiency of operating costs, especially through the cost recovery scheme, as well as supervision of operating activities that are still in accordance with work safety and environmental protection principles.

The grand theory that underlies this research is the inefficiency of budgeting for charter vessels related to budgeting theory and the absence of a reference standard for vessel technical specifications in determining the need for ships supporting oil and gas operations in Indonesia. Biswan and Widianto stated that budgets can translate general and abstract plans, fulfill the concept of responsibility accounting, allocate budget for priority activities, and identify organizational limitations and constraints [3].

Vessels charter agreement as needed in accordance with laws and regulations [4], inefficiency means not optimal utilization, there is no increase or the value is decrease, so that effort or work in running something wastes time, energy, and costs, for that certain benchmarks are needed to determine whether the process is running efficiently or not. Commonly used benchmarks are cost and time. Munandar explain budgeting is a quantitative expression of plans aimed at management over a certain period and helps coordinate what is needed to be completed against the implementation plan [5].

Aas classify logistic activities in the oil industry in two main categories: upstream logistics and downstream logistics [6]. Most common types of offshore support vessels namely Platform Support Vessels (PSV), Anchor Handling, Tug & Supply vessels (AHTS) and Offshore Construction Vessels (OCV) [7]. Oil and gas lifting activities are supported by several vessels that have their respective functions and roles [8]. Lifting support vessels refers to the readiness of pilotage facilities and infrastructure [9], including:

1) Tugboat, is a ship with certain characteristics used to push, pull, tow, escort, and assist ships moving in shipping lanes, anchorage areas and harbor pools, both for mooring or to release from the pier, jetty, trestle, pier, reservoir, dolphin, ship and other mooring facilities.
2) Pilot Boat, is a ship with certain characteristics used for transporting scouts from or to the ship to be guided.
3) Mooring Boat, is a ship with certain characteristics that is used for activities to take or carry the mooring rope to the dock, bolder, dolphin, and buoy.

Marine operations during the operation phase in supporting upstream oil and gas business activities are divided into several types according to their objectives, including:

1) Well drilling and maintenance support vessels, there are 3 (three) types of vessels, namely AHTS, PSV, AWB (Accommodation Work Barge).
2) Operational ships, there are 2 (two) types of ships, namely special Crew Boat and Utility Vessel.
3) Special operational vessels for logistics, there are 3 (three) types of ships, namely LCT (Landing Craft Tank), Cargo Vessel, Supply Vessel.

All vessels described above must have permits in accordance with applicable regulations [10] and the efficiency of the approval process for the needs and operations of ships supporting upstream oil and gas operations can be achieved in terms of technical, budget, and time to support the optimization of cost recovery.

Nofriansyah and Defit stated decision support system is a form of computer-based information system that functions to produce alternative decision recommendations specifically to assist management in making decisions on semi-structured problems [11]. With a decision support system using the ELECTRE (Elimination Et choix Traduisant La Realite) method, it can be used to determine the main technical specifications of operating support vessels that can represent the determination of the technical specifications of each type of operating support vessel. The ELECTRE method is a method that can search for an alternative based on predetermined criteria, the method determines the weight
value for each criterion then a ranking is carried out which will determine the optimal alternative, namely the main technical specifications that meet decision making as the main technical specifications for each type of operational support vessel.

According to Janko and Bernoider, ELECTRE is a multi-criteria decision-making method based on the concept of outranking by using pairwise comparisons of alternatives based on each appropriate criterion [12]. Kusumadewi describe an alternative is said to dominate another alternative if one or more of its criteria exceed (compared to the criteria of other alternatives) and is the same as the other remaining criteria [13].

2. Methodology

In solving this research problem, the parameters taken are vessels supporting upstream oil and gas operations in Indonesia, from the vessels database of all PSC Contractors the main specification data and daily charter prices of vessels are determined, then the alternatives and criteria for each problem are determined.

The ELECTRE method is used in conditions where alternatives that do not meet the criteria are eliminated, and a suitable alternative can be generated. ELECTRE is used for cases with many alternatives but few criteria involved, able to give a comprehensive procedure for determining the most suitable alternative [14] and provides scientific reference on the reasonable & avoiding reduplicate selection [15]. ELECTRE will offer valuable insight into the framework of MCDM methodology application and quite suitable for addressing the challenges of selection problems in diverse field [16] and MCDM in order to benefit practitioners to choose a method for solving a specific problem [17].

