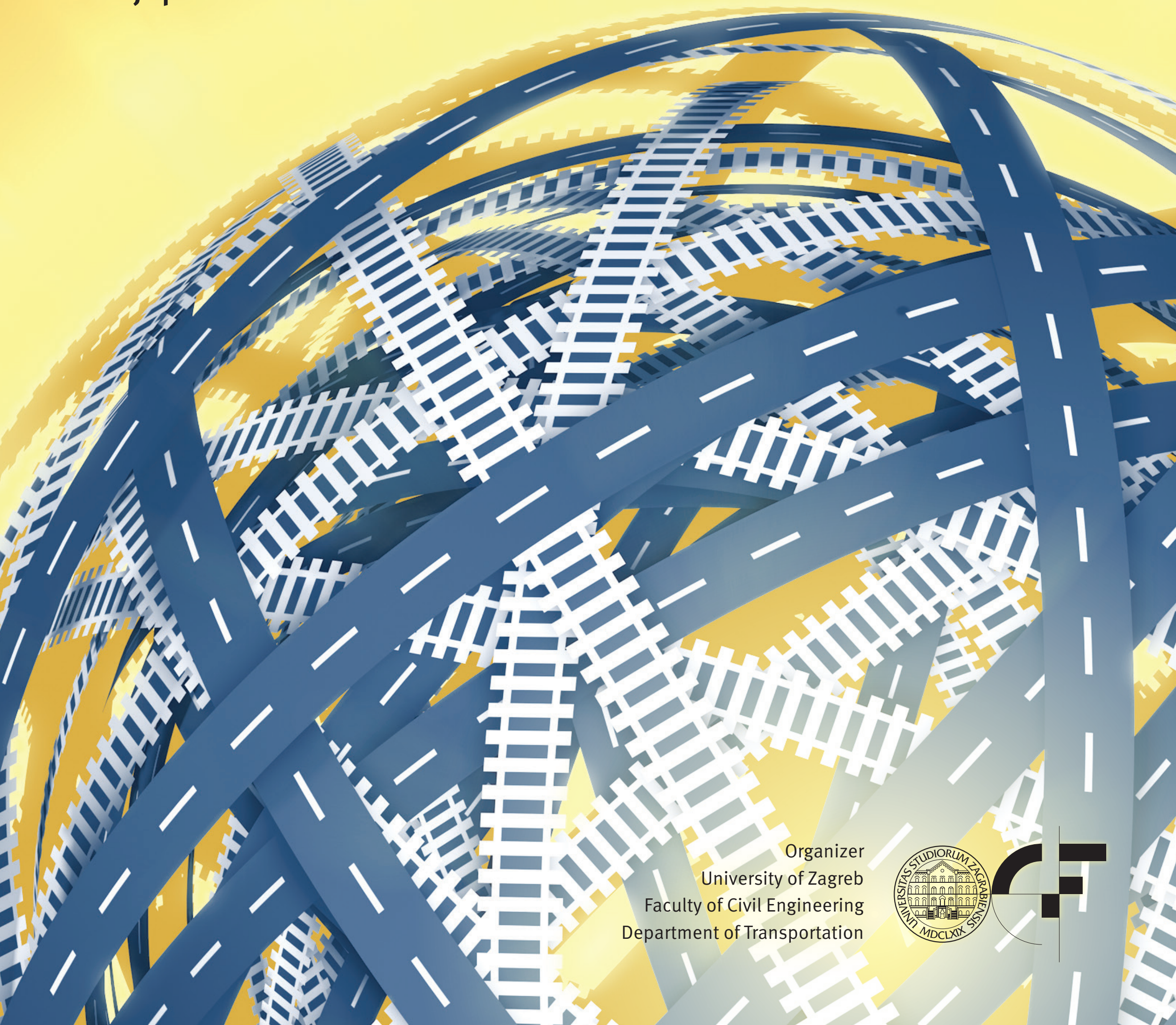
CETRA[2016]

4th International Conference on Road and Rail Infrastructure
23–25 May 2016, Šibenik, Croatia

Road and Rail Infrastructure IV

Stjepan Lakušić – EDITOR



Organizer
University of Zagreb
Faculty of Civil Engineering
Department of Transportation

CETRA[2016]
4th International Conference on Road and Rail Infrastructure
23–25 May 2016, Šibenik, Croatia

TITLE
Road and Rail Infrastructure IV, Proceedings of the Conference CETRA 2016

EDITED BY
Stjepan Lakušić

ISSN
1848-9850

PUBLISHED BY
Department of Transportation
Faculty of Civil Engineering
University of Zagreb
Kačićeva 26, 10000 Zagreb, Croatia

DESIGN, LAYOUT & COVER PAGE
minimum d.o.o.
Marko Uremović · Matej Korlaet

PRINTED IN ZAGREB, CROATIA BY
"Tiskara Zelina", May 2016

COPIES
400

Zagreb, May 2016.

