Evaluation of Determinant Factors Influencing the Selection of Ship Management Companies

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ABSTRACT: Looking at the high flow of the shipping industry and many things related to the ship operations that have to be done every day, several ship owners have collaborated with Ship Management Company (SMC) to assist them in managing their ships' operations. SMC is required to be responsible for the daily operational management of the ship on behalf of the ship owner such as crewing, technical management, administration, and chartering. Seeing the importance of collaboration and the diversity of services provided by the SMC, it is necessary to evaluate each determinant factor by the ship owner for the selection of an SMC to assist the ship owner in choosing an SMC that suits their needs. It is also to improve the service prioritized by the owner to SMC. The purpose of this research is to identify the determinant factors of SMC selection from the owner's perspective, evaluate the importance of each of these factors, and obtain different views between the owner and SMC in the selection of ship management. The Fuzzy Analytical Hierarchy Process (Fuzzy AHP) method is used for evaluating weight based on the opinions of the owners and SMC who are experts in their fields. Then, the different perspectives between the owner dan SMC were obtained from the processing result. The results show that owners placed their top priority on factors that they can get the most from SMC, such as human resource factors and services. Meanwhile, SMC placed its priority on cost and its services factors that described the things they must manage well and optimization provided to owners.

1 INTRODUCTION

Ships are crucial in driving economic growth because they are the main transportation modes to cross the sea. Indonesia is an archipelagic country that has large territorial coverage of waters. Two-thirds of its area is covered by the sea. It also has approximately 17,000 small and big islands. Ships are used to deliver goods and services domestically and internationally. They also function as commercial transportation for the people. Therefore, good ship operations with a support system can generate optimal economic activities and strengthen the maritime industry.

The high flow of shipping in Indonesia encourages some ship owners to collaborate with Ship Management Company (SMC) to support their operational matters. SMC is the third-party responsible for managing the daily operations of the ships on behalf of the owners. Their tasks are manning, chartering, periodic ship maintenance, and taking care of the ship's daily administration. Those duties can make it easier for the ship owners to manage their operations so that they can focus more on other operating aspects.

The ship management must be able to manage broader scopes. The scopes have been increasingly complex due to environmental regulations, expansion

of authority over coastal waters, and the development of offshore resources (Frankel, 1982). There are other settings based on specific regulations that must be complied with. They come from the ISM Code, ISPS provisions, flag state regulations, ship management growth, and maritime laws through IMO, making SMC must adjust their services. Service quality is a key factor to consider before choosing an SMC. Some owners only require the SMC to handle technical management for their ships. Some only need crew recruitment or insurance services. Based on this situation, it is necessary to identify the determinants of SMC selection from the ship owners' perspective.

Ship owners can achieve effective market segmentation, reduce operational costs, improve operational performance, and meet customer needs through the SMC to manage their non-core business matters (Panayides, 2003; Panayides & Gray, 1997, 1999). Some previous studies showed that ship owners choose the SMC that can support the best performance and profits. It is also based on the capabilities of the company's managers, directors, and accuracy in predicting demands for the ships they manage (Goulielmos et al., 2011; Pollalis, 2009). According to some considerations and views, it is important to evaluate the weighting of each factor contained in the SMC. Service evaluation is needed to assess the potential factors that can be developed and improved for the company's sustainability. On the other hand, the owners can express their opinions regarding the services provided, so that SMC can provide the best services as expected by the ship owners.

Good cooperation between the ship owners and the SMC can be realized by harmonizing and unifying the views of each party. This aims to determine and evaluate the services that influence the values of success. The research findings can help the SMC for improving the quality of its services on the determinants from the owners' perspective in selecting the best SMC. The results can also evaluate the weighting of the determinant values and find out the differences in views between the owners and SMC. Therefore, the owners can get the best services as expected, and SMC can carry out sustainable cooperation.

Previous findings examined the SMC and its development, as well as determining factors in selecting a Ship Management Companies using various methods. The methods include evaluating SMC success factors using fuzzy logic (Jeon et al., 2016) and determinants of SMC selection for tramp shipping companies (Lin et al., 2019). Previous research also studies the roles of SMC in the shipping industry's business activities (Bistrivci'c et al., 2011; King & Mitroussi, 2003; Mitroussi, 2013) and the scaling method for the priority hierarchical structure (T. L. Saaty, 1977). On the other hand, this research is related to the latest ones, namely those related to the analysis and evaluation of the determinants of an SMC using a combination of 2 methods, namely fuzzy logic concept and Analytical Hierarchy Process (AHP) decision support method with PT SISM, one of SMC in Indonesia as the object. Besides, this research aims to study SMC in more detail in Indonesia.

