An Analysis and Comparison of Multinational Officers of the Watch in the Global Maritime Labor Market

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Abstract: Officer of the watch (OOW) is an important part of the maritime labor market. For many years, countries have been improving their development of OOWs for the maritime market, in terms of both quantity and quality. As the supply of qualified OOWs for maritime transportation is such an important issue, shipping companies recruit multinational OOWs for both economic and socio-cultural reasons. This study aims to identify the qualifications of an ideal officer that holds office on commercial ships, and to make a comparison among Filipino, Chinese, Indian, Eastern European and Turkish OOWs. The research takes into account expert opinions of a number of shipping companies that employ multinational seafarers. A Fuzzy Analytic Hierarchy Process (FAHP) technique is applied in this study to assist in the comparison of officers. A number of main and sub-criteria are outlined to determine both positive and negative aspects of OOWs from the selected countries for decision making purposes. This study allows maritime countries to evaluate their maritime education and training policies for selection and assessment of OOWs.

Keywords: Seafarer, Multinational Crew, Maritime Safety, Manpower, FAHP.

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1. INTRODUCTION

Seafarers are vital in the maritime labor market, and their area of employment can be said to be all the seas around the world. The maritime labor market is a global market in which no country's organizations have a monopoly (Paixao and Marlow 2001; Alderton *et al*. 2004; Sampson and Schroeder 2006). Similarly, the market is shaped by a dynamic structure and supply-demand equilibrium as opposed to rules and policies (Lobrigo and Pawlik 2015). Although the number of personnel per ship has been falling with technological developments, there is still a requirement for ships, and specific personnel, as approximately 90% of global trade is by sea. The training of the labor force, that will manage these ships, differs considering growing and varying trade, as well as increases in vessel tonnage. The distribution of the labor force to ships and the integration with other personnel are major problems encountered in the commercial maritime industry. Furthermore, there has been a continuous deficit of seafarers, particularly those of officer class, in maritime trade fleets (BIMCO/ISF 2010; Lobrigo and Pawlik 2012; Thai *et al*. 2013; BIMCO/ICS 2015). Research has shown that officers end their active careers at sea early in life, due to challenging working conditions (Uğurlu 2015). Thus, the global maritime labor market has experienced a deficit in the supply of officers for many years.

Along with the supply of officers, qualification levels are one of the main problems in the field of maritime transportation (Uğurlu 2015). The supply of officers and engineers, who are specialized and have theoretical and practical knowledge in various areas, has become an important issue globally. Similarly, efforts are devoted to furthering the education and training of seafarers, as demonstrated by studies in the field (Borovnik 2006; Tang, Llangco and Zhao 2016). Countries and companies have been making an effort to educate and train a sufficient number of seafarers with adequate qualifications for the global market (Zhao and Amante 2005; Gekara 2009). Currently, multinational personnel have virtually replaced

personnel working under their own national flag. Some of the underlying reasons for this are the cosmopolitan nature of the profession, as well as the easy access and communication opportunities provided by globalization. Furthermore, national income gaps among nations shape technical factors, such as, international standards in education and certification, as well as the commercial and material factors provided by flag of convenience countries (Koch-Baumgarten 1998; Glen 2008). These technical factors are important as they provide ship owners with the opportunity to employ people of various nationalities.

Given the information outlined, maritime transportation has gained a multinational and multicultural identity, with many leading players in the market employing multinational crew on board their ships. Multinational crews are now an indispensable phenomenon for the global maritime sector, despite some of their unfavorable aspects (Horck 2004). The English, Spanish and Portuguese sailors who took a leading role in global maritime transportation and were known to be members of maritime nations, have been superseded by Filipino, Chinese and Indian seafarers who are willing to work for comparatively lower wages. In addition to these countries, Eastern European Countries (EECs), such as Russia, Ukraine, Poland, Croatia and Turkey, have been striving to provide influence in the global market with their considerable supply of officers (BIMCO/ISF 2010; Sulpice 2011). While all these factors make it possible, and even necessary for members of such nations to work together aboard the same vessel, they also bring certain disadvantages due to the cultural clashes, conflicts, the formation of groups, and misunderstandings, as well as communication problems that accompany the employment of multinational crew (Silos *et al*. 2012).

Although international organizations, such as the International Maritime Organization (IMO) and the International Labor Organization (ILO), have defined a minimum threshold for maritime education and work standards, some countries have still failed to produce seafarers with the required standard characteristics. This is possibly due to certain factors, such as,

income gaps, national perspective on maritime culture, professional infrastructures and cultural differences. This study attempts to present the negative and positive aspects of officers from certain countries that supply seafarers to the global maritime transportation market. Additionally, the scope of this study is limited to seafarers of officer class, and while this study allows countries to evaluate their policies concerning recruitment of seafarers, it also presents a practical selection and assessment tool that is applicable to HR experts when hiring (Officers of the Watch) OOWs. The scope of the study is limited to OOWs for a number of reasons. The main reason for this is the on-going long-term shortage for this class of seafarers (Li and Wonham 1999; Leggate 2004; Glen 2008; Uğurlu 2015). This problem requires focus for sustainable maritime transportation. A secondary reason for this limitation is the existence of important differences for recruitment and assessment between OOWs and ratings. OOWs are subject to a higher level of education which brings more liability and responsibilities compared to ratings. Thus, naturally there are great differences in the recruitment and assessment of crew regarding ratings and OOWs. This paper solely focuses on OOWs as it is a difficult task to assess all crew members at once.

This paper is broken down into the following sections. Section 2 provides a brief literature review, with Section 3 outlining the methodology and structure of the research as well as the set of criteria applied in the analysis. Section 4 outlines the Fuzzy Analytical Hierarchy Process (FAHP) theory while Section 5 applies the theory to the outlined criteria, utilizing expert judgements and presents the results of the analysis. Section 6 discusses the results of the analysis as well as the implications of the research, and finally, Section 7 provides a brief conclusion.

2. LITERATURE REVIEW

Recruitment of crew has always been an area of focus in the transportation industry, in which human factor is of critical importance. Previous literature sources contain many studies, which analyze crew-related issues in the transportation industry. Some of these studies include, the importance of human factors in port state controls and maritime accidents (Heij and Knapp 2018), the management of crew on high-speed trains (Ye *et al*. 2008), the selection of crew among civil aviation pilot candidates (Schnell *et al*. 2013), the analysis of the problems of civil aviation employees resulting from globalization (Blyton *et al*. 2001), and even problems with the multicultural crew employed on space stations (Lozano and Wong 2000). Given all the different transport industries, the one where the employment of crew of different nationalities is the most straightforward and common is the maritime industry. The education, selection and evaluation of seafarers of officer class, whose education and supply requires a great deal of effort and time, have been widely addressed in the literature as areas that need to be dealt with meticulously.

Celik, Er and Topcu (2009) developed a computer-aided personnel selection model based on the Analytic Network Process (ANP) method. Their study focused on selection of the ship's master, and classified the selection criteria under four groups. These four groups are professional knowledge, professional discipline and responsibilities, leadership, and personal traits. They found that the most important factors, among the personal traits, were psychological and physical endurance. Despite their study focusing on selection of the master, the method employed by Celik, Er and Topcu (2009) has the potential for further development and application to other crews.

John and Gailus (2014) developed a specific decision support system for recruitment of OOWs in shipping companies by utilizing a multi-dimensional model. While this study is concerned only with the recruitment and of OOWs, its methodology is applicable for

application to all levels and members of a ship's crew. This study also draws attention to the complexity and difficulties when assessing and recruiting OOWs.

Leggate (2004) assessed the supply and demand condition of seafarer, and listed the supply quantities by each country, regarding the possible future shortage on global maritime labor market. It is highlighted that there is a trend for seafarer supply from Organization for Economic Co-operation and Development (OECD) countries to nations in the East, Far East and Central Europe. It is also stressed that there are some deficiencies in education, English language levels and maritime customs of these new OOW supplying countries. Overall, the shortage of seafarers may be a minor source of concern for global merchant fleets, as well as the quality of OOWs.

Lin *et al.*'s (2001) study, regarding the shortage of OOWs, estimated the annual deck officer demand in Taiwan by using Markov Transition Matrix and Grey models. It is concluded that Taiwanese OOWs end their active sea careers earlier than most seafarers of other nation. This study is also interesting as it draws attention to seniority changes of OOWs. It may be advisory for the Taiwanese government and its maritime companies to consider the results of this study.

In their studies, Wang and Yeo (2016) listed 15 criteria that were considered to play a role in the selection of foreign seafarers for South Korean flag ships, based on Delphi, Fuzzy AHP and Technique for Order Performance by Similarity to Ideal Solution (TOPSIS) methods. They concluded that the most determining factors were the qualifications of seafarers (education, training and experience) in terms of total costs, and the mutual relations between the government of South Korea and the seafarer's country of origin. The analysis presented the strengths and weaknesses of alternative countries, concluding that the most suitable nation was Filipino, based on all identified assessment criteria. It is interesting to note

that all selected seafarer candidates originated from the Association of Southeast Asian Nations (ASEAN) countries and China, which are proximate to South Korea.