Proceedings of the
4th International Conference on Road and Rail Infrastructures – CETRA 2016
23–25 May 2016, Šibenik, Croatia

Road and Rail Infrastructure IV

EDITOR
Stjepan Lakušić
Department of Transportation
Faculty of Civil Engineering
University of Zagreb
Zagreb, Croatia

CETRA[2016]

4th International Conference on Road and Rail Infrastructure

23–25 May 2016, Šibenik, Croatia

ORGANISATION

CHAIRMEN

Prof. Stjepan Lakušić, University of Zagreb, Faculty of Civil Engineering
Prof. emer. Željko Korlaet, University of Zagreb, Faculty of Civil Engineering

ORGANIZING COMMITTEE

Prof. Stjepan Lakušić
Prof. emer. Željko Korlaet
Prof. Vesna Dragčević
Prof. Tatjana Rukavina
Assist. Prof. Ivica Stančerić
Assist. Prof. Saša Ahac
Assist. Prof. Maja Ahac
Ivo Haladin, PhD
Josipa Domitrović, PhD
Tamara Džambas
Viktorija Grgić
Šime Bezina

All members of CETRA 2016 Conference Organizing Committee are professors and assistants of the Department of Transportation, Faculty of Civil Engineering at University of Zagreb.

INTERNATIONAL ACADEMIC SCIENTIFIC COMMITTEE

Davor Brčić, University of Zagreb
Dražen Cvitanić, University of Split
Sanja Dimter, Josip Juraj Strossmayer University of Osijek
Aleksandra Deluka Tibljaš, University of Rijeka
Vesna Dragčević, University of Zagreb
Rudolf Eger, RheinMain University
Makoto Fujiu, Kanazawa University
Laszlo Gaspar, Institute for Transport Sciences (KTI)
Kenneth Gavin, University College Dublin
Nenad Gucunski, Rutgers University
Libor Izvolt, University of Zilina
Lajos Kisgyörgy, Budapest University of Technology and Economics
Stasa Jovanovic, University of Novi Sad
Željko Korlaet, University of Zagreb
Meho Saša Kovačević, University of Zagreb
Zoran Krakutovski, Ss. Cyril and Methodius University in Skopje
Stjepan Lakušić, University of Zagreb
Dirk Lauwers, Ghent University
Dragana Macura, University of Belgrade
Janusz Madejski, Silesian University of Technology
Goran Mladenović, University of Belgrade
Tomislav Josip Mlinarić, University of Zagreb
Nencho Nenov, University of Transport in Sofia
Mladen Nikšić, University of Zagreb
Dunja Perić, Kansas State University
Otto Plašek, Brno University of Technology
Carmen Racanel, Technological University of Civil Engineering Bucharest
Tatjana Rukavina, University of Zagreb
Andreas Schoebel, Vienna University of Technology
Adam Szeląg, Warsaw University of Technology
Francesca La Torre, University of Florence
Audrius Vaitkus, Vilnius Gediminas Technical University

EVALUATION OF THE CALIBRATED MICROSIMULATION TRAFFIC MODEL BY USING QUEUE PARAMETERS

Irena Ištoka Otković[1], Matjaž Šraml[2]
[1] *Josip Juraj Strossmayer University of Osijek, Faculty of Civil Engineering, Osijek, Croatia*
[2] *University of Maribor, Faculty of Civil Engineering, Transportation Engineering and Architecture, Slovenia*

