

Impact Assessment of Seafaring Occupation using Fuzzy Aggregation Method

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Abstract

The worldwide shortage of qualified seafarers indicates that occupational attraction of seafaring career is dropping. The importance of seafarer rights protection is increasingly recognized by the international communities. The Maritime Labour Convention, 2006, which is widely recognised as the “seafarers’ bill of rights,” entered into force on 20 August 2013. The Convention establishes minimum working and living standards for all seafarers working on ships, which will have an important impact on the seafaring occupation in China. The aim of this paper is to investigate and evaluate impacts of the rights protection improvement through implementation of MLC2006. It was found that seafarers regarded the income as the most important factor in seafarers’ rights protection, and attractiveness of the seafarer occupation may be increased by 16.8% through implementation of MLC2006.

Keywords: Maritime Labour Convention,2006 (MLC2006) ; Fuzzy Aggregation Method; Impact; Seafarers' Rights Protection

Introduction

The maritime sector transports over 90 percent of China’s imports and exports. Seafarer is the person who is employed or engaged on works in any capacity on board a ship. Without seafarers, international trade cannot be run in such a scale^[1]. Seafarer is a special occupational group who work and live on board for a long time. Due to the occupational characteristics, they have to suffer a lot of pressures, like bad weather, limited spaces, intense work, emotional loneliness, lack of social support and communication etc^[2]. In addition, the training

required to become a certificated seafarer is very intensive^[3]. It can take a prolonged period of time to achieve senior officer status.

Research indicates that the worldwide shortage of qualified seafarers has been due to the rapidly increasing world merchant fleet and the difficulty of attracting and retaining people in the industry^[5-6]. The importance of seafarers' rights protection has been more and more recognized by the international communities^[7]. In 2006, after five years of preparation by international seafarers' and ship-owners' organizations and governments, the ILO's International Labor Conference adopted a major new convention- the Maritime Labor Convention, 2006 (MLC2006) ,that consolidated and updated almost all of the existing maritime labor instruments^[8]. This is expected to significantly improve the working status of seafarers and thus help maintaining an adequate supply of seafarers.

The MLC2006 is an international labor Convention adopted by the International Labour Organization (ILO). It provides international standards for the world's first genuinely global industry-the maritime sector^[9-10]. For seafarers, the MLC2006 establishes minimum standards , like a safe and secure workplace that complies with safety standards; fair terms of employment; decent working and living conditions on board ship; health protection, medical care, welfare measures and other forms of social protection. For ship-owners, it helps to provide a level playing field for quality ship-owners operating under the flag of countries that have ratified the MLC2006^[11-12].

It is expected that the implementation of the MLC2006 will certainly improve working and living conditions of seafarers and thus increase the attractiveness of this old occupation^[13]. The implementation of MLC2006 has a significant impact on Chinese seafarers. How to best implement the convention to satisfy seafarers needs is key to make seafarer career much more enticing and to reduce the demand and supply gap of Chinese seafarers. For this purpose, a survey was conducted to investigate seafarers' perceived significance of factors in rights protection, and impacts of implementation of MLC2006 were evaluated using fuzzy aggregation method.

The method

Fuzzy aggregation is used to evaluate the significance of each concerned factor by each Chinese seafarer. To perform this fuzzy aggregation, various techniques have been applied including a fuzzy weighted average, a similarity measure, fuzzy multi-attribute analysis, fuzzy eigenvector method, and fuzzy entropy method. The fuzzy weighted average is an improvement over classical weighting methods. It is widely used in the fields of group decision, multi-objective decision, and quality control. Significance ranges (e.g., 1~5) is used to describe the uncertain linguistic terms such as social security. We divide each significance range into several segments (e.g., 1~2, 2~3, 3~4, 4~5). If the membership function within each significance segment is given, the seafarer's fuzzy perception utility related to the corresponding factor can be acquired by using the following equation incorporating fuzzy operations.

$$\bar{Y} = \sum_{i=1}^m (\bar{W}_i \otimes \bar{X}_i) / \sum_{i=1}^m \bar{W}_i \quad (1)$$

where, i is the segment whose total number is m . $\bar{X}_i = \{x_i, \mu_{\bar{X}_i}(x_i) | x_i \in X_i\}$ is a fuzzy number representing seafarer's opinion of the segment i . $\bar{W}_i = \{w_i, \mu_{\bar{W}_i}(w_i) | w_i \in W_i\}$ is the normalized fuzzy weight of segment i , which determines its importance among all the segments. X_i and W_i are fuzzy sets of segment and weight respectively. $\mu_{\bar{X}_i}$ and $\mu_{\bar{W}_i}$ are the membership functions of attribute and weight respectively, which are represented as triangular functions (shown as Figure 1) in this study. $\sum_{i=1}^m$ and \otimes are fuzzy operations using α -cut interval analysis.