Tsamourgelis (2009) noted that there was a trend away from developed countries towards developing countries regarding the employment of seafarers. The author characterized seafarers from developed countries as national, and the others as non-national, noting that seafarers in the national market were better regarding productivity and loyalty. Furthermore, the employment of a national crew increased company expenses due to a difference in wages. The results from the developed model concluded that that the best result would be to employ national seafarers as crew dealing with critical tasks, and the remaining personnel from non-national sources.

There have been various studies conducted into issues such as the selection, recruitment and employment of seafarers. These studies include the status of Chinese seafarers and their preferences for working on multinational ships (Wu, Lai and Cheng 2006), along with the effects of maritime policies on the maritime labor market (Lobrigo and Pawlik 2015). There are also studies regarding the employment opportunities open to European seafarers as well as the associated difficulties (Mitroussi 2008), and selection of an ideal ship type to ensure the professional continuity of oceangoing OOWs (Uğurlu 2015). In this study, the decisive factors relating to the preferences and recruitment of OOWs are determined and listed according to their level of importance given the opinion of maritime Human Resource (HR) experts. A comparison of nations that supply OOWs is also conducted in this study.

3. RESEARCH STRUCTURE AND METHODOLOGY

This study aims to identify the qualifications of an ideal OOW that will hold office on commercial ships, with an objective point of view, as well as comparing officers of different nationalities. The study consists of two stages; in the first stage, criteria (expectations) for

ideal officers, that shipping companies wish to employ, are defined given both an extensive literature review and the recommendations from significant market players (experts). In total, eight experts have been utilized with different perspectives and experience levels, and all have experience working with multi-national crews. Similarly, it is difficult to accurately measure the level of expertise and experience of the experts; therefore, this study does not prioritize any of the presented expert judgements. The background of the experts, who shall remain anonymous, is presented as follows:

Experts 1, 2 and *3* currently work in the crew department (HR) of three different shipping companies. All of these experts have individual sea-going experience and more than 10 years' experience in their field.

Experts 4 and *5* currently manage the HR department in two different multi-national shipping companies. They also each have more than 10 years' experience operating with multi-national crews but do not have on board experience.

Experts 6 and *7* are ocean-going masters of commercial vessels, and both have more than 10 years' experience working with multi-national crews. Both of these experts currently still maintain their active sea life.

Expert 8 has ended their sea-going career, with more than 7 years' experience, while holding a license of ocean going master. This person currently holds a position in academia with more than 5 years' experience.

While defining the criteria, technical aspects required by professionals, a company's business concerns and other factors that contribute to the harmonious employment of multinational crew are considered. Similarly, this research defines an evaluation hierarchy consisting of four main criteria and sixteen sub-criteria.

In the second stage of the study, the most advantageous criteria, considered by shipping companies for an ideal OOW, are assigned weights using the FAHP method, based on the

views of the above-mentioned experts. In assessing the criteria and sub-criteria, attempts were made to form an objective evaluation framework with independent views. The criteria are associated with officers of different nationalities, and the countries are compared based on the identified criteria. The process of weighting the criteria considers the requirements outlined by shipping companies when employing a multinational crew. Similarly, officers from different countries are compared based on the outlined criteria, with their professional differences and shortcomings identified.

3.1. Main and Sub-Criteria Used in the Selection and Assessment of Officers

This section briefly defines the criteria that influence the selection of an ideal officer. Apart from expert views, previous studies were also utilized to identify the criteria and sub-criteria (Ding and Liang 2005; Wu and Winchester 2005; Tsamourgelis 2009; Bulut, Duru and Yoshida 2010; Riahi *et al*. 2012; Lobrigo and Pawlik 2015; Wang and Yeo 2016; Uğurlu, Kum and Aydogdu 2017). The main criteria and sub-criteria are outlined in the following sections.

3.1.1. Cost Related (CR)

Wage (W): The monthly wage paid to seafarers during the term of their contract.

Social Security Fees (SSF): Social security fees include the compulsory insurance or social security expenses incurred for seafarers. Some states may require the payment of social security premiums for their citizens, even if they work on ships under flags of convenience.

Other Costs (OC): Other costs include the seafarers' costs of joining and leaving the ship, crew management commissions, state deductions and additional costs. The payments requested from companies, by states, that consider seafarers to be a national source of income can also be included in this category.

3.1.2. Cultural Properties (CP)

Professional Ethics (PE): Professional ethics refers to the seafarers' perspective on seafaring customs and traditions, including areas such as, work discipline, superior-subordinate relationships, approach to tasks and work attitude.

Ship Adaptation (SA): Adaptation to life on board is one of the key factors affecting professional continuity (sea life). There is a higher expectation regarding the adaptation to life on-board by seafarers from nations with a nautical culture.

Cultural Adaptation (CA): This includes teamwork skills and characteristics, such as being open to co-operation and, food culture tolerability.

3.1.3. Education (E)

Educational Status (ES): Refers to the level of education delivered by institutions where officers gain qualifications. Educational status may vary depending on the quality and output of academies, colleges, faculties and courses across different countries.

Language (English) Level (LL): Refers to the knowledge of the English language of seafarers from different countries. This is assessed in terms the quality of written and spoken English.

Training Level (TL): Practical knowledge is as important as theoretical knowledge in maritime activities and is a key determinant in the selection of officers.

3.1.4. Professional Properties (PP)

Professional Continuity (PrC): Refers to the time spent at sea and professional persistence, including the willingness to work at sea for a large number of years, readiness to sail at any time and loyalty to the company.

Safety Awareness (SA): Refers to the individuals' perspective on the concept of work safety and their perception of the safety culture. Safety awareness is a cultural phenomenon that is difficult to acquire later in life and is a key indicator of social development.

Alcohol-Drug Use (ADU): Refers to the use of alcohol and drugs by the officers. Alcohol and drug habits may vary in the cultures of different nations. This is one of the criteria that shipping companies are very sensitive about.

Performance & Sedulity (P&S): Refers to the officers' readiness to undertake tasks at a moment's notice during their time on the ship, their ability to cope with challenging and hazardous working conditions during and outside working hours, as well as ability to perform the tasks assigned to them duly.

Technical & Practical Knowledge (TPK): Refers to the seafarers' level of professional knowledge (theoretical and practical) and experience. This is exceptionally important from the perspective of the type of work that is carried out by OOWs.

Internal-External Communication Skills (IECS): Refers to the seafarers' ability to communicate on and off the ship.

Leadership (L): The definition of leadership is the ability to make the right decisions for the good of the ship, cargo and crew, as well as to manage the crew in the correct manner.

3.2. Identification of Alternative Countries Supplying Officers

The countries that supply officers to the sector are outlined considering the views of decision makers and sectoral reports (BIMCO/ICS 2015). The purpose of identifying these countries is to compare the officers of such nationalities based on the outlined criteria. The literature review contains many studies that compare seafarers at an international level (Li and Wonham 1999; Zhao and Amante 2005; Wang and Yeo 2016). However, there is not an expectation on officers of the same nationalities to have the same set of characteristics. There is some expectation that individuals of the same nationality may have similar professional properties due to factors, such as, national culture, education and even national income. The countries included in the comparison within this study are Philippines, India, China, Turkey

and EECs, which supply some 54% of the World's OOW demand (Glen 2008). The following paragraphs provide a brief outline of the countries involved in this study.

China: According to data provided by the Chinese Ministry of Transport, China has 1,610,000 seafarers, 650,000 of whom have Class-A Certification for working on oceangoing ships. Approximately 80,000 Class-A seafarers work together with multinational crews and constitute 5% of all seafarers globally. Around 40,000 seafarers graduate from over 100 educational institutions in China annually (Li *et al*. 2014). Chinese sailors first started working abroad in the 1980s and their numbers have grown to take a significant share of the global seafarer market (Li and Wonham 1999; Alderton *et al*. 2004). Following the economic reforms initiated in China in the 1990s, there was an expectation on Chinese sailors to become a key source of labor for the international maritime sector in the future. However, China's seafarer exports have been below expectations according to the overall distribution of today's seafarers in the global merchant fleet. When compared to other seafaring countries, Chinese sailors are less costly, with poorer English knowledge and skills, as well as a vastly different safety and work culture. Furthermore, the International Transport Workers' Federation has identified them as potentially problematic (Tang, Llangco and Zhao 2016).

Philippines: In the Philippines, seafarers are one of the most important providers of income to the country's economy. The Philippines is one of the leading countries in the supply of both officers and ratings to the international maritime sector (Amante 2004). Officer education takes four years to complete and the delivery of the courses is in English, providing a professional advantage to Filipino sailors (Zhao and Amante 2005). In the Philippines, there are 95 maritime education institutions, most of which are private, and about 12,000 sailors graduate from these institutions annually (Lobrigo and Pawlik 2015). The total number of Filipino sailors in 2014, including those employed as ratings, is estimated to be 402,000,

accounting for approximately one-third of the global maritime labor force. The Philippines ranks second after China regarding the number of seafarers (Richter 2016).

