VALENTINA BASARIĆ, Ph.D.
E-mail: plast@uns.ac.rs
JELENA MITROVIĆ, M.Sc.
E-mail: mjelena@uns.ac.rs
ZORAN PAPIĆ, Ph.D.
E-mail: njele@uns.ac.rs
University of Novi Sad, Faculty of Technical Sciences,
Trg Dositeja Obradovića 6, 21000 Novi Sad, Serbia

Traffic in the Cities
Preliminary Communication
Accepted: July 4, 2012
Approved: May 23, 2013

PASSENGER CAR USAGE FOR COMMUTING TO WORK AS FUNCTION OF LIMITED STAY AT CAR PARKS

ABSTRACT

Following the implementation of different transport policy measures, the analysis of experiences in the European cities has led to the conclusion that parking policy measures have the dominant effect on the choice of private car as a mode of transport. This effect is the greatest for the commutes to work, characterized by the longest duration of parking space occupancy. Given the aforementioned experiences in developed European cities, the main aim of the study presented here was the determination of the relationship between limiting the duration of parking space occupancy in the Novi Sad city centre and the transport participants' decision whether or not to use passenger car to commute to work. Based on the established interdependence between these parameters, a mathematical model has been developed for calculating the number of expected car (commuting) journeys that terminate in the city centre as function of limited duration of parking space occupancy.

KEY WORDS

parking policy, passenger car usage, commuting trips, mathematical model

1. INTRODUCTION

Modern city lifestyle is contingent on passenger car usage as the main mode of transport. The key problem of city traffic stems primarily from high participation of passenger cars that create high demand, i.e. utilize the greatest proportion of street network capacity (transport system supply), and yet have the lowest specific utility compared to all transport modes in the cities. A particular problem that emerges due to the overuse of passenger cars is an increasingly evident misbalance between demands—the requirements and actual capacity—on parking spaces. Thus the city centre, typically with the greatest concentration of commercial activities, suffers from the greatest spatial concentration of traffic. Within that area, the existing urban facilities limit the number of options when attempting to solve the transport problems and require carefully considered transport and parking policies, as well as their subsystems. The necessity of maintaining the appeal and economic efficacy of city centres creates the need for analyzing the effects of all implemented transport policy measures in the city on the entire user structure.

The journeys motivated by the commutes to work have permanent character, occur daily and are typically conducted in the peak demand periods, in which they predominate. These journeys imply longer stays, compared to those related to shopping, private business, visits, leisure, etc. and thus lead to longer parking space occupancy.

Given the aforementioned experiences in the developed European cities, the main aim of the study presented here was to determine the relationship between limiting the duration of parking space occupancy in the Novi Sad city centre and the transport participants' decision whether to use passenger car or an alternative mode of transport for their journeys. Based on the established interdependence between these parameters, a foundation for the mathematical model of modal commuting trip distribution was formed. Such models can be used to calculate the number of expected car journeys that terminate in the city centre and the proportion of the same users that opt for an alternative mode of transport, as function of limited duration of parking space occupancy. In addition to a range of statistical and logical validity tests, the developed model was tested practically in the Novi Sad city centre.

2. BACKGROUND RESEARCH

Limiting the duration of stay at car parks, as a transport policy element, is one of the key tools for reducing passenger car usage [1, 2, 3]. The increase of motorization and shortage of parking capacity, as well as requirements of business- and shopping-related traffic necessitated area-wide management of inner city parking facilities in many European cities [4]. Parking policies in these cities include different measures, such as determining the required number of parking spaces, limiting the duration of stay at car parks, establishing parking tariffs as function of demand of different user groups (employed, visitors, residents, etc.). As part of the study COST 342 "Parking Area Policy and its Effects on Mobility and the Economy" [4], the effect of parking policy in different cities (Graz, Linz, Wr. Neustadt, Vienna, Zurich, Mons, Helsinki, Riga, etc.) in 18 European countries participating in the project was shown.

The parking measures implemented in Bern [5] targeted primarily commuters to work, motivating them to use more environmentally-friendly transport modes, primarily public transport, as the available parking spaces are reserved for city centre visitors. Possibly, the key parking policy instrument is the introduction of the so-called "Blue zones", where during the workdays the stay at car parks is limited to 60 minutes in the period between 8 a.m. and 6 p.m., with 3-hour limit imposed to the stays during the rest of the day. The local residents and companies operating in these zones are given the opportunity to purchase a parking permit that allows unlimited stay at available parking spaces in their district, with daily permits offered to visitors and other users. The positive outcome of the introduction of these measures is a significant reduction of average traffic volume (by 15%), as well as 14% and 21% reduction of morning and afternoon peak period commutes, respectively. In addition, the number of passenger cars in these districts declined by 13%, due to the 10% reduction in available street parking. Consequently, as average parking space occupancy declined by 13%, the local residents can now find available parking more easily and do so faster than before. The key aspect of the introduction of "Blue zones" was the relocation of parking spaces commuters occupy for long periods to other zones and/or their shift to other transport modes. As result, the number of shoppers and visitors increased, as the area became more accessible and attractive to this user group.

