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Flag Choice Behavior in the Turkish Merchant Fleet: A Model Proposal with Artificial Neural Network Approach

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Abstract

Shipping companies have to take several strategic decisions about the vessels that perform transportation activities. The most important of these strategic decisions is "Flag Choice". This decision given by the company is shaped under the light of external and internal factors.

In this paper, initially, the factors which affect flag choice decision of shipping companies and ship owners who play an important role to handle Turkish merchant fleet are determined. Then, the relation and association status of the factors which have significant impacts on this decision are displayed with data mining application. Artificial Neural Networks (ANN) application is realized with the obtained outputs and a model is proposed for flag selection decision. It is expected that the results of the study provides certain outcomes and guidelines for related organizations dealing with shipping operations as well as suggestions for effective and efficient coordination among the relevant institutions.

Keywords: *Artificial Neural Network, Decision Making, Flag Selection, Turkish Merchant Fleet.*

Türk Deniz Ticaret Filosundaki Bayrak Seçim Davranışları: Yapay Sinir Ağı Yaklaşımı ile Bir Model Önerisi

Öz

Gemi yönetim firmaları, işlettiği gemiler ile ilgili çeşitli stratejik kararlar almaktadır. Bu stratejik kararların en önemlisi "Bayrak Seçim" kararıdır. İşletme tarafından verilen bu karar, iç ve dış faktörlerin ışığı altında şekillenmektedir.

Bu çalışmada öncelikle Türk deniz ticaret filosunun işleyişinde önemli rol oynayan gemi sahiplerinin bayrak seçim kararını etkileyen faktörler belirlenmiştir. Daha sonra, bu karar üzerinde önemli etkileri olan faktörlerin ilişki ve birliktelik düzeyleri veri madenciliği uygulaması ile tespit edilmiştir. Elde edilen çıktılar Yapay Sinir Ağları (YSA) uygulaması ile bayrak seçimi kararı için bir model üretilmesinde kullanılmıştır. Bu araştırmanın sonuçlarının, denizyolu taşımacılığında söz sahibi olan gemi sahipleri ve gemi yönetim firmalarının bayrak seçme kararı açısından bir kılavuz oluşturması ayrıca konuya ilişkin diğer kurum ve kuruluşlar açısından da koordinasyona katkı sağlaması hedeflenmektedir.

Anahtar Kelimeler: *Yapay Sinir Ağları, Karar Verme, Bayrak Seçimi, Türk Deniz Ticaret Filosu.*

1. Introduction

Transportation industry today is the most important weapon of economic power struggle. The obligation of ships for representing their nation is because of the fact that they navigate places which are not ruled by any country. Ships become nationals of the country of which flag they fly [1]. The nation of the ship also determines the status of the sovereignty according to international legislation. Lack of a mechanism for control, management and supervision on ships leads to a chaotic environment for the industry [2].

2. Flagging of Ships

Ships can be operated under different registration systems during the period between construction and recycling. There are several terms which refer to the same registrations system. In addition these registry systems can be named differently by varied institutions. For example ITF (International Transport Workers' Federation) defines the registration systems which offer economic convenience to ship-owners as "available registry" whereas ship-owners define the same registry systems as "obligatory registry" [3]. In Table 1, classification of names used in literature for ship registry systems is shown.

As can be seen from the Table 1, five different ship registry systems namely national registry, quasi national registry, open registry, bareboat registry, new building registry, preferred in the application have some 28 conceptual equivalents. Some registries are named especially based on the convenience they provide whereas some are named according to the institutional approaches of the bodies. Table 2 shows the environmental variables which affect flagging decisions of ship companies. These variables are determined as a result of the content analysis of sources obtained based on flagging literature search.

There are several factors which affect flag selection decisions of ship owners. Some of these factors are navigation region of the ship, "Port State Supervision" regime, risk levels of flag states, [10]. Veenstra and Bergantino [4] stated in their study that the most important factor for ship companies in terms of flag selection is operational costs. Alderton and Winchester [12] mentioned the importance of labor costs among operational costs and emphasized that economic factors are more important than political and military factors. Another

Table 1. *Classifications of Ship Registry Systems*

Open Registry			**National Registry**	**Quasi-National Registry**	**Bareboat Charter Registry**	**New Building registry**
Flags of Convenience	Free Booters	Cheap Flags	Classic Register	International Open Register	Open Flag	First Registry
Flags of Attraction	Flags Of Necessity	Open Register	Traditional Maritime Nation	Bogus Maritime Nation	Free Flags	Newborn Registry
Runaway Flags	Opportunist Register	Offshore Register	National Flag	Second Register	Shadow Flags	
Easy Registry	Flags of Opportunity	Flags of Accommodation	Embedded Maritime Nation	Dependent Territory Register	Fictitious Flags	
		Tax-Free Flags	Closed Register	International R.		

