Chapter 39

A Tool for GIS Based Risk Analysis for Transportation of Dangerous Goods on Road (the RAGISADR):
A Case Study for Fuel Products

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ABSTRACT

In this study, an environmental risk analysis model is developed as a decision support system (the RAGISADR) in order to assess environmental risks for transportation of dangerous goods. Transport of dangerous goods needs to be regulated to prevent accidents. Moving dangerous goods by road is governed by international regulations. GIS are used to quantify the factors on each link in the network that contribute to each of the evaluation criteria for a possible route. The Analytic Hierarchy Process (AHP) is used to assign weights to factors. The priority weights of each environmental criteria is calculated by using Analytical Hierarchy Process (AHP) before risk models are implemented in the road network of Izmir-Manisa-Aydın-Mugla-Denizli (Aegean Region of Turkey). The most convenient route according to the criteria set is determined. The results give decision maker the possibility to choose the best alternative among possible routes according to certain criteria.

INTRODUCTION

In most of the cases dangerous goods have to be transported from a point of origin to one or more destinations points. The dangerous goods are then transported from a production facility to storage, distribution, or another facility where the dangerous good is required. For example, many oil products are refined at the refinery and then shipped to storage tanks at different locations within a country. Dangerous goods transport risk is anything that product the probability of undesir-

able event during dangerous goods transportation on road network and the consequence of that event. Due to the nature of dangerous goods every production, storage, and transportation activity related to the use of these materials inherits many risks for both society and environment.

In this case, the problem is the definition of the desired criteria between two points regarding the most appropriate route selection process. Dangerous goods transportation generally involves multiple stakeholders such as shippers, carriers, and governments; each having its own priority and perspective, and each playing a role in the safe movement of the dangerous goods from origins to destinations over a transportation network. Therefore, dangerous goods transportation is a typical multistakeholder and multiobjective problem which is generally complicated to solve. Given the multiobjective nature of the dangerous goods transportation, it is usually impossible to identify a single optimal route that can optimize every single objective. In most cases, risk and safety interests conflict with economic interests, rendering the decision making process a complex task. Decision support systems such as routing and risk analysis models are used in management of dangerous goods transport operetions, which allow decision makers determine the best route for the transport of dangerous goods.

The transportation of hazmats can be classified according to the mode of transport, namely: road, rail, water, air, and pipeline. Approximately 450 million tons of hazardous materials are transported annually in the world. Historical evidence has shown that over 63 percent of dangerous goods shipments are moved by road (Alisan, 2009). In the United States, according to a report published in 2010 by the carrying amount of dangerous goods transportation mode portion of the 53% is transported by road (USDOT & USDOC, 2010). Also, annually 750,000 tonnes of hazardous materials are transported by approximately 15,000 on-road vehicles in Turkey (Alisan, 2009).

When dangerous goods are transported by road, an accident could cause considerable harm to people and the environment. Spillage of the goods could lead to fires, explosions and chemical poisoning or burning. In order to minimize any risk related to the use of dangerous goods, safety standards and codes are often implemented to regulate the proper use of dangerous goods. The purpose of these regulations and codes is to minimize the risk attached to the use of dangerous goods. There is an international agreement, published by United Nations Economic Commission for Europe, called ADR-European Agreement, concerning the International Carriage of Dangerous Goods by Road. The purpose of ADR is to ensure that dangerous goods being carried by road can cross international borders freely, as long as goods, vehicles and drivers comply with its provisions (UN, 2013).

ADR sets out the requirements for classifying, packaging, labelling and certifying dangerous goods. These requirements are set out in Annex A to ADR. Vehicles carrying dangerous goods must comply with the provisions of Annex B to ADR, which includes vehicle and tank specifications and other operational requirements.

Classification of dangerous goods is divided into nine classes based on their predominant hazard. The classes of dangerous goods according to ADR are the following (UN, 2013):

Class 1, Explosives are solid or liquid substances (or mixtures of substances) capable by chemical reaction of producing gases at such a temperature and pressure and at such a speed as to cause damage to the surroundings.

Class 2, Gases covers pure gases, mixtures of gases, mixtures of one or more gases with one or more other substances and articles containing such substances.

Class 3, Flammable liquids covers substances and articles containing have at 50 °C a vapour pressure of not more than 300 kPa (3 bar) and are not completely gaseous at 20 °C and at standard

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