



An Innovative Multi-Criteria Decision-Making (MCDM) Framework for Picking the Right Used Chemical Tankers: A Classified Model-Based Discussion

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Abstract

Because chemical tanker boats are so expensive to build and maintain, shipping firms may not be able to supply their clients with fair transportation pricing. As a result, shipping businesses may find various benefits and chances by purchasing second-hand chemical tanker vessels. But picking a chemical tanker is a hard task that requires overcoming numerous misunderstandings and weighing several conflicting factors. A novel MCDM technique has been proposed in this study for this aim. EDAS approach is used in the proposed model, to handle uncertainty. In order to demonstrate efficacy, relevance, and robustness, the model was used to address decision-making issues involving the selection of suitable second-hand chemical tankers from a pool of 10 (alternatives). The chemical tanker boats were evaluated using 14 distinct choice criteria in the present article. The findings show that the most important factor is "CTC6" Maintenance cost," and the best and most preferred chemical tanker is "CTA6"

Keywords: MCDM; Chemical tankers; EDAS; Maritime Industry; Transportation; Shipping firms

1. Introduction

The ever-increasing need for chemical goods drives the specialty chemicals economy's annual expansion. The annual increase in this market has been 2.5 percent since the previous year. Nevertheless, the specialty chemicals industry is expected to expand by 4.4 percent with the outbreak of COVID 19. [1]. The crude tanker vessel consumption is highly affected by the rise in the chemical industry. During 2014 and 2018, an average of 42 chemical tankers were constructed and delivered, with demand for chemical goods increasing by 2.5% annually[2]. The need for additional chemical tankers was decreased as a result of the pandemic uncertainty, and just 23 chemical tankers were supplied in 2020[3].

Similar expectations can be seen in the chemicals tanker shipping business, which is expected to grow at a rate of 4.5% in the next year. Chemicals tankers will need around 75 additional vessels next year to meet the industry's growing demand. However, adding more tanker boats to the chemical plants' fleet may not fix current supply and demand mismatches.

Moreover, since it may lead to shipping industry source usage, it may lead to source waste. In addition, there are roughly 325,000 DWT chemical tanker boats that are sitting idle, and choosing old ships over new vessels might be a suitable option for the chemical tanker shipping sector.

Furthermore, [2] said that the banking business has investments composed of second-hand boats worth around 450 billion dollars, which entails risk in finance. To alleviate their mounting financial

woes, banks are attempting to unload the massive floats they acquired from bankrupt shipowners, which has resulted in steadily declining second-hand ship purchase prices. Shipping firms may be able to secure ship investments as a result of the current circumstances. As a result, per the [4], the marine industry's operational expenses include a significant portion of its financing costs. Due to the significant financing costs of shipping businesses' ship investments, it's appropriate to acknowledge it as a component in determining the efficiency, productivity, and success of such organisations. [5] also found that these arguments were supported by the study's findings. Investment in older boats, according to Fan et al.[6], is crucial for shipping businesses looking for product differentiation in a complex and competitive business landscape.

An extremely competitive and challenging business climate also puts a lot of pressure on transportation businesses to deliver. This means that newer chemical tankers have two significant limitations. For starters, the order-to-delivery cycle for a new chemical tanker is lengthy[7], and shipping firms must wait at least one or two years for the newly ordered chemical tankers to be delivered. Due to the ever-changing nature of the shipping sector, it might take a long time for the needs of shipping firms to be met. To begin with, since chemical tanker boats are unique and have unique characteristics compared to other types of maritime vessels, they have very high financing expenses.

Because of these benefits, shipping firms might find a chemicals tanker vessel on the used vessel market that can open up a slew of possibilities. Purchasing a chemical tanker does not need to be put off, and shipping businesses may own chemical tankers for cheaper investment expenses as soon as they want to do so. It is difficult for decision-makers to choose the right chemical tanker because of the numerous conflicting factors and existing ambiguities in the evaluation process. Furthermore, the criteria used to pick a suitable second-hand chemical tanker vary from the criteria used to design new chemical tankers in terms of the total quantity of factors and their significance. As a result, while choosing a used chemical tanker, decision-makers should take these variations into account. Because of this, decision-makers must pick a proper second-hand chemical tanker.

With the help of this document, you'll be able to make better, more logical choices when it comes to buying used chemical tankers.

To ensure that our findings are as accurate as possible, we enlisted the help of a group of specialists with vast marine industry expertise. Also, we came up with a list of questions for the experts to answer. Round table discussions and one-on-one interviews were held with the committee of specialists to accomplish this goal. The following is a breakdown of the research questions.