Abstract

Application of microsimulation models in traffic analysis is a common professional practice. Methodology of calibration of microsimulation models is not finally adopted and various approaches are available. One of the available calibration methods is neural network approach for calibration of microsimulation traffic model. The comparison of the simulated and measured traffic indicators, in real traffic conditions, provides the best insight into the success of the model calibration process. The traffic indicator, used for the calibration of the model, is the travel time between the measuring points at a chosen urban intersection. The calibrated model has predicted the travel time for new sets of measured data at the same intersection with the prediction error smaller than 5%.
This paper analyses the simulation results for the traffic indicators that were not used in the model calibration – the queue parameters. The selected queue parameters are the maximum queue at the entrance and number of stops at the intersection entrance. The model has been additionally applied to the other intersection, in order to simulate its queue parameters. This has provided us with an insight into the issue of whether the calibration model is applicable only to the intersection for which the calibration has been done or it can have a wider application. The VISSIM microsimulation traffic model was used for calibration, and two single-lane roundabouts served as the research basis for evaluation of the calibrated traffic microsimulation model by means of queue parameters.

Keywords: queue parameters, microsimulations, VISSIM, roundabouts

1 Introduction

Microsimulation models are frequently used in traffic analysis. They are able to model the stochastic nature of traffic flow at a multi-modal level, through a detailed movement modelling of each entity and its interactions. Microsimulation traffic model, which enables a detailed analysis and a large number of iterations in real time, is based on testing of various traffic scenarios. Modelling results of each scenario are comparable. They focus on the analysis of alternative solutions, short-term traffic planning or optimization of particular elements of traffic objects and/or evaluation of specific traffic regulation. The microsimulation models are, undeniably, a very useful tool, but it is questionable whether they can be expected to give realistic modelling results that can be applied in the methodology, analysis and the design in local conditions.
The functioning of a traffic system is under the influence of various aspects of human behaviour [1]. Studies show that the behaviour of traffic participants is, among other things, territorially and culturally conditioned [2]. Microsimulation models include variable behaviour

of drivers, at a level of each particular entity, and the reality of modelling results depends on the initial choice of the model [3] and the efficiency of the calibration process [4].
In the calibration process, the parameters of traffic microsimulation models are adjusted in such manner, that the model outputs are similar to the observed data. According to the Highway Capacity Manual, calibration is the process of comparing model parameters with actual data obtained by counting and measuring at a local network [4]. Identification of influential parameters, the range of their values and optimization of these parameters and their values by some of the optimization tools, are an integral part of the calibration process [5-7].
In the last few years, there has been a lot of research work aimed at the procedures for calibration of traffic microsimulation models, but there have been no attempts to identify general calibration principles, based on the collective experience of the researchers [8].
Some studies deal with traffic calibration of microsimulation models, and they concentrate only on the calibration of driving behaviour parameters [9, 10], but some others [11-13] incorporate this issue in a research of a broader problem, which includes the calibration of a route choice model [14] and an origin-destination matrix too [15]. Analysis of acceptable time gaps and determination of a critical time interval by means of Greenshield's model [16] represent a description of the calibration method for the VISSIM microsimulation model at roundabouts in New York.
The method of calibration of microsimulation traffic models evaluated in this paper is the one using neural network approach. Calibration methods, based on the neural network prediction, have been analysed and the results show that a neural network is applicable in the process of calibration of microsimulation traffic models [17].

2 Evaluation of the calibrated traffic microsimulation model

A traffic microsimulation model typically consists of several sub-models, each of which trying to reproduce the mechanism of a single decision made by an individual driver, such as the decision to change lane or to use a gap in the opposing traffic in order to enter an intersection. Each sub-model includes several parameters, and a complete traffic microsimulation models sometimes include dozens of parameters.
The VISSIM microsimulation traffic model has been chosen for the analysis of the calibration process. Testing of all combinations of model input parameters by applying realistic VISSIM simulations (separately run for every combination) would be very time consuming. A computer can examine a great number of combinations of input values of model parameters in real time, if it can use a program for output simulation values of the observed microsimulation traffic model (e.g. of VISSIM).
In Fig. 1 a simplified scheme of program calibration is presented. The program calibration begins with the creation of a VISSIM simulation database for neural network training (Fig. 1). The task of the neural network is to predict the time of travel between measuring points for particular values of input parameters, obtained by the microsimulation model. The program calibration (MATLAB) calls the prediction function, provided by the neural network within the calibration program (subroutine), for each combination of values of input parameters within the given ranges of values and by a chosen/defined step [17].