A similar strategy, relying on parking zones with limited duration of stay, was implemented in Linz [6], and its positive effects are most apparent in mitigation of the problems caused by long parking space occupancy, which led to better utilization of available capacity. Traffic volume was also reduced, as the proportion generated by the drivers looking for free spaces was largely eliminated, thus limiting the negative effects on the environment.

In Wiener Neustadt [6], a study was conducted before and after the implementation of a parking regime based on limited stay and tariffs. The findings revealed that, of all commuters to work who had previously used passenger cars, after the introduction of the policy, 38% chose to use parking spaces in zones not affected by the changes. Private parking spaces and garages were used by 33% commuters to work, 23% opted for an alternative mode of transport and 8% parked illegally on the street.

The effects of the implementation of a new parking regime in Vienna [6] were also examined through two studies—before and after the introduction of tariffed limited stay zones—and the findings showed that a quarter of the visitors that had previously used passenger cars shifted to public transport. In the morning peak period (between 9 and 11 a.m.), the parking space utilization was reduced by about 25% in all zones affected by the new parking regime, with 10% reduction in the evening peak period (8 to 10 p.m.). Moreover, the traffic generated by drivers looking for parking spaces was reduced from 10 million passenger car kilometres annually, to 3.3 million, and the average time taken to find a free parking space declined from 9 to 3 minutes.

In Lisbon [4], after the introduction of limited stay parking, the public transport utilization increased from 27% to 35%, mostly due to the modal shift of commuting journeys. In addition, the usage of "park-and-ride" system increased from 5% to 8%, whereas 10% to 17% was achieved in those related to commutes to work in the city centre.

3. METHODOLOGY

For the purpose of developing and testing the model, two studies were conducted in different time periods on the territory of Novi Sad city centre. The first group of measurements of parking characteristics was collected in October 2004 [7] at four car parks, before the parking zones and their corresponding tariffs and controls were implemented. The aim of this first study was a dataset on the key parking characteristics (occupancy, turnover, duration of stay per user, acceptability of parking charges, as well as potential identification of the modal split across alternative means of transport) and identification of input data for the formation of commuter trip modal split model. The qualitative survey data was further analyzed with regards to the car park users' purpose of the visit to the town centre, as commuting trips were segregated from other reasons for travel.

The key assumptions on which the model is formed are (1) that the number of commutes made by passengers working in the city centre is equal to the number of parking spaces occupied for the same reason, and (2) the attractiveness of the city centre for commuting to work by any means of transport is constant.

The duration of car park space occupancy (length of stay in the car park) for this group of users was selected as a model input variable. The cumulative distributions of stay (cumulative relative frequencies) were also analyzed and modelled. This enabled the development of a model that identifies the number of passenger car users that will continue to use this mode of transport for work commutes once the measures limiting the duration of stay in the city centre car parks are introduced.

Based on this interdependency, a model for determining the number of commutes for work purposes was developed, after the duration of stay at all city centre car parks has been limited:

$$A_{ls\,t}^{pc} = A_b^{pc} \times CRF_{va}^{1} \qquad (1)$$

where:

$A_{ls\,t}^{pc}$ – number of passenger car commutes to work after the introduction of limited stay (t) at the city centre car parks;

A_b^{pc} - number of passenger car commutes to work before the introduction of limited stay at the city centre car parks;

CRF_{va}^{1} – cumulative relative frequency;

$$CRF_{va}^{1} = \frac{\text{percentage of users occupying parking space up to time } t}{100} \qquad (2)$$

The results of the study conducted in 2009 [8] were analyzed in order to test the model's ability to determine the number of passenger car commutes to the Novi Sad city centre.

The research conducted was aimed at developing NOSTRAM Transport Model [8] at the city centre car parks, where the tariffed parking zone system limiting the duration of stay to maximum 2 hours has already been in place for a considerable time. By comparing the journey distribution by purpose, before and after the introduction of the parking policy in Novi Sad, the effect of these measures on the overall attractiveness of the city centre was analyzed for different user groups (local residents, commuters, visitors, etc.)

