Predictive models for routing in urban distribution

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Abstract

Traffic congestion and urban road safety directly affect all the city logistics processes. Bucharest is a large city with an inhomogeneous land use structure and with unpredictable and instable traffic pattern. These characteristics cause uncertainty in evaluating urban transport time and, as consequence, there are difficulties in optimal routing planning for city logistic operators. Therefore freight urban distribution faces various and complex uncertainties in relation to travel and idle times in operation. In order to schedule the distribution, time reserves have to be factored in to compensate for the random travel time variations. The paper presents methodologies to estimate the time reserves based on travel and idle time costs, and statistical data.

The comparison between alternatives for a certain origin and destination is performed with the aid of multi-criteria analysis. The problem of finding the optimal route is solved employing a specific methodology. In urban distribution, in highly connected networks there are multiple routes between an origin and a destination. Route choice is performed based on route length, travel time and cost. Taking into account the dependency between route length and travel time, route length is mostly used. It is to be noted that the length used to rank the choices is not the length obtained from summing up the length of the arcs that make up the route. Choosing between the possible route options has to be done in relation to an equivalent length that is taking into account the route characteristics which substantially influence the travel time. We are taking into consideration the road type, number and characteristics of intersections, number of left turns, average road occupancy, temporary or permanent speed restrictions, etc. Obtaining an equivalent length that takes into account all these characteristics is difficult and marked by uncertainties. The equivalence should look at extending the travel time due to the above mentioned characteristics, in other words use the travel speed in the absence of all those elements which impiede on traffic continuity and stability.

The routing problem analysed in the second part of the paper looks for a set of customers B_i needing to be visited following the arc of the network on the right hand side – the direction of the traffic. The return maneuvre on any arc of the network is not possible (the two traffic directions are physically separated). The nodes of the analysed network are simple intersections except for one node which is a roundabout. The optimal route is calculated. The resulted routes show that certain arcs of the road network are used two or three times. This means that those arcs used more than once can be the source of additional uncertainties in estimating the travel time if the adjacent arc or nodes have a high road safety risk. When ranking the route choices a criterion like this is taken into account especially when the difference in total equivalent length is not significant. If certain arc has a high road safety risk, then the customer served by a route including that arc can be left last to be served. An option like this eventhough means a greater equivalent route length can be recommended if the time windows required to reach the customers have to be strictly obeyed.

Recommendations are being made for the additional analysis of the routes resulting after employing the minimum equivalent length route criterion, and for estimating the delivery time from the distribution centre. The consequences of routing including returning to the distribution centre are compared to routing including directing the vehicle to another destination after it has visited the last customer.