Source: *[3, 4]*

Table 2. *Flag Selection Determinants*

Macro External Environment Determinants	Micro External Environment and Internal Determinants	

• Socio-cultural factors
• Political factors
• Legal factors
• Natural factors
• Financial factors
• Globalization
• Safety and security related factors
	• Competition between registry systems
	• Ship-owners variable expectations
	• Safety standards and related necessities
	• Fleet structure
	• Financial and political stability of flag state
	• Voyage areas, Geographical location of flag state
	• Quality of labor market
	• Dynamism in ship S/P market
	• International regulations
	• Increase in number and strict of port state and flag state control
	• Cultural, historical and linguistic closeness
	• Reputation of classification societies
	• Number and location of flag state branch offices
	• Charterers and other party's requests
	• Promotive and preventive policies
	• Strong historical business relations
	• Dual and parallel registration
	• Bilateral agreements, Level of trade union relations
	• Embargos, Flag state service quality
		• Flag state reputation
		• Financial factors
		  • Capital, Bank finance
		  • Operational costs
		  • Crew costs, Maintenance costs
		  • Insurance costs
		  • Cost of conformity
		  • Cost of registration
		  • Taxes
		• Operational factors
		  • Certification, Auditing
		  • Trade type
		  • Age, size and type of ship
		  • Managerial flexibility
		  • Registry system performance
		  • Port state control scores
		  • Accident statistics
		  • Detention rates
		  • Labor nationality
		• Discounts and privileges due to number and type of ships
		• Armament and defense infrastructure

Source: *[3, 4, 5, 6, 7, 8, 9, 10, 11]*

cost variable is the tax. In application, taxing regimes for shipping industry are classified under two heading, namely [13] Tonnage Tax Regime and Navigation Incentive Regime. The most improtant of these changes is the creation of tax system based on the size of ships [14].

Age of the operated ship is another important factor in terms of flag selection [7]. Type of ship has important effect on flagging decision [10]. Another variable which has importance in terms of flagging decision is the performance of classificiaton society. In the literature, several studies can be found on the criteria which determine flagging decisions. Some of these studies are qualitative and some others are quantitative. Detailed information on these studies is given in Table 3.

As can be understood from the Table 3, the studies used several different methods. Haralambides and Yang [8] used Fuzzy Logic method and tried to display the impact level of determined factor so as to be able to choose the ideal registry systems in terms of flag selection decision of ship-owners. Chung and Hwang [15] used AHP (Analytic Hierarchy Process) method in their study

Table 3. *Literature Related to the Selection of Ship Registry*

Method	Study	Authors	Year
Markov Chain Modeling	Changing Ownership Structures in the Dutch Fleet	Veenstra and Bergantino	2000
FLASCI	Globalization and De-Regulation in the Maritime Industry.	Alderton and Winchester	2002
FUZZY Model	A Fuzzy Set Theory Approach to Flagging Out: Towards a New Chinese Shipping Policy	Haralambides and Yang	2003
AHP-DEA	Analysis on Vessel Registration and Operational Performance of Bulk-Shipping Firms.	Chung and Hwang	2005
AHP	An Analysis of Key Influence Factors for Containership Registration in Taiwan	Chung and Hwang	2007
FEAHP	Application of Fuzzy Extended AHP Methodology on Shipping Registry Selection: The Case of Turkish Maritime Industry	Celik et al.	2009
SWOT-AHP-TOPSIS	A Multi-Methodological Approach for Shipping Registry Selection in Maritime Transportation	Kandakoglu et al.	2009
Qualitative Analysis	The Impact of Choice of Flag on Ship Management	Mitroussi and Marlow	2010
AHP-GRA	An Evaluation of Containership Registrations in Taiwan: Application of the Grey Relation Analysis Model	Lin et al.	2011
FUZZY-AHP	Maritime Policy Development Against Ship Flagging Out Dilemma Using A Fuzzy Quantified SWOT Analysis	Celik and Kandakoglu	2012
Qualitative and Quantitative Analyses	Flagging Decisions of Ship-owners and Impact on Shipping Markets	Toz	2013
GRA-TOPSIS	Containership Flag Selection: The Opening of Direct Shipping Between Taiwan and China	Yang et al.	2014

and measured the level of impact of factors which affect flag selection decision. Celik et al. [16] used Fuzzy Extended AHP method and performed a multi-criteria decision making analysis so as to be able to make the appropriate selection between Turkish, Maltese and Panamanian flags.

Mitroussi and Marlow [17] used a qualitative method in their research and found out that the processes which are most affected by registry selection is strategic management decision making process. Lin et al. [18] evaluated different registry systems and reasons for selection for container ship-owners in Taiwan using AHP and GRA (Grey Relation Analysis) methods.

Celik and Kandakoglu [19] developed a method based on strategy development and evaluation in terms of flag selection decision using Fuzzy AHP approach and SWOT method. Yang et al. [20] used GRA and TOPSIS methods and performed a study for identifying the determinants required for ideal flag selection.

