

# SUVREMENI PROMET

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n. dujmović, i. miloš, i. dujmović PROJEKT SETA U FUNCIJI RAZVOJA OSOVINE CETC d. milewski ECONOMI AND SOCIAL EFFECTS OF TRANSPORT DEVELOPMENT d. pupavac, s. vukmirović, m. drašković SUVREMENI PRISTUP PROBLEMU PLANIRANJA OPTIMALNIH RUTAJA s. dvorski, v. kovsca, z. lacković ANALIZA TOKOVA PRIJEVOZA KAO POKAZATELJA GOSPODARSKIH KRETANJA t. stanivuk, i. tokić, m. dujmović TROSKOVI PRIJEVOZA LNG-A MORSKIM PRAVCIMA z. hinšt POSLOVNO IZVJESCIVANJE U HZ-PUTNICKI PRIJEVOZ D.O.O. i. cvetanovski, v. atanasova, v. dančevska BIMODALNI TERMINALI U LOGISTICKOM LANCU v. vidučić, j. žanić mikuličić, m. raboteq, e. oreč KVANTIFIKACIJA VAPORNI JABLI MENTALNO VERBALNOG MODELA PROMETA TURIZMA U FUNKCIJI ODRZIVOG RAZVOJA GOSPODARSTVA REPUBLIKE HRVATSKE ZA 2013. GODINU k. vodić TRZISTE KRSTARENJA JEDRENJACIMA j. blaškić zavada, j. grgić, a. perković INTERMODALNI TRANSPORT – TEMELJNI ČIMBENIK UKLJUCIVANJA REPUBLIKE HRVATSKE U EUROPSKE PROMETNE TOKOVE e. marušić, v. plazibat, r. singolo ZNACENJE I RAZVOJ KRUZNIH PUTOVANJA U HRVATSKIM LUKAMA j. bučevska talevska, m. malenkovska tođorova, h. trajčevska

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# SUVREMENI PROMET

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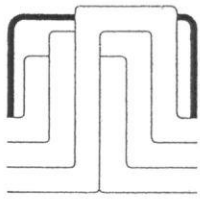
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*Preliminary communication\**

# SOFTWARE ANALYSIS OF THE LEVEL OF AIR POLLUTION AND PEDESTRIAN LEVEL OF SERVICE IN THE DOWNTOWN AREA OF BITOLA, FYROMACEDONIA

U.D.C. 656.1:504

## 1 Introduction

Increased awareness of environmental problems and the need for physical fitness encourage the demand for provision of more and better pedestrian facilities. To provide better pedestrian facilities, the appropriate standard and control of the facilities need to be determined. To decide the appropriate standard and control of pedestrian facilities, pedestrian studies, which consist of pedestrian data collection and pedestrian analysis, need to be done, [4]. One of the objectives of the pedestrian studies is to evaluate the effects of a proposed policy on the pedestrian facilities before its implementation. The implementation of a policy without pedestrian studies might lead to a very costly trial and error due to the implementation cost (i.e. user cost, construction, marking etc.). On the other hand, using good analysis tools, the trial and error of policy could be done in the analysis level. Once the analysis could prove a good performance, the implementation of the policy is straightforward. The problem is how to evaluate the impact of the policy quantitatively toward the behavior of pedestrians before its implementation. Within this paper we will present

a comprehensive approach to road users analysis that goes far beyond the standard amenities. By expanding the concept to quality of life analysis, based on the study amount, chronology, and technology used, this study becomes an optimized all-inclusive package.

road users analysis

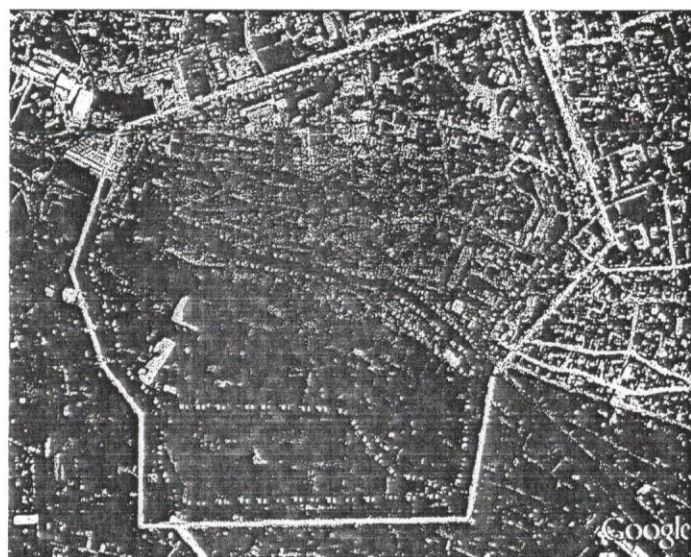
## 2 Micro Simulation Model Development

The idea behind the model development and micro simulation software analysis was that model should be capable of dealing with data about vehicle and pedestrian level of service, air pollution, fuel consumption, safety and accessibility. Namely, by building a model, a relatively simple and general applicable tool would become available, [3].