4. MODEL DEVELOPMENT RESULTS

The data pertaining to the number of surveyed car park users that commuted to work and their duration of car park occupancy obtained in the study conducted in 2004 [7] were collated for all four car parks and shown in *Table 1*.

Table 1 - Number of surveyed car park users that commuted to work and their duration of car park occupancy

Interval (min)	Group mean x	No. of users F
0-30	15	14
31-60	45	4
61-90	75	1
91-120	105	9
121-180	150	2
181-240	210	2
241-300	270	5
301-360	330	5
361-420	390	11
421-480	450	24
481-540	510	3
541-600	570	0
601-660	630	1
661-720	690	1

In line with the results reported by other authors in this field [9, 10, 11], while determining variable dependency, it was established that the best results were obtained by applying a logistic curve, thus yielding a functional dependence between duration of car park occupancy and cumulative relative frequency CRF:

$$CFR = \frac{1}{1 + e^{-(b_0 + b_2 \cdot x)}} \qquad (3)$$

Or, in a transformed (linearized) form:

$$y = \ln \frac{CRF}{1 - CRF} = b_0 + b_1 \cdot x \qquad (4)$$

Number of unknown parameters: 2;

Validation method: ordinary least squares applied to linearized model;

Independent variable: CRF;

Dependent variable: X (group mean);

Number of data pairs: 13;

Coefficient of determination: R2=0.9155;

Validated regression model:

$$CRF = \frac{1}{1 + e^{2.10206 - 000976 \cdot x}} \qquad (5)$$

According to the t-test, the hypothesis on statistical significance of the parameters b0 and b1 was confirmed.

Table 2 - Variable descriptions

VARIABLE	Mean value	Standard deviation	Minimum	Maximum
Duration of car park occupancy X	317.1429	227.3232	15.00000	690.0000
No. of users F	5.8571	6.6778	0.00000	24.0000

Parameter	Validated value	Standard error	t-test	Error risk	Lower confidence interval limit (5%)	Higher confidence interval limit (5%)
b_0	-2.10206	0.313882	-6.697	<1%	-2.79291	-1.41121
b_1	0.00976	0.000894	10.918	<1%	0.00779	0.01172

Table 3 - Original and validated values

R. No.	Interval (min)	X	CRF1	y	yva	Residual=y-yva	CRF1va
1	0-30	15	0.1707	-1.5805	-1.95570	0.37525	0.1239
2	31-60	45	0.2195	-1.2685	-1.66299	0.39448	0.1594
3	61-90	75	0.2317	-1.1987	-1.37029	0.17159	0.2026
4	91-120	105	0.3415	-0.6568	-1.07758	0.42080	0.2540
5	121-180	150	0.3659	-0.5500	-0.63851	0.08847	0.3457
6	181-240	210	0.3902	-0.4463	-0.05310	-0.39319	0.4869
7	241-300	270	0.4512	-0.1957	0.53232	-0.72807	0.6302
8	301-360	330	0.5122	0.0488	1.11774	-1.06895	0.7538
9	361-420	390	0.6463	0.6030	1.70316	-1.10016	0.8461
10	421-480	450	0.9390	2.7344	2.28857	0.44579	0.9080
11	481-540	510	0.9756	3.6889	2.87399	0.81489	0.9466
12	541-600	570	0.9756	3.6889	3.45941	0.22947	0.9696
13	601-660	630	0.9878	4.3944	4.04483	0.34962	0.9828
14	661-720	690	1.0000		4.63234		0.9904

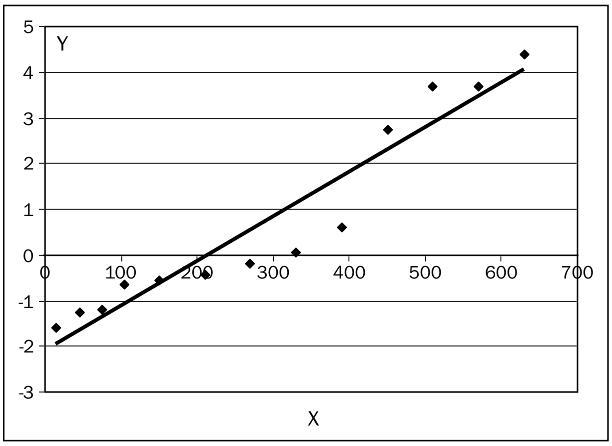

Figure 1 - Scatter diagram of X (group mean) and Y (transformed value of the number of users)