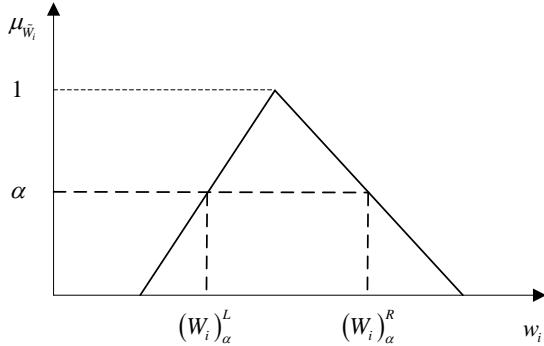


Figure 1. Weight in terms of triangular fuzzy function

The fuzzy operation in the computation of fuzzy weighted average is an extended algebraic interval operation. This operation can achieve the membership function $\mu_{\bar{Y}}$ with respect to fuzzy perception \bar{Y} , which is described in the following five steps^[14].

- (1) Discretize the complete range of the membership [0, 1] of the fuzzy numbers into the following finite number of n α -cuts, $\alpha_1, \dots, \alpha_n$, where an instance is shown in Figure 1.
- (2) For each α_j , using the following equations to find the corresponding interval for W_i in \bar{W} and X_i in \bar{X}_i . Denote the end-points of the intervals of \bar{W} and \bar{X}_i by $[(W_i)_{\alpha_j}^L, (W_i)_{\alpha_j}^R]$ and $[(X_i)_{\alpha_j}^L, (X_i)_{\alpha_j}^R]$, respectively.

$$W_i(\alpha_j) = \left[\min_{w_i} \left\{ w_i \in W_i \mid \mu_{\bar{W}_i}(w_i) \geq \alpha_j \right\}, \max_{w_i} \left\{ w_i \in W_i \mid \mu_{\bar{W}_i}(w_i) \geq \alpha_j \right\} \right] \quad (2a)$$

$$X_i(\alpha_j) = \left[\min_{x_i} \left\{ x_i \in X_i \mid \mu_{\bar{X}_i}(x_i) \geq \alpha_j \right\}, \max_{x_i} \left\{ x_i \in X_i \mid \mu_{\bar{X}_i}(x_i) \geq \alpha_j \right\} \right] \quad (2b)$$

(3) Construct the 2^{2m} distinct permutations of the $2m$ array

$(\bar{W}_1, \dots, \bar{W}_m; \bar{X}_1, \dots, \bar{X}_m | \alpha_j)$ that involve just the interval end-points of the fuzzy number intervals.

(4) Compute $\bar{Y}_k(\alpha_j) = f(\bar{W}_1^k, \dots, \bar{W}_m^k; \bar{X}_1^k, \dots, \bar{X}_m^k | \alpha_j)$, where $(\bar{W}_1^k, \dots, \bar{W}_m^k; \bar{X}_1^k, \dots, \bar{X}_m^k | \alpha_j)$ is the k^{th} permutation of the 2^{2m} distinct permutations. Then the desired interval for $\bar{Y}(\alpha_j)$ is:

$$Y(\alpha_j) = \left[\min_k \bar{Y}_k(\alpha_j), \max_k \bar{Y}_k(\alpha_j) \right] \quad (3)$$

(5) Repeat step (2-4) for every α_j , compute $\mu_{\bar{Y}}$ using every $Y(\alpha_j)$ and an α -cut decomposition theorem, i.e., let

$$I_{\alpha_j}^{\bar{Y}} = \begin{cases} 1, & \forall \bar{Y} \in Y(\alpha_j) \\ 0, & \forall \bar{Y} \notin Y(\alpha_j) \end{cases} \quad (4a)$$

so that

$$\mu_{\bar{Y}} = \sup_{\forall \alpha_j (j=1, \dots, m)} \alpha_j \cdot I_{\alpha_j}^{\bar{Y}} \quad (4b)$$

Since the output perception variable is expressed by fuzzy numbers, they should be defuzzified into a crisp number to be used as the desired utility. Out of several defuzzification methods, we choose the center of gravity method due to its simplicity and ease of computation. The estimated utility is represented in Formula (5). This value describes the factor significance solely evaluated by a surveyed seafarer. Via looping all the seafarers, comparison work about these factors can be conducted in the result analysis part.

$$COA(\bar{Y}) = \frac{\int \mu_{\bar{Y}}(y) \cdot y dy}{\int \mu_{\bar{Y}}(y) dy} \quad (5)$$

The survey

To evaluate potential impacts of the implementation of the MLC2006, a large scale survey of seafarers was conducted. The key part of survey is the evaluation of factors considered under rights protection, which is shown in Table 1. Each subject was asked to rank the importance of each factor (very important, important, modest, not important, not important at all), and describe current and perceived (expected after the implementation of MLC2006) condition of each factor using linguistic terms (very good, good, acceptable, poor, very poor) which was then converted to the relative weights for fuzzy aggregation. In total, 125 seafarers took part in the survey. Most of the respondents were middle-aged (Between 20 to 50 years old, 89%), 35% respondents service on Ocean Going Shipping Lines and 65% service on Near-Sea Shipping Line. Deck officers accounted for 48% and engineering officers accounted for 37%. The coverage of the survey is therefore satisfactory..

