

AN AHP MODEL FOR THE CHOICE OF SHIP FLAG: A CASE STUDY OF TAIWANESE SHIPOWNERS

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SUMMARY

The choice of an appropriate ship flag for the existing fleet or new-building ships is one of important issues of shipowners. The main purpose of this paper is to construct an Analytic Hierarchy Process (AHP) model for the choice of ship flag. An application of the proposed AHP model to the case study on the ship flag choice of Taiwanese shipowners is shown in this article. The results show that the most important influential factors on the ship flag choice of Taiwanese shipowners are in order of the importance as follows: (a) crew cost, (b) incentive, (c) fiscal reason, (d) dual class expense, (e) tax-related expense, (f) PSC inspection, (g) freedom to employ foreign crew, (h) priority to transport, (i) ship registry process, (j) market consideration, (k) level of bureaucracy, and (l) law restrictions. The top four nations for Flag of Convenience (FOC) registry are in order of shipowner's preferences as follows: (a) Panama, (b) Liberia, (c) Hong Kong, and (d) Singapore. The above findings can be a reference for the maritime departments of Taiwanese government transportation to help the maritime departments offer response strategies and policies for future development of national ship registration system.

1. INTRODUCTION

The choice of ship flag is one of the most important issues of shipowners. Because the ship flag performs several important functions such as costs, flexibility of ship operations, crew employment, trade route and market, ship inspection, identifying ships that would be eligible for financial support and the level of ship safety. Therefore, the choice of ship flag is a so critical process for shipowners, ship management companies, shipping carriers, port managers and international banks and so on.

On the other hand, the choice of ship flag will result in the ship flagging-out problem. For example, the shipowners in the traditional maritime countries with inconvenient ship flag systems attempt to improve their competitive positions. They will look for a convenient ship flag to reduce the operation costs and increase the flexibility of shipping operation. As a result, the registered ship tonnages would be lost dramatically. The dramatic loss of registered ship tonnages will cause the recession of shipping industry in the traditional maritime country. Therefore, the choice of ship flag is not only the important issue for shipowners, but also the major concern for governmental maritime departments.

In the competitive shipping market, to analyze the influential factors on the choice of ship flag and to realize the flagging-out problem are major concerns and important issues for the shipowners in the traditional marine countries all over the world. Especially, the proportion of the Flag of Convenience (FOC) fleet in Taiwan is increasing yearly and the ratio is higher than the global average. Obviously, Taiwanese ship flagging-out problem is getting serious in the recent 10 years. The flagging-out problem results in the Taiwanese ship tonnage loss. Therefore, the main purpose of the study is to analyze the key factors influencing the ship flag choices of Taiwanese shipowners.

2. LITERATURE REVIEW

The relative literature has been proposed previously in the past. The shipping registry can be recognized as interfaces for complying with international requirement relating to jurisdiction (Celik and Kandakoglu [1]). Stopford [2] and Celik et al. [3] indicated the shipping registry can be separated into three catalogues: national registry, international registry (also named as the second registry), and open registry (also named as FOC).

In the past studies, the cost is the most important factor in determining the registry nation of ship flag (Metaxas [4], Tolofari [5], Bergantino and Marlow [6]). They also pointed out the registry choice of ship flag are influenced by multiple factors, no one reason acts in isolation. Haralambides and Yang [7] mentioned the ship flagging-out is an internationalization strategy that changes a ship's registry from an expensive to a cheap flag.

The key factors influencing the ship flag choice are shown in the previous literature e.g. tax-related expense, fiscal reason, crew cost, incentive, dual class expense, priority to transport, market consideration, PSC inspection, freedom to employ foreign crew, ship registry process, level of bureaucracy, law restrictions, trade routes or trading region of the world, labor quality and availability, maintenance and insurance costs, public relationship, type of ship or ship age, and historical reasons.