- I. In the marine business, is there a mathematical instrument or decision support technology that is used to assess used chemical tankers?
- II. When it comes to selecting the right second-hand chemical tankers, how do decision-makers get to their conclusions?
 - Is there a list of the most important criteria and aspects that influence the assessment process?
- III. Buying a used chemical tanker vs. any other sort of vessel raises some interesting questions.

According to the specialists, there is no approved process monitoring and control or framework in the marine business. Chemical tankers are selected based on the expertise and personal judgment of the professionals in charge of making such decisions. In addition, they see every selection procedure as a unique situation and treat it accordingly. Chemical tankers, on the other hand, have more specific technical requirements than any other vessel category. Finally, researchers asked experts to compile a set of criteria for determining which candidates should be considered. Once the redundant criteria had been eliminated, a definitive list of criteria for selection had been compiled, resulting in total agreement among decision-makers.

The logistical costs of specialty chemicals supply chains are heavily dependent on ocean shipping, which is among the most critical segments of the global supply chain. Consumers may face a 20% rise in purchase expenses due to logistical expenditures, according to [8]. For those in the logistics business looking to save expenses, finding the right used tanker ships is essential.

The remainder of the paper is laid out in this way. Related work was conducted in Section 2. Section 3 demonstrates in detail the MCDM EDAS method. This model's application is shown numerically in Section 4, which deals with chemical tanker vessel selection issues on the used market. In Section

5, organizational implications are conducted. Conclusions are made in Section 6, where the findings are reviewed, and the articles' management implications and limits are noted.

2. Related Work

While maritime shipping firms and other maritime industry players use ship selection as a strategic and management choice, we found significant and significant literature gaps when we conducted a full and exhaustive literature analysis. In the first place, there are just a few studies out there. Despite a thorough study, only eight publications were located that dealt with ship choice issues utilizing different decision-making methods. As far as the author is aware, there is no study in the literature focused on the selection of chemical tankers, although various publications have evaluated crude oil tankers, bulk carriers, and cruise ships. MCDM frameworks used in these investigations are the source of the second hole. MCDM techniques that are more conventional and classical are favoured by most of the writers that write in the literature.

In the literature on ship selection, there are many management and theoretical gaps that need to be filled. To begin with, the MCDM models and frameworks developed in prior research have several structural issues.

The shipbuilding business was studied by Gavalas et al.[9]. The Fuzzy DEMATEL, Fuzzy ANP, and MOORA methods were used to analyze the operating efficiency of shipbuilding enterprises in addition to their financial performance. The AHP method was used by Santos et al. [10] to evaluate the Brazilian navy's vessel options.

[11] DEMATEL technique features a sophisticated algorithm that necessitates several comparisons and calculations. It may be necessary to exclude certain criteria for the decision-makers to obtain their desired outcome yet removing some elements may result in variances from the outcomes. As a consequence, this issue has the potential to influence the validity of the data collected. The traditional form of the DEMATEL procedure, which relies on crisp values obtained from decision-makers assessments, cannot be used when there are uncertainties in the evaluation process. In addition, it does not take into account the degree of the desire of the factors or the partial ranking of criteria into account[12].

It is also not possible to show the absolute correlation among the choice criteria and the degree of correlation[13]. As a consequence, it is impossible to tell how each factor influences the final ranking results. However, selecting used chemical tankers necessitates considering several factors and variables to arrive at a logical and sensible conclusion. DEMATEL's structural flaws and disadvantages mean that it cannot offer a realistic, reliable, and useful environment for tackling the present decision-making challenge.

Because of the QFD technique[14], may neglect several important criteria and aspects, such as the degree of satisfaction. Decision-makers must first prepare a large matrix[15], and this method is unable to give useful answers to complex decision-making issues because it fails to take into account a large number of interrelated criteria, factors, and uncertainties.

It also takes a lot of data to evaluate and cannot show the link between criteria and variables. Moreover. For these reasons, the QFD cannot be used to tackle the present issue of decision-making since it has a fairly static structure that does not allow for dynamic decision-making.

Traditional MCDM strategies such as the PROMETHEE may not provide logical and acceptable answers if decision-makers cannot communicate their desire between 0 and 1[16].