In terms of uniformity of ship types according to operating needs, grouping of technical specifications, and grouping of vessel charter prices. Rate of the spot charter will be higher than the long term contract [18], alternatives are determined according to the types of vessels that have the same function, where the criteria are taken from the main technical specifications of the vessel which vary and from the daily charter price of the vessel. According to the type and size of the ship. After obtaining the dominant alternative, qualitative data analysis was then carried out to describing, interpreting, and generating theories [19].

The ELECTRE evaluation method is widely recognized for high-performance policy analysis involving both qualitative and quantitative criteria [20] and multiple criteria nature problem may induce a conflict of interests and an effort must be put to find a compromise solution [21]. By determining the suitability of the alternatives taken, the technical specifications, daily charter rates according to the type of vessels that have been grouped can be determined and will simplify the types of vessels supporting operations in Indonesia's upstream oil and gas operations.

The steps taken in solving the problem using the ELECTRE method are as follows:

1) Normalization of decision matrix.

Data or criteria and sub-criteria from the shipping database (main technical specifications) are normalized with the aim of being able to be compared.

Any normalization of the value of $x_{ij}$ can be done with the formula:

$$r_{ij} = \frac{x_{ij}}{\sum_{i=1}^{m} x_{ij}^2}, \quad i=1,2,3,\ldots,m \text{ and } j=1,2,3,\ldots,n.$$  \hspace{1cm} (1)

So that the matrix R results normalization

$$R = \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1n} \\ r_{21} & r_{22} & \cdots & r_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ r_{m1} & r_{m2} & \cdots & r_{mn} \end{bmatrix}.$$  \hspace{1cm} (2)

$R$ is the normalized matrix, where $m$ represents the alternative type/main technical specifications of the operational support vessel, $n$ represents the pre-determined criteria and $r$ is the normalized measurement of choice from the alternative $i$ in relation to the criterion $j$. 

3
2) Weighting on the normalized matrix

After normalization, each column of the \( R \) matrix is multiplied by the weights (\( w \)) which will be determined based on the importance of each alternative and criteria. So it is written as:

\[
V = W \cdot R
\]

(3)

\[
\begin{bmatrix}
v_{11} & v_{12} & \cdots & v_{1n} \\
v_{21} & v_{22} & \cdots & v_{2n} \\
\vdots & \vdots & \ddots & \vdots \\
v_{m1} & v_{m2} & \cdots & v_{mn}
\end{bmatrix} =
\begin{bmatrix}
w_{1}r_{11} & w_{2}r_{12} & \cdots & w_{n}r_{1n} \\
w_{1}r_{11} & w_{1}r_{11} & \cdots & w_{n}r_{1n} \\
\vdots & \vdots & \ddots & \vdots \\
w_{1}r_{11} & w_{1}r_{11} & \cdots & w_{n}r_{1n}
\end{bmatrix}
\]

(4)

Where \( W \) is the weighted matrix, \( R \) the normalized matrix and \( V \) the matrix resulting from the product of the weighted matrix and the normalized matrix.

\[
W = \begin{bmatrix}
w_1 & 0 & \cdots & 0 \\
0 & w_2 & \cdots & 0 \\
\vdots & \vdots & \ddots & \vdots \\
0 & 0 & \cdots & w_n
\end{bmatrix}
\]

(5)

3) Determine the set of concordance and discordance index.

For each pair of alternatives \( k \) and \( l \) (\( k, l = 1, 2, 3, \ldots, m \) and \( k \neq l \)) the set of \( J \) criteria is divided into two subsets, namely concordance and discordance. A criterion in an alternative is concordance if:

\[
C_{kl} = \{ j, v_{kj} \geq v_{ij}, j = 1, 2, 3, \ldots, n \}
\]

(6)

On the other hand, the complement of the concordance subset is the discordance set, that is, if:

\[
D_{kl} = \{ j, v_{kj} < v_{ij}, j = 1, 2, 3, \ldots, n \}
\]

(7)

4) Calculate the concordance and discordance matrix.