In addition, Li and Wonham [8], Lapa et al. [9] analyzed the relationship between the ship flag and the navigation safety. Cariou and Wolff [10] and Fan et al. [11, 12] identified the relationship between the PSC inspection and the ship flag choice. Chou et al. [13] proposed a fuzzy multiple-criteria decision-making (MCDM) model for the ship flag choice. Various ship flagging policies were discussed and suggestions were proposed by Lee [14], Goulielmos [15, 16, 17], Marlow

and Mitroussi [18], Tenold [19], Thanopoulou [20], Toh and Phang [21], Tsai et al. [22], Yannopoulos [23] and Guy [24].

Based on the above literature review, this study summarizes influential factors on the ship flag choice as follows: (a) tax-related expense, (b) fiscal reason, (c) crew cost, (d) incentive, (e) dual class expense, (f) priority to transport, (g) market consideration, (h) PSC inspection, (i) freedom to employ foreign crew, (j) ship registry process, (k) level of bureaucracy, and (l) law restrictions. The description of these key factors is shown in Table 1.

3. AHP METHODOLOGY

AHP methodology was proposed initially by Saaty [31] in 1970s. It was applied to solve many complex decision-making problems based on comparing concepts (alternatives) in pairs. Furthermore, some modified AHP methodologies were also proposed by Saaty [32] and Chang [33]. Chou [34] pointed that although many studies applied AHP to solve decision-making problems, few used AHP to solve marine affairs. Therefore, this paper proposed an AHP model for ship flag choice of Taiwanese shipowners. The proposed AHP model for the ship flag choice involves six computational procedures as follows.

Table 1: Important criteria for ship flag choice

Criteria	Description	Author
Crew cost	<i>The different levels of crew cost result from different management and policy requirements in the flag register nation.</i>	Celik and Kandakoglu ^[1] , Bergantino and Marlow ^[6] , Haralambides and Yang ^[7] , Chou et al. ^[13] , Cullinane and Robertshaw ^[25] , Veenstra and Bergantino ^[26] , Alderton and Winchester ^[27] , Llácer ^[28] , Ademun-Odeke ^[29]
Fiscal reason	<i>The different fiscal cost in different flag register nation.</i>	Celik and Kandakoglu ^[1] , Celik et al. ^[3] , Bergantino and Marlow ^[6] , Haralambides and Yang ^[7] , Cullinane and Robertshaw ^[25] , Veenstra and Bergantino ^[26] , Llácer ^[28]
PSC inspection	<i>The different levels of PSC inspection depend on the flag register nation.</i>	Celik and Kandakoglu ^[1] , Cullinane and Robertshaw ^[25]
Market consideration	<i>The shipping companies registered in a nation might have more opportunity to expand the market share.</i>	Celik and Kandakoglu ^[1] , Celik et al. ^[3] , Bergantino and Marlow ^[6] , Cullinane and Robertshaw ^[25]
Law restrictions	<i>The restrictions of national and international laws result from the register nation.</i>	Celik and Kandakoglu ^[1] , Celik et al. ^[3]
Ship registry process	<i>The complexity of ship registry process in complying with registry qualification acquirement from the register nation.</i>	Celik and Kandakoglu ^[1] , Celik et al. ^[3] , Bergantino and Marlow ^[6] , Cullinane and Robertshaw ^[25] , Veenstra and Bergantino ^[26] , Llácer ^[28]
Tax-related expense	<i>The different levels of tax-related expense result from the different register nation.</i>	Celik and Kandakoglu ^[1] , Celik et al. ^[3] , Haralambides and Yang ^[7] , Veenstra and Bergantino ^[26] , Llácer ^[28] , Ademun-Odeke ^[29]
Dual class expense	<i>The ships registered in Taiwan have to pay for both certifications issued by China Corporation Register of Shipping and International Association of Classification Societies.</i>	Celik and Kandakoglu ^[1] , Chou et al. ^[13] , Ademun-Odeke ^[29]
Level of bureaucracy	<i>The efficiency of maritime authority in processing ship's registry.</i>	Celik and Kandakoglu ^[1] , Celik et al. ^[3] , Bergantino and Marlow ^[6] , Haralambides and Yang ^[7]
Incentive	<i>The register nation offers various incentives to attract more ships to register or flagging-in.</i>	Haralambides and Yang ^[7] , Chou et al. ^[13]
Freedom to employ foreign crew	<i>The freedom of employing foreign crews in different register nation.</i>	Celik et al. ^[3] , Llácer ^[28] , Ding and Liang ^[30]
Priority to transport	<i>The ship has the priority to transport the cargo from/to the register nation.</i>	Celik et al. ^[3] , Bergantino and Marlow ^[6] , Haralambides and Yang ^[7] , Veenstra and Bergantino ^[26]