3. Purpose and Scope of the Research

The main purpose of this study is to propose a model which will serve as a reference for flagging decisions of ship-owners and ship operating companies active in Turkey. Sub-purposes determined below the main purpose are determination of the factors that affect flag selection decision based on a literature search, and displaying the relation and association levels of factors obtained from literature search with data mining application and to create a model for flag selection decision by performing ANN application with the

outputs obtained as a result of data mining application. This research covers the ships which constitute Turkish Merchant Fleet and companies which operate these ships.

4. Research Methodology

The mixed research method that comprises qualitative and quantitative techniques is conducted to create the conceptual model. The variables influencing choice of flag are defined by means of a pre-study covering a thorough literature review and the level of significance of determinants has been determined through content analysis in second stage. In the third stage the determinants obtained from content analysis have been tested with Delphi survey. The stages of the study are shown in Figure 1.

Considerable data have been reached with literature review and fleet analysis. In order to determine variables and find the association and relations between variables, Association Rule Analysis (ARA) was employed. In this paper, Apriori algorithm, one of the association rule algorithms, is used. ANN application was performed with the outputs obtained as a result of the application of ARA.

4.1. Content Analysis

In this study initially a qualitative study has been conducted to determine the variables likely to affect flag selection decisions. Within this purpose, content analysis was carried out after literature survey. Totally 132 studies which are related with flagging decision of ship-owners were examined and factors which were obtained from these studies are grouped. Totally 36 determinants were defined as main factors likely to affect flag selection decision of ship-owners. These

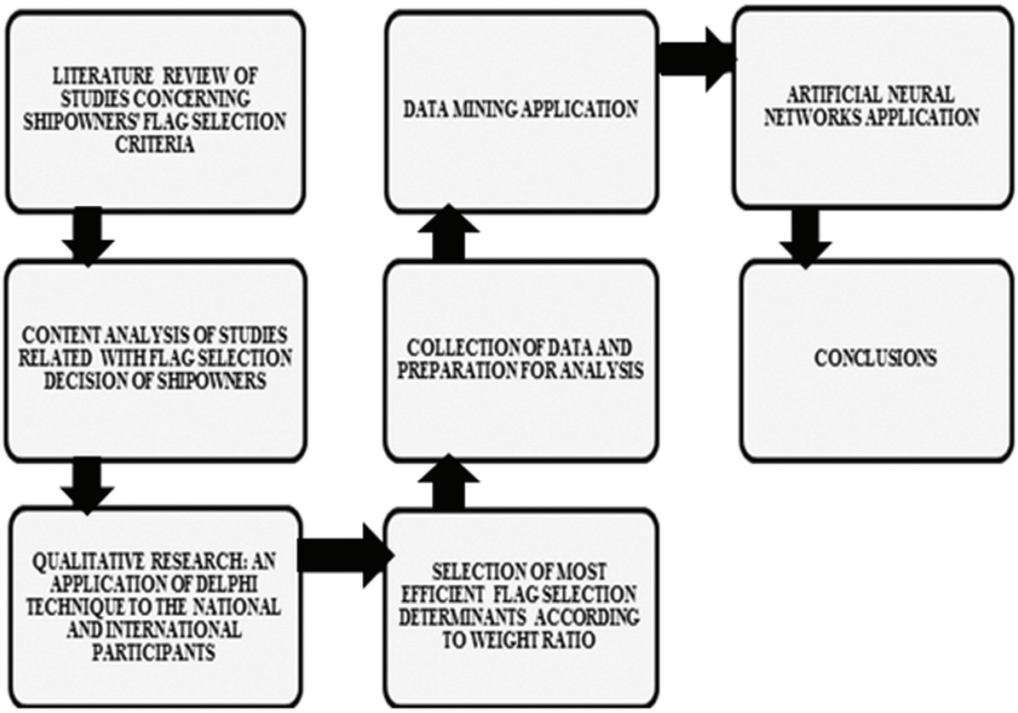

Figure 1. *Stages of Study*

determinants then rearranged regarding to weight ratio. Then these factors were inserted in the statements which would be utilized in Delphi process.

4.2. Qualitative Study: Delphi Process

The Delphi technique, which is the ability to gather opinions from experts from various areas, has been selected to bring about consensus in this study [21].

The experts who work in such areas that are directly and indirectly related with maritime markets were selected for Delphi study. Twenty experts were identified with judgment sampling method and fifteen [16] experts accepted to contribute, sample size has been considered as satisfactory regarding to Clayton's rule that defines 15-30 people are an adequate panel size [22]. Details of experts are shown in Table 4.

A two-round online Delphi study was conducted to explore the views of experts on issues relating to variables that affect flag selection decisions. Totally 60 variables obtained via literature review have been used in 20 statements to identify the variables that affect flag selection. The Delphi questions have also been translated into English language so that they could be conducted through international experts. Every statement has been reviewed by 2 lecturers and 1 expert by means of scope and structure. The main results of Delphi survey are shown in Table 5.