India: In India, where there are 133 maritime training institutions and 7 maritime universities, officer education consists of three years of undergraduate study and a one-year open sea internship. India has approximately 110,000 seafarers in total, 30,000 of whom are officers, meaning that Indian seafarers constitute 6.6% of the global seafarer supply (MSGI 2018).

Turkey: In Turkey, the delivery of oceangoing officer education is provided at an undergraduate level. Approximately more than 1,200 OOWs graduate from 13 maritime faculties annually. According to the state records of the Ministry of Transportation, Maritime and Telecommunications (UDHB 2016), there are more than 100,000 seafarers in Turkey. According to the figures from the Turkish Chamber of Maritime (DTO 2017), official authorities declare that the share of Turkish seafarers in the global seafarer market is below 1%, despite the high number of seafarers originating from the country.

EECs: Delivery of oceangoing OOW education is at an undergraduate level in EECs (Zvonimir, Galic and Pusic 2012). Russia, Ukraine, Bulgaria, Romania and Croatia are included in this group of countries, and among these, the Russian Federation has the highest number of seafarers. However, Croatia has the highest share of seafarers in terms of percentage of the country's population as shown in Table 1 (Marinov, Maglić and Bukša 2015). Approximately 21% of the global seafarer supply is from EECs (Glen 2008).

Table 1. Populations and number of seafarers in EEC (Marinov, Maglić and Bukša 2015)

4. FUZZY ANALYTIC HIERARCHY PROCESS (FAHP)

The FAHP approach is an effective method, as it enables decision-makers to make judgments using values within certain ranges rather than definite values. When assessing criteria and alternatives, decision-makers also use natural grammatical stresses in addition to absolute numbers. Thus, FAHP bears a remarkable resemblance to human thoughts and perceptions (Uğurlu 2015 & 2016), hence justifying why many researchers have applied this method (Van Laarhoven and Pedrycz 1983; Bulut *et al*. 2012; Duru, Bulut and Yoshida 2012; Tseng and Cullinane 2018).

Outlined below are the backgrounds and explanations regarding fuzzy sets, Triangular Fuzzy Numbers (TFN) and the methodology utilized for applying FAHP.

Definition 1 - Fuzzy subset: Let *X* be a universal set of elements, where *A* is a set contained in *X*, and *x* represents a subset of *A*. Then the set of ordered pairs (x, $\mu_A(x)$) gives the fuzzy subset *A* of *X*, where *x* is an element in *X* and $\mu_A(x)$ is the degree of membership of *x* in *X*.

Definition 2 - Fuzzy number: A fuzzy number is a generalization of a real number. It refers to a connected set of possible values, where each possible value has its own grade between *zero* and *one* [0, 1]. For example, the grade of an element that belongs to the set is expressed as *one*, whereas, an element that does not belong to the set is *zero*.

Definition 3 - Triangular Fuzzy Number (TFN): A TFN is a special type of fuzzy set over a set of real numbers. These real numbers are shown in the x-axis of Figure 1, and are given as *l*, *m*, and *u*. These denote the smallest possible value (*l*), the most promising value (*m*) and the largest possible value (*u*) respectively. The fuzzy number $\tilde{A}$, is a TFN, if its membership function is given by Equation 1:

$$\mu_{\tilde{A}}(x) = \begin{cases} 0, & x \le l, \\ \frac{(x-l)}{(m-l)}, & l < x < m, \\ 1, & x = m, \\ \frac{(u-x)}{(u-m)}, & m < x < u, \\ 0, & u \le x \end{cases} \quad (1)$$

Figure 1. An example of a triangular membership function

This study applies Chang's (1996) extended synthesis FAHP method, which uses the TFNs for the pairwise comparison scale of FAHP, due to its ability to address the uncertainty of the natural way of thinking in resolving multi-criteria decision-making problems (Chan and Kumar 2007). Similarly, when compared to other approaches it is deemed to be less complex and more efficient (Chao 2017). An outline and explanation of Chang's (1996) FAHP applications in the light of previous studies in the literature are as follows:

Let $X = \{x_1, x_2, \dots, x_n\}$ be a set of objects and $G = \{g_1, g_2, \dots, g_h\}$ be a set of goals. According to Chang (1996), degree analysis is applied to each criterion and to each goal (g_i). Therefore, for each criterion, there will be h numbers of degree analysis values obtained through the application of Equation 2:

$$M_{g_i}^1, M_{g_i}^2, \dots, M_{g_i}^h, \ i = 1,2, \dots, n \tag{2}$$

All $M_{g_i}^{\mathrm{h}}$ values represent the TFNs, which are given by *l*, *m* and *u*, as shown in Figure 1. There are a few steps for FAHP and the degree analysis, as stated by Chang (1996). These steps are outlined as follows:

Step 1:

The value of the fuzzy synthetic extent, S_i,, with respect to the j^{th} object and the i^{th} goal, is given by Equation 3:

$$S_i = \sum_{j=1}^{h} M_{g_i}^j \otimes \left[\sum_{i=1}^{n} \sum_{j=1}^{h} M_{g_i}^j\right]^{-1} \qquad j = 1, 2, \dots, h \qquad i = 1, 2, \dots, n \tag{3}$$

To obtain $\sum_{j=1}^{h} M_{g_i}^j$ given in Equation 3, the fuzzy addition operation is applied to h extent analysis values. Equation 4 demonstrates this as follows:

$$\sum_{j=1}^{h} M_{g_i}^j = \left[\sum_{j=1}^{h} l_j, \sum_{j=1}^{h} m_j, \sum_{j=1}^{h} u_j\right] \tag{4}$$

Similarly, to obtain $\sum_{i=1}^{n}\sum_{j=1}^{h} M_{g_i}^{j}$ given in Equation 3, the fuzzy addition operation is applied to $M_{g_i}^{j}(j = 1,2, \dots, h)$, as expressed in Equation 5.

$$\sum_{i=1}^{n}\sum_{j=1}^{h} M_{g_i}^{j} = \left(\sum_{i=1}^{n} l_i, \sum_{i=1}^{n} m_i, \sum_{i=1}^{n} u_i\right) \quad (5)$$

Equation 6 demonstrates the inverse of the vector given in Equation 5:

$$\left[\sum_{i=1}^{n}\sum_{j=1}^{h} M_{g_i}^{j}\right]^{-1} = \left(\frac{1}{\sum_{i=1}^{n} u_i}, \frac{1}{\sum_{i=1}^{n} m_i}, \frac{1}{\sum_{i=1}^{n} l_i}\right) \quad (6)$$

The inverse vectors calculated from Equation 6 are then rearranged in ascending order.

Step 2:

Equation 7 demonstrates the degree of possibility of $M_2 = (l_2, m_2, u_2) \geq M_1 = (l_1, m_1, u_1)$:

$$V(M_2 \geq M_1) = sup\left[\min(\mu_{M_1}(x), \mu_{M_2}(y))\right] \quad (7)$$

where $y \geq x$. Similarly, Equation 8 can also demonstrate Equation 7 as:

$$V(M_2 \geq M_1) = hgt(M_1 \cap M_2) = \mu_{M_2}(d) = \begin{cases} 1, & if \;\; m_2 \geq m_1, \\ 0, & if \;\; l_1 \geq u_2, \\ \frac{l_1 - u_2}{(m_2 - u_2) - (m_1 - l_1)}, & otherwise \end{cases} \quad (8)$$

Figure 2 illustrates Equation 7 and Equation 8, where d is the ordinate of the highest intersection point between μ_{M_1} and μ_{M_2}. Comparing M_1 and M_2, requires the values of $V(M_1 \geq M_2)$ and $V(M_2 \geq M_1)$.

Figure 2. The intersection between $M_1 and\ M_2$ (Chang, 1996)

Step 3:

The degree possibility for a convex fuzzy number to be greater than a specific number (k) of convex fuzzy numbers can be defined as follows:

$$V(M_i \geq M_1, M_2, .. M_k) \quad i, k = 1, 2, \dots, n;\ i \neq k \quad (9)$$

Applying Equation 10 de-fuzzifies the weight vector by finding the minimum values within each comparison (min $V(M_i \geq M_k)$, which is calculated by Equations 8 and 9.

$$d'(A_i) = \min V\ (S_i \geq S_k) \quad for \quad i, k = 1,2, \dots n;\ i \neq k \tag{10}$$

Therefore, the weight vector becomes:

$$W' = (d'(A_1), d'(A_2), \dots, d'(A_i)) \quad i = 1, 2, \dots, n \tag{11}$$

where, $d'(A_i)$, is the minimum value of each decision element, which is obtained from comparison of fuzzy number pairs and represents the de-fuzzified weight of each criterion. *W'* represents the set of de-fuzzified weights.

While $d'(A_i)$ are not fuzzy numbers, they do need to be normalized, utilizing Equation 12:

$$d(A_i) = \frac{d'(A_i)}{\sum_{i=1}^{n} d'(A_i)} \quad i = 1, 2, \dots, n$$

$$W = (d(A_1), d(A_2), \dots, d(A_n)) \tag{12}$$

where *W* represents the normalized weights of the specified criteria.