The model was created using the existing road network and simulated with real-time traffic data. However, Bitola is medium sized city so that traffic flows strongly depends on the topology, the organization of the city, its urban structure and the Local Authority's policies. City of Bitola is built around an historical centre, (Fig.1) and in general the average space mean speed is lower than 40 km/h. Even if in absolute terms the time wasted in congestion is less, but it still feels significant. Congestion created by stop and go movements involves a pollution peak by 5 to 10 cars stopped with running motors. The traffic data were observed open-spaced and counted manually.

As the output of simulation traffic models usually includes performance indicators, this model provides measure of effectiveness in term of effectiveness and environment. By modeling and simulating of the overall street geometry and streetscape and traffic characteristics as well, model enables certain estimations. For instance, emission levels (NO<sub>x</sub>, CO), fuel consumption, pedestrian level of service and congestion.

The modeling task was accomplished by using educationally developed software, SFStreetSIModel, version 1.0, [1] so that



Legend:



-  regulation line
-  presentation of congestion and emission levels

Fig. 1. Congested downtown area of Bitola: area under study

Source: Authors, adopted from Google Earth



the results were compared with the results produced through the simulations with commercially developed software, Synchro,7.

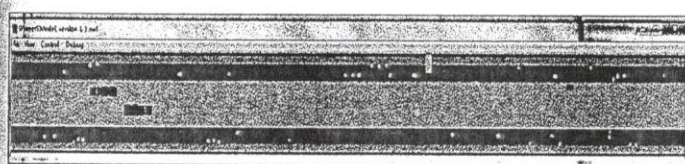
## 2.1 The Characteristics of a Microscopic Simulation Software SFStreetSIModel

Side Friction Street Simulation Model, version 1.0 - SFStreetSIModel, version 1.0 is microscopic simulation software made in programming language Action Script 3, implemented in Adobe Flash and Adobe Flex technology. SFStreetSIModel, version 1.0 simulates movement of vehicles - Microscopic Vehicle Simulation Module (MVSM) and pedestrians Microscopic Pedestrian Simulation Module (MPSM) on two-lane two-way section on low speed urban street under the influence of elements which form a condition known as side friction. MPSM simulates pedestrian movement where every pedestrian is treated as an individual. Based on the internal model of the simulation, the MPSM can be categorized as cellular based, physical force based and queuing network model. During simulation pedestrians are approximated with yellow circles, moving towards the destination by time headways distributed according to the negative exponential distribution and with a repulsive effect toward other pedestrian or obstacles, (Fig.2).

The basic characteristics for pedestrians in the traffic flow naturally are similar with the characteristics of the flow of motor vehicles. But, there are its specifics, like: possibilities for cutting the flow for pedestrians, movement in opposite direction and maneuvering without conflicts and change of speed. Here, the characteristics and parameters needed for determining the Level Of Service - LOS for pedestrians, are:

- **Functional comfort** with average vehicle speed [km/h], average speed of pedestrian movement [m/min] and pedestrian density as parameters, and
- **Environmental comfort** with the degree of pollution level [g/km] as parameter.

The algorithm to compute the fuel consumption and emission levels is based on the COPERT III methodology [2]. Information such as the street length, street class, average value of speed and number of cars are used.



Legend:

 pedestrian on sidewalk

Fig. 2. SFStreetSIModel, version 1.0, MPSM: 2D animation

Source: [1]

## 3 Micro Simulation Software Analysis

Useful baseline data as for instance geometric, functional and design characteristics of the street sections under study were conducted manually, combined with open-space methodology as well as with the use of GPS device in the vehicle (GARMIN nuvi 1390t). Afterwards, they were used as input parameters (Fig.3), for creation, simulation and analysis of the scenarios

into the SFStreetSIModel, version 1.0 and Synchro,7, (Fig.4). Namely, 10 hour micro-simulation of the defined urban area of scope has been carried out.