Step 1: Constructing an analytic hierarchical structure

Based on the above mentioned literature review and the results of interviewing with the marine experts, this study summarized three dimensions and twelve key influential factors on ship flag choice as Figure 1. The first dimension is the international environment and restrictions including freedom to employ foreign crew, ship registry process, law restrictions, and PSC inspection and so on. The second dimension is the cost and fiscal including tax-related expense, dual class expense, fiscal reason, and crew cost and so on. The third dimension is the national environment and restrictions including market consideration, level of bureaucracy, priority to transport, and incentive and so on. Finally, there are several major maritime registry alternatives including Panama, Liberia, Hong Kong, Singapore, Taiwan and other. The analytic hierarchical structure is shown in Figure 1.

Step 2: Assigning priority weights on dimensions and key factors

The linguistic variables for importance weight of dimensions and key factors for ship flag choice include “Equally important”, “Weakly important”, “Strongly important”, “Demonstrably important”, and “Absolutely important” and so on.

Step 3: Calculating priority weights of dimensions and key factors

Central to the AHP is the pairwise comparisons (PC) matrix $B=[a_{ij}]$. Let's consider the factors $C_1, \dots, C_i, \dots, C_j, \dots, C_n$, someone level in the hierarchy. One wishes to find their weights of importance, $W_1, \dots, W_i, \dots, W_j, \dots, W_n$, on some elements in the next level. Allow a_{ij} , $i, j=1, 2, \dots, n$ to be the importance strength of C_i when compared with C_j . In general, a_{ij} expresses a quantitative relationship over the set of factors C_i and C_j . The matrix of these numbers a_{ij} is denoted B as follows.

$$B = \begin{bmatrix} a_{11} & a_{12} & \dots & a_{1j} & \dots & a_{1n} \\ \vdots & \vdots & & \vdots & & \vdots \\ a_{i1} & a_{i2} & \dots & a_{ij} & \dots & a_{in} \\ \vdots & \vdots & & \vdots & & \vdots \\ a_{n1} & a_{n2} & \dots & a_{nj} & \dots & a_{nn} \end{bmatrix}_{n \times n}$$

where $a_{ji}=1/a_{ij}$, that is, B is reciprocal. The values a_{ij} and a_{ji} are interpreted as the relative importance, value or indicators of the factors C_i and C_j . If one's judgment is perfect in all comparisons, then $a_{ik}=a_{ij} \cdot a_{jk}$ for all i, j, k and one calls the matrix B consistent. An obvious case of a consistent matrix B is its elements.

$$a_{ij}=w_i/w_j, i, j=1, 2, \dots, n$$

Thus, when matrix B is multiplied by the vector formed by each weighting $w=(w_1, w_2, \dots, w_n)^T$. The values of w for the sequence of factors $C_1, \dots, C_n$ is a priority vector $w=[w_1, w_2, \dots, w_n]$. In AHP, vector w is obtained by calculating the principal eigenvector of B and rescaling it.

$$Bw = \begin{bmatrix} w_1/w_1 & w_1/w_2 & \dots & w_1/w_j & \dots & w_1/w_n \\ w_2/w_1 & w_2/w_2 & \dots & w_2/w_j & \dots & w_2/w_n \\ \vdots & \vdots & & \vdots & & \vdots \\ w_i/w_1 & w_i/w_2 & \dots & w_i/w_j & \dots & w_i/w_n \\ \vdots & \vdots & & \vdots & & \vdots \\ w_n/w_1 & w_n/w_2 & \dots & w_n/w_j & \dots & w_n/w_n \end{bmatrix} \begin{bmatrix} w_1 \\ w_2 \\ \vdots \\ w_j \\ \vdots \\ w_n \end{bmatrix} = n \begin{bmatrix} w_1 \\ w_2 \\ \vdots \\ w_j \\ \vdots \\ w_n \end{bmatrix} = nw$$

