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Developing an Intelligent Decision Support System for Shipyard Region Selection

A Thesis submitted to the Department of Computer Science, Faculty of Computer and Information Science, Ain Shams University, in partial fulfillment of the requirements for the degree of phd of Computer and Information Sciences.

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To my parents

To my wife

To my son

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Publications

1. M.R.Awad, I.A.Ismail, T.M.Nazmy. Multi-criteria evaluation based on Fuzzy AHP and TOPSIS (Case study: Transportation Modes in Cairo) .Fifth International Conference on Intelligent Computing and Information System .ICICI 2011 Faculty of Computer and Information Science Ain Shams University (2011).

2. M.R.Awad, I.A.Ismail, T.M.Nazmy. A Consensus Model For Choosing The Best Bulk carrier Regional Shipbuilding .Global Engineering, Science and Technology Conference ,Dubai, UAE.1-2 April, (2013).

3. T.M.Nazmy, M.R.Awad, I.A.Ismail. "Bulk Carrier Market Prediction using Artificial Neural Network", Al-Zaytoonah University of Jordan. Faculty of Science and Information Technology ICIT conference (2013).

4. M.R.Awad, I.A.Ismail, T.M.Nazmy." Integrating Approach For Multi-Criteria Decision Making (Case Study: Ranking For Bulk Carrier Shipbuilding Region)" International Journal of Scientific & Technology Research Volume 2, ISSUE 10, ISSN 2277-8616 ,October (2013).

5. M.R.Awad, I.A.Ismail, T.M.Nazmy." A Consensus Model for Choosing the Best Bulk carrier Regional Shipbuilding". International Journal of Scientific & Technology Research. IJSTR, April (2014).

Abstract

Investing in Bulk Carrier market constitutes risky investment due to the volatility of the Bulk Carrier orderbook. Ship owners invariably take several quotations before making an order for building new ship. Shipyard process has indeed swung upwards or downwards depending upon the number of shipyards competing for a given volume of orders, and the shipyard region.

The decision makers for strategic purchasing in navigation company greatly require a fair tool to assist them in determining the best time to build a new ship, and appropriate region forthwith, which belongs by the prosperity of the problem to Multi Criteria Decision Making problem, which were discussed and developed by many different researches because it is one of the significant keys in reducing cost.

In this study, a Multi-layer Perceptron Neural Networks (MLP) was implemented to forecast Bulk Carrier shipyard market to determine the best time to make an order for building a new Bulk Carrier ship. In addition, a decision support system model was developed for select best shipyard region which combined fuzzy set theory and group decision with the methodology known as Analytical Hierarchy Process (AHP) that deals with multi-criteria decision making (MCDM) to decrease the influence of decision maker's subjective preferences and control the uncertain and imprecise variations during evaluation process. The Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) was applied to the final rank of alternatives.

Linguistic variables with triangular fuzzy numbers are used to develop the decision makers risk attitudes in order to define a more complete Fuzzy Analytical Hierarchy Process technique.

Another methodology was used for the same object called Consensus Group Decision Making (CGDM), with interval Fuzzy preference relation, finally a comparison of the two methodologies results was illustrated.

In the domain of multi-criteria supplier selection problem, a lot of criteria have been discussed. These criteria fall into two kinds: tangible criteria (quantitative variables) such that “number of enterprise in each region”, and intangible criteria (qualitative variables) such that “specialization”.

The data were collected from "Clarksons Research Studies" (CRS) for quantitative variable which provides a statistical and research service to Clarkson brokers, their clients and the shipping world in general. Four decisions makers in marine strategic purchasing were invited and asked to give the intangible criteria: two senior persons from the commercial department in National Navigation Company, one representative from maritime training institutions, and one representative from Misr maritime transportation company.

The developed model was applied to predict the Bulk Carrier order book for year 2012, 2013, and a comparison was made between the prediction and real data for Bulk Carrier order book for the same year. The correlation was (0.8039) and (0.9039), which means that both of the predictions and the real data follow the same direction together. The model was applied to predict Bulk Carrier order book for year 2014.

A rank for suitable shipyard region to build a new Bulk Carrier ship depending on the selected criteria based on experts working in this field was determined using FAHP methodology and TOPSIS. The model output for shipyard region rank was: 1.China, 2.Europe, 3.Japan and 4.South Korea. Also, Consensus Group Decision Making methodology gave the same result.

The model has some advantages compared to other similar models. For example, this model supports the decision makers to determine not only the best time to purchase the Bulk Carrier ship with minimum error than other best model error by (8.3%) but also the suitable region to purchase from, taking into consideration the qualitative variables. The degrees of risk index are also joined, so that decision makers can adjust them to match real context.

Finally, this work assists the decision makers in navigation companies making correct and accurate decisions in a simple way in a short time even if there is a big gap between them.

Table of Contents

List of Figures

List of Tables

Abbreviations

AHP: Analytical Hierarchy Process

ANN: Artificial Neural Network

BP: Back Propagation

CGT: Capital Gain Tax

CGT: Compensated Gross Tonnage

CIM: Character Institute of Marketing

CRS: Clarksons Research Studies

DBMS: Data Base Management System

DEA: Data Development Analysis

DGMS: Dialog Generation and Management System

DSS: Decision Support System

DWT: Dead Weight Tonnage

FAHP: Fuzzy Analytical Hierarchy Process

FL: Fuzzy Logic

FPS: Fuzzy probability Simulation

GA: Genetic Algorithm.

GT: Gross Tonnage

IDSS: Intelligent Decision support system

MCDM: Multi Criteria Decision Making

MEDM: Multi Expert Decision Making

MLP: Multi Layer Perceptron

MODM: Multi Objective Decision Making

MP: Mathematical Programming

MSE: Mean Square Error

NMSE: Normalize Mean Square Error

QFD: Quality Function Deployment

SCM: Supply Chain Management

SDT: Standard Displacement Tons

TOPSIS: Technique for Order Preference by Similarity to Ideal Solution

VLCC: Very Large Crude Carrier

VMP: Vector Maximum Problem

Chapter 1

Introduction