Calculating the concordance matrix, to determine the value of the elements in the concordance matrix is to add up the weights included in the concordance set, mathematically as follows:

\[
c_{kl} = \sum_{j \in C_{kl}} w_j
\]

(8)

Calculating the discordance matrix, to determine the value of the elements in the discordance matrix is to divide the maximum difference in criteria included in the discordance subset by the maximum difference in the values of all existing criteria, mathematically as follows:

\[
d_{kl} = \frac{\max\{v_{kj} - v_{ij}\}}{\max\{v_{kj} - v_{ij}\}}_{v_{ij}}
\]

(9)

5) Determine the dominant matrix of concordance and discordance

Calculating the dominant concordance matrix, the \( f \) matrix as the dominant concordance matrix can be built with the help of the threshold value, namely by comparing each element value of the concordance matrix with the threshold value. The threshold value \( \zeta \) is:

\[
f_{kl} \geq \zeta
\]

(10)
\[
c_i = \frac{\sum_{k=1}^{m} \sum_{l=1}^{m} c_{kl}}{m(m-1)} \tag{11}
\]

So that the elements of the matrix \( f \) are determined as follows:

\[
f_{kl} = \begin{cases} 
1, & \text{if } c_{kl} \geq c \\
0, & \text{if } c_{kl} < c
\end{cases} \tag{12}
\]

Calculating the dominant discordance matrix, the \( g \) matrix as the dominant discordance matrix can be constructed with the help of the threshold value \( d \):

\[
d = \frac{\sum_{k=1}^{m} \sum_{l=1}^{m} d_{kl}}{m(m-1)} \tag{13}
\]

And the elements of the matrix \( g \) are defined as follows:

\[
g_{kl} = \begin{cases} 
1, & \text{if } d_{kl} \geq d \\
0, & \text{if } d_{kl} < d
\end{cases} \tag{14}
\]

6) Determine the aggregate dominance matrix

The matrix \( e \) as an aggregate dominance matrix is a matrix in which each element is a product of the elements of the matrix \( f \) with the corresponding elements of the matrix \( g \), which can be mathematically expressed as:

\[
e_{kl} = f_{kl} \times g_{kl} \tag{15}
\]

7) Elimination of less favorable alternatives

The matrix \( e \) provides a sequence of choices from each alternative, i.e. if \( e_{kl} = 1 \) then alternative \( A_k \) is a better alternative than \( A_l \). Thus, the row in the matrix \( e \) that has the least number of \( e_{kl} = 1 \) can be eliminated. Thus, the best alternative from the type/main technical specifications of the operational support vessels is the alternative that dominates the other alternatives.

So that in this research, alternatives and criteria have been determined according to Table 1.

| Table 1. Alternative and criteria |
|----------------------------------|
| **Alternative** | **Criteria** |
| A1  | Brake Horse Power | Tug Boat | C1 |
| A2  | Bollard Pull | Pilot Boat | C2 |
| A3  | Clear Deck Space | Mooring Boat | C3 |
| A4  | Deck Strength | AHTS | C4 |
| A5  | Speed | PSV | C5 |
| A6  | DP System | AWB | C6 |
| A7  | Crane Capacity | Crew Boat | C7 |
| A8  | Pax Capacity | Utility Vessel | C8 |
| A9  | Engine Number | LCT | C9 |
| A10 | Propulsion Type | Cargo Vessel | C10 |
| A11 | Fire Fighting Class | Supply Vessel | C11 |
| A12 | Thruster |  |
| A13 | Tank Volume |  |
| A14 | Tank Volume |  |

The system analysis carried out in the decision support system for the selection of technical specifications for operational support vessels using the ELECTRE method is divided into several parts
with the initial part being weighting the criteria against alternatives. The weighting of the criteria is carried out to determine the absolute value of the weight of each criterion so that it can be assimilated easily into the ELECTRE method used. In this section, the weighting based on the standard of determination is used as shown in Table 2.

Table 2. Compatibility rating

| Determining the suitability rating of each alternative on each criterion, assessed from one to five, namely: |
|-------------------------------------------------|
| 1 = Not Suitable |
| 2 = Less Suitable |
| 3 = Enough |
| 4 = Suitable |
| 5 = Very Suitable |

So that after being weighted according to the predetermined rating, a weighting table is obtained according to Table 3.