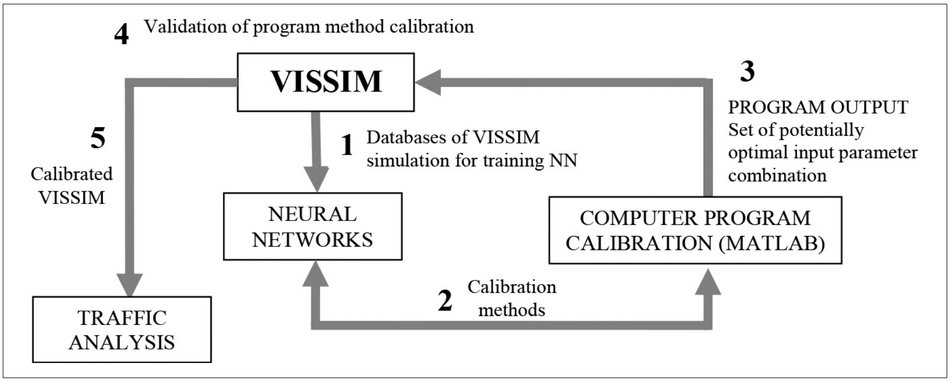


Figure 1 Scheme of computer program calibration [17]

The most common indicator used for calibrations of traffic models is the travel time [8,11,18]. In accordance with the best practice, the traffic indicator, which is used for the calibration of the examined traffic microsimulation model, is the travel time between the measuring points at a chosen urban intersection. The calibrated model has predicted the travel time for new sets of measured data at the same intersection with the prediction error smaller than 5% [20]. The model validation is the evaluation of the efficiency of the calibration model by comparison between modelled and measured traffic parameters. The validation stage is meant to confirm the predictive power of the calibrated model, using an independent set of data. However, it is important to ensure that the validation test does not simply repeat what has already been tested in the calibration process. The basic requirement, which every calibrated traffic microsimulation model must meet, is that it can be successfully validated with a new set of data of the same type. A higher standard of validation is reached, if it can be confirmed that the model calibrated with one type of data can also give good estimates of other types of traffic data, such as queue length or flows, [8].
In this case, for the purpose of the model validation, two queue parameters were selected – the maximum queue at an entrance and the number of stops at an intersection entrance. The queue parameters are the traffic indicators that were not used in the model calibration. The selected parameters are also easy to measure in the real traffic conditions, as is the case with the travel time between the measuring points. As the research basis for the evaluation of the calibrated traffic microsimulation model using queue parameters, two single-lane roundabouts were utilized.

2.1 Comparison of the calibrated and non-calibrated model outputs and the measured data

The calibration of the model has been done on the roundabout 1 (Vinkovačka – Drinska) by travel time observation for left turn traffic streams (from Drinska to Vinkovačka South). The validation of the model has been done by the comparison of the calibrated and non-calibrated (default) model outputs of queue parameters and the measured data at all entrances into the first examined intersection (Tables 1).

Table 1 Comparison of the calibrated and non-calibrated model outputs

ROUNDABOUT 1						
Entrance	MAXIMUM QUEUE (m)			NUMBER OF STOPS		
	calibrated	default	measured	calibrated	default	measured
FIRST MEASURING						
1	27	24	26	88	84	89
2	108	108	110	660	646	685
3	24	21	25	30	30	31
4	65	65	62	333	304	324
SECOND MEASURING						
1	22	15	21	58	60	61
2	106	106	103	462	509	475
3	18	23	18,5	34	14	33
4	60	60	62	225	204	221
THIRD MEASURING						
1	15	23	15,5	52	50	54
2	107	77	110	152	178	158
3	17	17	18	15	14	15
4	46	37	48	135	129	140

1 – Drinska; 2 – Vinkovačka North; 3 – Bosutska; 4 – Vinkovačka South

The fourth set of measured data has been gathered at the other urban roundabout (Opatijska – Kirova) with the aim to check if the calibrated model is applicable only to the roundabout at which the calibration was done or it can be applied wider (Table 2).