Because a_{ij} is the subjective ratings given by the shipowners, there must be a distance between it and the actual values w_i/w_j . Thus, $Bw=nw$ cannot be calculated and obtained directly. Thus, Saaty suggested that it is more appropriate to use the maximum eigenvalue,

$$\lambda_{\max} = \frac{1}{n} \left(\frac{w_1'}{w_1} + \frac{w_2'}{w_2} + \dots + \frac{w_n'}{w_n} \right), \text{ the solution of matrix } B$$

to replace n , then $Bw=\lambda_{\max} w$.

By this method, one can obtain the characteristic vector, referred to as the priority vector. Besides Saaty [32]

suggested to apply the consistency index ($C.I.=\frac{\lambda_{\max}-n}{n-1}$)

and the consistency rate ($C.R.=\frac{C.I.}{R.I.}$) to test the

consistency of the intuitive judgment. In general, it is satisfactory and accepted if the value of $C.I.$ is about 0.1 and the value of $C.R.$ is less than 0.1. For example, a case of ship flag choice by AHP approach is shown as follows to illustrate the consistency index ($C.I.$) and the consistency rate ($C.R.$).

$$Aw = \begin{bmatrix} 1 & 1/3 & 1/2 \\ 3 & 1 & 4 \\ 2 & 1/4 & 1 \end{bmatrix} \begin{bmatrix} 0.1515 \\ 0.6301 \\ 0.2184 \end{bmatrix} = \begin{bmatrix} 0.4707 \\ 1.9582 \\ 0.6789 \end{bmatrix},$$

$$\lambda_{\max} = \frac{1}{3} \left(\frac{0.4707}{0.1515} + \frac{1.9582}{0.6301} + \frac{0.6789}{0.2184} \right) = 3.1078$$

$$C.I. = \frac{\lambda_{\max} - n}{n - 1} = \frac{3.1078 - 3}{3 - 1} = 0.054,$$

$$C.R. = \frac{C.I.}{R.I.} = \frac{0.054}{0.58} = 0.093$$

Step 4: Assigning preference to alternatives

For example, the linguistic variables for ship flag's preference include "Very poor", "Poor", "Fair", "Good" and "Very good". The ratings for preferences are from 1 to 5, respectively.

Step 5: Calculating total preference of each alternative**Step 6: Choosing an appropriate ship flag**

Finally, based on the total preference of each alternative, the shipowner could choose easily the best ship flag.

4. CASE STUDY**4.1 PRE-TESTING**

After sorting out the influencing criteria of ship flag choice, interviews were carried out with 7 maritime experts with practical experiences and academics to pre-test the original questionnaire and held a discussion with them. We then made a questionnaire from the issues raised and advised by each expert and academic separately. With their recommendations, we finalised the formal questionnaire. The validity of questionnaire is achieved by amending the style and the direction of the questionnaire with the suggestions and comments from experts and academics.

4.2 ESTABLISHMENT OF FORMAL QUESTIONNAIRE

After pre-testing and re-editing with the experts and academics, the questionnaire was finalised and distributed out for testing, and then was collected from the experts and the academics. The three major test variables in the questionnaire include: (a) international environment and restrictions, (b) cost and fiscal, (c) national environment and restrictions shown in Figure 1. The international environment and restrictions involves four sub-criteria: freedom to employ foreign crew, ship registry process, law restrictions, and PSC inspection. The cost and fiscal criteria includes four sub-criteria: tax-related expense, dual class expense, fiscal reason, and crew cost. The national environment and restrictions includes four sub-criteria: market consideration, level of bureaucracy, priority to transport, and incentive.