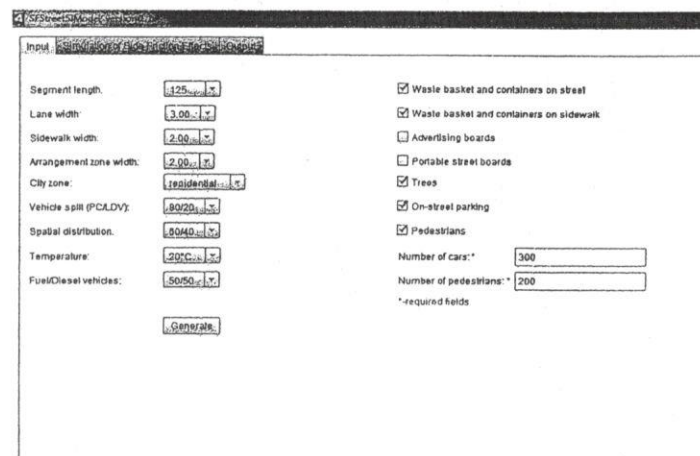


Fig. 3. Scenario example of Geometric, Functional and Design Characteristics of the street sections under study, simulated with SFStreetSIModel, version 1.0



Fig. 4. An example of Geometric, Functional and Design Characteristics of the street sections under study, simulated in Synchro,7

As it was mentioned before SFStreetSIModel, version 1.0, output parameters enable analysis of functional and environmental conditions at the studied locations, (Fig.5 and Fig.6).

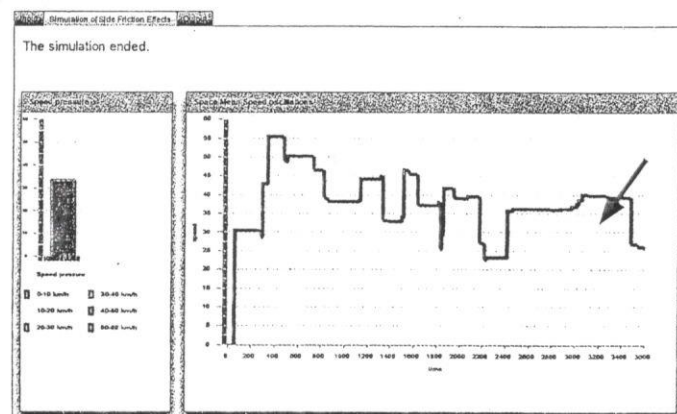


Fig. 5. An example of hourly Space Mean Speed Profile, simulated in SFStreetSIModel, version 1.0



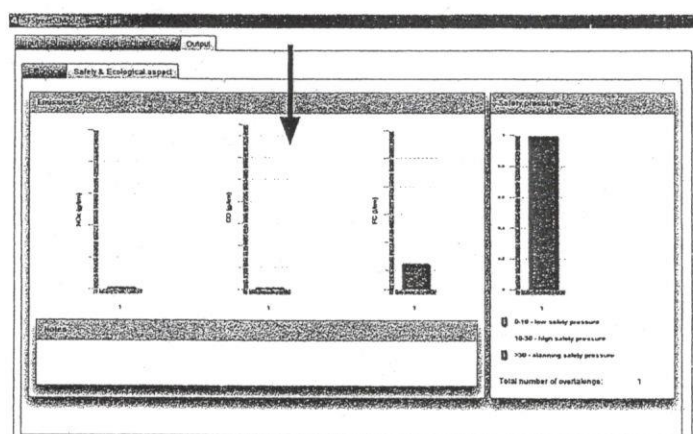


Fig. 6. An example of Pollution Levels (i.e. CO<sub>2</sub>, NO<sub>x</sub>) and Fuel Consumption for studied locations, simulated in SFStreetSIMModel, version 1.0

#### 4 Comparison of Results Obtained with Micro Simulation

It must be mentioned that in the process of method formulation some aspects of flow circulation in comparison to other (geometric elements, vehicular flow, etc), were considered. Since often, recorded results are not comparable among themselves if all the analytical methods used in the same case study are applied, here, the results obtained by studying were analyzed in terms of pedestrian level of service and emission levels, (Table 1).

As can be seen, the results obtained by both simulation software in 80-90% match. Namely, in the area of analysis the level of service for pedestrians is reduced, there is increased congestion, so that CO and NO<sub>x</sub> emissions are alarming in comparison to the upper threshold according to the Regulations of the Ministry of Environment of the FYROMacedonia, [5].

#### 5 Conclusion

The importance of traffic and traffic pollution in reported quality of life and pedestrian level of service in the downtown area of

Bitola, is observed by analyzing the results obtained with the use of two micro-simulation software's. The relationship between reported results suggest that the relationship between traffic and quality of life is strong. As traffic volumes increase the safety of our streets declines along with property value, air quality, and the quiet we enjoy in our living. Protecting our quality of life from traffic impacts boils down to minimizing the speed and volume of traffic, particularly the volume of truck traffic. Long after the comparison of the results the authors thought about the possible proposal of measures to alleviate this situation. Here is what we propose:

1. Inspire a vision by sharing concrete ideas and experiences from around the world providing resources, tools, and support for successful collaboration in the campaign to make our streets livable.
2. Sharing a vision with the press, to introduce media writers who cover lifestyle, health and environment with the meaning of street eco-design concept, in order to offer quotes, opinions, raise public awareness and articulate a vision of this issue.