This study applies five fuzzy linguistic variables to compare the criteria. Table 2 outlines the linguistic terms used.

Table 2. Transformation for TFN's membership functions

In this study, aggregation of individual judgement matrices for decision makers is obtained by using the geometric mean of all individual matrices (Bulut *et al*. 2012).

4.1. The Consistency Control for Pairwise Matrices

The consistency control is important for the pairwise matrices of decision-makers. Assessing the weight values obtained in the pairwise comparison matrix for consistency using a Consistency Ratio (CR) is key for the analysis. Equation 13 demonstrates the calculation for the CR value. Equations 14 and 15 represent the calculations for the terms in Equation 13.

$$C = \frac{CI}{RI} \tag{13}$$

$$CI = \frac{\lambda_{max} - n}{n-1} \tag{14}$$

$$\lambda_{max} = \frac{\sum_{j=1}^{n} \frac{\sum_{k=1}^{n} w_k a_{jk}}{w_j}}{n} \tag{15}$$

where *n* equals the number of items being compared, λ_{max} stands for maximum weight value of the n × n comparison matrix, *RI* stands for average Random Index and *CI* stands for Consistency Index. The values for *RI*, outlined by Saaty, are presented in Table 3 (Saaty 1990).

The *CR* is designed so that a value greater than 0.10 illustrates an inconsistency in the pairwise comparison. If the *CR* is 0.10 or less, then the pairwise comparison is consistent and reasonable. Should the inconsistency level in the pairwise comparison be unacceptably high, a revisit to the expert judgements would be required. It is also possible to approach more domain experts in the elicitation process.

Table 3. Average Random Index values for matrix order (Saaty 1990).

5. METHOD APPLICATION AND EMPIRICAL ANALYSIS

This study utilizes the opinions of experts who have professional experience with multi-national crews, as previously mentioned. These experts conducted assessments relating to the criteria that are key in the recruitment of OOWs. The experts also made comparisons between the previously outlined, seafaring nations in relation to the outlined criteria. In this stage of the analysis, the experts provided their opinions individually through the application of independent questionnaires. FAHP is then applied to the qualitative results of the questionnaires in order to develop a quantitative analysis. FAHP is a widely used and accepted method for the development of quantitative analyses from the application of qualitative data gathering methods, such as Pairwise Comparison. (Van Laarhoven and Pedrycz 1983; Bulut *et al*. 2012; Duru, Bulut and Yoshida 2012; Tseng and Cullinane 2018). Furthermore, it is difficult to accurately obtain, with a competent level of accuracy, absolute values for the quantitative analysis. This is yet another reason why FAHP is applied to this research as opposed to the standard AHP method (Wang and Yeo 2016).

It is now possible to formulate the hierarchical structure following the identification of the alternative countries and the criteria that play a role in defining an ideal officer, as shown in Figure 3.

Figure 3. The hierarchical structure of the study

It is vital to utilize experts and companies, which operate in different markets, to obtain accurate and impartial results. Table 2 shows the transformation for TFNs membership functions.

Table 4 shows an example of the questionnaire items used to assign weights to the four main criteria. Table 4 also demonstrates an example comparison of the Cost-Related (CR) criterion with the Cultural Properties (CP), Education (E) and Professional Properties (PP) criteria. Subsequently, all the main criteria, sub-criteria and countries undergo comparison, as shown in the example, with weights and preference values calculated based on the expert judgments.

Table 4. Questionnaire form used to facilitate comparisons of main criteria.

Table 5 demonstrates the aggregated fuzzy judgment matrix obtained from the experts' assessment of the main criteria CR, CP, E and PP together with the consistency ratio.

Table 5. The aggregated fuzzy judgment matrix for main criteria.

The following example demonstrates the calculation for the priority weights for the main criteria given the fuzzy matrix in Table 5. This part of the numerical example represents Step 1 in the FAHP methodology, and utilizes Equations 3, 4, 5 and 6.

$$S_i = \sum_{j=1}^{h} M_{g_i}^{j} \otimes \left[\sum_{i=1}^{n} \sum_{j=1}^{h} M_{g_i}^{j} \right]^{-1}$$

Applying Equation 4 to the fuzzy matrix in Table 5 gives the following calculations:

$$\sum_{j=1}^{h} M_{gCR}^{j} = (1,1,1) \oplus (1.41,1.8,2.23) \oplus (0.78,1.09,1.52) \oplus (0.81,1.09,1.46)$$

$$= (3.99, 4.98, 6.21)$$

$$\sum_{j=1}^{h} M_{gCP}^{j} = (0.45,0.56,0.71) \oplus (1,1,1) \oplus (0.61, 0.77,1) \oplus (0.5,0.64,0.84)$$

$$= (2.56, 2.97,3.55)$$

$$\sum_{j=1}^{h} M_{gE}^{j} = (0.66,0.92,1.29) \oplus (1,1.3,1.64) \oplus (1,1,1) \oplus (0.66,0.92,1.29)$$

$$= (3.32,4.13,5.22)$$

$$\sum_{j=1}^{h} M_{gPP}^{j} = (0.68,0.92,1.24) \oplus (1.2,1.57,2) \oplus (0.78,1.09,1.52) \oplus (1,1,1)$$

$$= (3.65,4.57,5.76)$$

Following the application of Equation 4, Equations 5 and 6 can be utilized as follows:

$$\left[\sum_{i=1}^{n}\sum_{j=1}^{h} M_{g_i}^{j}\right]^{-1} = \left[\sum_{j=1}^{h} M_{gCR}^{j} + \sum_{j=1}^{h} M_{gCP}^{j} + \sum_{j=1}^{h} M_{gE}^{j} + \sum_{j=1}^{h} M_{gPP}^{j}\right]^{-1}$$

$$= [(3.99,4,98,6.21) \oplus (2.56,2.97,3.55) \oplus (3.32,4.13,5.22) \oplus (3.65,4.57,5.76)\ ]^{-1}$$

$$= [13.52,16.65,20.74]^{-1} = (1/20.74, 1/16.65\,, 1/13.52)$$

The results of the calculation are arranged in increasing order, with 1/20.74 being the smallest value and 1/13.52 being the largest.

The final S_i values for each of the main criteria can now be calculated through Equation 3 as follows:

$$S_{CR} = \sum_{j=1}^{h} M_{gCR}^{j} \otimes \left[\sum_{j=1}^{h} M_{gCR}^{j} + \sum_{j=1}^{h} M_{gCP}^{j} + \sum_{j=1}^{h} M_{gE}^{j} + \sum_{j=1}^{h} M_{gPP}^{j}\right]^{-1}$$

$$= (3.99,4.98,6.21) \otimes (1/20.74, 1/16.65\,, 1/13.52) = (0.19, 0.30, 0.46\ )$$

$$S_{CP} = \sum_{j=1}^{h} M_{gCP}^{j} \otimes \left[\sum_{j=1}^{h} M_{gCR}^{j} + \sum_{j=1}^{h} M_{gCP}^{j} + \sum_{j=1}^{h} M_{gE}^{j} + \sum_{j=1}^{h} M_{gPP}^{j}\right]^{-1}$$

$$= (2.56, 2.97, 3.55) \otimes (1/20.74, 1/16.65\,, 1/13.52) = (0.12, 0.18, 0.26\ )$$

$$S_E = \sum_{j=1}^{h} M_{gE}^{j} \otimes \left[\sum_{j=1}^{h} M_{gCR}^{j} + \sum_{j=1}^{h} M_{gCP}^{j} + \sum_{j=1}^{h} M_{gE}^{j} + \sum_{j=1}^{h} M_{gPP}^{j}\right]^{-1}$$

$$= (3.32,4.13,5.22) \otimes (1/20.74, 1/16.65\,, 1/13.52) = (0.16, 0.25, 0.39\ )$$

$$S_{PP} = \sum_{j=1}^{h} M_{gPP}^{j} \otimes \left[\sum_{j=1}^{h} M_{gCR}^{j} + \sum_{j=1}^{h} M_{gCP}^{j} + \sum_{j=1}^{h} M_{gE}^{j} + \sum_{j=1}^{h} M_{gPP}^{j}\right]^{-1}$$

$$= (3.65,4.57,5.76) \otimes\ (1/20.74, 1/16.65\,, 1/13.52) = (0.18, 0.27, 0.43\ )$$

Following this Step 2 can be applied. According to Equation 7 and Equation 8 if $S_2 \geq S_1$ then $V(S_2 \geq S_1) = 1$, if not then the following section of Equation 8 is utilized:

$$\text{if } S_2 < S_1, \text{ then } V(S_2 \geq S_1) = \frac{l_1 - u_2}{(m_2 - u_2) - (m_1 - l_1)}$$

All possible comparison combinations within the main criteria are now analyzed utilizing Equations 7 and 8. This is applied to the main criteria as follows:

