|  |  |  |
| --- | --- | --- |
|  | **MARMARA UNIVERSITY**  **INSTITUTE FOR GRADUATE STUDIES IN PURE AND APPLIED SCIENCES** |  |

**A MODEL FOR THE FACILITY LOCATION PROBLEM IN DISASTER EVACUATION MANAGEMENT AND AN APPLICATION FOR KADIKOY DISTRICT OF ISTANBUL**

ŞAKİR BİNGÖL

**MASTER THESIS**

Department of Industrial Engineering

**Thesis Supervisor**

Assoc. Prof.Dr. Gülfem Tuzkaya

ISTANBUL, 2015

**PREFACE/ ACKNOWLEDGMENT**

**TABLE OF CONTENTS**

ABSTRACT ……………………………………………………………………… iii

SYMBOLS ……………………………………………………………………….. iv

ABREVIATIONS ……………………………………………………………….... v

LIST OF FIGURES ………………………………………………………………. vi

LIST OF TABLES ……………………………………………………………….. vii

INTRODUCTION ………………………………………………………………… 1

LITERATURE REVIEW …………………………………………………………. 6

EVACUATION MANAGEMENT ……………………………………………… 14

FACILITY LOCATION AND ALLOCATION …………………………………. 20

MODEL FORMULATION ………………………………………………………. 27

AN APPLICATION FOR KADIKOY, ISTANBUL …………………………….. 36

CONCLUSION ...…………………………………………………………………. 60

REFERENCES ……………………………………………………………………. 61

**ABSTRACT**

**A MODEL FOR THE FACILITY LOCATION PROBLEM IN DISASTER EVACUATION MANAGEMENT AND AN APPLICATION FOR KADIKOY DISTRICT OF ISTANBUL**

Disasters are grim realities in humanity which result in serious damage on both ecological environment and population. Most of disasters occurs naturally and impress big impacts on human both personal and social life. Beside biological ones, there are many geophysical catastrophes that happen frequently worldwide. The commonly occurred calamities around the world are; earthquake, volcano, flood, landslide, storm, hurricane, cyclone etc. Unfortunately, there are also man-made disasters like terrorist attacks, nuclear wars that cause permanent damage on societies and nations. These disasters result in dead of thousands of people and badly effects millions of others. Concurrently, damage the global economy in big scale as billions of dollars.

Since both natural and man-made disasters results in big damage in human life and economy, it becomes a big challenge for mankind to mitigate their harmful effects. The unavoidable fact here is, for the great majority of disaster, the uncertainty about disaster occurrence time, its impact area, and its intensity. Since it is impossible to prevent occurrence of hazards almost in all cases, the best thing to do is to be ready for them in order to mitigate their damage. Therefore, pre-disaster operations become crucial as preparedness phase. The pre-disaster operations include, relief pre-positioning, planning and organizing an efficient coordination between governmental and non-governmental stakeholders, construction and selection of emergency facilities. There are some disasters which a forecasting can be made about theirs happening time and impact area. Tsunami, hurricane, typhoon are examples for this kind of disasters. For these disasters, evacuation operation started and carried out as pre-disaster operation.

In business life, facility location and allocation is one of critical link in supply chain (SC), for companies and organization. Constructing or selecting facilities in feasible places, decrease the service time and transportation time of products which result in customer satisfaction. On the other hand, also decrease the total transportation cost of goods and services. That truth is valid in the case of emergency logistic and evacuation facility location. The selection of most feasible location among several potential alternatives and allocation of demand points, which are disaster areas in disaster case, to most suitable facility, will decrease the evacuation time and total transportation cost of evacuees and relief.

In this study, a facility location and allocation solution is examined for evacuation operation in the case the possible earthquake in Istanbul City. A mixed integer linear programming model with deterministic approach is proposed as problem solution. An application for Kadıköy district is implemented as case application.

**SYMBOLS**

**ABBREVIATIONS**

**DA :** Disaster Area

**AA :** Assembly Area

**HC** **:** Health Centre

**SH :** Shelter

**DCC** **:** Disaster Coordination Centre

**SC :** Supply Chain

**LIST OF FIGURES**

**Figure 1.1. :** Natural disaster classification

**Figure 1.2. :** Trends in occurrence and victims

**Figure 2.1. :** The flow illustration of pre-disaster and post-disaster operations and related facilities

**Figure 3.1. :** An illustration of evacuation operation network

**Figure 3.2. :** General pattern of arrivals at a shelter location

**Figure 4.1. :** Locations of customers and facilities

**Figure 4.2. :** A generic supply chain network

**Figure 4.3.:** Generic location–allocation framework for addressing uncertainty

**Figure 5.1. :** Network model for evacuation facility location

**Figure 6.1. :** Kadıköy district detailed disaster layout plan

**Figure 6.2. :** The screen shot of Lingo output including general results data

**Figure 6.3. :** A sample of evacuees flow between disaster areas and facility network

**Figure 6.4. :** The changes in number of opened shelters in different scenarios with

different evacuees’ number

**Figure 6.5. :** The changes in number of opened shelters in different scenarios with

different evacuees’ number

**LIST OF TABLES**

**Table 1.1. :** Disaster subgroup definition and classification

**Table 1.2. :** The largest world disasters 2000-2011

**Table 2.1:** Report published by SCOPUS about surveys on facility location and allocation

**Table 2.2. :** A classification of literature by their methodologies

**Table 2.3.:** The academic surveys on humanitarian aid distribution and victims’ transportation

**Table 3.1. :** The criteria set used in shelters evaluation process

**Table 4.1. :** Factors commonly taken into consideration for facility site selection

**Table 5.1. :** Nomenclature

**Table 6.1. :** The list of disaster areas in Kadıköy with population data

**Table 6.2. :** The list of schools selected to be used as shelters

**Table 6.3. :** The list of places selected to be used as meeting areas

**Table 6.4. :** The hospitals and health centres in Kadıköy district

**Table 6.5. :** The distances between disaster areas and assembly areas

**Table 6.6. :** The distances between disaster areas and shelters

**Table 6.7. :** The distances between disaster areas and health centres

**Table 6.8. :** The distances between assembly areas and shelters

**Table 6.9. :** The distances between assembly areas and health centres

**Table 6.10. :** The distances between shelters and health centres

**Table 6.11. :** The parameters values of model to reach global optimal solution

**Table 6.12. :** The allocation values of assembly areas to disaster areas and number of

evacuees transported from disaster areas to assembly areas

**Table 6.13. :** The allocation values of shelters to disaster areas and number of evacuees

transported from disaster areas to shelters

**Table 6.14. :** The allocation values of health centres to disaster areas and number of evacuees

transported from disaster areas to health centres

**Table 6.15. :** The allocation values of shelters to assembly areas and number of evacuees

transported from assembly areas to shelters

**Table 6.16. :** The allocation values of health centres to assembly areas and number of evacuees

transported from assembly areas to health centres

**Table 6.17. :** The allocation values of health centres to shelters and number of evacuees

transported from shelters to health centres

**Table 6.18. :** The number of opened shelters and total evacuation cost in different tries

with different number of evacuees

**Table 6.19. :** Effects of changes in maximum acceptable distances to model feasibility