Table.1: The factors considered under rights protection

No.	Factors
1	Salary
2	Social security
3	Taxes
4	Career and skill development
5	Onboard living conditions, recreational facilities
6	Food catering
7	Personal security and safety
8	Paid annual leave
9	Repatriation
10	Complain handling

Results

The key question of the survey is to evaluate impacts of the rights protection on seafaring occupation through implementation of MLC2006. Seafarers were asked to rank the importance of each factor in linguistic terms. The derived weights are shown in Figure 2. Salary is ranked as the most important factor, while social security, paid annual leave and personal security and safety are regarded as important factors. The result suggests that economic incentives, including pay, social security and paid leave are key rights seafarers wanted to protect. This seems reasonable as one of the most important incentives choosing a seafaring career is the high pay compared to onshore jobs. Therefore, guaranteed full payment of seafarers wages on time is the most important manifestation of the seafarers' rights protection. If shipowners unduly delay, or fail to make, payment of all remuneration due, it will hurt the enthusiasm of

seafarers. Occupational attraction of seafaring career will drop.

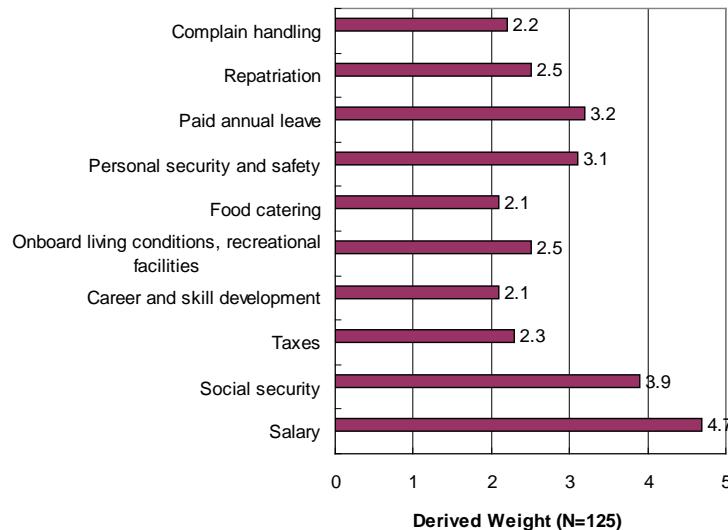


Figure.2. Reasons of choosing seafarer career

The impacts of rights protection through implementation of MLC2006 on seafaring occupation was investigated by comparing current (before implementation of MLC2006) and perceived (after implementation of MLC 2006) fuzzy utility values. The utility was calculated using fuzzy aggregation method considering all factors and all participating seafarers. The result is shown in Figure 3.

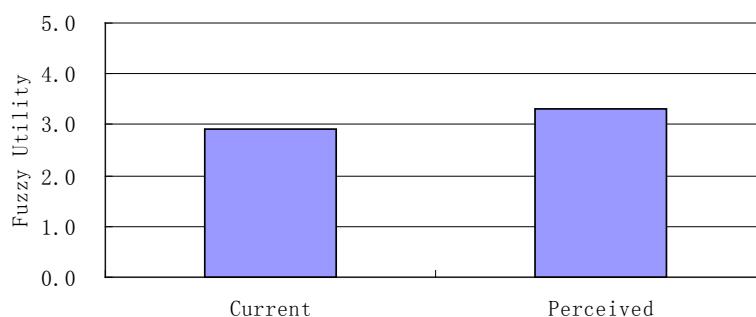


Figure.3. Fuzzy utilities of seafaring occupation

The results suggest that implementation of MLC2006 is perceived by seafarers as having significant positive impacts on seafaring occupation, as suggested in

the increased fuzzy utilities of seafaring occupation. Overall, it is identified that the implementation of MLC2006 should be targeted to increase economic incentives as well as other improvements on rights protection.

Conclusions

The overall aim of this paper is to evaluate potential impacts of the implementation of MLC2006 on seafaring occupation. The analysis in this paper has shown that salary, social security and paid leave are regarded as important factors in seafarers' right protection. Those are all economic related. Besides, seafarers placed importance on protection (safety, repatriation etc.) and personal development (e.g. training). The results are in agreement with the 2009 Nautilus International survey of seafarers' living and working conditions^[15]. The analysis also reveals that the implementation of the MLC2006 is regarded by seafarers as having significant positive impacts on the seafaring occupation, it is therefore importation to implement MLC2006 in China, specially increase the economic incentives to seafarers, e.g. through direct or indirect state aid, in order to achieve overall attractiveness of seafarer profession.

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