$V(S_{CR} \geq S_{CP}) = 1,$
$V(S_{CR} \geq S_E)\ = 1,$
$V(S_{CR} \geq S_{PP}) = 1,$

$$V(S_{CP} \geq S_{CR}) = \frac{(l_{CR} - u_{CP})}{(l_{CR} - m_{CR}) - (u_{CP} - m_{CP})} = \frac{(0.19 - 0.26)}{(0.19 - 0.30) - (0.26 - 0.18)} = 0.37,$$

$$V(S_{CP} \geq S_E)\ \ = \frac{(l_E - u_{CP})}{(l_E - m_E) - (u_{CP} - m_{CP})} = \frac{(0.16 - 0.26)}{(0.16 - 0.25) - (0.26 - 0.18)} = 0.59,$$

$$V(S_{CP} \geq S_{PP}) = \frac{(l_{PP} - u_{CP})}{(l_{PP} - m_{PP}) - (u_{CP} - m_{CP})} = \frac{(0.18 - 0.26)}{(0.18 - 0.27) - (0.26 - 0.18)} = 0.47,$$

$$V(S_E \geq S_{CR}) = \frac{(l_{CR} - u_E)}{(l_{CR} - m_{CR}) - (u_E - m_E)} = \frac{(0.19 - 0.39)}{(0.19 - 0.30) - (0.39 - 0.25)} = 0.79,$$

$V(S_E \geq S_{CP}) = 1,$

$$V(S_E \geq S_{PP}) = \frac{(l_{PP} - u_E)}{(m_E - u_E) - (m_{PP} - l_{PP})} = \frac{(0.18 - 0.39)}{(0.25 - 0.39) - (0.27 - 0.18)} = 0.91,$$

$$V(S_{PP} \geq S_{CR}) = \frac{(l_{CR} - u_{PP})}{(l_{CR} - m_{CR}) - (u_{PP} - m_{PP})} = \frac{(0.19 - 0.43)}{(0.19 - 0.30) - (0.43 - 0.27)} = 0.89,$$

$V(S_{PP} \geq S_{CP}) = 1,$
$V(S_{PP} \geq S_E) = 1,$

Step 3 is now applied to determine the de-fuzzified weights and the normalized weights.

By applying Equation 9 and Equation 10, the minimum degrees of possibility (*i.e*. the de-fuzzified weights) for each main criterion are stated as follows:

$d'(CR) = V(S_{CR} \geq S_{CP}, S_E, S_{PP}) = \min(S_{CR} \geq S_{CP}, S_E, S_{PP}) = \min(1,1,1) = 1$

$d'(CP) = V(S_{CP} \geq S_{CR}, S_E, S_{PP}) = \min(S_{CP} \geq S_{CR}, S_E, S_{PP} = \min(0.37, 0.59, 0.47) = 0.37$

$d'(E) = V(S_E \geq S_{CR}, S_{CP}, S_{PP}) = \min(S_E \geq S_{CR}, S_{CP}, S_{PP}) = \min(0.79, 1, 0.91) = 0.79$

$d'(PP) = V(S_{PP} \geq S_{CR}, S_{CP}, S_E) = \min(S_{PP} \geq S_{CR}, S_{CP}, S_E) = \min(0.89, 1, 1) = 0.89$

Therefore, Equation 11 gives the de-fuzzified weight vector as:

$$W' = (1, 0.37, 0.79, 0.89)$$

After normalization (Equation 12), the normalized weight vector of the main criteria is obtained as follows:

$$W = (0.33, 0.12, 0.26, 0.29)$$

Calculation for sub-criteria for each country was completed in the same manner. The pairwise comparisons of the sub-criteria, taken into consideration by decision-makers, are given in

Tables 6 and 7. The consistency of each matrix has been calculated utilizing Equations 13, 14 and 15, and the consistency ratios are demonstrated in Table 5, Table 6 and Table 7.

The following example demonstrates the calculation for the CR for the main criteria. Firstly Equation 15 is applied to the aggregated fuzzy judgment matrix in Table 5 to determine the value of λ_{max}.

$$\lambda_{max} = \frac{\sum_{j=1}^{n}\left[\frac{\sum_{k=1}^{n} w_k a_{jk}}{w_j}\right]}{n}$$

$$\sum_{CR}\left[\frac{w_{CR}a_{CR}}{W_{CR}}\right] = 0.33 \otimes \frac{[(1,1,1) \oplus (1.41,1.8,2.23) \oplus (0.78,1.09,1.52) \oplus (0.81,1.09,1.46)]}{(2.79, 3.39, 4.24)} = 4.09$$

$$\sum_{CP}\left[\frac{w_{CP}a_{CP}}{W_{CP}}\right] = 0.12 \otimes \frac{[(0.45,0.56,0.71) \oplus (1,1,1) \oplus (0.61, 0.77,1) \oplus (0.5,0.64,0.84)]}{(4.61, 5.66, 6.87)} = 4.07$$

$$\sum_{E}\left[\frac{w_{E}a_{E}}{W_{E}}\right] = 0.26 \otimes \frac{[(0.66,0.92,1.29) \oplus (1,1.3,1.64) \oplus (1,1,1) \oplus (0.66,0.92,1.29)]}{(3.16, 3.95, 5.04)} = 4.1$$

$$\sum_{PP}\left[\frac{w_{PP}a_{PP}}{W_{PP}}\right] = 0.29 \otimes \frac{[(0.68,0.92,1.24) \oplus (1.2,1.57,2) \oplus (0.78,1.09,1.52) \oplus (1,1,1)]}{(2.96, 3.65, 4.59)} = 4.09$$

$$\sum_{j=1}^{4}[\sum_{CR}\left[\frac{w_{CR}a_{CR}}{W_{CR}}\right] + \sum_{CP}\left[\frac{w_{CP}a_{CP}}{W_{CP}}\right] + \sum_{E}\left[\frac{w_{E}a_{E}}{W_{E}}\right] + \sum_{PP}\left[\frac{w_{PP}a_{PP}}{W_{PP}}\right]$$

$$= 4.09 + 4.07 + 4.1 + 4.09 = 16.35$$

Given that the values have been determined and the value of *n* is known, λ_{max} can be determined. The value of *n* is known to be 4 as it is the order of the matrix outlined in Table 5

$$\lambda_{max} = \frac{16.35}{4} = 4.088$$

The CI can now be calculated through Equation 14.

$$CI = \frac{4.088 - 4}{3} = 0.029$$

Equation 13 is now applied to determine the final CR for the main criteria. The CI has been calculated and the RI is known to be 0.9 for a matrix of the order of 4, as stated in Table 3.

$$CR = \frac{0.029}{0.9} = 0.033$$

Tables 6 shows the aggregated pairwise comparison, from all expert judgments, for all of the sub-criteria. Table 6 also presents the consistency ratios of the sub-criteria.

Table 6. The aggregated fuzzy judgment matrix for sub-criteria

6. RESULTS AND DISCUSSION

This section defines the order of priority for the main and sub-criteria, as well as the positive and negative aspects of the countries considered in this study. Table 7 demonstrates the normalized weights for the four main criteria, the sixteen sub-criteria, and the preference weights for each nation. Table 7 also presents the CRs for each criterion and nation in the analysis.

Table 7. Summary of calculation results

The order of priority for the main criteria considered by shipping companies in recruiting OOWs is as follows: Cost-Related (0.325), Professional Properties (0.296), Education (0.258) and Cultural Properties (0.12). The ranking of Professional Properties below the Cost-Related criteria is indicative of the fact that crew expense, which forms part of the running cost of ships is one of the major factors considered when recruiting officers (Stopford 2009). Crew costs outweigh other criteria in the maritime market, and this may indicate that companies unfortunately opt for “inexpensive officers” rather than “qualified

officers" to reduce their costs. HR managers highlighted this as a common complaint during interviews for this study.

Within the Cost-Related criteria, Wage has the highest weighting, followed by Social Security Fees and Other Costs, respectively. The weight values of Wage (0.119) and Social Security Fees (0.113) are very similar in value, which demonstrates that, apart from the crew's wages, their social security and insurance costs are a great burden for companies. Thus, many companies sail under flags of convenience, which brings serious advantages regarding eliminating or reducing such costs (Piniella, Silos and Bernal 2013).

Professional Properties is the second main criterion that companies consider when recruiting OOWs for their ships. The four major sub-criteria in this group are as follows: Alcohol/Drug Use (0.074) and Performance & Sedulity (0.056), Technical and Practical Knowledge (0.044), and Safety Awareness (0.044). In the literature, alcohol and drug use is one of the leading factors contributing to ship accidents (Wagenaar and Groeneweg 1987; Marsden and Leach 2000; Howland *et al*. 2001). Many shipping companies screen their employees for alcohol and drug use before they join the crew and may conduct random screening without warning, in an attempt to ensure the safety of life and property. The concept of "dry ships" has grown in recent years, particularly for tankers, which indicates that shipping companies take the issue of alcohol and drug use very seriously.