Table 3. Weighting table

| Alternative         | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 | C11 |
|---------------------|----|----|----|----|----|----|----|----|----|-----|-----|
| Brake Horse Power   | 5  | 3  | 3  | 5  | 5  | 5  | 1  | 3  | 5  | 3   | 3   |
| Bollard Pull        | 5  | 1  | 1  | 5  | 1  | 1  | 1  | 1  | 1  | 1   | 1   |
| Clear Deck Space    | 2  | 1  | 1  | 5  | 5  | 5  | 5  | 4  | 5  | 5   | 5   |
| Deck Strength       | 1  | 1  | 1  | 5  | 5  | 5  | 5  | 4  | 5  | 5   | 5   |
| Speed               | 3  | 5  | 5  | 4  | 4  | 1  | 5  | 4  | 2  | 4   | 4   |
| DP System           | 1  | 1  | 1  | 5  | 5  | 1  | 1  | 1  | 1  | 1   | 1   |
| Crane Capacity      | 1  | 1  | 1  | 4  | 4  | 5  | 1  | 1  | 1  | 5   | 5   |
| Pax Capacity        | 1  | 5  | 2  | 2  | 2  | 5  | 5  | 4  | 3  | 3   | 4   |
| Engine Number       | 4  | 4  | 4  | 4  | 4  | 1  | 5  | 4  | 4  | 1   | 1   |
| Propulsion Type     | 5  | 2  | 2  | 3  | 3  | 1  | 5  | 2  | 2  | 1   | 1   |
| Fire Fighting Class | 3  | 1  | 1  | 5  | 5  | 1  | 4  | 1  | 3  | 3   | 3   |
| Thruster            | 4  | 4  | 4  | 5  | 5  | 1  | 5  | 4  | 5  | 5   | 5   |
| Tank Volume         | 1  | 1  | 1  | 5  | 5  | 5  | 3  | 1  | 5  | 1   | 5   |
| DWT                 | 1  | 1  | 1  | 1  | 1  | 5  | 1  | 5  | 5  | 1   | 1   |

3. Result

As in the previous section, it has been explained that the use of the ELECTRE method has seven steps, after weighting, the next steps can be described as follows:

1) Normalization of decision matrix

$$R_{\text{matrix}}:$$

|         | 0.430 | 0.258 | 0.258 | 0.430 | 0.430 | 0.086 | 0.258 | 0.086 | 0.258 | 0.258 | 0.258 |
|---------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 0.430   | 0.086 | 0.086 | 0.430 | 0.430 | 0.086 | 0.086 | 0.086 | 0.086 | 0.086 | 0.086 | 0.430 |
| 0.430   | 0.086 | 0.086 | 0.430 | 0.430 | 0.430 | 0.430 | 0.430 | 0.430 | 0.430 | 0.430 | 0.430 |
| 0.430   | 0.086 | 0.086 | 0.430 | 0.430 | 0.430 | 0.430 | 0.430 | 0.430 | 0.430 | 0.430 | 0.430 |
| 0.430   | 0.086 | 0.086 | 0.430 | 0.430 | 0.086 | 0.086 | 0.086 | 0.086 | 0.086 | 0.086 | 0.086 |
| 0.430   | 0.086 | 0.086 | 0.430 | 0.430 | 0.430 | 0.430 | 0.430 | 0.430 | 0.430 | 0.430 | 0.430 |
| 0.430   | 0.086 | 0.086 | 0.430 | 0.430 | 0.430 | 0.430 | 0.430 | 0.430 | 0.430 | 0.430 | 0.430 |
| 0.430   | 0.086 | 0.086 | 0.430 | 0.430 | 0.086 | 0.086 | 0.086 | 0.086 | 0.086 | 0.086 | 0.086 |
| 0.430   | 0.086 | 0.086 | 0.430 | 0.430 | 0.430 | 0.430 | 0.430 | 0.430 | 0.430 | 0.430 | 0.430 |
| 0.430   | 0.086 | 0.086 | 0.430 | 0.430 | 0.086 | 0.086 | 0.086 | 0.086 | 0.086 | 0.086 | 0.086 |
| 0.430   | 0.086 | 0.086 | 0.430 | 0.430 | 0.086 | 0.086 | 0.086 | 0.086 | 0.086 | 0.086 | 0.086 |
| 0.430   | 0.086 | 0.086 | 0.430 | 0.430 | 0.430 | 0.430 | 0.430 | 0.430 | 0.430 | 0.430 | 0.430 |
| 0.430   | 0.086 | 0.086 | 0.430 | 0.430 | 0.086 | 0.086 | 0.086 | 0.086 | 0.086 | 0.086 | 0.086 |
2) Weighting on the normalized matrix.