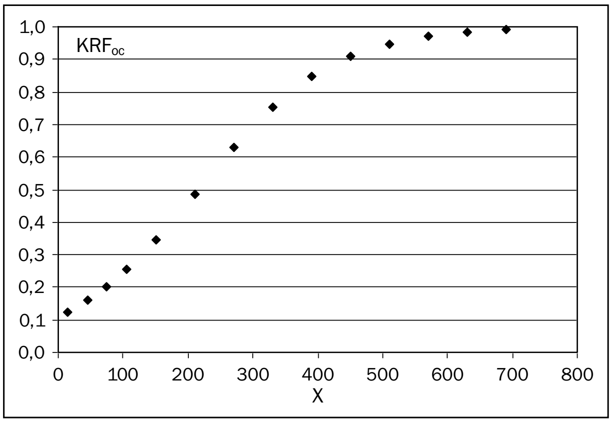

Figure 2 - Scatter diagram of X (group mean duration of car park occupancy) and CRF^1_{va} (cumulative relative frequency)

5. THE RESULTS OF TESTING THE MODEL ON THE CASE OF NOVI SAD AND THEIR ANALYSIS

The potential for practical application of the developed model and the quality of its output have been tested using the data collected as part of the studies conducted in 2004 [12] and 2009.

The model was applied to commutes to work that terminated in District 1 (*Figure 3*).

The number of passenger car work commutes to the city centre in 2004 and the choice of transport mode were sourced from the database created in October 2004 for the purpose of the project aimed at monitoring local and intercity public transport for the Novi Sad area [12].

In 2004, the total number of daily work journeys using different modes of transport (*Table 4*) that terminated in the city centre was 7,020, of which 31.8% (2,232) were made by passenger cars.

Assuming specific values for limited duration of car park occupancy and applying the previously developed model (Eq. 1), the number of passenger car work commutes into the city centre was determined (*Table 5*).

The model output results were compared to the findings of the study on parking characteristics conducted in 2009 [8].

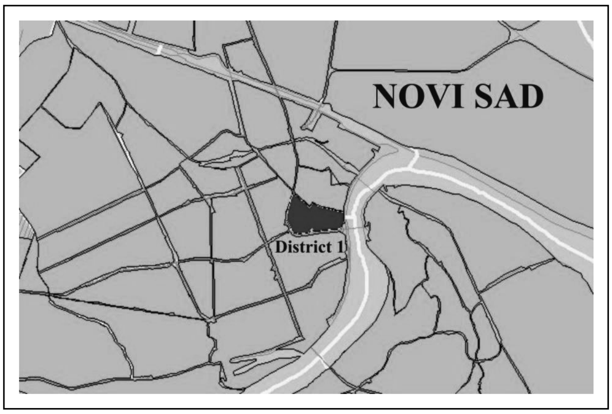

Figure 3 - District 1

By 2009, all city centre car parks had been subjected to the tariffed limited stay regime, with maximum car park occupancy of 2 hours (red zone). The exceptions are two car parks (blue zone) and one parking garage, where hourly parking fares apply and stay is not limited, which prompted the need for the adjustment of the model output values through several iterations. The total number of parking spaces was not significantly changed in 2009 compared to the year 2004. All parking places in District 1 are placed under the regime based on limited stay and tariffs. The area of research included about 814 parking spaces in 2009: parking garage has a capacity of 100 places and all other places are on-street parking.

In the total number of daily arrivals to the city centre car parks (4,012), passenger car work commutes contribute by 25.4% (1,019).

$A_{1\ \ ls}^{pce} = 1,019$ daily passenger car work commutes;

$A_{1\ \ ls}^{pce}$ – empirically established value.

The data from the same study indicate that 10.9% (111) users who use the same car parks for work purposes have parking permits, which led to the adjustment in the model application (*Table 5*) by deducting this number from the total, as for the passengers with permits the parking restrictions do not apply:

$$A_{1\ \ ls}^{pcm} = \left(A_{1\ \ b}^{pc} - B_{pp}\right) \times CRF_{va}^{1} + B_{pp} \tag{6}$$

$$A_{1\ \ ls}^{pcm} = (2,232 - 111) \times 0.2827503 + 111 = 711$$

where:

B_{pp} – number of parking permits;

$A_{1\ \ ls}^{pcm}$ – model-derived number of passenger car work commutes.