Table 4. *Details of Experts Participating Delphi Study*

Sector	Position	Com. Type	Delphi First Round		Delphi Second Round	
			Type of Contact	Date	Type of Contact	Date
University	Head of Department	E-mail	E-mail	05.09.2013	E-mail	///
Ship Expertise	General Manager	Phone	E-mail	09.07.2013	E-mail	21.09.2013
Shipping and Logistics	Shipping Agency Director	Phone	E-mail	12.07.2013	E-mail	///
Legal Authority	Shipping Expert	Phone	E-mail	09.07.2013	E-mail	12.09.2013
Port	Commerce group manager	Phone	E-mail	16.07.2013	E-mail	///
Pilotage and Towage Company	Assistant General Manager	E-mail	E-mail	09.07.2013	E-mail	12.09.2013
Law Office	Maritime Lawyer	Phone	E-mail	09.07.2013	E-mail	15.09.2013
Insurance and Brokering Company	Marine Insurance Expert	Phone	E-mail	18.07.2013	E-mail	14.09.2013
Civil society organization	Board Member	E-mail	E-mail	26.07.2013	E-mail	///
Shipping Company	General Manager	E-mail	E-mail	29.07.2013	E-mail	///
Shipping Agency	Coordinator	Phone	E-mail	30.07.2013	E-mail	///
Ship Management Company	Assistant Manager	Phone	E-mail	28.07.2013	E-mail	01.10.2013
Ship Management Company	Designated Person Ashore (DPA)	Phone	E-mail	25.07.2013	E-mail	29.09.2013
Ship Registration Company	General Manager	E-mail	E-mail	05.08.2013	E-mail	///
Classification Society	Surveyor	Phone	E-mail	11.07.2013	E-mail	///

Table 5. *Delphi Survey Results*

Results	First Round	Second Round
Majority Agreements	220	51
Majority Disagreements	59	26
Sum up agreements and disagreements	279	77
Total Opinions Expressed	300	91
Cut Off Rate	%93	%85
Number of Statements Over Cut Off Rate	9	5
Total Statements	20	13
Good Degree of Consensus (>90)	9	5
Less than Satisfactory Degree of Consensus (89>x>80)	4	2
Poor Degree of Consensus (79>x>70)	5	-

First round of Delphi study has high cut off rate due to high participation rate and good degree of consensus exists in both rounds. According to the opinions expressed, financial determinants have been determined as the most important variables of flag selection decisions.

Also administrative flexibility and bureaucratic barriers have great importance in flag selection decisions. Short registration process, quick response infrastructure and solution oriented structure are the other factors considered by the participants for flag selection.

4.3. Collection of Data and Preparation for Analysis

In this study, ship owners who operate of their fleet in Turkey were taken into account. Within this scope the fleet information of a total of 63 ship operation companies active in Turkey were reached. In this study the

Table 6. *Variables in Literature and Selected Determinants for the Study*

Micro External Environment and Internal Determinants		

• Competition between registry systems
• Ship-owners variable expectations
• **SHIP BUILDING COUNTRY**
• Safety standards and related necessities
• Fleet structure
• Financial and political stability of flag state
• **VOYAGE AREAS**
• Geographical location of flag state
• Quality of labor market
• Dynamism in ship sale and purchase market
• International regulations
• **PORT STATE CONTROL REGIMES**
• Flag State Control
• Cultural, historical and linguistic closeness
• **REPUTATION OF CLASSIFICATION SOCIETIES**
• Number and location of flag state branch offices
• Charterers and other party's requests
• Promotive and preventive policies
• Strong historical business relations
• Dual and parallel registration
• Bilateral agreements, Level of trade union relations
• Embargos , Flag state service quality
	• Flag state reputation
	• Financial factors
	  • Capital, Bank finance
	  • **OPERATIONAL COSTS**
	  • **CREW COSTS**
	  • Maintenance costs
	  • Insurance Costs
	  • Cost of conformity
	  • Cost of registration
	  • **TAXES**
	• Operational factors
	  • Certification, Auditing
	  • Trade type
	  • **AGE, SIZE AND TYPE OF SHIP**
	  • Managerial flexibility
	  • Registry system performance
	  • Port state control scores
	  • Accident statistics
	  • Detention rates
	  • **LABOR NATIONALITY**
	• Discounts and privileges due to number and type of ships
	• Armament and defense infrastructure
		• **CREW COSTS**
		• **LABOR NATIONALITY**
		• **VOYAGE AREAS**
		• **AGE OF SHIP**
		• **SIZE OF SHIP**
		• **TYPE OF SHIP**
		• **SHIP BUILDING COUNTRY**
		• **REPUTATION OF CLASSIFICATION SOCIETIES**
		• **PORT STATE CONTROL REGIME**
		• **TAXES**

ships larger than 500 GRT which are used for commercial purposes by these companies were included and ships operated for purposes other than commercial ones were excluded. Details of 536 ships which meet these criteria were reached. The details of the ships covered by this study were reached from Equasis database, internet sites of the companies, face-to-face interviews held with ship operators, industry reports and resources of agencies and institutions which provide national and international statistics. Data were collected between 20/04/2015 and 01/06/2015 but changes in the fleet structure within this period were also taken into consideration. Under the light of the obtained data, total carriage capacity was calculated as 19.226.461 DWT, which represents 69.44% of the entire carriage capacity of Turkish Merchant Fleet (27.687.770 DWT) [23]. Information on the ships covered by the study is given in Table 7.

