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ScienceDirect

Energy Procedia 113 (2017) 82 – 89

Energy Procedia

International Scientific Conference "Environmental and Climate Technologies", CONECT 2016, 12–14 October 2016, Riga, Latvia

Reduction of energy costs and traffic flow rate in urban logistics process

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Abstract

Energy cost is a phenomenon relating to logistics and transportation activities of logistics operators, as well as governments, local authorities and citizens. Actually, all the logistics parties may be affected by energy costs. At the same time, logistics and transportation flow rate is declining continuously. Increases in traffic volume and decreased logistics flow rate cause to decrease in logistics productivity and efficiency in a city. On the other hand, changes in these factors cause to increase energy cost. Minimum energy consumption plays an important role for efficient and productive urban logistics operations. Increasing traffic volume and congestion may absorb the energy of cities, in addition to that, it causes to increase energy requirements of urban areas. According to scientific research, a significant correlation can be seen between traffic volume, congestion, energy cost and using the urban economic resources. This study focus on relations between these factors and it tried to show that, ways for reduction of energy cost on optimum traffic volume and traffic flow rate. In addition to that, the findings of this study depend on fieldwork related to Istanbul city.

Peer-review under responsibility of the scientific committee of the International Scientific Conference "Environmental and Climate Technologies".

Keywords: energy costs; traffic flow rate; congestion; marginal costs

1. Introduction

The traffic flow rate is one of the factors affecting the energy costs of transportation activities. There is a significant correlation between the traffic flow rate and energy costs of transportation, traffic volumes in urban areas can influence

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1876-6102
Peer-review under responsibility of the scientific committee of the International Scientific Conference "Environmental and Climate Technologies".
doi:10.1016/j.egypro.2017.04.023

the energy costs of transportation directly or indirectly. From this perspective, traffic flow rate can be evaluated as a variable for energy costs. On the other hand, since the traffic flow may easily change, it is difficult to measure its impact. This paper focuses on the effects of the changes in traffic flow in marginal energy costs of transportation and logistics activities as well as impacts of traffic volume on total energy costs. In this paper it is argued that, if the traffic flow rate decreases to a certain level, unit energy costs of transportation can become unbearable. Accordingly, decreases in traffic flow may cause a negative effect on the energy cost and it may lead to an increase in marginal energy cost. Traffic flow rate and volume on a specific route may vary depending on a number of factors and variables. These variables can be listed as follows: the number of vehicles on the route, the number of intersections, the peak hours of the route, the number of residential and social areas around the highway, types and characteristics of vehicles in traffic, driver behaviors. These factors may be affected by the traffic volume together or individually. The traffic flow rate can be decisive in the formation of total costs of logistics and transportation. Additionally, its impacts on energy costs may be measured at the micro level. According to various traditional assumptions, when traffic slows down, energy consumption of each vehicle increases. Although this proposition is true, it does not allow an analysis at the macro level. A different set of data is necessary for an analysis in a broader perspective. As a result, some variables such as total energy consumption obtained from official sources, the number of vehicles on the route, the gradual flow of traffic, times of day when the route is used as well as the distances may be beneficial for this analysis. This research is based on the field studies which related to the Istanbul city. On the other hand, observation and analysis are within the scope of this research.

2. Literature

There are many studies about transportation and traffic management focusing on energy consumption. These studies, trying to establish a link between performance and efficiency of logistics operations and energy consumption, focus on energy consumption at the micro level. The increase in the energy consumption in each vehicle leads to negative effects on the efficiency and productivity of logistics and transportation operations. The majority of these studies argue that, if energy consumption is reduced, performance and efficiency of transportation operations might be increased. At the same time, the decrease in energy consumption would lead to economic benefits. However, the common assumption of these studies is reducing the energy consumption for more efficient logistics operations.

The majority of these studies focus on unit energy consumption, emissions, and other external costs of transportation. According to Mraihi, Abdallah ve Abid [1] the unplanned urbanization and rapid increase in population have caused economic and environmental problems. As a result, energy consumption is increasing rapidly in urban areas. Therefore, unit consumption per vehicle, population, urbanization and traffic density are interrelated concepts. Wang et al. [2] drew attention to the relationship between energy consumption and increases in production volume. They argued that significant and positive correlation can be observed between energy and production activities. Increases in production volume lead to increase in transportation needs. Because of the increasing transportation needs, energy consumption and cost may be increased. According to Manzone and Balsari [3], energy consumption may vary depending on vehicle types and specifications. Hao et al. [4] tried to establish a link between energy consumption and transportation modes such as road, maritime, railway. According to them, each transportation mode has different energy consumption and emissions levels. If choosing transportation modes that have lower emission and energy consumption, energy costs of transportation may be reduced. According to Huzayyin and Salem [5], increases in energy demands and consumption are linked to rapid urbanization. Marique and Reiter [6] associated vehicles types and energy costs. Unit energy consumption per vehicle type as a variable is taken into consideration in their study. Görçün [7] has compared the energy consumption and emission of fossil fuel vehicles and electric vehicles. He argued that, if electric vehicles used for passenger transportation such as subways and trams can be used for freight transportation, energy costs may be reduced in urban areas. Hosseinlou et al. [8] tried to determine an optimal speed limit in traffic networks. Their study argues that determining the speed limit of road transport systems has a significant role in the speed management of vehicles. In most cases, setting a speed limit is considered as a trade-off between reducing travel time on the one hand and reducing road accidents on the other, while the two factors of vehicle fuel consumption and emission rate of air pollutants have been neglected. Yanli et al. [9] drew attention to energy demand of road transportation. They argued that since energy demand is restricted by many factors, which have complex relationships with each other, it is difficult to apply causality model or structure proportion to forecast the energy demand. Even though it is, the forecast result is not accurate due to the uncertainty of some factors in