\( V \) matrix:

| \( w \) | 0.091 |
|-------|-------|
| 0.039 | 0.023 |
| 0.039 | 0.008 |
| 0.016 | 0.008 |
| 0.008 | 0.039 |
| 0.023 | 0.039 |
| 0.008 | 0.008 |
| 0.039 | 0.031 |
| 0.008 | 0.008 |
| 0.008 | 0.039 |
| 0.031 | 0.016 |
| 0.039 | 0.031 |
| 0.039 | 0.008 |
| 0.008 | 0.008 |
| 0.750 | 1.000 |
| 0.455 | 0.364 |

3) Determine the set of concordance and discordance index.
For each pair of alternatives \( k \) and \( l \) (\( k, l = 1,2,3, \ldots, m \) and \( k \neq l \)) the set of \( J \) criteria is divided into two subsets, namely concordance and discordance to determine the concordance and discordance matrix.

4) Calculate the concordance and discordance matrix.

\( c_{kl} \) matrix:

| -   | 1.001 | 0.546 | 0.546 | 0.546 | 1.001 | 0.728 | 0.637 | 0.637 | 0.910 | 0.637 | 0.455 | 0.728 | 0.728 |
|-----|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 0.273 | - | 0.364 | 0.364 | 0.273 | 0.91 | 0.637 | 0.182 | 0.455 | 0.455 | 0.546 | 0.273 | 0.546 | 0.728 |
| 0.637 | 0.91 | 0.91 | - | 0.728 | 1.001 | 1.001 | 1.001 | 0.819 | 0.728 | 0.728 | 0.91 | 0.637 | 1.001 |
| 0.637 | 0.819 | 0.455 | 0.455 | - | 0.819 | 0.728 | 0.819 | 0.819 | 0.91 | 0.728 | 0.364 | 0.546 | 0.728 |
| 0.273 | 0.91 | 0.364 | 0.455 | 0.273 | - | 0.728 | 0.273 | 0.455 | 0.455 | 0.546 | 0.273 | 0.637 | 0.728 |
| 0.273 | 0.819 | 0.455 | 0.546 | 0.455 | 0.819 | - | 0.546 | 0.455 | 0.455 | 0.546 | 0.273 | 0.637 | 0.91 |
| 0.546 | 0.819 | 0.455 | 0.546 | 0.456 | 0.819 | 0.637 | - | 0.546 | 0.728 | 0.728 | 0.273 | 0.637 | 0.819 |
| 0.455 | 0.819 | 0.364 | 0.637 | 0.819 | 0.728 | 0.637 | - | 0.91 | 0.637 | 0.546 | 0.546 | 0.728 |
| 0.273 | 0.91 | 0.364 | 0.364 | 0.364 | 0.819 | 0.546 | 0.455 | 0.455 | - | 0.546 | 0.273 | 0.546 | 0.728 |
| 0.637 | 0.91 | 0.455 | 0.455 | 0.455 | 0.819 | 0.728 | 0.455 | 0.455 | 0.546 | - | 0.273 | 0.728 | 0.728 |
| 0.910 | 0.910 | 0.819 | 0.819 | 0.819 | 1.001 | 0.910 | 0.819 | 1.001 | 0.910 | 1.001 | - | 0.819 | 0.819 |
| 0.546 | 0.91 | 0.637 | 0.728 | 0.455 | 1.001 | 0.910 | 0.546 | 0.546 | 0.728 | 0.455 | - | 0.91 |
| 0.273 | 0.819 | 0.455 | 0.546 | 0.273 | 0.819 | 0.728 | 0.364 | 0.364 | 0.364 | 0.546 | 0.273 | 0.273 | - |

\( d_{kl} \) matrix:

| -   | -   | 1.000 | 1.000 | 1.000 | -   | 1.000 | 1.000 | 1.000 | 0.667 | 0.250 | 1.000 | 1.000 | 1.000 |
|-----|-----|-------|-------|-------|-----|-------|-------|-------|-------|-------|-------|-------|-------|
| 1.000 | - | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 0.750 | 0.750 | - | - | 1.000 | - | 1.000 | 0.750 | 0.750 | 0.253 | 0.750 | - | - |
| 1.000 | 1.000 | 1.000 | 1.000 | - | 0.250 | 1.000 | 1.000 | 0.667 | 0.667 | 0.250 | 1.000 | 1.000 |
| 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | - | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 0.500 | 0.500 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 0.500 | 1.000 | 1.000 | 1.000 | 1.000 |
| 0.250 | 0.250 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 0.250 | 1.000 | 1.000 | 1.000 |
| 0.250 | 0.250 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 0.250 | 1.000 | 1.000 | 1.000 |
| 0.500 | 0.500 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 0.500 | 1.000 | 1.000 | 1.000 |
| 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 0.250 | 1.000 | 1.000 | 1.000 |
| 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 0.250 | 1.000 | 1.000 | 1.000 |