At this point, it is only possible to propose a few hypotheses to explain this observation: traffic intensity might be judges via pollution or the traffic aggregation embedded in the level of service indicator might be just the way to aggregate traffic intensities over an area that corresponds best to perceptive evaluation.

The models obtained in this work provide an interesting step forward for building a general model for evaluating the overall impact of land use planning and mobility planning on the quality of life.

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Comparison of the functional and environmental simulation features, SFStreetSIMModel, version 1.0 vs. Synchro,7

Table 1.

Street (Name)	Pedestrian Level of Service		CO Emissions (g/km)		NO <sub>x</sub> Emission (g/km)	
	SFStreetSIMModel, version 1.0	Synchro,7	SFStreetSIMModel, version 1.0	Synchro,7	SFStreetSIMModel, version 1.0	Synchro,7
Ivan Milutinovic – Edvard Kardelj	B	B	0.21	0.4	0.10	0.27
Edvard Kardelj - Prilepska	D	E	0.16	0.43	0.08	0.08
15 Maj – Prilepska – Cvetan Dimov	C	B	0.11	0.56	0.06	0.11
4ti Noemvri – Boris Kidrik	C/D	D	0.22	0.17	0.12	0.23
Boris Kidrik – Nikola Tesla	D	C	0.18	0.29	0.09	0.15
Stolarska – Dobrovoje Radosavljevik	C	B	0.18	0.7	0.09	0.13
Zone total		/	1.06	2.55	0.54	0.97

Source: Results from SFStreetSIMModel, version 1.0 and Synchro,7 REPORTS

## SUMMARY

## SAŽETAK

Jasmina Bunevska Talevska  
Marija Malenkovska Todorova  
Hristina Trajcevska  
Hristijan Trajcevski  
Darko Milkovski

**Software Analysis of the Level of Air Pollution  
and Pedestrian Level of Service in the Downtown Area  
of Bitola, FYROMacedonia**

FYRO Macedonia is a country that needs improved transportation, land-use planning, mobility planning, less congested streets and more up-to-date, affordable and reliable transport systems. The transport system and services have suffered from decades of under-investment. The result is overcrowding, congestion, delays and pollution. Turning around this trend is not an easy task. The flow of vehicles, especially freight flows in and out of the urbanized areas has huge impact on the City, method of its operation, and the general quality of life. Inefficient transportation of goods and services contributes to congestion and higher emission levels, and has a demonstrable impact on the general quality of life, problems common across cities in the FYRO Macedonia. This paper is focused on the assessment of air pollution and pedestrian level of service in the downtown area of Bitola, through micro simulation software analysis and comparison. The overall aim was to introduce measures for emissions reduction, energy consumption, and to upgrade the overall quality of life as well.

**Key words:** software analysis, micro-simulation, emissions, level of service, pedestrians

Jasmina Bunevska Talevska  
Marija Malenkovska Todorova  
Hristina Trajcevska  
Hristijan Trajcevski  
Darko Milkovski

**Programska analiza razine zagađenja zraka  
i pješačke razine usluge u centru grada Bitole,  
FYRO Makedonija**

Bivša jugoslavenska Republika Makedonija je zemlja koja treba bolji transport, planiranje korištenja zemlje, planiranje mobilnosti, manje zagušene ulice i modernije, dostupne i pouzdane prijevozne sustave. Prijevozni sustav i usluge trpe posljedice od dugogodišnjeg manjka ulaganja. Rezultati su pretrpanost, zagušenje, zakašnjenja i zagađenje. Zaokret u ovom trendu nije lak zadatak. Tok vozila, naročito teretni toкови u gradska područja i iz gradskih područja imaju velik utjecaj na grad, metodu rada i opću kvalitetu života. Neučinkovit prijevoz roba i usluga pridonosi zagušenju i većim razinama emisija, i ima vidljiv utjecaj na opću kvalitetu života, probleme koji su zajednički svim gradovima u bivšoj jugoslavenskoj Republici Makedoniji. Ovaj se rad bavi procjenom zagađenja zraka i pješačkom razinom usluge u centru grada Bitole, pomoću mikrosimulacijske softverske analize i usporedbe. Opći je cilj bio uvesti mjere za smanjenje emisija, potrošnje energije, a također i poboljšanje opće kvalitete života.

**Ključne riječi:** softverska analiza, mikrosimulacija, emisije, razina usluge, pješaci