This study also found that the concept of safety awareness was as important as professional knowledge in recruitment of personnel. As specified in a number of studies (Gunnar and Rolf 2004; Hansen *et al*. 2008), this is one of the key issues that need to be addressed in the prevention of shipping accidents, particularly work-related accidents. Internal/External Communication Skills (0.033) and Leadership (0.033) both ranked below other criteria, within Professional Properties. It is possible to attribute this to officers not standing out as much as the master and/or chief engineers in areas, such as, communication

and leadership. Furthermore, it is interesting that Professional Continuity (0.012) had the lowest priority among the sub-criteria in this group. The concept of a qualified seafarer is only possible if professional continuity is ensured at seas. Considering the imbalance between the supply and demand of officers, and the fact that supply failed to meet demand until recently, it is no surprise that this sub-criterion has a low value. On the other hand, it is clear that this requires addressing more meticulously, in order to ensure a safer and more professional working environment.

The other main criterion, Education, has a considerable degree of importance at 0.258. Among the sub-criteria in this group, Language Level and Training Level (both 0.090) have the highest priority, followed by Educational Status (0.078). An unsatisfactory language level is one of the key obstacles that prevent seafarers, in the countries outlined in this study, from expanding abroad in the international market (Strauch 2010; Zvonimir, Galic and Pusic 2012; Fan *et al*. 2017). Foreign language level is determined to be as important as training level in the selection of officers.

While the weights of Professional Properties and Education are close in weight, Cultural Properties was found to be less important than the other criteria, which may be attributed to companies considering characteristics, such as, harmony and cooperation between crewmembers and eating/drinking habits to be less important than the other criteria.

When all sub-criteria were analyzed together, the three main sub-criteria considered by companies when recruiting officers are all under the Cost-Related criteria (Wage 0.119, Social Security Fees 0.113 and Other Costs 0.094). Similarly, the next three sub-criteria in the ranking are all under Education (Language Level 0.09, Training Level 0.09, and Educational Status 0.078) with Alcohol and Drug Use (0.074) also demonstrating a relatively high comparative ranking.

A summary of the results for each country is presented in Table 7, from which it can be seen that Turkish officers (0.284) rank first, followed by officers from EECs (0.262), Filipino (0.180), Indian (0.157) and Chinese officers (0.117) respectively.

The second part of the study outlines the comparison of officers from different nationalities, based on the sub-criteria. From the analysis, EECs seems strong in Cultural Properties, Education and reasonable regarding Professional Properties. The highest score among officers from EECs, in these three criteria was associated with the qualified seafarer. These nations have proven to be maritime nations and good providers of maritime education (Tsamourgelis 2009). The relatively high scores of officers from EECs in the sub-criteria, such as, Performance and Sedulity, and Safety Awareness, may be associated with their good educational status. In this regard, the conservation and strengthening of the existing education systems will be important for these nations.

In contrast, officers from EECs scored lowest in the Cost-Related criterion where the sub-criteria in this group carry the highest weights. Low scores in the Cost-Related criterion are indicative of a need for tax regulation and incentive applications in seafarer supply policies. This may make seafarers from these nations more attractive to employers and hence lead to a larger share in the maritime labor market. Furthermore, the low scores in Alcohol and Drug Use are challenging and can be associated with the excessive alcohol consumption and high mortality from alcohol in EECs when compared to the other countries in this study (World Health Organization 2014). Considering the anti-alcohol policies of shipping companies, these low scores may be a serious disadvantage to officers from EECs in the international arena. It may be prudent to apply preventive measures in an effort to eliminate this negative perception.

In this study, Turkish officers are the most appropriate option, based on the overall results of the assessment. These officers ranked a clear first in Alcohol & Drug Use,

Performance & Sedulity and Professional Properties. However, Turkish officers ranked second in the main criteria: Education and Cost-Related. Given the number of accidents caused by fatigue, the importance of the high score in Performance & Sedulity is clearly demonstrated (Akhtar and Utne 2014; Uğurlu *et al*. 2015; Xia *et al*. 2018). Turkish officers are also preferable in terms of their costs, as they scored the second highest following Chinese officers in the Cost-Related criterion. Aside from the positive aspects by companies, the negative aspects of Turkish officers were also identified. For instance, Turkish officers scored low in the criteria that may affect life on the ship, such as Ship Adaptation and Cultural Adaptation. This follows the need to improve Turkey's maritime culture, which is something reported frequently by the Turkish public. Turkish officers ranked below officers from EECs and India regarding Language Level, which is a key criterion. Turkish seafarers, including cadets, ratings and officers, may experience problems in language use, as mentioned by experts. This is one of the impediments faced by Turkish seafarers when looking to work abroad (DTO 2017). Having invested in maritime activities and its officer education potential in recent years, Turkey should focus further on English education. According to the results of the assessment, Turkish officers ranked second in Education, following the officers from EECs.

India has a dense and young population, with serious potential regarding the supply of officers to the global seafaring market (MSGI 2018). As the English language is widely spoken across India, it is no surprise that Indian officers scored high in Language Level, along with the officers from EECs. In contrast, they scored low in the Education criterion due to their shortcomings in the Training Level and Educational Status. Indian officers ranked fourth under the Cost-Related criteria, following China, Turkey and the Philippines, respectively. Among the alternative countries, India is at the bottom of the list regarding GDP per capita in 2016 (The World Bank 2017). There is a perception that Indian officers are relatively costly

compared to their rivals and is considered a negative trait from the perspective of employers. This may be due to the successful integration and high demand of Indian officers in the global market, which in turn helps them earn high wages at well-established companies. They ranked fourth in the main criteria Professional Properties and Cultural Properties, noting low scores in some of the sub-criteria such as Training Level, Performance & Sedulity and Leadership. This identifies a need to increase efforts to provide better maritime education in India.

Having ranked ahead of Indian officers on the overall preference scale, Filipino officers, recorded the highest score in the main criterion of Cultural Properties. This is not an unexpected outcome as the Philippines has become a proven maritime nation, suppling a high percentage of officers and rating in the maritime labor market, as previously stated (Amante 2004; Zhao and Amante 2005). The Filipino officer's high scores in the sub-criteria of Ship Adaptation and Cultural Adaptation, under the main criterion Cultural Properties, may be attributed to the fact that it is a country composed of islands, and that seafaring is an economic necessity for this country (Amante 2004). The Philippines demonstrated a lower score than Turkey and EECs in the Professional Ethic sub-criteria. As reported by above mentioned HR experts and decision makers of this study, as well as support from literature, this finding is in parallel with the fact that Filipino seafarers are, like their Chinese counterparts, generally employed as ratings and are behind other nations regarding the officers/total seafarer ratio (Tsamourgelis 2009). Although Filipino officers ranked second following China in the Wage sub-criterion, they are behind Turkish officers in the Cost-Related criterion, which indicates that policy makers in this country may make revisions in the extra labor costs. As with the Cost-Related criterion, Filipino officers also ranked third in Professional Properties, and their low scores in Alcohol and Drug Use, and Leadership contributed to their lower ranking. As with EECs, the negative perception of Filipino officers regarding Alcohol and Drug use is interesting and is something that the country may need to

think about very seriously. According to the results of the assessment, the Philippines performed poorly in the Education main criterion. This maritime nation may need to revise its maritime education system to overcome the negative perception that Filipino officers demonstrate a low quality of knowledge regarding the English language (Zhao and Amante 2005). Any contribution to maritime education for this country may be fruitful due to highest score of their OOWs in the Professional Continuity criterion.

For Chinese OOWs, who offer great potential for global maritime trade, the survey results are interesting. Having scored first by far, above Turkey in the Cost-Related group, Chinese officers gained a serious advantage but seemed to underperform in the remaining main criteria. The key characteristics of China that make it a potentially good alternative nation for seafarers, in terms of costs in the international arena, are that it has a large maritime labor pool, being rich in human resources (Li and Wonham 1999; Leggate 2004). Similarly, China is optimistic about expanding abroad, as they can earn better wage aboard foreign ships as opposed in their domestic companies (Wu 2004; Wu *et al*. 2006; Li *et al*. 2014). They are also less of a financial burden than seafarers from other countries, and Chinese officials actively encourage labor export (Zhao 2011).

However, it is worth noting that China scored zero in the Education criterion. This appears to be already known, to some extent, as China has been heavily investing in the infrastructure of its maritime education (Zhao and Amante 2005; Wu, Lai and Cheng 2006; Zhao 2011). While the education standards in China have improved, the results of this study show that they have failed to reach a desired level. In this regard, improvements in the educational infrastructure for Chinese officers would be beneficial. The poor level of communication in English may be the main obstacle faced by Chinese officers when looking to expand abroad, as stated in literature (Li and Wonham 1999; Wu, Lai and Cheng 2006; Tang, Llangco and Zhao 2016; Fan *et al*. 2017). The fact that Chinese officers ranked last in

all of the sub-criteria, excluding Alcohol and Drug Use, brings various scenarios to mind. Chinese officers have a "different safety/work culture", and usually work in their national fleets (Tang, Llangco and Zhao 2016; Zhao 2011). Their high score in Alcohol and Drug Use is a plus, however, for Chinese officers.

In conclusion, the main issues faced by Chinese officers include their failure to expand the global seafarer market sufficiently, as along with inadequate language training. The root cause of the problem may be that they cannot efficiently introduce themselves into the world maritime labor market. It is possible to address this issue through the creation of institutions to facilitate the export of seafarers. The claims in literature stating problems with retention rates, are consistent with their low score in Professional Continuity (Tang, Llangco and Zhao 2016). Once these problems are resolved, Chinese officers may come to be in high demand in the international arena.