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5) Determine the dominant matrix of concordance and discordance.
Calculating the concordance dominant matrix and the elements of the concordance dominant matrix.

\[ F \text{ matrix:} \]

|   | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | - | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| 0 | 1 | - | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 |
| 0 | 1 | 1 | - | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 |
| 0 | 1 | 0 | 0 | - | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 |
| 0 | 1 | 0 | 0 | 0 | 1 | 0 | - | 0 | 1 | 1 | 0 | 1 |
| 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | - | 1 | 0 | 0 | 1 |
| 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | - | 0 | 0 | 0 | 1 |
| 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | - | 0 | 0 | 1 | 1 |
| 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | - | 1 | 1 | 1 | 1 |

Calculating the discordance dominant matrix and the elements of the discordance dominant matrix.

\[ G \text{ matrix:} \]

|   |   | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | - | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 |
| 0 | 0 | - | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 |
| 1 | 1 | 1 | - | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 |
| 1 | 1 | 1 | - | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 |
| 1 | 1 | 1 | - | 1 | 1 | 1 | 1 | 1 | 1 | - | 1 |
| 1 | 1 | 1 | 0 | - | 1 | 1 | 1 | 0 | 1 | 1 | 1 |
| 1 | 1 | 0 | 0 | 0 | 1 | 0 | - | 0 | 1 | 0 | 0 | 0 |
| 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | - | 1 | 1 | 1 |
| 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | - | 1 | 1 | 1 |
| 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 |
| 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

6) Determine the aggregate dominance matrix.

\[ E \text{ matrix:} \]

|   | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | - | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | - | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 |
| 1 | 1 | - | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 |
| 0 | 0 | 0 | - | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| 0 | 1 | 0 | 0 | - | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 0 | 1 | 0 | 0 | 0 | 0 | - | 0 | 0 | 0 | 0 | 0 | 1 |
| 0 | 1 | 0 | 0 | 0 | 0 | - | 0 | 1 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 1 | 0 | - | 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | - | 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | - | 1 | 1 |
| 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 |
| 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |

7) Elimination of less favorable alternatives.
In this section, the alternatives that have the least value of 1 in the aggregate dominance matrix are eliminated. Table 4 shows the results of this elimination are the alternative with the highest value of 1 in the aggregate dominance matrix.
Table 4. Aggregate dominance matrix

|   | Total | Rank | Total | Rank |
|---|-------|------|-------|------|
| A1 | 4     | 5    | A8    | 2    |
| A2 | 2     | 10   | A9    | 2    |
| A3 | 6     | 3    | A10   | 1    |
| A4 | 9     | 1    | A11   | 4    |
| A5 | 3     | 7    | A12   | 9    |
| A6 | 3     | 8    | A13   | 5    |
| A7 | 2     | 11   | A14   | 3    |

From the previous aggregate dominance matrix calculation process, alternative rankings are carried out based on the highest value of 1 and sorted up to the smallest value of 1 according to table 5.

Table 5. Ranking result

| No. | Alternative | Rank | No. | Alternative | Rank |
|-----|-------------|------|-----|-------------|------|
| 1   | Brake Horse Power | 5    | 8   | Pax Capacity | 12   |
| 2   | Bollard Pull | 10   | 9   | Engine Number | 13   |
| 3   | Clear Deck Space | 3    | 10  | Propulsion Type | 14   |
| 4   | Deck Strength | 1    | 11  | Fire Fighting Class | 6    |
| 5   | Speed       | 7    | 12  | Thruster     | 2    |
| 6   | DP System   | 8    | 13  | Tank Volume  | 4    |
| 7   | Crane Capacity | 11   | 14  | DWT         | 9    |

So that an alternative sequence of decision results from the ELECTRE method can be obtained which then becomes a decision to determine the technical specifications of the operational support vessel based on criteria and possible alternatives shown in table 6.

