Qualitative and quantitative criteria evaluation using fuzzy AHP: application to the problem of ship bunkering

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Abstract:
Criteria used to make a decision could have numeric values or could have a verbal form used to express properties that are opinions or descriptive evaluations. By using the fuzzy AHP, it is possible to compare all these criteria while still maintaining the proper consistency of the AHP method.

Defining an optimal ship bunkering policy is based on a multitude of qualitative and quantitative criteria connected to tank capacity, quantity of cargo on board, fuel price, port facilities, weather conditions, etc. The proper ranking of criteria is vital in order to allow the crew on board to make a decision that adequately weighs the various aspects.

The aim of the paper (which is based on a literature review) is to detect the proper criteria to choose an optimal bunkering and make a proper AHP criteria evaluation. For this purpose, experts from the sector will be involved in the analysis and fuzzy logic computation properties to be used to obtain highly reliable assessments with a high membership degree that could be combined in a multicriteria goal function.

Results:
Evaluation of the criteria, that are qualitative and quantitative, with the Fuzzy AHP method, that helps the experts to define a better evaluation. Results (and evaluation) have a high membership degree and are more reliable.

Methods:
Factors used in Linear shipping:
Factors are obtained from the literature review and are sorted according to the order of importance proposed by the literature review.

Additional performance factor used in Hub and Spoke shipping model: Cargo/Containers on board or to be loaded

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<th>Key factors</th>
<th>Important factors</th>
<th>Less important factors</th>
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<td>Supply waiting time</td>
<td>Experienced human resources</td>
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<td>Bunker quality</td>
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</tr>
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Fuzzy AHP evaluation of criteria

Fuzzy weights are triangular fuzzy numbers

\[ \mu(x) = \begin{cases} \frac{x - a_i}{a_i - b_i}, & a_i \leq x \leq b_i \\ 0, & \text{otherwise} \end{cases} \]

with the following membership functions:

\[ \mu_n(x) = \begin{cases} \frac{1}{m}, & x \leq \frac{n}{m}, n, 0 < m \leq 3 \\ \frac{1}{m}, & x > m, \frac{3}{m} \leq n, 0 < m \leq 3 \\ \frac{1}{m}, & \text{otherwise} \end{cases} \]

References:


Key words: qualitative criteria, quantitative criteria, fuzzy logic, AHP, ship bunkering