These two periods may also not be sufficient in real life to represent and identify the preferences of the decision-maker. To be successful, it requires a realistic and strong set of weighted criteria that can be independently verified. As a consequence, the overall ranking results are very sensitive to changes in the correctness of the criterion weights. As a result, the issue of rank reversal is not circumvented by this strategy. Furthermore, it is unable to cope with complex ambiguity due to its inability to collect and handle uncertainties, whereas the marine business is full of complex uncertainties. Due to the method's flaws and structural issues, it is unable to give decision-makers a sufficiently dependable environment in which to address the challenge of selecting used chemical tankers.

When it comes to evaluating ship choice issues, the TOPSIS is a favoured decision-making technique in the literature. Rank reversal issues reduce the dependability of the findings acquired

using this approach. There has been no good resolution to the rank reversal issue using the approximation TOPSIS method [17], an expanded version of the traditional TOPSIS technique. This is because it can better cope with uncertainty than the conventional version.

An independent piece of evidence is assumed in the Dempster-Shafer [18] because each item of evidence is examined individually. It has a sophisticated algorithm and necessitates a large number of calculations [19]. Furthermore, the D-S approach's actual findings may be inaccurate for decision-makers if the rules are not identified completely and impressively at the outset of the procedure. FGP [20], a strategy that has been shown to work well with ambiguity, is another option worth considering. Nevertheless, it is an enlarged form of the classical approach with the assistance of type-1 fuzzy sets; it cannot collect and handle uncertainty at a suitable level. Because of this, it may not be able to come up with effective answers, and it suggests this unproductive and ineffective approach to experts [21]. When using the FGP technique, it is possible for practitioners to have serious reservations regarding its accuracy, and even though the findings are completely optimal, they cannot be certain of the results' correctness.

Xie [22] has a sophisticated algorithm and cannot handle intricate ambiguity. The E.R. also requires a vast amount of data and information for analysis.

It is possible to combine preferences and uncertainty into the Fuzzy Multi-Attribute Utility Model [23] approach [24] but a substantial quantity of information and data is required to conduct an analysis; opinions of experts should also be exact.

3. Optimization Method

In certain MCDM settings, the standard EDAS approach may investigate incompatible properties. With this model's assessment score (AS), the differences between 10 options may be interpreted, and the AS value is dependent on the PDA and NDA distances from the mean (NDA). The refrigerant with the highest PDA and lowest NDA values is the ideal choice. An EDAS formula's framework is described in the following manner [25]–[28].

Step 1: Initial decision matrix development $(x_{ij})_{mn}$: the first step

Step 2: It's time for the average answer. Experimentation run number, output response number and the normalized value of i th experimental period (alternatives) associated with the j th output response (criteria).

$$AV_j = \frac{\sum_{i=1}^n x_{ij}}{n}$$

Step 3: Compute the PDA value (positive distance)

$$PDA_{ij} = \begin{pmatrix} \frac{\max(0, (x_{ij} - AV_j))}{AV_j}; \text{for positive criteria} \\ \frac{\max(0, (AV_j - x_{ij}))}{AV_j}; \text{for cost criteria} \end{pmatrix}$$

Step 4: Compute the NDA value (negative distance)

$$NDA_{ij} = \begin{pmatrix} \frac{\max(0, (AV_j - x_{ij}))}{AV_j}; \text{for positive criteria} \\ \frac{\max(0, (x_{ij} - AV_j))}{AV_j}; \text{for cost criteria} \end{pmatrix}$$