Today, 70% to 80% of the world's commercial fleets have multicultural crew (Hanzu-Pazara and Arsenie 2010). This is indicative of the international and multicultural nature of the maritime sector, and accordingly, multiculturalism has become a general characteristic of crews in shipping operations (Lu, Hsu and Lee 2016). One of the key components of running costs in maritime transport is crew expenses. This is why cost is a high priority for companies when recruiting seafarers. One of the main reasons why the wage ranges vary from country to country is because of the relative income gaps between them. Seafarers from countries with low-level incomes have low wage expectations, and this is one of the main reasons why seafarers of Turkey, China, India, Philippine's and EEC are preferred by companies around the world.

For the continuity of multinational crews in shipping companies, seafarers' competencies in communication should be high. For seafarers, competence in general communication and language skills has become an even more important requirement in the

current maritime labor market (Fan *et al*. 2017). One of the basic elements of communication is speaking the same language. Multiculturalism, along with the lack of a common language, may be a hazard for intensive working environments on ships (Theotokas and Progoulaki 2007), with lack of effective communication known to be one of the key factors in ship accidents (Froholdt and Knudsen 2007; Laursen *et al*. 2008; Berg, Storgard and Lappalainen 2013; Uğurlu, Kum and Aydogdu 2017). Moreover, the lack of sufficient language education triggers intercultural conflicts, in this instance, the poor level of English. Hence, addressing the issue of the *lingua franca* of seafaring is vital. If the delivery of compulsory maritime education is in English, more opportunities arise for maritime students to join education programs like Erasmus and Socrates to improve their English further, which is highly beneficial. Additionally, the provision of opportunities for seafarers to receive education for six months to one year in countries where the official language is English (*e.g.* United States or United Kingdom) may also be beneficial.

Keeping work safety awareness and work adaptation at a maximum level is key, as practical knowledge is just as important as theoretical knowledge. Practical training courses and training equipment, such as bridge, survival at sea and firefighting simulators are important parts of maritime education. In this regard, any level of high-quality maritime training requires a great deal of training infrastructure. Hence, addressing the supply of qualified ratings is a key issue. While officer education is subject to global standards, regular education and certification programs for ratings to be employed on ships are somewhat lacking. The IMO has been working on this for many years in an attempt to promote the safety of life and property at sea, as well as developing basic training and certification programs for employment at sea. However, the training and quality standards for ratings have not yet reached the desired level. In this context, language education for all seafarers to a level at which they can work with multinational personnel, improvement of the training

infrastructure for the rating class, and the development of a general maritime culture seem to be common requirements. Many practices in maritime education institutions may require revision and improvement, including the controversial boarding school order, as well as uniforms and the hierarchical education. Developing an infrastructure and a common understanding in maritime education is key to ensure the supply of specialized seafarers for different types of ships required under the current prevailing conditions.

HR managers should create an effective crew setting on ships if their company is to survive in the challenging competitive maritime environment. There is a great demand by companies to identify the appropriate crews for their ships, as well as ensuring the safety of the ship, its cargo and its personnel are safe. Accordingly, companies should consider various factors, such as the contribution of crew costs to the operating cost of ships, crew's communication skills, educational and training levels, cultural values and experience in a multicultural setting, as well as delicately balancing all of these factors simultaneously.

7. CONCLUSION

Multinational crews are an indispensable asset in the maritime labor market, with a number of positive and negative aspects. In today's maritime labor market, countries are making great efforts to develop a well-qualified marine labor force, primarily for their own national fleet's needs, as well as to export a labor force. This export of good quality labor is invaluable to many nations' economies. This study provides an overview of the ideal characteristics sought for in OOWs, as well as investigating these characteristics in the seafarers of various countries. The criteria considered by companies in recruiting OOWs have been identified, with the strongest and weakest aspects of the officers, from several countries also demonstrated. Furthermore, the educational conditions, maritime infrastructure and maritime culture of the countries have also been assessed according to the findings of the

analysis, along with the wage expectations of their seafarers. This study provides information for maritime HR managers and policy makers, related to maritime education and training. This allows managers and policy-makers to identify the strengths and weaknesses of officers, of various nationalities, and evaluate the training of OOWs. This study's primary focus is OOWs; however, it provides guidance for future studies with application to a wider scope to include ratings, which form the majority of a ship's crew.

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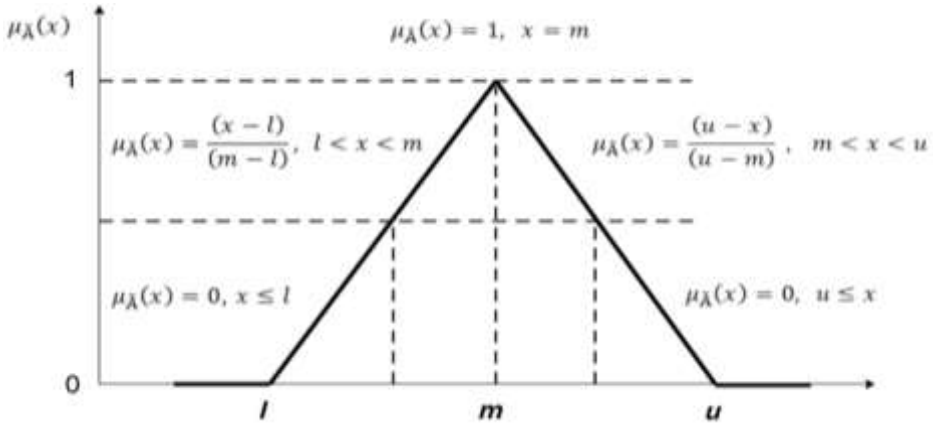

Figure 1. A triangular membership function

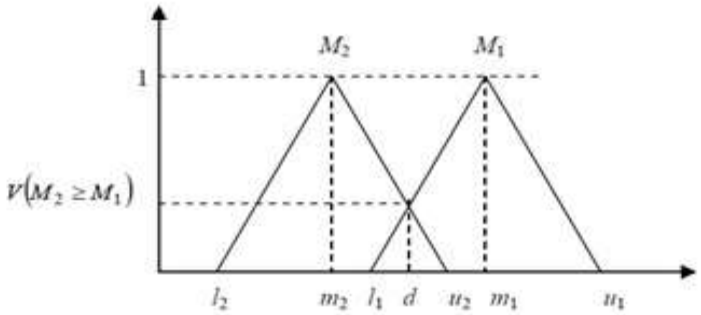

Figure 2. The intersection between $M_1 and \ M_2$ (Chang, 1996)

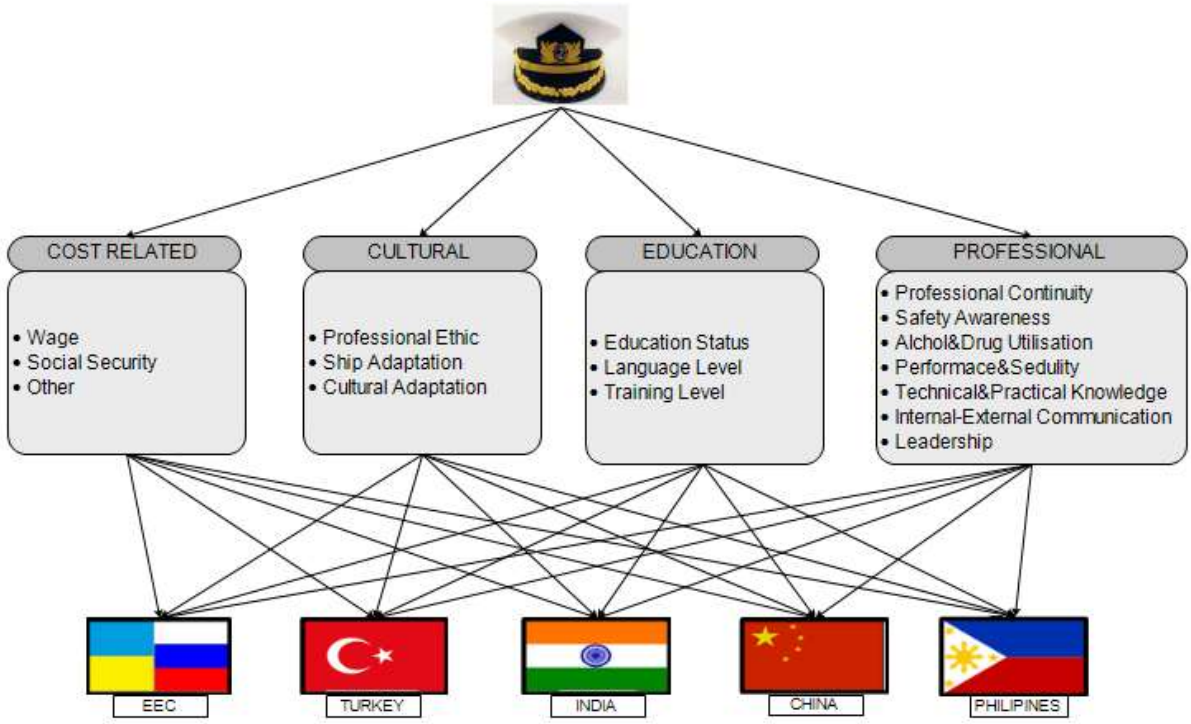

Figure 3. The hierarchical structure of the study

Table 1. Populations and number of seafarers in EEC (Marinov, Maglić and Bukša 2015)

