TRAFFIC SIMULATION MODELING TO INVESTIGATE THE IMPACT OF ON-STREET MICROBUS-STOPS ON TRAFFIC FLOW

By

Elhashemi Mohammed Elsayed Ahmed Ali

A Thesis Submitted to the
Faculty of Engineering at Cairo University
in Partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENCE
in
CIVIL ENGINEERING - PUBLIC WORKS

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT
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Under the Supervision of

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Key Words:
Macroscopic Model, Traffic Simulation, Microbus-Stops, Dwell time, Microbus Headway, Traffic Delay

Summary:
The main objective of the study was to investigate the effect of Microbus-stops on traffic parameters and traffic operation by re-developing a macroscopic stochastic simulation model. Also, the study used to estimate the reduction in traffic speeds, change in traffic density and to calculate the average traffic delay due to the microbus stops. A macroscopic traffic simulation model is created using MATLAB programming language to investigate the impact of on street microbus informal stops on the traffic stream parameters; traffic speed, traffic density and average traffic delay. The model was utilized to study the effect of number of blocked lanes, microbus headway, microbus dwell time, separating distance between microbus stops at different levels of volume to capacity ratios.

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Abstract

Microbuses in Greater Cairo have almost become one of the largely public transit systems in the city's lifeline. Operation of microbuses has been mostly unplanned and informal that causes interruptions in traffic flows due to the informal on-street stops that block some of the traffic lanes during the microbus dwell time and consequently reduce the traffic capacity of the roadway.

The main objective of the study was to investigate the effect of Microbus-stops on traffic parameters and traffic operation by re-developing a macroscopic stochastic simulation model. Macroscopic traffic simulation models were created using the MATLAB programming language to simulate one microbus stop as well as two microbus stops with a defined separation distance. Model verification and validation were considered for the development of models that can be used to prediction reliable estimates for reduction in traffic speeds, change in traffic density and the average traffic delay due to the microbus stops. The models were utilized to study the effect of number of blocked lanes, microbus headway, microbus dwell time, separating distance between microbus stops, and different levels of volume to capacity ratios(v/c) on the traffic stream characteristics.

Results of the one-stop models showed that the average speed upstream the microbus stop decreased and the average density gradually increased as the v/c ratio increased. The two-stop models were used to study the effect of the separating distance between microbus stops on traffic flow. Model results showed a significant increase in the average traffic delay due to the increase in v/c ratio. For case of one-lane blockage [BL=1], the average delay significantly increased as the v/c ratio increased. For the case of blocking two lanes [BL=2], traffic delay increased as the separating distance

decreased. A significant increase in traffic density was observed in case of two-lane blockage compared with that of the one-lane model. Results of the two-stop model indicated that the average traffic density at the location of the first stop increased by increasing the number of lanes blocked.

The microbus dwell time [DT] has a significant impact of on the traffic stream. The average traffic density in case of one-stop model increased as the dwell time increased. Percentages of increase equal 175%, 163%, 150% and 131% for microbus headway 3, 5, 7, and 10 minutes, respectively. The percentages of increase in average traffic density at the second location of microbus stop were 165%, 145%, 130% and 109%.

Regression models were developed to approximate the response surface, which in this case were the average traffic speed, density and delay at the location of the microbus stops. For the average traffic delay, the model goodness of fit statistic (R-squared) equals 0.87 and 0.91 for the one-stop and two-stop models, respectively. In case of different dwell times, R^2 were equals 0.83 and 0.86 for case of one microbus stop and two microbus stops respectively. Also, In case of different headways, R^2 were equals 0.8 and 0.85 respectively for case of one microbus stop and two microbus stops.

Chapter 1 : Introduction

1.1. Background

Greater Cairo is considered one of the world's most congested cities. The state of transport in Greater Cairo is rapidly deteriorating and is one of the most important areas in need of reform to improve Cairo's quality of life and business environment. In Cairo, the economic costs of traffic congestion may be as high as 4% of GDP yearly. These economic costs are not only due to the increase in trip time due to traffic delay, but also include the cost of excess fuel consumption as well as the negative effect of air pollution on people's health, and accidents. When all these outputs combined, the yearly economic cost of traffic congestion may reach up to 4% of Egypt's GDP. In other words, Egypt suffers from losing nearly EGP 50 billion every year because of traffic congestion. (World Bank, 2012).

Traffic congestion and traffic delay in Cairo are going from bad to worse. If anyone makes a trip during peak hour, the trip time will be expected to increase at least double the normal time. In order to reach an important meeting on time, one has to allow for additional time to overcome the unexpected but frequent delays resulting from road accidents, Microbus informal stops, and vehicle breakdowns. Average speeds on major corridors in Cairo are at least half (about 15 to 40 km/h) the normally expected average speeds (about 60 to 80 km/h). Whereas the average speeds on some local roads in central Cairo are even worse, sometime it is faster to make short trips on foot. (World Bank, 2012).

Microbuses have almost become one of the largely public transit systems in the city's lifeline. Microbuses help transporting many people, but mainly they need to be

cleaner, safer and be able to pick up and drop off passengers more easily. The microbus drivers' bad behavior and poor implementation often result in the general disregard of traffic rules. Operation of microbuses has been mostly unplanned and informal that causes interruptions in traffic flows due to the informal stops that block some of the traffic lanes during the microbus dwell time and consequently reduce the traffic capacity of the roadway. This problem negatively impacts the efficiency of road transportation and leads to great reduction in road capacity due to the drop traffic lanes.

1.2. Research Objectives

The objective of this research is to investigate the effect of microbus stops on traffic operation and congestion. This objective can be achieved using a simulation model to determine extent of influence on traffic stream. The target outcomes of the research study are:

- Develop traffic simulation models to study the effect of microbus stops on the traffic speed and traffic density. The models can be used to estimate the reduction in traffic speeds, change in traffic density and to calculate the average traffic delay due to the microbus stops.
- Carry out a sensitivity analysis to study the effect of different traffic properties such as: number of blocked lanes, microbus headway, microbus dwell time, separating distance between microbus stops and traffic volume to capacity ratio on the traffic speed, traffic density and traffic delay.
- Develop regression models to predict negative impact of the informal microbus stops.