Step 5: SP and SN values are normalized

$$NSP_i = \frac{SP_i}{\max_i(SP_i)} \sum_{j=1}^m w_j * PDA_{ij}$$

$$NSN_i = 1 - \frac{SN_i}{\max_i(SN_i)} \sum_{j=1}^m w_j * PDA_{ij}$$

Step 6: Compute the score of the appraisal

$$AS_i = \left[\frac{NSP_i + NSN_i}{2} \right]$$

Step 7: Rank alternatives based on the highest value of AS_i

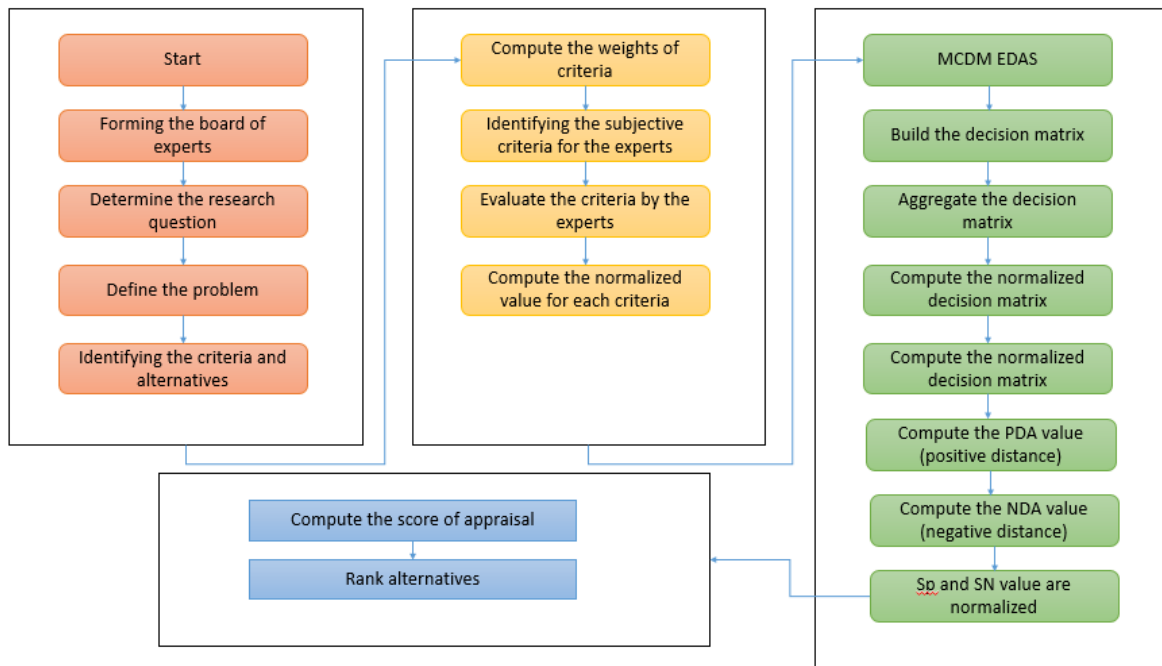


Figure 1: The framework of the study.

4. Application

Solving difficult MCDGM issues in the marine and logistics sectors has never been easier because of a new mathematical method presented in this study. Together with one of the largest chemical tanker shipping firms, we looked at the real evaluation procedure for second-hand chemical tanker boats. MCDM can use the model to solve the chemical tanker vessel decision problems. In addition, it may serve as a source of inspiration for researchers who want to investigate this topic further.

Initially, the firm sought a pre-meeting with us, which we agreed to. According to the author's first views, these officials had purchased multiple new-building chemical tanker boats on separate dates. Nevertheless, they assessed chemical tankers based on the purchase price and financing facilities offered by shipbuilders in offer letters. Furthermore, the shipbuilders were informed by the corporation that the volume of the chemical tankers was the most important demand.

Consequently, it has been shown that decision-makers lack thorough and deep knowledge of the criteria for influences. Furthermore, their knowledge of the second-hand boat market is quite restricted and sparse.

As part of this procedure, we interviewed chemical tanker vessel industry specialists face-to-face and conducted preliminary investigations to gather information regarding chemical tanker vessel choice. After this analysis stage, we found that the choice of marine vessels is a hugely complicated decision-making issue that is influenced by many conflicting objectives and highly complex ambiguities; also, misjudgements and mistaken choices of ships can hurt maritime shipping companies' efficiency and productivity. All levels of government agree that this is a difficult

decision-making challenge plagued by enormous uncertainty. They've achieved an agreement. This decision-making issue necessitates the use of a research procedure.

Because we wanted the input of specialists with vast expertise in the chemical transportation sector, we formed a committee composed of these individuals to ensure the assessment process yielded the most accurate and fair findings possible. To join the board, you must have at least 15 years of experience as a senior executive in the chemical shipping sector and a thorough understanding of the needs of chemical shipping firms regarding chemical tanker vessel choice. After a lengthy and extensive examination procedure, three experts were chosen to serve on the board of specialists. Apart from a thorough literature search, extensive fieldwork with specialists was carried out to develop a criterion list that is fully updated and suited for real-life decision-making challenges experienced in the marine business. The following section outlines the stages involved in this procedure. Figure 1 depicts the process for determining the criteria to be used and the framework.

In this stage, we met with experts in a variety of settings, including round tables and one-on-one interviews. Each expert was asked to compile a list of criteria. We gave the pros time to prepare for the next meeting to do this.

DMs were asked to provide lists of criteria and variables impacting the choice of second-hand chemical tanker boats, and each expert did so based on his or her knowledge and expertise in the field. As a reminder, we informed the specialists that there have been no restrictions on the number of criteria that may be added to the list.

