DOI 10.20544/HORIZONS.B.03.1.16.P14
UDC 656.1.05:303.446

A COMPARATIVE ANALYSIS OF TRAFFIC SIMULATION SYSTEMS[1]

Jasmina Bunevska Talevska
University "St. Kliment Ohridski"
Faculty of Technical Sciences, Makedonska Falanga 33
Bitola, Macedonia
jasmina.bunevska@tfb.uklo.edu.mk

Abstract

The past one and a half decade a rapid evolution in the sophistication of micro-simulation models have been seen, as well as a major expansion of their use in transportation engineering and planning practices.
Models of the mid-nineties required inputs which were expensive to collect and not accurate enough to reflect the full range of traffic behaviour. Trough introduction of new technologys for advanced traffic control and information systems next generation models abound a source of data which can be used to reduce the cost of collecting the required data and improving its fidelity. The new datasets will help both the validation and calibration exercises. Continuing improvements in computer hardware will allow more detailed models to be developed, more simulation runs to be carried out, bigger networks to be modelled and for better visualisation of results. This lead to new challenges for software developers to fulfil customer needs. In this context this paper aims to perform as an overview that combines both, current traffic simulation systems - TSS capabilities and customer expectations. Therefore, a comparison of simulation tools as well as SWOT analysis has been conducted by analysing scientific papers and technical specifications.

Key words - Traffic Simulation Systems – TSS; Micro-Simulation Models – MSM; Comparative Analysis; SWOT Analysis;

---

[1] Professional paper

INTRODUCTION

The impact of traffic congestion on individual driver's time is well understood. However, traffic congestion actually does much more than the test of our patience. There are reports that quantify the cost of traffic congestion on national economies in the U.S., U.K., France and Germany. Common tools for traffic congestion analysis are traffic simulation systems – TSS. Looking up for papers which have been published between 2000 and 2016 by entering the keywords "Traffic modelling and simulation" showed some 420 papers including 24 reports on simulation system comparison. Evaluating these comparison studies, it revealed that there was no in-depth comparison study of simulation tools since the "SMARTEST" project coordinated by the University of Leeds and funded by the European Commission, published in 2000 [1]. I found paper [2] that forecast the projected increases in these costs in these countries and their most congested cities between 2015 and 2030. Driven by urbanization and increased GDP per capita over the next 15 years, a few of the key findings include:

- The combined annual cost of gridlock to these countries is expected to soar to $293.1 billion by 2030, almost a 50% increase from 2013.
- Over this period, the cumulative cost of congestion for these economies combined is estimated to be a staggering $4.4 trillion.
- The overall economic impact is greatest in the U.S. where the estimated cumulative cost of traffic congestion by 2030 is $2.8 trillion – the same amount Americans collectively paid in U.S. taxes last year.
- However the UK (at 66%) and London (at 71%) will see the greatest annual rise in the cost of congestion by 2030, mainly as a result of seeing the highest increase in urbanization.

The TSS evaluation process included two independent assessments. While one focused on TSS features, the other one tried to collect customer expectations and needs on TSS. In general, most of the authors careful on simulation model goals and development (principles modeling), calibration with field data, validation, simulation and animation, output parameters, and consistency with HCM methodologies, and in recent years and analysis of air quality, fuel consumption and exhaust emissions. It is clear that there are different driving forces, like there are main factors influencing research in simulation. These forces could be described as:

- advances in traffic theory,
- continuous improvement computer hardware,
- continuous improvement software,
- development of the general information infrastructure, and

- society’s demand for more detailed scenario analysis.

COMPARISON OF TRAFFIC SIMULATION SYSTEMS

In mid-2012 a general presentation of Side Friction Street SImulation Model - SFStreetSIModel characteristics, performances and modeling principles has been shown [3]. Later in the same year, in order to obtain directions for its improvement educationally developed micro-simulation model SFSTreetSIModel, version 1.1 was compared and evaluated with two other commercially available simulation models [4]. Namely, as it was stated in [4], further research is needed to achieve complete insight in the state of the art in elementary models sed in traffic micro-simulation. In relation to these conclusions, comparison continues within this paper.

Table 1. Comparison Legend

Traffic Simulation Model (System)	**SFStreet SIModel**	**FreeSim**	**Aimsun 7**	**PTV Optima**	**Corsim**
Legend for the model numbering	**1**	**2**	**3**	**4**	**5**
Legend for the feature explanation	Yes – supported function No – function NOT supported [empty] – no information				

Table 2. Comparison of Software Features and Compatibility

	1	**2**	**3**	**4**	**5**
Microsoft Windows	Yes	Yes	Yes	Yes	Yes
Linux	Yes	Yes	Yes	Yes	No
MacOS	No	Yes	Yes	No	No

Source: Author

Table 3. Comparison of the calibration parameters

Calibration Parameter	**1**	**2**	**3**	**4**	**5**
Time steps (min/max time interval in seconds)	**1/1**		**0.1/1**	**1/1**	**1/1**
Gap acceptance criteria	Yes *	Yes	Yes	Yes	No

Gap acceptance	Based on vehicle class				

* = within the lane-changing process, based on the safety distances
Source: Author

Table 4. Comparison of the basic simulation features

FEATURE	**1**	**2**	**3**	**4**	**5**
Level of detail	Micro scopic	Macro scopic	m/m/m	Macro Meso	Micro scopic
Dimension	Stochastic	Stochastic	Stochastic		
Model type	Discreet		Discreet	Discreet/ Continuous	Discreet
Objects and phenomena modeled	Yes	Yes	Yes	Yes	Yes
Graphical presentation (friendliness)	Yes	Yes	Yes	Yes	No
Animation	2D	2D	3D		3D