Table 6. Alternative sort order

| No. | Alternative | No. | Alternative |
|-----|-------------|-----|-------------|
| 1   | Deck Strength | 8   | DP System   |
| 2   | Thruster     | 9   | DWT         |
| 3   | Clear Deck Space | 10  | Bollard Pull |
| 4   | Tank Volume  | 11  | Crane Capacity |
| 5   | Brake Horse Power | 12  | Pax Capacity |
| 6   | Fire Fighting Class | 13  | Engine Number |
| 7   | Speed       | 14  | Propulsion Type |

Furthermore, for the charter rate, an analysis of the charter rate data grouping is carried out based on the national upstream oil and gas vessels database, the data obtained are as follows:

Table 7. Tugboat average charter rate

| Tugboat | Klasifikasi BHP | Bollard Pull (Min) | Bollard Pull (Max) | USD/day (Min) | USD/day (Max) | USD/BHP (Min) | USD/BHP (Max) | Average (USD/BHP) |
|---------|-----------------|--------------------|--------------------|---------------|---------------|---------------|---------------|-------------------|
| 1       | Conventional    | 700 - 1,000       | 10,00              | 12,00         | 463,49        | 863,70        | 0,48          | 0,92              | 0,70             |
| 2       | Conventional    | 1,001 - 2,000     | 12,00              | 25,00         | 512,67        | 1,942,40      | 0,39          | 1,17              | 0,78             |
| 3       | Conventional    | 2,001 - 3,000     | 25,75              | 37,50         | 804,62        | 2,294,00      | 0,38          | 1,11              | 0,74             |
| 4       | Conventional    | 3,001 - 4,000     | 40,00              | 50,00         | 1,347,00      | 3,321,92      | 0,38          | 1,04              | 0,71             |
| 5       | Harbour tug     | 3,000 - 5,000     | 45,00              | 62,50         | 2,385,00      | 4,655,00      | 0,66          | 0,94              | 0,80             |
### Table 8. Crewboat average charter rate

| No | Operation Area | Pax | Service Speed (knot) | USD/day (Min) | USD/day (Max) | USD/Pax (Min) | USD/Pax (Max) | Average (USD/Pax) |
|----|----------------|-----|----------------------|--------------|--------------|--------------|--------------|------------------|
| 1  | Nearshore      | 25  | 150,68               | 710,00       | 22,20        | 78,89        | 38,96        |
| 2  | Nearshore      | 47  | 770,55               | 2,192,00     | 38,53        | 126,00       | 81,04        |
| 3  | Offshore       | 32  | 1,030,00             | 3,283,00     | 22,89        | 82,08        | 52,85        |
| 4  | Offshore       | 25  | 1,630,14             | 3,680,00     | 21,44        | 61,33        | 33,42        |
| 5  | Offshore       | 25  | .561,64              | 5,250,00     | 13,01        | 26,25        | 20,05        |

### Table 9. AHTS average charter rate

| No  | Klasifikasi BHP | Clear Deck Space (m²) | Bollard Pull | USD/day (Min) | USD/day (Max) | USD/BHP (Min) | USD/BHP (Max) | Average USD/BHP |
|-----|-----------------|-----------------------|--------------|---------------|---------------|---------------|---------------|----------------|
| 1   | 4.000 - 5.000   | 250 - 400             | 40 - 70      | 2133,56       | 3047,95       | 0,44          | 0,61          | 0,53           |
| 2   | 5.001 - 6.000   | 300 - 500             | 50 - 80      | 2435,00       | 5300,00       | 0,47          | 1,07          | 0,77           |
| 3   | 6.001 - 10.000  | 300 - 600             | 60 - 140     | 3600,00       | 7500,00       | 0,56          | 0,85          | 0,71           |
| 4   | 10.000 - Up     | 385 - 800             | 120 - 300    | 8972,60       | 11050,00      | 0,73          | 1,04          | 0,88           |

### Table 10. PSV average charter rate

| No  | Range DWT (m²) | DWT Min | DWT Max | BHP Min | BHP Max | Clear Deck Space (m²) Min | Clear Deck Space (m²) Max | USD/ day (Min) | USD/ day (Max) | USD/ BHP Min | USD/ BHP Max | Avgr. USD/ DWT |
|-----|----------------|---------|---------|---------|---------|---------------------------|---------------------------|---------------|---------------|--------------|--------------|----------------|
| 1   | 1,000-3,000    | 1473    | 1650    | 4180    | 4962    | 350                       | 403                       | 3500          | 5417          | 2,38         | 3,58         | 3,08           |
| 2   | 3,100-5,300    | 3250    | 5257    | 5000    | 8924    | 680                       | 1000                      | 7000          | 15900        | 1,34         | 3,81         | 2,56           |