Collecting and removing repeated criteria from lists supplied by experts was the fourth step in the process. It was also decided to combine various criteria, stated in different ways, even if they are all the same.

Identifying criteria utilized in prior publications was accomplished by conducting a thorough examination of the literature and using the reputable scientific databases.

A final qualifications list has been developed by mixing all the criteria utilized in the research and identified by experts, and this list has been provided to the experts for approval.

In this step, we asked the experts to assign each of the criteria a relative importance value between 1 and 9. Next, the geometric mean of the values provided to each criterion was used to identify each criterion's final significance scores. In addition, the experts unanimously agreed to delete other factors that had a low relative relevance rating. Figure 2 shows the hierarchy tree of criteria and alternatives. Let experts evaluate the criteria. Then normalized it to compute the weights of the criteria in figure 3. In order to find a parameter set that is both up-to-date and applicable to the kinds of real-world decision-making issues that arise in the marine sector, extensive research with specialists was conducted in addition to a thorough literature analysis. The next section lays out the measures to be taken for this procedure.

Experts were consulted in depth via a series of face-to-face discussions and in-depth interviews, "Meeting with the Experts." We asked that each specialist prepare a list detailing the requirements. We did this by giving the experts some breathing room until the next scheduled meeting.

List creation by each DM Based on his or her knowledge and expertise, each DM compiled a list of criteria and aspects that should be taken into account when choosing a pre-owned chemical tanker. We also emphasised to the experts that they are free to add as many criteria as they see fit to the list.

Expert-made lists were gathered, and redundant criteria were removed, "Collecting the Lists." Further, by incorporating the thoughts of all specialists, we were able to merge some criteria that were previously articulated in distinct ways while being equivalent.

At this point, we conducted a thorough literature search and consulted the top scientific databases indicated in the literature survey to identify the criteria employed by prior publications.

The final group criteria list was submitted to the experts which included mixing the criterion set utilised in the literature with those indicated by the specialists.

We had each specialist provide a score among 1 and 9 to each criterion based on how important they thought it was. The final relevance scores for each criteria were then determined by taking the mean and standard deviation of the values assigned to each criterion. Then, all of the experts agreed that

the criterion with scores of four or below should be disregarded. In addition, we assigned a low relative relevance value to every criterion and reached a decision to drop some criteria with unanimous support from the experts.

The choice criteria were establishing the final criterion set. The final list of criteria, the requirements that were dropped, and their respective importance ratings are shown.

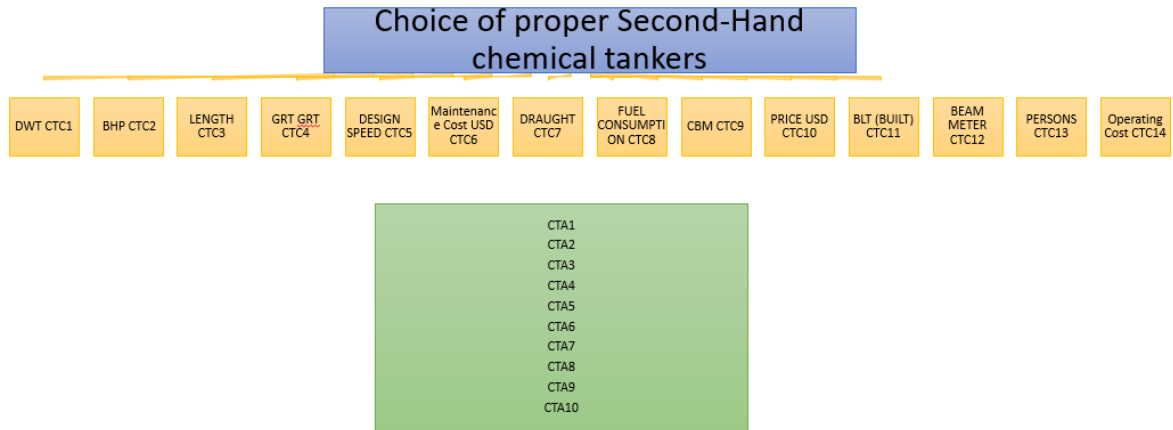


Figure 2: The hierarchy tree of the criteria and alternatives.