Source: Author

Table 5. Comparison in terms of interactions between objects, objects and phenomena modeled

Object / phenomenon	**1**	**2**	**3**	**4**	**5**
Cars	Yes	Yes	Yes	Yes	Yes
Commercial vehicle/trucks	Yes	Yes	Yes	Yes	Yes
Bicycles	No	No	Yes	Yes	Yes
Pedestrians	Yes **	No	Yes	Yes	Yes
Public transports	No	Yes	Yes	Yes	Yes
Parked vehicle	Yes	No		No	Yes
Car-following, overtaking and lane changing logic	Yes	Yes	Yes	Yes	Yes
Weather conditions	No	Planned		Yes	No
Variable travel time	Yes	Yes	Yes	Yes	Yes
Variable acceleration	Yes *	Yes	Yes		

Headways	Yes		Yes		Yes
Incidents	No	Yes		Yes	Yes

***** in function of the concentration of the side obstacles and distance to them
****** on sidewalk
Source: Author

Table 6. Comparison in terms on Environmental impact calculations

Model	**Environment objectives**
SFStreetSIModel	• Exhaust emissions • Fuel consumption
FreeSim	• Planned
Aimsun 7	• Exhaust emissions • Fuel consumption
PTV Optima	• Exhaust emissions • Fuel consumption • Noise • Particulate matter
CORSIM	• Exhaust emissions • Fuel consumption

Source: Author

SWOT ANALYSIS

In order to determine the necessary performance aspects and details for improvement and upgrading of micro-simulation model SFStreetSIModel, version 1.1, a SWOT analysis has been drawn.

Table 7. SFStreetSIModel, version 1.1 SWOT analysis

Strengths	**Opportunities**
• user interface (easy to use and by a non-technical person) • graphical presentation • 2D animation • All pedestrian parameters can be examined and modified • High level of detail in the modeling process • modeling of vehicles as rectangles, not points (which is one of the primary recommendations of critics) • identification of vehicles by type • following distances has been model: • vehicle kinematic properties are defined (speed and acceleration) and	• pedestrians' appearance, movement and interaction with other modes of transport • Visual pedestrian evaluation: visualizing speed or acceleration of pedestrians • modeling of other traffic users (as public transport, bicycles) • introducing variable response time for drivers by introducing categories of drivers • vehicle-pedestrian interaction modeling • modeling of crossections and access points detailed geometry

their status (moving, overtaking or waiting in the queue) • speed, acceleration and vehicle status and speed and pedestrian status are calculated in each time step	• signal controllers • O-D matrices • 3D animation
Weaknesses • No interaction between vehicles and pedestrians at crossings: signalized or non-signalized, with priority for pedestrians or vehicles • Street restriction • Limited number of driver profiles • No ITS functionalities	**Threats** • Complexity

Source: Author

CONCLUSION

Within this paper, in order to compare, describe and evaluate the capabilities of educationally developed micro-simulation model SFSTreetSIModel, version 1.1, a state-of-the art review has been drawn up. Notably, all five simulation models had strengths and weaknesses that made it suitable for certain applications, as well as to estimate current traffic situation and predict traffic conditions as for example traffic congestion. Most systems are designed for the use in “urban” road networks. These systems are additionally able to deal with real-time traffic data. However, every system tries to deliver huge amounts of functionalities but fail by providing all functionalities. Some of the TSS have limitations in links, etc., so that they are not able to be used for wide area networks, as it was stated in [9]. A more detailed analysis requires a comparison of simulations based on field data, in order to investigate the differences between the individual models, and results with changes to the traffic volumes or other feature. Additionally, a GIS (Geographic Information System) would improve the data consistency and efficiency of the network.

REFERENCES

[1] Algers, S., et al., “Review of Micro-Simulation Models-SMARTEST”, Final report for publication, ITS University of Leeds, 2000.

[2] Meingast, A. et al., “Evaluation of market requirements and offered functionalities in traffic simulation systems supporting advanced traffic management systems”, European Transport Conference 2013, Campus Westend, Frankfurt, Germany, 2013.

[3] Bunevska, T.,J., “Side Friction Impact Analysis on the Traffic Flow Performances for the Low Speed Urban Streets”, Ph.D.Dissertation, University St.Kliment Ohridski Bitola, Faculty of Technical Sciences, Department for Traffic and Transport Engineering, 2012.

[4] Bunevska, T.,J. and Malenkovska Todorova M., “A comparative analysis of educationaly developed microscopic traffic simulation model - SFStreetSIModel,version 1.1”, Journal of Road and Traffic Engineering, ISSN 0478-9733, Belgrade, 2013.

[5] http://mctrans.ce.ufl.edu.

[6] http://www.sistemaits.com/wp-content/uploads/OPTIMA-Brochure-ENG.pdf.

[7] https://www.aimsun.com.

[8] CORSIM Reference Manual, Version 5.0, FHWA Office of Operations Research, Development and Technology, Federal Highway Administration, 2001.

[9] Bunevska, T.,J. and Malenkovska Todorova M., “Microsimulation analysis of introducing the “shared space” concept in the City of Bitola: A Case Stydy”, ARSA-2015, 4-thVirtual International Conference on Advanced Research in Scientific Fields, 2015.