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Study on Route Selection for Hazardous Chemicals Transportation

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Abstract

With the rapid development of the national economy, transportation of hazardous chemicals has aroused widespread concern of different fields including government, industry and academia, due to its huge demand, high frequency of accident and huge losses. The study on optimal route selection is a quite important issue for the safety of hazardous chemicals transportation. In this paper, we firstly analyzed the comprehensive factors influential in road security, such as environment, population density, emergency response time and so on. Start from the index system consists of "comprehensive factors influential in road security", "safety management level of enterprises" and "transport of hazardous materials", we defined the risk levels of goods. Meanwhile the weights of influence factor were also obtained by using analytic hierarchy process methods. Then the weighted route length were calculated by normalizing the parameters of each secondary effects. Ultimately, we successfully found out the optimal route by using Dijkstra's algorithm. This work provided a theory basis for the effective and practical use of routing model.

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Keywords: hazardous chemicals transportation, optimal route, weight, risk evaluation

1. Introduction

Hazardous goods(or materials) are solids, liquids, or gases that easy to cause personal casualty and property damage and therefore need special protection during the process of transport, handling and storage, including materials that are explosive, flammable, biohazardous, corrosive or radioactive. Since the special hazards of these materials, the water resources will surely be polluted once the leakage occurs during transport or handling. The pollution treatment are quite difficult and people's normal life and production activity will be influenced, which is extreme easy to create panic among the resident nearby.

According to the statistics of relevant departments, the transport of hazardous goods has exceeded 4 billion tons annually. Though the total number of its transport accidents is lower than other ones, once an accident happens, it will bring huge loss to the population health and public property along the route. For example, in a liquid chlorine leakage accident which happened on the highway of Huai'an part in the evening of 3, 29th 2005, 9 people died and more than 500 people required hospital treatment. Moreover, the normal lives of over 10,000 residents nearby were also disturbed. Therefore, how to choose an optimal route to meet the transportation demand of hazardous goods without accidents is worthy of further studies.

In this paper, optimal route selection for hazardous chemicals transportation was studied. From the microscopic view point, such research is helpful for the reduction of the cost and risk of transportation of enterprises, and therefore the transportation efficiency can be improved. While in macro view the government macro-control ability will be strengthened by controlling the transportation risk effectively. More importantly, people's life property safety can be ensured due to the reduction of accidents.

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2. Case and Assumptions

A hazardous goods transportation company now need to transport a number of hazardous chemicals, and the starting point of national road 601 and destination of national road 109 were marked on the route map as shown in Fig. 1. This paper assumes that the company had equipped vehicle traveling data recorder and GPS for all the trunks in order to strengthen the safety management. Moreover, additional measures like personnel's supervision and 24-hour monitoring were also taken to master and adjust the running status immediately and deal with emergency. Thus dynamic safety monitoring can be realized.

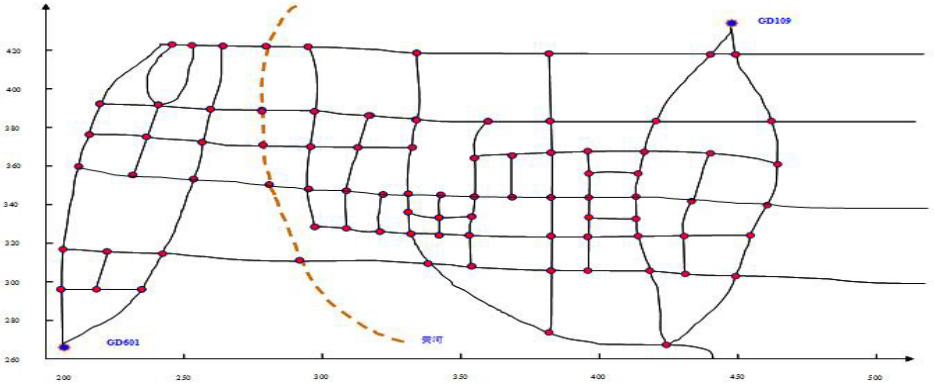

Fig. 1. Route map of transportation.

According to the "Standard System for the Identification of the Hazards of Materials for Emergency Response" formulated by the U.S.-based National Fire Protection Association [1], the assessment of level of hazard consists of following four parts: N_H: health hazard, N_F: flammability, N_R: reactivity and N_S: special hazards. Each index is rated on a scale from 0 (no hazard) to 4 (severe risk). By querying the dangerous goods emergency system identification standard treatment, the value of N_H, N_F, N_R and N_S is 2, 3, 0 and 1, respectively. All the node coordinate along the route from the start point(set as point A) to the destination(set as point B) were obtained by using Matlab and the length of road section were also calculated, which can be seen from Fig. 2.

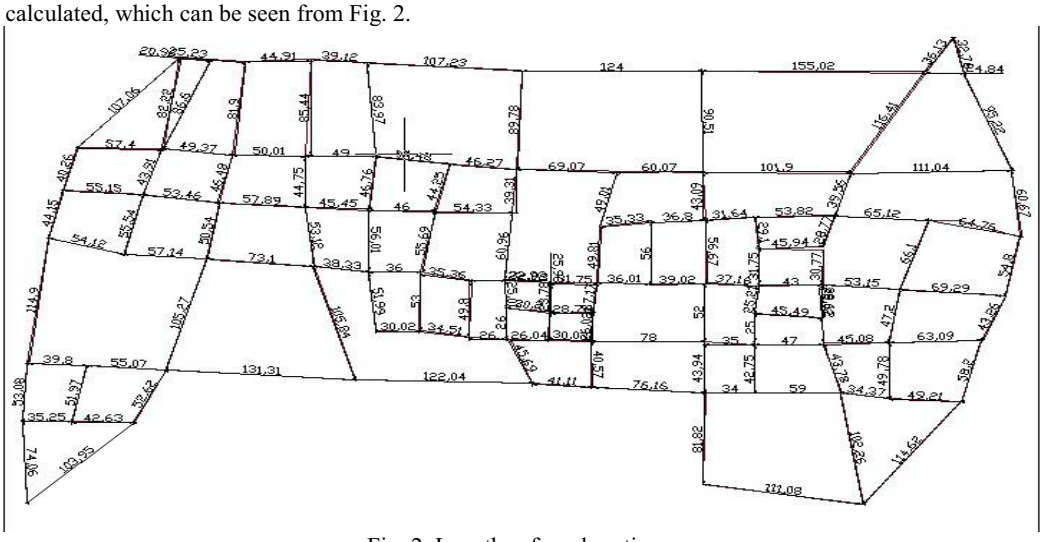

Fig. 2. Lengths of road sections.

2.1. Assessment of Hazards Level

The weighted risk level of goods can be calculated as follows:

$$N = \frac{(N_H{}^2 + N_F{}^2 + N_R{}^2 + N_S{}^2)}{(N_H + N_F + N_R + N_S)} = \frac{(2^2 + 3^2 + 0^2 + 1^2)}{(2 + 3 + 0 + 1)} = 2.33 \quad (1)$$