Table 2 Comparison of the calibrated and non-calibrated model outputs – fourth measuring

ROUNDABOUT 2						
Entrance	MAXIMUM QUEUE (m)			NUMBER OF STOPS		
	calibrated	default	measured	calibrated	default	measured
1	22	27	23	58	50	56
2	5	5	5	6	5	6
3	18	18	18,5	18	13	19
4	13	12	12,5	18	18	18

1 – Sportska; 2 – Obilaznica; 3 – Opatijska; 4 – Kirova

3 Discussion

At the heart of any calibration technique, there is a comparison between simulation outputs and gathered measurements of various traffic indicators. A comparison of the traffic indicators, the ones measured in the field and the ones simulated with the calibrated and non-calibrated microsimulation traffic model, provides an insight into the efficiency of the calibration procedure. The basic requirement, that every calibrated traffic microsimulation model must meet, is that it can be successfully validated with a new set of data of the same type. In this case, it is the traveling time between the measurement points. A higher standard of validation is reached, if the model calibrated with traveling times data can also give good estimates of other parameters such as queue parameters – the maximum queue and the number of stops at the entrance of intersection.

According to [18], the model approximates the real traffic conditions well, if the criteria for the observed traffic indicators are satisfied (1).

$$\left|\frac{Q\max_{MOD} - Q\max_{MEAS}}{Q\max_{MEAS}}\right| \text{ and } \left|\frac{STOP_{MOD} - STOP_{MEAS}}{STOP_{MEAS}}\right| \leq 5\% \quad (1)$$

Where:

$Qmax_{MOD}$ – modelled maximum queue at the entrance;
$Qmax_{MEAS}$ – measured maximum queue at the entrance;
$STOP_{MOD}$ – modelled number of stops at the entrance;
$STOP_{MEAS}$ – measured number of stops at the entrance.

The comparison of VISSIM simulation results for calibrated and non-calibrated (default) model and the measured values of queue parameters, according to the formula (1), is presented in the Tables 3 and 4.

Table 3 Comparison of the simulated and the measured traffic parameters –first location

ROUNDABOUT 1				
Entrance	MAXIMUM QUEUE (%)		NUMBER OF STOPS (%)	
	calibrated	default	calibrated	default
FIRST MEASURING				
1	3,85	7,69	1,12	5,62
2	1,82	1,80	3,65	5,70
3	4,00	16,00	3,23	3,23
4	4,84	4,84	2,78	6,17
SECOND MEASURING				
1	4,76	28,57	4,92	1,64
2	2,91	2,90	2,74	7,20
3	2,70	24,32	3,03	57,58
4	3,23	3,23	1,81	7,69
THIRD MEASURING				
1	3,23	48,39	3,70	7,41
2	2,73	30,00	3,80	12,70
3	5,56	5,56	0,00	6,67
4	4,17	22,92	3,57	7,86

Table 4 Comparison of the simulated and the measured traffic parameters – fourth measuring, second location

ROUNDABOUT 2				
Entrance	MAXIMUM QUEUE (%)		NUMBER OF STOPS (%)	
	calibrated	default	calibrated	default
1	4,35	17,39	3,57	10,71
2	0,00	0,00	0,00	16,7
3	2,70	2,70	5,26	31,58
4	4,00	4,00	0,00	0,00

The analysis of the two parameters of the queue (Tables 3 and 4) shows that the calibrated microsimulation model provides good results of modelling with regard to the measured value of parameters in actual traffic conditions. In conditions of a low traffic load (Table 3, third measuring and Table 4), even the calibrated model provides the results that are a little bit more than 5% different from the measured values, but the differences are not significant (5.56% and 5.26%). For the first parameter, the maximum length of queue, the result show that the vehicles in real conditions had a greater stop distances between the vehicles in queue. For the second parameter, the number of stops at the entrance, indicates a little bit longer reaction time of drivers in the local traffic network under conditions of low traffic load.

4 Conclusion

The traffic indicator, which is used for calibration of the model, is the travel time between the measuring points at the selected urban single-line roundabouts. The comparison of travelling times between measuring points shows that the calibrated microsimulation model gives results that differ from the measured values of the travelling time by less than 5%, and such modelling results are considered to be realistic. This paper has analysed the simulation results for the other parameters that were not used in the model calibration – the maximum queue and the number of stops. The parameters of queue for both intersections are measured and compared to the outputs of the parameters modelled with the calibrated and the non-calibrated (default) model.
The results show that the model was successfully calibrated. The calibrated model simulation results have provided the expected accuracy in relation to the measured traffic parameters for the traveling time, as well as for the queue parameters. By using a calibrated microsimulation model VISSIM, it is possible to obtain results that reflect realistic traffic characteristics at the examined roundabouts in local conditions.