Country	Population (Millions)	Seafarers Population (%)
Croatia	4.3	0.47
Bulgaria	7.3	0.45
Romania	19.9	0.12
Ukraine	45.5	0.0084
Russia Federation	143.5	0.045

Table 2. Transformation for TFNs membership functions

Fuzzy	Linguistic scale	Triangular fuzzy scale	Triangular fuzzy reciprocal scale
Ã1	Equally important (EI)	(1,1,1)	(1,1,1)
Ã2	Weakly important (WI)	(2/3,1,3/2)	(2/3,1,3/2)
Ã3	Fairly strong important (FSI)	(3/2,2,5/2)	(2/5,1/2,2/3)
Ã4	Very strong important (VSI)	(5/2,3,7/2)	(2/7,1/3,2/5)
Ã5	Absolutely important (AI)	(7/2,4,9/2)	(2/9,1/4,2/7)

Table 3. Average Random Index values for matrix order (Saaty 1990).

n	1	2	3	4	5	6	7	8	9	10
R.I	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49

Table 4. Questionnaire form used to facilitate comparisons of main criteria.

	⟵ Comparison or preference of one criteria over others ⟶									
	Main Criterion	AI	VSI	FSI	WI	EI	WI	FSI	VSI	AI	Main Criterion
Question 1	CR		X								CP
Question 2	CR				X						E
Question 3	CR			X							PP
Question 4	CP							X			E
Question 5	CP						X				PP
Question 6	E						X				PP

Table 5. The aggregated fuzzy judgment matrix for main criteria.

	CR	CP	E	PP
CR	*(1,1,1)*	*(1.41, 1.8, 2.23)*	*(0.78, 1.09, 1.52)*	*(0.81, 1.09, 1.46)*
CP	*(0.45, 0.56, 0.71)*	*(1,1,1)*	*(0.61, 0.77, 1)*	*(0.5, 0.64, 0.84)*
E	*(0.66, 0.92, 1.29)*	*(1, 1.3, 1.64)*	*(1,1,1)*	*(0.66, 0.92, 1.29)*
PP	*(0.68, 0.92, 1.24)*	*(1.2, 1.57,2)*	*(0.78, 1.09, 1.52)*	*(1,1,1)*
				CR: 0,03

Table 6. The aggregated fuzzy judgment matrix for sub-criteria

The aggregated fuzzy judgment matrix for criteria under Cost Related

	W	SSF	OC
W	*(1,1,1)*	*(0.69, 0.92, 1.23)*	*(1, 1.30, 1.64)*
SSF	*(0.82, 1.09, 1.44)*	*(1,1,1)*	*(0.78, 1, 1.29)*
OC	*(0.61, 0.77, 1.00)*	*(0.78, 1, 1.29)*	*(1,1,1)*
			CR:0,05

The aggregated fuzzy judgment matrix for criteria under Cultural Properties

	PE	SA	CA
PE	*(1,1,1)*	*(0.66, 0.92, 1.29)*	*(0.86, 1.19, 1.62)*
SA	*(0.78, 1.09, 1.51)*	(1,1,1)	*(0.68, 0.84, 1.05)*
CA	*(0.62, 0.84, 1.16)*	*(0.95, 1.19, 1.46)*	*(1,1,1)*
			CR:0,07

The aggregated fuzzy judgment matrix for criteria under Educational Criterion

	ES	LL	TL
ES	*(1,1,1)*	*(0.78, 1, 1.29)*	*(0.68, 0.84, 1.05)*
LL	*(0.78, 1, 1.28)*	*(1,1,1)*	*(0.89, 1.09, 1.32)*
TL	*(0.95, 1.19, 1.46)*	*(0.76, 0.92, 1.12)*	*(1,1,1)*
			CR:0,03

The aggregated fuzzy judgment matrix for criteria under Professional Competencies

	PrC	SA	ADU	P&S	TPK	IECS	L
PrC	*(1,1,1)*	*(0.55, 0.67, 0.85)*	*(0.44, 0.55, 0.68)*	*(0.56, 0.65, 0.77)*	*(0.63, 0.77, 0.95)*	*(0.57, 0.72, 0.93)*	*(0.6, 0.77, 0.99)*
SA	*(1.18, 1.49, 1.82)*	*(1,1,1)*	*(0.53, 0.65, 0.81)*	*(0.7, 0.9, 1.16)*	*(0.67, 0.84, 1.06)*	*(0.87, 1.19, 1.62)*	*(0.92, 1.19, 1.55)*
ADU	*(1.46, 1.83, 2.26)*	*(1.24, 1.54, 1.89)*	*(1,1,1)*	*(0.88, 1.19, 1.6)*	*(1.23, 1.49, 1.78)*	*(1.24, 1.57, 1.99)*	*(1.11, 1.46, 1.9)*
P&S	*(1.31, 1.54, 1.79)*	*(0.86, 1.11, 1.43)*	*(0.63, 0.84, 1.14)*	*(1,1,1)*	*(0.87, 1.09, 1.35)*	*(1.18, 1.41, 1.66)*	*(0.95, 1.3, 1.74)*
TPK	*(1.05, 1.30, 1.58)*	*(0.94, 1.19, 1.5)*	*(0.56, 0.67, 0.81)*	*(0.74, 0.92, 1.14)*	*(1,1,1)*	*(0.91, 1.15, 1.44)*	*(0.84, 1.09, 1.41)*
IECS	*(1.08, 1.39, 1.76)*	*(0.62, 0.84, 1.15)*	*(0.5, 0.64, 0.81)*	*(0.6, 0.71, 0.85)*	*(0.69, 0.87, 1.1)*	*(1,1,1)*	*(0.8, 1.05, 1.38)*
L	*(1.01, 1.30, 1.67)*	*(0.64, 0.84, 1.08)*	*(0.53, 0.68, 0.90)*	*(0.57, 0.77, 1.05)*	*(0.71, 0.92, 1.19)*	*(0.73, 0.95, 1.25)*	*(1,1,1)*
							CR: 0.02

Table 7. Summary of calculation results

		Alternative Nations					
		EEC	*Turkey*	*India*	*Philippines*	*China*	
Assessment Criterion's	**Total**	**0.262**	**0.284**	**0.157**	**0.180**	**0.116**	***CR***
Cost Related	**0.325**	**0.028**	**0.073**	**0.061**	**0.071**	**0.091**	***0.05***
Wage	0.119	*0.007*	*0.025*	*0.023*	*0.029*	*0.036*	*0.03*
Social Security Fees	0.113	*0.014*	*0.026*	*0.017*	*0.023*	*0.030*	*0.03*
Other Costs	0.094	*0.007*	*0.022*	*0.021*	*0.019*	*0.025*	*0.02*
Cultural Properties	**0.120**	**0.035**	**0.028**	**0.015**	**0.037**	**0.004**	***0.07***
Professional Ethic	0.042	*0.013*	*0.015*	*0.004*	*0.008*	*0.002*	*0.03*
Ship Adaptation	0.038	*0.010*	*0.007*	*0.006*	*0.016*	*0.000*	*0.03*
Cultural Adaptation	0.039	*0.013*	*0.007*	*0.005*	*0.013*	*0.002*	*0.03*
Education	**0.258**	**0.123**	**0.076**	**0.036**	**0.024**	**0.000**	***0.03***
Education Status	0.078	*0.044*	*0.027*	*0.007*	*0.000*	*0.000*	*0.03*
Language Level	0.090	*0.035*	*0.021*	*0.022*	*0.013*	*0.000*	*0.02*
Training Level	0.090	*0.044*	*0.029*	*0.007*	*0.011*	*0.000*	*0.02*
Professional Properties	**0.296**	**0.076**	**0.107**	**0.045**	**0.048**	**0.021**	***0.02***
Prof. Continuity	0.012	*0.002*	*0.003*	*0.002*	*0.004*	*0.000*	*0.03*
Safety Awareness	0.044	*0.014*	*0.013*	*0.007*	*0.010*	*0.001*	*0.02*
Alcohol-Drug Utilization	0.074	*0.008*	*0.025*	*0.013*	*0.010*	*0.018*	*0.03*
Performance and Sedulity	0.056	*0.017*	*0.026*	*0.003*	*0.010*	*0.000*	*0.03*
Technical&Practical Knowledge	0.044	*0.013*	*0.015*	*0.007*	*0.007*	*0.002*	*0.03*
Int-Ext Comm. Skills	0.033	*0.009*	*0.009*	*0.008*	*0.007*	*0.000*	*0.03*
Leadership	0.033	*0.012*	*0.016*	*0.003*	*0.001*	*0.000*	*0.03*