Using real-time information to improve Emergency Medical Service response: A vehicle dispatching analysis

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Author keywords: EMS, Emergency Medical Service, Real-time information, Simulation, Vehicle dispatching

Background

In an era of fast technological improvements and easy access to real-time data from various sources, intelligent transport systems emerge. Emergency medical services (EMS) response is one of the transport systems that can take advantage of these technological advances. Moreover, cities present themselves as dynamic environments where traffic flows change during the day as well as people’s location. Therefore, a static overview of urban drivability is inappropriate and unable to fully support EMS tactical decisions, i.e. chose which vehicle will be dispatched to an active medical emergency call. At the present, most of the EMS entities still rely on the closest idle vehicle policy to decide which vehicle to dispatch. Many of these, chose the closest idle vehicle using distance based or average based calculations. This leads to a solution that disregards real-time drivability conditions, resulting in a bad use of the available resources (i.e. emergency vehicles).

Aim

This study assesses the use of real-time traffic information or estimations in the EMS dispatching decisions to achieve higher system performance. Furthermore, errors might exist in the real-time estimations, thus these errors are forced in the study to measure how big they can be till performance starts to drop when compared to practices that do not use or estimate this real-time information.

Method

We propose the use of a simulation model to measure EMS response performance. This performance is measured in terms of average response time and victims’ survival. The simulated EMS agent has direct access to real-time travel times from the road network and makes decisions upon this information. Several test cases are computed where an error component is added to the information accessed by the EMS agent. This error is obtained randomly from a normal distribution with parameters mean = 0 and standard deviation = Maximum Error/ 2, i.e. A Maximum Error in the obtained information is ensured with a confidence of 95%. Several Maximum Errors are tested and then compared with a control case where EMS uses average travel time for dispatching decisions (i.e. no access to real-time information or estimations)

We apply our methodology to a case study, Porto city, to validate it and assess the impact of real-time information in dynamic environments for EMS response.

Results

The use of real-time information when deciding which vehicle to dispatch leads to an average response of 4.45 minutes while without real-time information the value rises to 4.50 minutes when emergency vehicles are homogeneously distributed through the city. If vehicles are concentrated in the higher demand areas, the values drop to 4.32 and 4.36 respectively. The same happens when analyzing the emergencies responded within 8 minutes. For homogenous vehicle distribution the use of real-time information leads to a total of 95.24% calls responded within 8 minutes, whilst without real-time information the value drops to 94.55%. Similar relative results were observed when
vehicles are concentrated in the higher demand areas. When performance is measured by victims’ survival, the simulations show that with the use of real-time information for a period of one year, the system can achieve an increase in its survival by a magnitude of 10 (i.e. the accumulated survival gain adds up to 1000%, where 100% means a victim has a 100% chance of survival), and 50 life-threatening victims assisted within 8 minutes.

In terms of error in the real-time estimated information, the simulations shown that in terms of average response time, if a maximum error of 35% (deviation from the real value) is ensured the system still outperforms the non-use of real-time travel estimations. This value drops as the number of vehicle stations increases.

Conclusions

This study shows that efforts should be made to introduce available real-time drivability tools in the EMS vehicle dispatching decisions. It was shown that significant survival improvements can be achieved with the use of real-time information, and that even estimations that deviate up to 35% from the real values can still bring improvements to the EMS response performance.