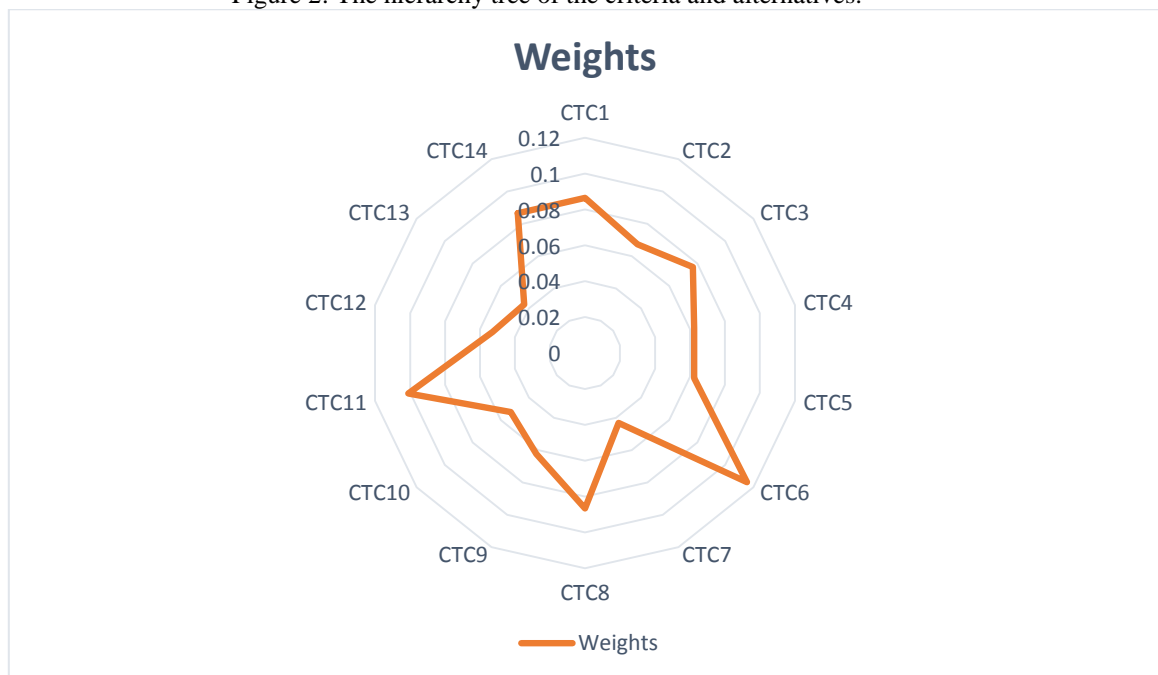


Figure 3: The weights of the criteria

Experts combined their opinions in table 1. Tables 2 and 3 show the normalized values of PDA, and NDA for EDAS analysis by considering performance elements.

Table 1: The combined value of specialists.

	CTC1	CTC2	CTC3	CTC4	CTC5	CTC6	CTC7
CTA1	5.333333	3	2.333333	5.333333	5.333333	4.666667	5.333333
CTA2	7	7	3.666667	5.333333	6	5.333333	5.333333
CTA3	3.666667	3	4	3.666667	4.333333	5.333333	5.333333
CTA4	2.333333	7	7	3.666667	6	5.333333	2.333333
CTA5	7	4.666667	5.333333	3	3	3.666667	6

CTA6	6.333333	5.333333	2.333333	1.666667	4.666667	3	3
CTA7	8	6	4.666667	6	6	6	1.666667
CTA8	4.666667	3	7	3	6	4.666667	5
CTA9	5.333333	3.666667	3.666667	4.333333	3	5.333333	6.333333
CTA10	5	2.333333	3	7	5	8	3
	CTC8	CTC9	CTC10	CTC11	CTC12	CTC13	CTC14
CTA1	4.333333	3	2.333333	4.333333	5.333333	2.333333	6
CTA2	6	3	3	7	3	3	5.333333
CTA3	4.666667	3	7	4.666667	6	5.333333	5
CTA4	4	5.333333	7	4.666667	3	7	3.666667
CTA5	3.666667	6	4.666667	3.666667	4.666667	4.333333	3
CTA6	1.666667	3.666667	6	3	2.333333	3	1.666667
CTA7	6.333333	3.666667	7	2.333333	5	6	1.666667
CTA8	7	6	3	3	6	3	2.333333
CTA9	4.333333	3	1.666667	6	5	3.666667	6
CTA10	3	2.333333	6	3.666667	4	5.333333	6