The evaluation variables in the Shipping Management Industry are intangible and heterogeneous (Jeon et al., 2016). Some factors cannot be measured, such as knowledge, information, and service capabilities. They are included in the determinants discussed in this research. Therefore, this research uses the Fuzzy Analytical Hierarchy Process (Fuzzy AHP) method. It is a combination of the AHP method and the fuzzy set used to evaluate measurable and non-measurable factors and makes it easier to weigh each factor in this research.

2 DATA COLLECTION AND METHODOLOGY

2.1 *Data Collection*

The data consist of the primary data. They are collected using questionnaires distributed to PT SISM as the SMC, and customers from PT SISM as the ship owners. The data are collected using questionnaire instruments that are easily and commonly distributed to the respondents to obtain the primary data. This questionnaire facilitates answering paired questions and getting the value preference of a measure. The questions are based on the arrangement of each criterion and sub-criteria. The results show that seven respondents can represent the company's internal and external clients in terms of the ship owners and PT SISM related to the SMC.

Respondents' data are assessed using a Likert scale to measure a person's opinions, perceptions, and attitudes. The scale also shows the level of agreement with a series of questions. In this research, the Likert scale data are changed into numbers that follow the concept of fuzzy logic with lower, middle, and upper limits (l, m, u) as shown in table 1 below.

Table 1. Likert scale (concept of fuzzy logic), (Source: (Puspitasari, 2009))

Saaty Scale	Fuzzy Number (l, m, u)	Definition of Linguistic Variable
1	(1,1,1)	Two elements have the same importance
3	(1,3,5)	One element is slightly more important than the other
5	(3,5,7)	One element is more important than the other
7	(5,7,9)	One element is more important than the other
9	(7,9,11)	One element is more important than another
2,4,6,8	(1,2,4), (2,4,6), (4,6,8) and (6,8,10)	One element with a similar value to another

2.2 *Determination of Criteria and Sub-criteria of Determinant Factors*

Criteria and sub-criteria of the determining factors are prepared to fix the questions for the respondents. Determination of the factors for the questionnaire is done using literature reviews from previous journals/research related to the general description, objectives, and functions of the SMC. There is also a consideration of the 2009 BIMCO Standard Ship Management Agreement as a reference for the agreement between the ship owner and SMC (BIMCO

et al., 2009). The obtained criteria and sub-criteria are written in Table 2.

Table 2. Determinants of Criteria and Sub-criteria

No.	Criteria	Sub-criteria
1.	Cost	Efficient management of ship operating costs
		Ship management fees
		Commission days
		Transparency of the use of funds
2.	Human resources	Ability to recruit skilled workers
		Experience in the ship management industry
		Professional and knowledgeable workforce
3.	Services	Good quality management service potential
		Quick responses to the owners
		Coordination of ship verification reports
		Sensitivity to IT systems
		Responsiveness towards the owners' policies
4.	Business Development	Building sustainable collaboration
		Company reputation
		SMC Fleet Size

2.3 Method

Fuzzy AHP is a ranking method for making a decision (multi-criteria decision making). Fuzzy AHP can cover the shortcomings of AHP related to problems in each criterion which tend to be subjective and many (Elveny & Syah, 2014). Meanwhile, the logic of fuzzy concepts can help in making measurements related to subjective human judgments in language or linguistics.

The AHP method was introduced by Prof. Thomas Lorie Saaty (R. W. Saaty, 1987). It is a model for supporting decision-making by looking for rankings or priority sequences from various alternatives for solving problems. Some basic foundations in solving problems using AHP include hierarchical models, considerations or judgments, synthesizing priorities, and logical consistency. Besides, there are basic axioms, including reciprocity, uniformity, interdependence, and hope (T. L. Saaty, 1977). Pairwise comparisons with all hierarchical elements aim to determine the priority arrangement of elements. A scale with an interval of 1 to 9 is needed to test the overall priority against changes in the comparisons.