4.3 DATA ANALYSIS

25 copies of the questionnaires were distributed for test by interview and of which 25 were returned, i. e. questionnaires for analysis at an effectively respond rate of 100%. The background information of the respondents are summarised in Table 2. The respondents were mainly between the age of 41~50 at 36%, followed by 51~60 years old at 32% and over 60 years old at 20%. The level of education was mainly of college at 32%, university-

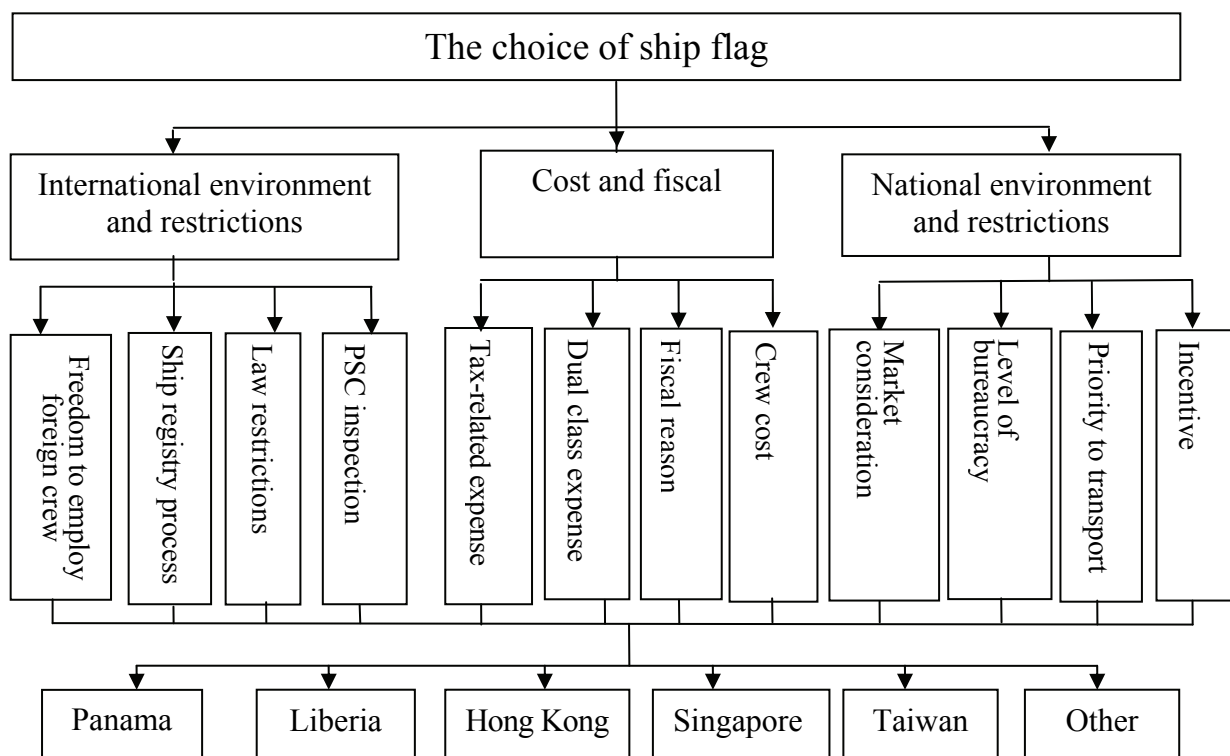


Figure 1: The analytic hierarchical structure for the choice of ship flag.

level at 24% and master-level at 24%. Practical experts were at 80%, followed by academics at 20%. For work experience, 60% of them had over 20 years of experience, 16% with 11~15 years of experience, and 12% had 16~20 years of experience. Because most of the surveyed subjects have had experience serving in a variety of vessels, the data representation is different from others. If container vessels were 25%, for example, it meant that out of the 25 respondents, 14 of them had experience serving on container vessels, while they might also have served on other type of vessels.

4.4 RESULT DISCUSSION

The proposed AHP model was applied to a case study on the ship flag choices of Taiwanese shipowners. This paper designed a questionnaire based on the previous

literature review and the interview with marine experts and academics. Three major dimensions and 12 key factors are involved in this questionnaire for ship flag choice. After the calculation by using AHP approach, some interesting findings are shown as follows. The *C.R* for AHP model is 0.09 less than 0.1. The value of *C.R* is acceptable. The most important dimension is the cost and fiscal with 0.550 score. The cost is the most important factor in determining the registration nation of ship flag. The finding in this study is the same with that proposed in the previous literature (Metaxas [4], Tolofari [5], Bergantino and Marlow [6]).