Table 7. *General Profile of Ships*

Voyage Area	**%**	**Crew Nationality**	**%**	**Paris MOU**	**%**	**Shipbuilding Country**	**%**
Worldwide	40,6	Turkey	87,1	White	96,8	S. Korea	15,0
Mediterranean	27,5	India	3,4	Grey	2,1	Philippines	,7
Europe	3,6	Philippines	2,8	Black	1,1	Turkey	38,9
Domestic	2,6	Multi National	6,7	**Tokyo MOU**	**%**	Vietnam	1,1
Far East	5,2	**Ship Type**	**%**	White	58,7	Japanese	17,6
Continent-Baltic	4,5	Bulk	39,4	Grey	39,4	Chinese	13,8
Black Sea	3,4	Product- Chemical	14,2	Black	1,9	Denmark	1,3
Caspian Sea	0,4	Product Tanker	8,8	**USCG**	**%**	Netherland	1,1
Europe - America	0,2	General Cargo	15,9	Not Risky	20,9	Russian	0,4
Caribbean Sea	0,6	LPG	1,5	Risky	79,1	Germany	8,0
Mediterranean-America	0,9	Chemical	4,9	**Class**	**%**	Poland	1,3
Mediterranean-Europe	2,8	Container	12,3	LR	4,1	England	0,2
Mediterranean-Far East	0,2	Ro-Ro	3,0	Russian	0,4	Ukraine	0,2
Mediterranean-Africa	1,1	**P&I**	**%**	AUT	0,4	India	0,4
America	2,2	Skuld	16,4	BV	50,1	**Flag**	**%**
Europe-Africa	2,1	Swedish	8,0	DNV-GL	4,3	Marshall	13,8
Africa	0,4	Steamship	5,4	ABS	17,8	Turkey	38,7
Black Sea -Mediterranean	0,9	Standard	28,8	Turkish	2,6	Malta	32,0
Black Sea -Europe	0,4	London	1,7	NKK	16,4	Panama	6,9
Mediterranean-Baltic	0,6	Lodestar	2,2	Rina	1,1	Cook Island	1,1
Tax	**%**	UK Club	8,6	RM	2,6	Singapore	0,4
Tonnage Tax	37,0	Shipowner M.	1,7	TLV	0,2	Italy	0,9
Shipping Incentive Tax	63,0	British Marine	1,3	**Ship Age**	**%**	Liberia	1,1
Crew Expenses ($)/Month (8-10 person)	**%**	West of England	12,0	0-5	34,4	St. Kitt & Nevis	1,9
Philippines-35.000/40.000	2,6	Gard	10,3	6-10	37,2	Russia	3,0
India-40.000/42.500	3,4	North of England	1,9	11-20	19,6	Portugal	0,2
Multi Nat.-45.000/47.500	6,7			21 and more	8,8		
Turkish-47.500 /and more	87,3						

From the Table 7, it is seen that most of the ships subject to this study are dry cargo vessels, most of them are navigating in all seas and Mediterranean. 38.7% of ship companies preferred Turkish flag whereas the remaining preferred foreign flags. It is observed that most of the ship companies which preferred foreign flag chose Malta and Marshall Island. It is also observed that mostly Turkish personnel were employed at the operated ships and 72% were 10 years old or younger.

4.4. Analysis of Data

The variables obtained as a result of literature search, the data created after analyzing merchant fleet of ship owning and operation companies active in Turkey were coded and processed. In order to determine the relations between as a result of WEKA application, best estimation model was created using variable layer at ANN, number of neurons, and learning algorithms. ANN is preferred in this study as they are used as an effective method in estimations.

4.4.1. Data Mining Application

ARA was performed with the dataset consisting of 13 variables as seen in Table 8. The result and associations are shown in the Table 9 below. In Apriori algorithm minimum support was taken as 10%, and some combinations were tried with support, lift, and confidence values and effort was paid to obtain the best rule and association ratios. The output depending on inputs in Analysis is given in Table 8. As output, association and relation were found between 9 variables.

In Table 8, the variables related to WEKA application analysis results can be seen. Of the 14 variables, no association was found between navigation area of ships, type of ships, size of ships, insurance company of ships and age of ships variables and other variables. In Table 9 the analysis results of relations consisting of sets of 8 and 9 among 14 variables is seen as a result of the Association Rule Analysis. With the analysis performed until reaching the 10% value, which is the minimum support value of Analysis, a set of qualifications of 9 was reached and relation was identified between 9 variables.