References

[1] Onieva, E., Milanés, V., Villagrá, J., Pérez, J., Godoy, J.: Genetic optimization of a vehicle fuzzy decision system for intersections, Expert Systems with Applications, 39, pp. 13148–13157, 2012

[2] Olstam, J. J., Tapani, A.: Comparison of queue models, Swedish national road and transport research institute, Project VTI meddelande 960 A, Linköping, Sweden, 2004

[3] Fang, F. C., Elefteriadou, L.: Some guidelines for selecting microsimulation models for interchange traffic operational analysis, Journal of Transportation Engineering, 131(7), pp. 535–543, 2005

[4] Highway Capacity Manual 2000, Transportation Research Board, National Research Council, Washington D.C., 2000

[5] Park, B., Won, J., Yun, I.: Application of microscopic simulation model calibration and validation procedure: a case study of coordinated actuated signal system, Journal of Transportation Research Record, TRB, National Research Council, Washington D.C., pp. 113-122, 2006

[6] Park, B., Qi, H.: Development and Evaluation of Simulation Model Calibration Procedure, 84th Annual Meeting, Transportation Research Board, Washington D.C., 2005

[7] Ištoka Otković, I., Tollazzi, T., Šraml, M.: Analysis of the influence of car-following input parameters on the modelled travelling time, Tehnički vjesnik, no. 5; pp. 919-925, 2013

[8] Hollander , Y., Liu, R.: The principles of calibrating traffic microsimulation models, Transportation 35(3), pp. 347-362, 2008, DOI:10.1007/s11116-007-9156-2

[9] Kim, K.O., Rilett, L.R.: Simplex-based calibration of traffic microsimulation models with intelligent transportation systems data, Transp. Res. Rec. 1855, pp. 80–89, 2003

[10] Kim, K. O., Rilett, L. R.: A genetic algorithm based approach to traffic microsimulation calibration using ITS data. In: Proceedings of the 83rd TRB Annual Meeting, Washington D.C., 2004

[11] Toledo, T., Koutsopoulos, H.N., Davol, A., Ben-Akiva, M.E., Burghout, W., Andreasson, I., Johansson, T., Lundin, C.: Calibration and validation of microscopic traffic simulation tools – Stockholm case study. Transp. Res. Rec. 1831, pp.65–75, 2003

[12] Ben-Akiva, M.E., Darda, D., Jha, M., Koutsopoulos, H.N., Toledo, T.: Calibration of microscopic traffic simulation models with aggregate data. In: Proceedings of the 83rd TRB Annual Meeting, Washington D.C., 2004

[13] Dowling, R., Skabardonis, A., Halkias, J., McHale, G., Zammit, G.: Guidelines for calibration of microsimulation models: framework and application. In: Proceedings of the 83rd TRB Annual Meeting, Washington D.C., 2004

[14] Flötteröd, G., Chen, Y., Nagel, K.: Behavioral calibration and analysis of a large-scale travel microsimulation. Networks and Spatial Economics, 12(4), pp. 481–502, 2012

[15] Flötteröd, G., Bierlaire, M., Nagel, K.: Bayesian demand calibration for dynamic traffic simulations. Transportation Science, 45(4), 541–561, 2011

[16] Cicu, F., Illotta, P. F., Bared, J., Isebrands, H.: VISSIM calibration of roundabouts traffic performance, In: Transportation research board annual meeting, Washington D.C., 2011

[17] Ištoka Otković, I., Tollazzi, T., Šraml, M.: Calibration of microsimulation traffic model using neural network approach, Expert systems with applications, 40, pp. 5965-5974, 2013

[18] Kim, S.J.: Simultaneous calibration of a microscopic traffic simulation model and of matrix, Ph dissertation, Texas A&M University, 2006

[19] Ištoka Otković, I., Zagvozda, M., Šraml, M.: Comparison between modelled and measured traveling time in urban roundabouts, In: Lakušić, Stjepan (Ed), Road and Rail Infrastructure III (CETRA 2014), Građevinski fakultet Zagreb, Zagreb, 2014, pp.269-274