The concept of fuzzy logic ("vague") was developed by Professor Lotfi Zadeh. It is a development of the previous theory related to the crips or firm set. In the crips set, there are only two possibilities for membership; being a member or not, or something like "black or white" (Goguen, 1973). Meanwhile, the fuzzy set members have a fuzzy value between false and true or such as "gray" (fuzziness) displayed in a curve to show the mapping of fuzzy number points to set the degree of membership (Equation 1). It has an interval from 0 to 1. This research uses triangular fuzzy numbers (TFN) arranged based on linguistic sets to obtain the degree of membership in the Fuzzy AHP method. Significant levels in AHP are converted into a set of TFN scales represented by a triangle that has three parameters, namely a, b, and c (with a < b < c) expressed through a triangle (x; a, b, c). The image mapping of triangular fuzzy numbers is described in Figure 1.

$$\mu A_{(x)} = \begin{cases} 0, & x < \alpha_1 \\ (x - \alpha_1)/(\alpha_2 - \alpha_3), & \alpha_1 \le x \le \alpha_2 \\ (\alpha_3 - x)/(\alpha_3 - \alpha_2), & \alpha_2 \le x \le \alpha_3 \\ 0, & x > \alpha_3 \end{cases}$$
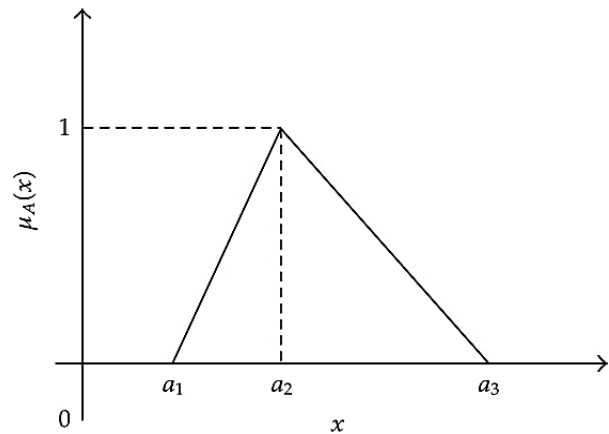

Figure 1. Image mapping of triangular fuzzy numbers, (Source: (Goguen, 1973))

TFN can describe the subjectivity in pairwise comparisons and the degree of certainty of the obscurity. Therefore, the linguistic variables can be used by decision-makers to represent the data fuzziness if there is a discontinuity with the TFN.

The data are processed using the fuzzy AHP method supported by spreadsheet application. The stages start with forming a fuzzy pairwise comparison matrix (Equation 2).

$$A = \begin{bmatrix} 1 & a_{12} & \dots & a_{1n} \\ a_{21} & 1 & \dots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & \dots & 1 \end{bmatrix} \qquad (2)$$

where:
$a_{ij} = [l_{ij}, m_{ij}, u_{ij}]$
$\forall_{ij} = 1, 2, \dots, n$
l_{ij} is the lower limit value, m_{ij} is the ideal value, and u_{ij} is the upper limit value.

The consistency of fuzzy pairwise comparison matrix must be tested. Since the matrix is inverse, only the lowest and highest triangular element values are tested. A comparison matrix is consistent if it meets the following conditions.

$$\text{Max}_k \left(l_{ik} l_{jk} \right) \le \text{Min}_k \left(u_{ik} u_{jk} \right) \qquad (3)$$

for all $i,j,k = 1, 2, 3, \dots, n$

Next step is the calculation of fuzzy weighting. The fuzzy weighting assessment is calculated using the geometric mean of the column vector. The fuzzy weighting assessment of $\tilde{W}_i$ can be calculated as follows:

$$\tilde{W}_i = \tilde{Z}_i \otimes \left(\tilde{Z}_1 \oplus \tilde{Z}_2 \oplus \dots \oplus \tilde{Z}_N \right)^{-1} \qquad (4)$$

$$\tilde{Z}_i = \left(\tilde{a}_{i1} \otimes \tilde{a}_{i2} \otimes \dots \otimes \tilde{a}_{iN} \right)^{1/N} \qquad (5)$$

where:
a_{ij} : column i, row j of matrix, $i, j = 1, 2, ..., n$;
Z_i : the mean value of the column vector of fuzzy numbers, $i = 1, 2, ..., n$;
W_i: weighting of indicators i
$\otimes$: multiplication of fuzzy numbers
$\oplus$: additional fuzzy numbers

The next step is the calculation using the center area method. The defuzzification can be calculated to assess the fuzzy weight (DF_{ij}) (Tzeng & Teng, 1993):

$$DF_{ij} = \frac{\left[\left(u_{ij} - l_{ij}\right) + \left(m_{ij} - l_{ij}\right)\right]}{3 + l_{ij}} \quad (6)$$

where:
u_{ij}: upper value of TFN in column i row j
m_{ij}: middle value of TFN in column i row j
l_{ij} : the lower value of TFN in column i row j