Table 2: Positive distance PDA

	CTC1	CTC2	CTC3	CTC4	CTC5	CTC6	CTC7
CTA1	0.02439	0	0	0.24031	0.081081	0	0.230769
CTA2	0	0.555556	0	0.24031	0.216216	0.038961	0.230769
CTA3	0.329268	0	0	0	0	0.038961	0.230769
CTA4	0.573171	0.555556	0.627907	0	0.216216	0.038961	0
CTA5	0	0.037037	0.24031	0	0	0	0.384615
CTA6	0	0.185185	0	0	0	0	0
CTA7	0	0.333333	0.085271	0.395349	0.216216	0.168831	0
CTA8	0.146341	0	0.627907	0	0.216216	0	0.153846
CTA9	0.02439	0	0	0.007752	0	0.038961	0.461538
CTA10	0.085366	0	0	0.627907	0.013514	0.558442	0
	CTC8	CTC9	CTC10	CTC11	CTC12	CTC13	CTC14
CTA1	0	0	0	0.023622	0	0.457364	0
CTA2	0.333333	0	0	0.653543	0.323308	0.302326	0
CTA3	0.037037	0	0.468531	0.102362	0	0	0
CTA4	0	0.367521	0.468531	0.102362	0.323308	0	0.098361
CTA5	0	0.538462	0	0	0	0	0.262295
CTA6	0	0	0.258741	0	0.473684	0.302326	0.590164
CTA7	0.407407	0	0.468531	0	0	0	0.590164
CTA8	0.555556	0.538462	0	0	0	0.302326	0.42623
CTA9	0	0	0	0.417323	0	0.147287	0
CTA10	0	0	0.258741	0	0.097744	0	0

Table 3: The negative distance NDA

	CTC1	CTC2	CTC3	CTC4	CTC5	CTC6	CTC7
CTA1	0	0.333333	0.457364	0	0	0.090909	0
CTA2	0.280488	0	0.147287	0	0	0	0
CTA3	0	0.333333	0.069767	0.147287	0.121622	0	0
CTA4	0	0	0	0.147287	0	0	0.461538
CTA5	0.280488	0	0	0.302326	0.391892	0.285714	0
CTA6	0.158537	0	0.457364	0.612403	0.054054	0.415584	0.307692
CTA7	0.463415	0	0	0	0	0	0.615385
CTA8	0	0.333333	0	0.302326	0	0.090909	0
CTA9	0	0.185185	0.147287	0	0.391892	0	0
CTA10	0	0.481481	0.302326	0	0	0	0.307692
	CTC8	CTC9	CTC10	CTC11	CTC12	CTC13	CTC14
CTA1	0.037037	0.230769	0.51049	0	0.203008	0	0.47541
CTA2	0	0.230769	0.370629	0	0	0	0.311475
CTA3	0	0.230769	0	0	0.353383	0.24031	0.229508
CTA4	0.111111	0	0	0	0	0.627907	0
CTA5	0.185185	0	0.020979	0.133858	0.052632	0.007752	0
CTA6	0.62963	0.059829	0	0.291339	0	0	0

CTA7	0	0.059829	0	0.448819	0.12782	0.395349	0
CTA8	0	0	0.370629	0.291339	0.353383	0	0
CTA9	0.037037	0.230769	0.65035	0	0.12782	0	0.47541
CTA10	0.333333	0.401709	0	0.133858	0	0.24031	0.47541

Then compute the values of Sp , SN and AS_i of normalization in table 4. Then figure 4 shows the rank of alternatives. From figure 4. The best alternative is CTA6 followed by CTA7, the CTA8. The worst alternative is CTA3.

Table 4: The values of SP, SN, and AS.

	SP	SN	AS
CTA1	0.054358	0.16461	0.458389
CTA2	0.205415	0.096581	0.635034
CTA3	0.081293	0.10798	0.396972
CTA4	0.236997	0.06596	0.637726
CTA5	0.093973	0.134397	0.478881
CTA6	0.115352	0.239461	0.743361
CTA7	0.197805	0.139649	0.708906
CTA8	0.212832	0.119524	0.698588
CTA9	0.075568	0.14821	0.468893
CTA10	0.130764	0.187984	0.668392