Table 8. *WEKA Analyses Process*

Variable	ARA	Output
Voyage Area / Crew Nationality Ship Type / Ship Tonnage Port State Control Regime (ParisMou / TokyoMou/ Uscg) P&I / Classification Society / Age / Shipbuilding Country Flag / Tax / Crew Expense		Crew Nationality ParisMou / TokyoMou Uscg / Classification Society Shipbuilding Country Flag / Tax Crew Expense

Table 9. *Association Rules Large Item Set (8-9)*

No	Large Item Set (8): 17/17	Freq.	Supp.
1	Turkishcrew-Parismou White-Tokyomou Grey-Uscg Risky-BV Class-Turkish Flag-Shipping Incentive Tax-47500 And More (Usd)	95	0,18
2	TurkishCrew-ParisMou White-TokyoMou White-Uscg Risky-BV Class – Malta Flag-Tonnage Tax-47500 and more (usd)	94	0,18
3	Mediterranean-TurkishCrew-ParisMou White-TokyoMou Grey-Uscg Risky-Turkish Flag-Shipping Incentive Tax-47500 and more (Usd)	87	0,16
4	TurkishCrew-ParisMou White-TokyoMou Grey-Uscg Risky-PI Standard-Turkish Flag-Shipping Incentive Tax-47500 and more (Usd)	84	0,16

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Table 9. *Association Rules Large Item Set (8-9) (Cont')*

No	Large Item Set (8): 17/17	Freq.	Supp.
5	TurkishCrew-ParisMou White-TokyoMou Grey-Uscg Risky-Building Turkey-Turkish Flag-Shipping Incentive Tax-47500 and more (Usd)	74	0,14
6	TurkishCrew-Dry Bulk-ParisMou White-TokyoMou Grey-Uscg Risky-Turkish Flag -Shipping Incentive Tax-47500 and more (Usd)	70	0,13
7	Worldwide-TurkishCrew-ParisMou White-TokyoMou White-Uscg Risky-Malta Flag-Tonnage Tax-47500 and more (Usd)	66	0,12
8	TurkishCrew-ParisMou White-TokyoMou White-Uscg Risky-Building Turkey-Malta Flag-Tonnage Tax-47500 and more (Usd)	65	0,12
9	Worldwıde- TurkishCrew-ParisMou White-TokyoMou Grey-Uscg Risky-Turkish Flag -Shipping Incentive Tax-47500 and more (Usd)	63	0,12
10	TurkishCrew-Dry Bulk-ParisMou White-TokyoMou White-Uscg Risky-Malta Flag-Tonnage Tax-47500 and more (Usd)	62	0,12
11	ParisMou White-TokyoMou White-Uscg Risky-BV Class-Building Turkey-Malta Flag-Tonnage Tax-47500 and more (Usd)	62	0,12
12	TurkishCrew-ParisMou White-TokyoMou White-Uscg Risky-BV Class-Building Turkey-Malta Flag-Tonnage Tax	61	0,11
13	TurkishCrew-ParisMou White-TokyoMou White-Uscg Risky-BV Class-Building Turkey-Malta Flag- 47500 and more (Usd)	61	0,11
14	TurkishCrew-ParisMou White-TokyoMou White-Uscg Risky-BV Class-Building Turkey-Tonnage Tax-47500 and more (Usd)	61	0,11
15	TurkishCrew-ParisMou White-TokyoMou White-BV Class-Building Turkey-Malta Flag-Tonnage Tax-47500 and more (Usd)	61	0,11
16	TurkishCrew-ParisMou White-Uscg Risky-BV Class-Building Turkey-Malta Flag-Tonnage Tax-47500 and more (Usd)	61	0,11
17	TurkishCrew-TokyoMou White-Uscg Risky-Bv Class-Building Turkey-Malta Flag-Tonnage Tax-47500 and more (Usd)	61	0,11
No	**Large Item Set (9): 1/1**	**Freq.**	**Supp.**
1	TurkishCrew-ParisMou White-TokyoMou White-Uscg Risky-BV Class-Building Turkey-Malta Flag-Tonnage Tax-47500 and more (Usd)	61	0,11

As a result of the analysis, tax, personnel expenses, building place of the ship are equally effective variables on flag selection. Preferring Turkish personnel is an important factor in flag selection. General examination of Table 9 shows that ParisMou, TokyoMou and USCG criteria evaluation as well as the country where the ship was built are also essential factors in selection. Table 10 shows the best 10 rules obtained with WEKA.

Table 10. *Best 10 Rules*

Best 10 Rules					
No	**Antecedent**	**Freq.**	**Consequent**	**Freq.**	**Accuracy**
1	TurkishCrew-Uscg Not Risky-Shipping Incentive Tax	63	Marshall Flag	58	0,92
2	TurkishCrew-Uscg Not Risky-Shipping Incentive Tax	63	Marshall Flag- 47500 and more (usd)	58	0,92

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Table 10. *Best 10 Rules (Cont')*

