Expected Impacts of the Implementation of ITS on Congested Periods Regarding the Hungarian National Road Network

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Abstract
The objective of the project was to estimate the impact of the public road emergency system named eCall to be introduced in our country soon on the traffic loss of time caused by accidents with personal injuries. To determine the losses of time needed for the assessment of economic efficiency of the eCall system by means of models. It was presented some case studies how building-up and then ceasing of a traffic queue due to an accident can be simulated in a motorway with 2×2 lanes in details by means of a known program (VISSIM), if a complete road block emerges due to the accident, or if only one lane is passable.

Introduction
The main goal was to estimate the impact of the eCall automated emergency call system [1] to be introduced in Hungary soon on the loss of time in road traffic caused by accidents with personal injuries. To determine the losses of time needed for the assessment of economic efficiency of the eCall system by means of a newly created model. There are several methods for this calculation, there are simple analytical procedures for this purpose and simulation based methods too. We have used both methods and the results are usually very similar. In this paper we will present a simulation based method, called DECA.

1. Related studies
As a first step the international experience in relation to modelling of congestion, and the current results of the related fields were studied. It can be said that the international literature does not consider the traffic congestion as a kind of unavoidable, unimpressionable fact. On the one hand, the congestion may result from the failures of traffic control and the deficiencies of the road network (e.g. the road capacity is not sufficient in the rush hours), as well as the hindrance caused by road accidents. The shortage of capacity can be reduced only at the expense of rather costly investment. However, the losses caused by the traffic congestion possibly developing due to accidents may be significantly reduced through professional preparedness and correct traffic engineering decisions made in time. The study is dealing with the congestions arising in the national road network due to accidents with personal injuries. In his case we create a model to simulate the congestions caused by the accidents in the public road network. It is presented through some case studies how building-up and then ceasing of a traffic queue due to an accident can be simulated in VISSIM (see
Figure 1), if a complete direction is blocked due to the accident, or if only one lane is passable.

Figure 1: Main screen of the VISSIM simulation software

2. Modelling congestions using DECA

The main task of the project was to elaborate a model which can handle accident caused delay and cost on the basis of the Hungarian road, traffic volume and accident database. The model named DECA (Delay Caused by Accidents), was made definitely for calculation of the losses caused by the congestions after accidents. Estimations are executed by the DECA model using the actual road accident data of 2012 about the expected benefits arising from the introduction of eCall system in this country.

2.1 Main steps of the simulation

Main steps of modelling congestions in the public road network are:

- Gathering the volume and composition of traffic at the moment of accident on the spot of road network from different available database.
- Simulate the vehicle queue
  - Build-up the vehicle queue
  - Fall-off the vehicle queue
- Determine the delay and cost caused by waiting in built up and ceased queue.

Estimation of the loss caused by congestions:

- Estimate the number of affected vehicles (based on the traffic database).
- Calculate the delay for each type of vehicles one by one.
- Calculate the estimated cost of traffic delay for each vehicle.

Using this method, we can estimate the impact of various measures:

- Run the simulation with the original data
- Run the simulation considering the effect of the eCall system
- Analyse the differences (loss of time, cost, etc.)
2.2 Input data

It is one of its outstanding advantages that it is able to use the database formats used in Hungary (data of the Central Statistical Office about accidents, traffic volume data and data of road parameters).

The common annual accident database containing the following field data:

- Exact location and time of accident.
- Severity, type and nature of accident.
- Information about participants and injured persons.
- Environmental data.

The delay time estimation based on the following time intervalls:

- $t_1 =$ Elapsed time between the the date of accident and the inbound emergency call.
- $t_2 =$ Call center operator’s activity (alarm of police/rescue team/ambulance).
- $t_3 =$ Travel time of rescue units.
- $t_4 =$ Medical attendance of injured persons on the spot, police investigation, technical rescue.
- $t_5 =$ Cleaning of the accident scene, removing barriers etc.

The different parameters are variable in the model. The basic data came from the survey made by Dr. Lindenbach et al. [2], [4]

Traffic at the moment of the accident:

- Traffic database contains the Annual Average Daily Traffic (AADT) values
- The traffic at the moment of the accident are estimated using some seasonal weighting factors to AADT, based on the known monthly – weekly – daily – hourly distribution of traffic. [3].

Miscellaneous constant factors:

- Vehicle queue degradation time
- Financial loss factors (9500 HUF/hour for lorries, and 3300 HUF/hour for not-lorries)
- The total length of the Hungarian national road network is 31 000 km.

![Accidents on national road network in 2012](image-url)

*Figure 2. Average number of personal injury accidents/hour on the Hungarian national road network in 2012.*
2.3 Results

The number of accidents of year 2012 in the national road network are:
- Fatal accidents: 391
- Serious accidents: 2103
- Light accidents: 4101

Based on the followings, we have run the simulation. The DECA software shows the results (and input parameters) in the final screen (see Figure 3). It is also able to show a detailed log about the simulation process.

Table 1 shows the estimated impact of eCall system on delay caused by accidents in 2012 in Hungary (vehicle-hour).

Table 2 shows the estimated impact of eCall system on delay caused by accidents in 2012 in Hungary (MM HUF). It is worth noting that the estimated socioeconomic loss caused in 2012 by an average personal injury accident on the national road network is: 55 million HUF. The estimates loss caused by congestion due to the same average accident is near 5 million HUF.
Summarized final results (based on vehicle-hours):

- On national road network in built area: -18.16%
- On national road network out of built area: -17.45%
- Total on national road network: -17.67%

Table 3 shows the detailed log generated by the application. This Excel log file is well usable for checking the results and for further processing.

It contains the following columns: ID of the accident, road number, section, road category, month of the accident, monthly traffic weighting factor, day of the accident, daily traffic weighting factor, hour of the accident, hourly traffic weighting factor, annual average daily traffic, estimated traffic at the time of the accident, percent of trucks, number of trucks, number of non-truck vehicles, place of the accident (in built area or not), county, T1+T2 times, T3 time, accident type, accident nature, T4 time, T5 time, overall T time, number of affected vehicles, time of building-up the congestion, time of ceasing of the congestion, total vehicle loss (hour), non-truck loss (hour), truck loss (hour), non-truck loss (HUF), truck loss (HUF), overall loss in HUF dimension.

Conclusions

In accordance with the final results of the calculations the inland introduction of the eCall system in the entire national road network is expected to entail a reduction of the time loss due to congestion caused by accidents by about 17%-18%, by taking the accident data of 2012. If expressed the costs in HUF, it is about 2.7 billion (in built up areas) and 6.1 billion
(outside of built areas) the estimated socioeconomic saving on the national road network due to eCall. [5]

In the last chapter of the study briefly introduced one of a significant developments made for traffic policemen, the so-called P(olice)-BAL program running in smart telephones, which (among others) is also able to record the GPS coordinates of accident spot so supporting the precise localization of the accident by the police and to send information to TMC, thereby the number of vehicles running into traffic jams will be reducible significantly.

References


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