The next step is the weighting normalization process (Ni). It is calculated as follows:

$$N_i = \frac{DF_{ij}}{\sum DF_{ij}} \quad (7)$$

where:
DF_{ij} : defuzzification value in column i row j
$\sum F_{ij}$: total defuzzification value in column i row j

3 RESULTS AND DISCUSSION

3.1 *Results*

The fuzzy AHP method starts with creating a pairwise comparison matrix such as the formula (2). The next steps are fuzzy weighting, defuzzification, and normalization carried out sequentially by referring to the formula (3), (4), (5), (6), and (7). It can be seen in the order of factors from those with the highest priority level. The data obtained through the questionnaires filled out by the ship owners and SMC are processed. The final results of the weighting for each criterion and sub-criteria are in line with the previous descriptions related to the perception of the ship owners and SMC.

Based on the weighting for each criterion, there are some differences in perception between the two parties. They are related to the factors of interest in choosing an SMC, as can be seen in Figure 2. The figure shows the difference in the order of priority between the owners and the SMC. The owners feel that superior human resources owned by an SMC are the most important because in the business services industry, human resource advantages the power offered that the customers focus more. On the other hand, SMC believes that cost is a good factor because it is related to the amount of money for each ship in daily operations.

Figure 3 shows the weighting for cost sub-criteria. From the figure, it seems that both owners and SMC have the same view. The priority is efficient cost management of ship operations. It is due to the amount of nominal money that must be managed by SMC and issued by the owners for one voyage for each ship. They also agree on commission days based on the

ability to operate within one year. It aims to minimize breakdown time and maximize benefits.

Figure 4 shows the weighting for human resource sub-criteria. The figure shows that according to the owners, the SMC must have a professional and knowledgeable workforce. Expert workforces can also determine the quality of management services (Dickie, 2014). SMC thinks experience in the ship management industry is good. Long experience means more problems can be solved by internal workers. The owners want to get the best provided by the human resources of an SMC.
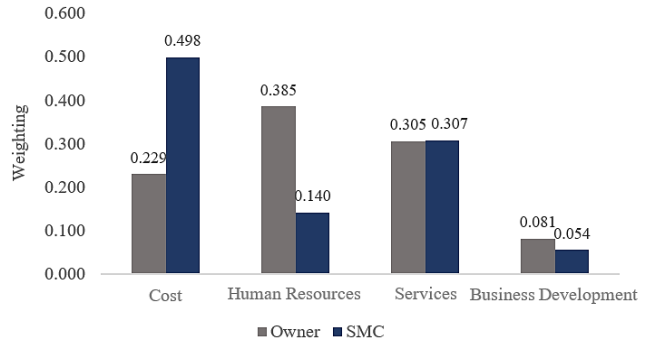
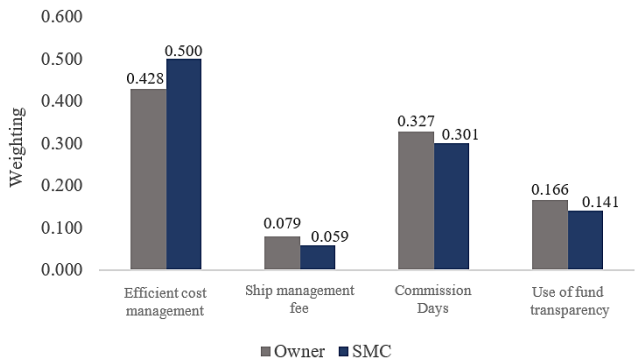Figure 2. Result of Main Criteria Comparison
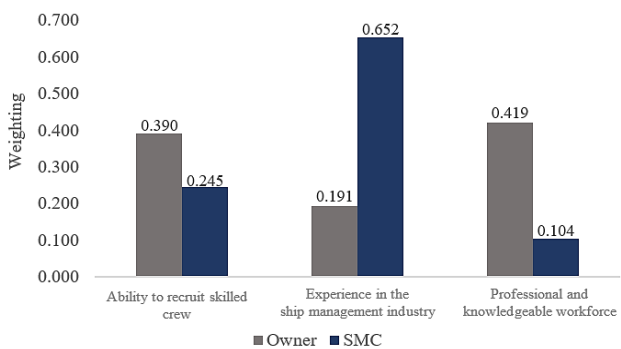
Figure 3. Comparison Results of Cost Sub-Criteria