Best 10 Rules					
No	**Antecedent**	**Freq.**	**Consequent**	**Freq.**	**Accuracy**
3	Uscg Not Risky-Shipping Incentive Tax-47500 and more (usd)	63	TurkishCrew-Marshall Flag	58	0,92
4	TurkishCrew-Uscg Not Risky-Shipping Incentive Tax	63	Paris MouWhite-Marshall Flag 47500 more (usd)	58	0,92
5	TurkishCrew-ParisMou White-Uscg Not Risky Shipping Incentive Tax	63	Marshall Flag- 47500 and more (usd)	58	0,92
6	Uscg Notrisky -Shipping Incentive Tax-47500 and more usd	63	Turkish Crew-ParisMou White-Marshall Flag	58	0,92
7	TurkishCrew-TokyoMou White-Uscg Not Risky- Shipping Incentive Tax	60	ParisMou White-Marshall Flag-47500 and more (usd)	55	0,92
8	TokyoMou White-Uscg Not Risky -Shipping Incentive Tax-47500 and more (usd)	60	TurkishCrew-ParisMou White-Marshall Flag	55	0,92
9	ParisMou White-TokyoMouWhite-Uscg Not Risky-Shipping Incentive Tax-47500 or more (usd)	60	TurkishCrew-Marshall Flag	55	0,92
10	Marshall Flag- 47500 and more (usd)	66	TurkishCrew-ParisMouWhite-Uscg-Not Risky- Shipping Incentive Tax	58	0,88

4.4.2. Artificial Neural Networks Applications and Results

In this research, the factors that affect flag selection decision of marine companies in Turkey were identified and analyzed with data mining, the results of which were used to perform an ANN application. In Figure 2 this mathematical model is briefly demonstrated [24].

In this study, different combinations were created using single and two layers, different number of neurons and different activation functions. As a result, an effort was paid to reach the best learning and highest accuracy value.

In this research, an ANN model was established with the dataset created using with WEKA association application

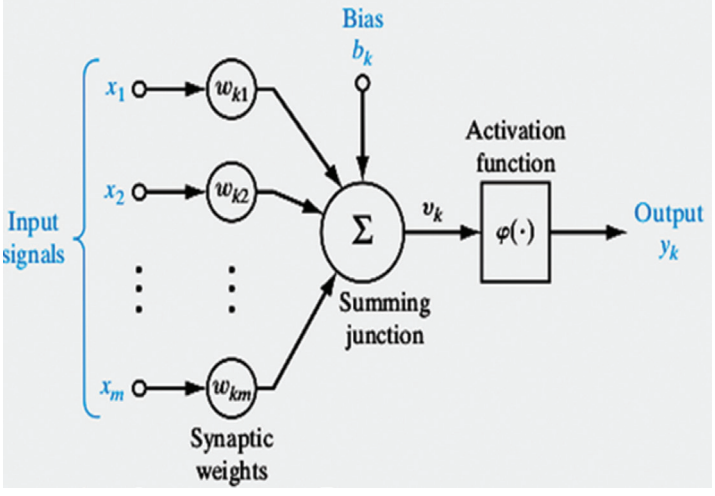

Figure 2. *McCulloch and Pitts Neural Structure* [23]

and findings from flag selection ratios. While creating the model, findings and association ratios obtained as a result of WEKA association rule application were used as input values. The dataset used as input consists of 12 rows and 121 columns. Selection ratios were evaluated as target value. Dataset used as target value consists of 1 row and 121 columns. Input and output variables are given in Table 11.

Table 11. *ANN Input and Output Variables*

Input Variables	ANN	Output
Crew Nationality ParisMou / TokyoMou Uscg / Class / Ship Building Country Flag / Tax / Crew Expense	⇒	Percentage of Flag Choice

The model consists of an input layer, a hidden layer and an outlet layer. In input layer, hidden layer and outlet layer, 12, 12 and 1 neurons are found respectively. Training of the ANN model was realized with Matlab R2015a computer package programme. In order to reach the best results, various numbers of layers and neurons were tried and various numbers of activation and training functions were tested. The functions used and numbers are shown in Table 12.

Table 12. *ANN Model Trials*

Network Type	Feed-Forward Backpropagation
Training Function	Trainml, Levenberg-Marquardt
Learning Function	Learngdm
Performance Function	MSE
Number of Hidden Layer	1-10
Number of Neuron	1-20
Training-Verification-Test - Data Percentage	%90 - %5 - %5 %80 - %10 - %10 %70 - %15 - %15 %60 - %20 - %20
Activation Function	Tansig, Logsig

In the study, a multi-layer feed forward back-propagated ANN was used. For training of the network, different activation functions, neuron numbers, hidden layer and iteration numbers were changed and its performance was measured. In the designed ANN, Levenberg & Marquardt algorithm was used as learning algorithm as it creates parameter updating operations for all inlet sample values and its speed compared to other algorithms. In Figure 3 ANN model created as a result of trials can be seen.