### Table 11. LCT average charter rate

| No  | Range BHP | GT Min | GT Max | Clear Deck Space (m²) Min | Clear Deck Space (m²) Max | Design Speed knot | USD/ day (Min) | USD/ day (Max) | USD/ BHP Min | USD/ BHP Max | Avgr. USD/ BHP |
|-----|-----------|--------|--------|---------------------------|---------------------------|------------------|---------------|---------------|--------------|--------------|----------------|
| 1   | 300-1000  | 10     | 750    | 100                       | 400                       | 8                | 558,97        | 1998,00       | 0,60          | 2,58         | 1,23           |
| 2   | 1001-1700 | 319    | 722    | 300                       | 600                       | 8                | 746,30        | 3335,62       | 0,59          | 2,66         | 1,34           |

### Table 12. Utility vessel average charter rate

| No  | Range BHP | Clear Deck Space (m²) Min | Clear Deck Space (m²) Max | USD/ day (Min) | USD/ day (Max) | USD/ BHP Min | USD/ BHP Max | Avgr. USD/ BHP |
|-----|-----------|---------------------------|---------------------------|---------------|---------------|--------------|--------------|----------------|
| 1   | 300 - 1500| 50                        | 90                        | 643,84        | 2770,00       | 0,66         | 2,13         | 1,35           |
| 2   | 1501 - 3000| 98                       | 300                       | 954,86        | 3500,00       | 0,35         | 1,46         | 0,69           |
| 3   | 3001 - 4000| 305                      | 400                       | 1260,42       | 3664,38       | 0,39         | 1,15         | 0,64           |

### Table 13. AHT average charter rate

| No  | Klasifikasi BHP | Bollard Pull Min | Bollard Pull Max | USD/day (Min) | USD/day (Max) | USD/BHP Min | USD/BHP Max | Avgr. USD/BHP |
|-----|-----------------|------------------|------------------|---------------|---------------|--------------|--------------|---------------|
| 1   | 1,300-3,000     | 32,50            | 49,00            | 613,01        | 1665,00       | 0,24         | 0,80         | 0,53          |
| 2   | 3,001-4,000     | 40,00            | 48,80            | 1050,00       | 3500,00       | 0,31         | 1,08         | 0,66          |
Table 14. AWB average charter rate

| No | Category | Pax Min | Pax Max | Crane Cap. Min | Crane Cap. Max | USD/ day Min | USD/ day Max | USD/ Pax Min | USD/ Pax Max | USD/ Crane Cap. Min | USD/ Crane Cap. Max |
|----|----------|---------|---------|---------------|---------------|--------------|--------------|--------------|--------------|------------------|-------------------|
| 1  | Swamp   | 38      | 107     | 25            | 250           | 3450,00      | 8333,33      | 44,16        | 130,21       | 67,63            | 200,00            |
| 2  | Offshore| 120     | 200     | 50            | 180           | 3554,79      | 16000,00     | 20,67        | 102,56       | 19,75            | 156,86            |

4. Conclusion
As presented in this paper, the selection of technical specifications and the standardization of charter rate of the operations support vessel is multi stage process as indicated by the authors, technical specifications evaluated using ELECTRE taken from several technical specification items collected from the discussions with oil and gas industry actors, especially in national oil and gas companies, then group charter rate data from the national upstream oil and gas vessels database.

The results using the ELECTRE method in the table shows that the grouping of technical specifications for supporting operational vessels focuses on the ship's maneuverability, where the ship's capacity related to tank capacity is more taken into account than capacity such as lifting equipment and passenger capacity because the nature of the ship supporting oil and gas operations focuses more on the capability ships in supporting oil and gas exploration and exploitation activities in the offshore field. From the results of clustering of vessel charter data supporting upstream oil and gas operations, it shows that the upstream oil and gas industry actors, especially vessel users, focus more on the average vessel charter rate on vessel capabilities, such as the average rate per BHP, the average rate per pax, the average average rate per DWT, and arguably based on average per capacity.

Technical and economic considerations can be a reference that can be combined in formulating a decision to use ships optimally, especially in the upstream oil and gas business in Indonesia. The use of MCDM is not the main method in determining a decision in terms of ship selection, especially upstream oil and gas operation support vessel, but it can be used as a support in the assessment of decision making in oil and gas companies and on the government side. Other technical considerations in accordance with field conditions and operational needs in the field are very influential. Further research is needed to study other technical and economic aspects that can improve the selection of technical specifications and standard charter rates to be able to create optimum and efficient marine operations in the upstream oil and gas sector.

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