Figure 4. Comparison Results of Human Resources Sub-Criteria

Figure 5 shows the weighting for services sub-criteria. SMC agrees that quick response to the owners is a top priority. Establishing communication between two parties is good, especially for deciding certain conditions. Quick responses and coordination of ship verification reports are the two most important factors in terms of service. It means that the communication and coordination provided to the owners must be considered deeply based on the SMC perspective.
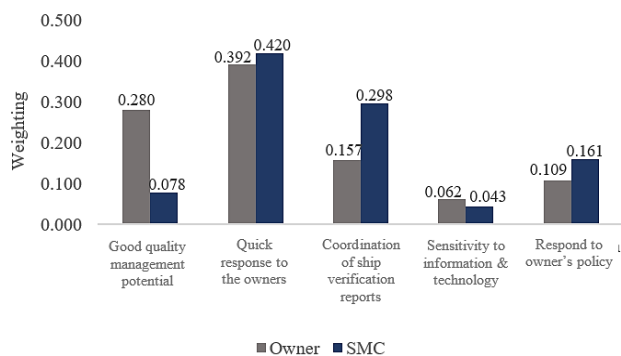
Figure 5. Comparison Results of Services Sub-Criteria

Figure 6 shows the weighting for business sub-criteria. According to the ship owners, building sustainable cooperation is the best factor because the ship operations must be based on their ages. The SMC must have sustainable characteristics so that the owners do not need to change the SMC until there is a ship demolition. A company's reputation becomes the second priority for SMC because companies usually raise better chances to promote themselves to the clients. Besides expanding their market shares, better companies' reputations can also make clients sure to establish cooperation. According to the owners, this factor is not so important because it is external or does not directly intersect with them.
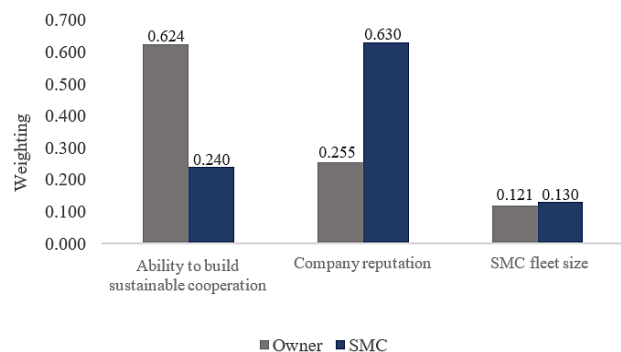

Figure 6. Comparison Results of Business Sub-Criteria

3.2 Discussion

The research findings show that the ship owners place their top priority on something they can feel directly, such as human resources (HR). It is because the HR provided by SMC can directly affect the quality of their services. Previous study indicated the three most influential factors; operational cost, the ability to recruit human resources, and good management quality as the first rank (Jeon et al., 2016). There are similarities between these two findings. The ship owners consider human resources and management services as the most crucial matters. However, the previous study proves the owners place their most important priority on managing ship costs. The owners prioritize the best things they can get in selecting an SMC.

Meanwhile, the SMC prioritizes the cost and services. This illustrates that an SMC focuses more on good cost management, considering that cost reduction is good for efficiency. Quality service also becomes a selling point of ship management to the owners. That is why because the service is one thing that the SMC

emphasizes. If SMC follows the ship owners' view by prioritizing and developing workforces, there will be a good and sustainable collaboration in the future. However, money must also be prioritized in future strategic steps.

4 CONCLUSION

This research aims to identify and evaluate the determinants in the selection of a ship management company. The ship owners can consider and select an SMC appropriately. The findings can also assist the SMC in improving the quality of its services. Therefore, the owners can get the best service as expected, and the SMC can carry out sustainable cooperation. The research generates a priority order of the factors in the selection of an SMC by the owners. The results show that the owners are more concerned with the factors that can directly influence or support maximum and optimal achievement. They do not care about external matters. Human resources and services belong to the top priorities. The owners focus more on human resources in choosing an SMC. Meanwhile, the SMC does not describe the same thing but highlights another factor (cost). It mistakenly thinks that the owners only focus on management and its financing. Therefore, there is a difference of opinion between the two parties, where the owners concern more about the factors that they can get the best from an SMC, while the SMC thinks more deeply about something they must manage well and the optimization they can provide.

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