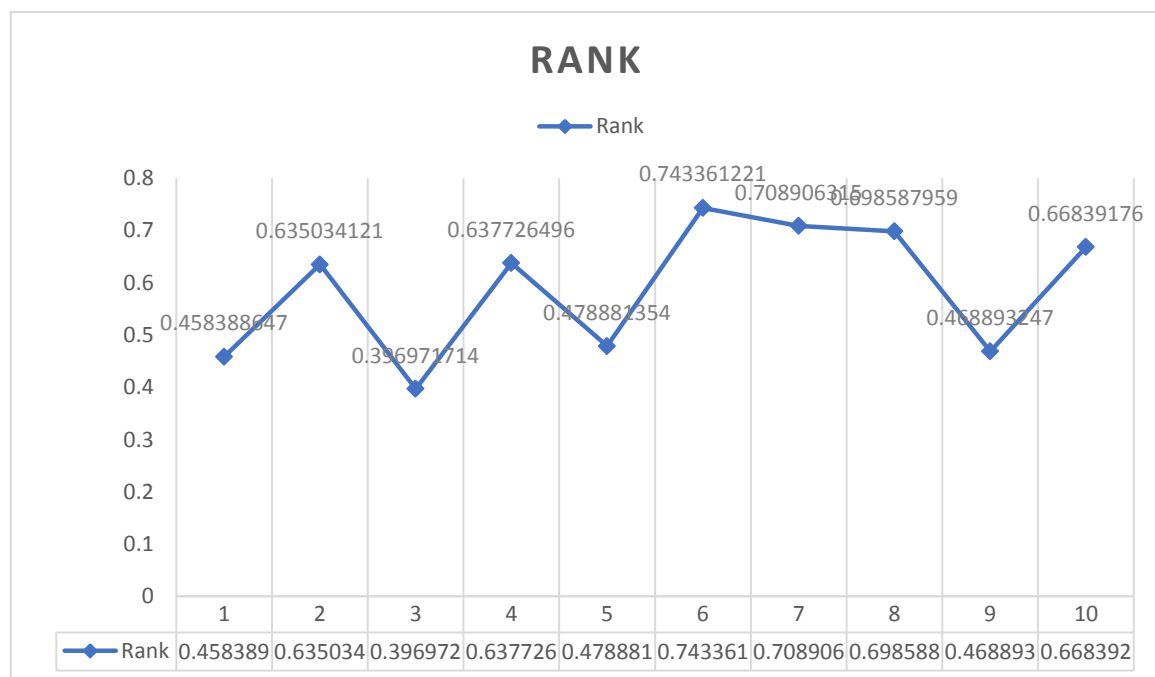


Figure 4: The rank of alternatives

5. Organizational Implications

Several important management implications may be found in this article. When faced with a choice on which chemical tanker to use, practitioners should think about the ramifications. By studying the tactics described in this article, managers will be able to better structure their assessment processes,

which will allow them to make rational and reasonable decisions in this very complex decision-making process.

Concerning the second-hand market, decision-makers could be interested in owning the vessels they need at acceptable costs and with little environmental impact. In addition, the present study helps practitioners understand the distinctions between both the new construction market and the second-hand vessel trade in terms of dynamic frameworks and circumstances. Both marketplaces have a very diverse set of criteria and their significance. As a result, new shipbuilding trade practices regarding vessel selection may not give practical and optimum solutions for the petrochemical tanker shipping business in the second-hand market.

According to the findings of this research, the following are the most important management implications.

Chemical shipping firms save money by selecting the best chemical tanker boats. Creating a more ecological, profitable, and efficient transportation network may assist all global supply chain participants to enhance their supply chain surplus (profits).

Second-hand chemical tanker ships may be evaluated using acceptable and logical criteria and factors.

6. Conclusion

When it comes to selecting chemical tanker boats, there are many difficult uncertainties. In addition, the 2nd ship market is more complicated and unpredictable than the new construction industry. A lack of data on tanker boats' usage, maintenance, and maritime accidents is common since past owners may not have documented numerous occurrences involving the ships. The chemicals tanker vessel recruitment process on the used market is thus fraught with numerous intricate risks. The present study aims to promote awareness of the difficulties in the 2nd vessel market by highlighting the complexity and uncertainties. The suggested model may be simply used by practitioners to identify the right chemical tanker boats based on the criteria outlined in this study. It's also possible to cope with both known and unpredicted uncertainty using the paradigm described below. As a result, the strategy we've developed is well suited to the decision-making challenges faced by the marine sector.

Chemical tanker shipping's annual growth is tied to the chemical manufacturing industries and the market's expansion. A lack of research in this area has led to econometric models being used to pick chemical tankers based only on the purchase price. Secondhand tanker vessel purchase costs are the primary focus of their research. They don't give much thought to the selecting criterion.

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