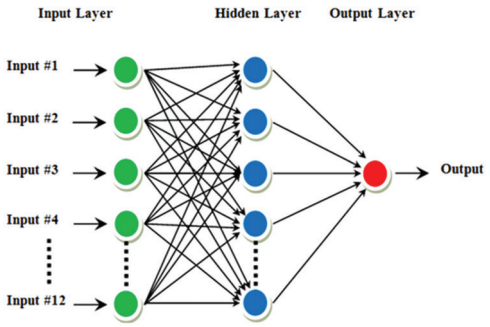

Figure 3. *The Mathematical Model of ANN*

In the research, it can be seen that regression value is 0.91, which is close to 1. In order to test the estimation accuracy and success of applied methods, Mean Square Error statistics were used. This means that as estimation error becomes smaller, the accuracy degree of the model increases [25]. Results of the study and MSE values are seen in Table 13.

Flag selection ratio values entered for training, verification and test data and the values calculated using ANN are compared in Figure 4.

Table 13. *ANN Results*

Results	Regression	MSE	Data Set
Training	0.910678e-1	2.63450e-3	97
Verification	0.943884e-1	1.88043e-3	12
Test	0.918552e-1	4.08912e-3	12

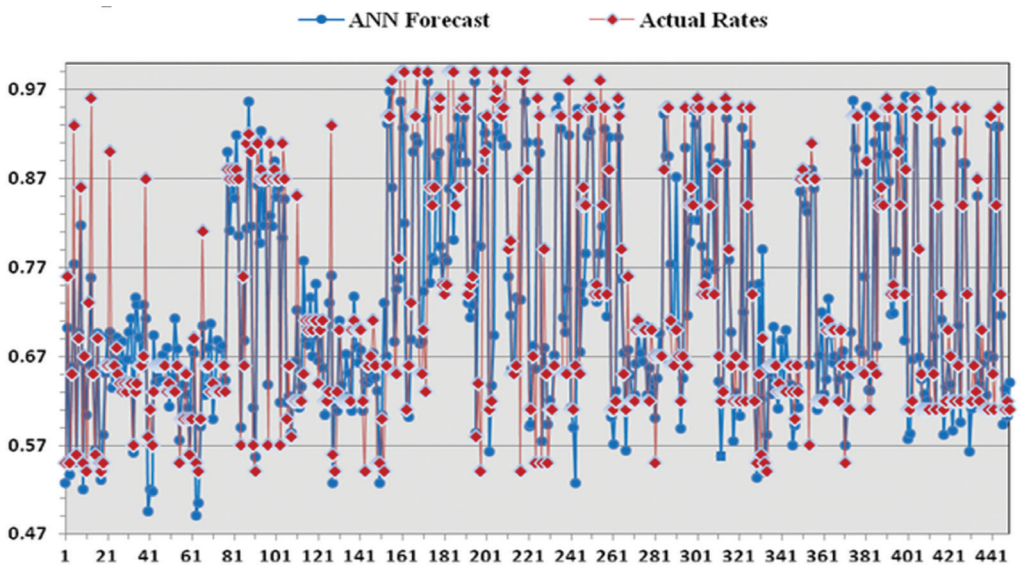

Figure 4. *Comparison of ANN Forecast and Actual Rates*

It has been seen that there were several factors which affected the accuracy of the study, namely input parameters, number of intermediate layers, number of neurons at intermediate layers and iteration number. As a result, the values of these factors were determined so that the most appropriate solution for this application could be obtained and presented in the study. As a result of the obtained findings, it turned out that artificial neural networks provided values which are close to real results.

5. Conclusion and Discussion

In this study several algorithms were examined within extraction of association rules and ANN. Performance measurements can be done by operating these algorithms with different working conditions and methods on different data structures. ARA can be extracted with more data and results can be compared with different techniques. As a result of Association Rule Analysis, tax, personnel expenses, building place of ship are seen as equally effective variables on flag selection. Preferring Turkish personnel is an important factor in flag selection in addition; it is also observed that ParisMou, TokyoMou and USCG evaluation criteria and classification of the ship and the country where the ship was built are also important factors in flag selection.

While ANN model is being established, the variables found as a result of Association Rule Analysis were used as input variables and flag selection ratios created by combination of these associations were used as output variables. The model was tried with various layer, neuron number, and activation and learning algorithms and tested after training and a model with high accuracy rate was created. It is found out that the designed artificial neural networks model provided close-to-real values.

In the research, optimization techniques were used and a model was designed so that factors which affect flag selection decisions of shipping companies in Turkey could be identified and relations between these factors could be determined so that prospective decisions could be made. This study shows that using ANN flag selection can be estimated, and implementers and decision-making managers can use optimization techniques in their prospective planning efforts in addition

to the conventional decision making techniques.

As a result of the findings, it is clear that ANN technique provides close-to-real values. There is no rule developed for determining appropriate network structure of ANN, creating a network structure suitable for the specific problem and determining the parameter value of the network. Suitable network structure can be determined with experience and trial-error method. Although there is no certain standard for determining these values, a different approach can be used for each problem. This is one of the limitations of the research.

It would be beneficial in future studies to reach more abundant and detailed data and add new data inputs and variables to the used methods and techniques to examined different aspects. Future studies can make comparisons using different techniques. Studies on decision-making processes can be performed with additional variables and different techniques.

Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

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