The second important dimension is the national environment and restrictions with 0.240 score. The last one is the international environment and restrictions with 0.210 score.

Table 2: Background information of the respondent

	Type	Amount	Ratio (%)
Age	20~30 years	1	4%
	31~40 years	2	8%
	41~50 years	9	36%
	51~60 years	8	32%
	Over 60 years	5	20%
Level of education	College	8	32%
	University	6	24%
	Master	6	24%
	PhD	5	20%
Corporate	Practical expert	20	80%
	Academics	5	20%
Work experience	1~5 years	2	8%
	6~10 years	1	4%
	11~15 years	4	16%
	16~20 years	3	12%
	Over 20 years	15	60%
Type of vessel	Container	14	25%
	Bulk	12	22%
	Tanker	10	18%
	Ferry	2	4%
	Ore carrier	2	4%
	General cargo	6	11%
	LNG/LPG	3	5%
	Others	6	11%

Table 3: The weights of dimensions and factors

Dimension	Dimension weight	Factor	Factor weight	Total weight	Rank
International environment and restriction	0.21	Freedom to employ foreign crew	0.2334	0.049	7
		Ship registry process	0.2022	0.042	9
		Law restrictions	0.0477	0.010	12
		PSC inspection	0.5143	0.108	6
Cost and fiscal	0.55	Tax-related expense	0.2145	0.118	5
		Dual class expense	0.2255	0.124	4
		Fiscal reason	0.2328	0.128	3
		Crew cost	0.3255	0.179	1
National environment and restrictions	0.24	Market consideration	0.1165	0.028	10
		Level of bureaucracy	0.0625	0.015	11
		Priority to transport	0.1875	0.045	8
		Incentive	0.6375	0.153	2

In addition, in terms of the weights of key factors, the important key factors are in order of importance as follows: crew cost (0.179), incentive (0.153), fiscal reason (0.128), dual class expense (0.124), tax-related expense (0.118), PSC inspection (0.108), freedom to employ foreign crew (0.049), priority to transport (0.045), ship registry process (0.042), market consideration (0.028), level of bureaucracy (0.015), and law restrictions (0.010).

Finally, the Taiwanese shipowners prefer to choose Panama as the best ship flag. The preference value for Panama is 0.232, followed by Liberia, Hong Kong, Singapore, Taiwan and other countries. The preference values for Liberia, Hong Kong, Singapore, Taiwan and other countries are 0.225, 0.159, 0.140, 0.126, and 0.118, respectively.

5. CONCLUSIONS

This paper proposed an AHP model for the registry choice of ship flag. The results for the AHP model show that the most important dimension is the cost and fiscal in the decision-making procedure for the choice of ship flag. The second important dimension is the national environment and restrictions. The last one is the international environment and restrictions.

In terms of the weights of key factors, the important key factors are in order of importance as follows: (a) crew cost, (b) incentive, (c) fiscal reason, (d) dual class expense, (e) tax-related expense, (f) PSC inspection, (g) freedom to employ foreign crew, (h) priority to transport, (i) ship registry process, (j) market consideration, (k) level of bureaucracy, and (l) law restrictions.

The top four nations for FOC registry are in order of Taiwanese shipowner's preferences as follows: (a) Panama, (b) Liberia, (c) Hong Kong, and (d) Singapore. In other words, most of Taiwanese shipowners prefer to choose Panama and Liberia as the nations for FOC registry, some would like to choose Hong Kong and Singapore as the nations for FOC registry. Based on the interesting findings in this paper, the marine departments of Taiwanese government could realize what the Taiwanese shipowners concern on in determining the registry nation of ship flag and to make useful strategies and policies to avoid Taiwanese ships continuing flagging-out and further to attract more foreign and Taiwanese ships flagging-in.

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