The existence of a large number of parking spaces in the parking garage where lower hourly rates and unlimited stay apply results in a greater number of work commutes (40% or 202). Theoretically, if the same restrictions that apply to all other car parks in the city centre were introduced at this location, based on the aforementioned duration of car park occupancy rule, only 57 would continue to use the garage. The same is true for the two city centre car parks with no maximum stay, where the survey revealed 183 work commuters per day. Assuming that the maximum 2-hour stay was imposed, it is estimated that this number would decline to 52. Applying these adjustments, a new empirical value for passenger car work commutes was obtained:

$$A_{1\ \ ls}^{pce\,adj} = A_{1\ \ ex.gb}^{pce} + A_{1\ \ g}^{pce} \times 0.2827503 + \\ + A_{1\ \ b}^{pce} \times 0.2827503 \tag{7}$$

$$A_{1\ \ ls}^{pce\,adj} = 634 + 202 \times 0.2827503 + \\ + 183 \times 0.2827503 = 743;$$

where:

$A_{1\ \ ls}^{pce\,adj}$ – adjusted empirical value;

$A_{1\ \ ex.gb}^{pce}$ – number of passenger car work commutes to car parks in District 1, excluding parking garage and parking spaces in the blue zone;

$A_{1\ \ g}^{pce}$ – number of passenger car work commutes to the parking garage;

Table 4 - Work commutes to District 1 using different transport modes [12]

Transport mode	Pedestrians	Passenger car	Public transport	Bicycles	Other	Total
No. of journeys	1,067	2,232	3,510	98	112	7,020
%	15.2	31.8	50.0	1.4	1.6	100

Table 5 - Model-derived work commutes to District 1 using different transport modes

Maximum duration of car park occupancy (t)	CRF_{va}^{1}	Number of passenger car commutes $CRF_{1\ \ ls}^{pcm}$	Participation of passenger car journeys in the total number of work commutes (%)
30 min	0.1407276	314.104	4.474
60 min	0.1799834	401.723	5.722
90 min	0.227293	507.32	7.227
120 min	0.2827503	631.1	9
180 min	0.4145323	925.23	13.18
240 min	0.5597974	1,249.47	17.8

Table 6 - Passenger car participation in the modal split of commuting trips (work commutes)

Total number of passenger car journeys $A_{1\ ls}^{pc}$ (Maximum duration of car park occupancy – 120 min)	Participation of passenger car journeys in the total number of work commutes (%)
– model-determined value $A_{1\ ls}^{pcm} = 711$	10.13
– empirical number of journeys $A_{1\ ls}^{pce} = 1{,}019$	14.52
– adjusted empirical value $A_{1\ ls}^{pce\ adj} = 743$	10.58

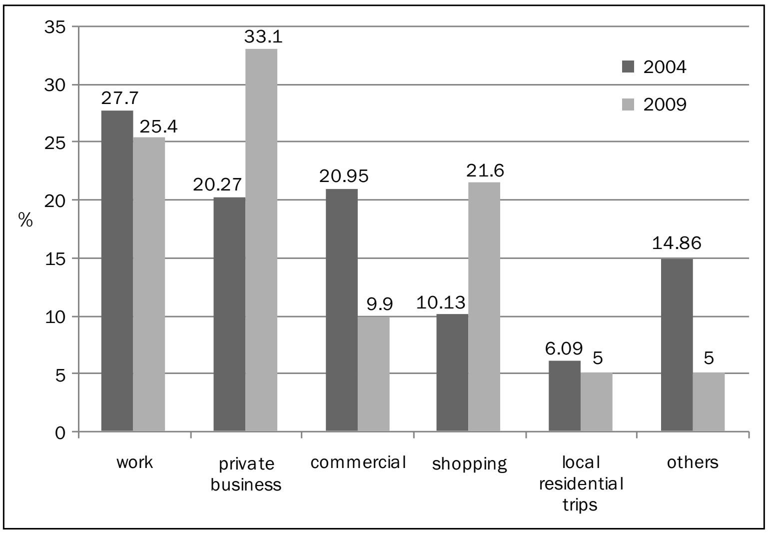

Figure 4 - Participation of different travel purposes before and after the introduction of parking zones

$A_{1\ b}^{pce}$ – number of passenger car work commutes to the blue zone.

By applying these restrictions uniformly across the entire district, the empirical value and the model output converge. Considering that the number of work commutes (7,020) is a fixed value, the passenger car participation in the total number of commuting trips was calculated (*Table* 6):

Comparative analysis of other data obtained in the parking characteristics studies conducted before and after the parking zones were implemented in the Novi Sad city centre has shown significant effect of passenger car access restriction policy on the increased attractiveness of this area. Limiting the duration of stay and the introduction of parking tariffs have resulted in the reduction in passenger car work commutes to the city centre and a significant increase in the appeal of this district as a commercial, cultural and recreational travel destination (*Figure 4*).

6. CONCLUSION

The analysis of the effects of application of new city transport policy measures reveal that the emphasis should be placed on the existing infrastructure optimization, management of transport demand, as well as the promotion of modal split that favors increased utilization of public and other environmentally friendly forms of transport, such as walking and cycling. With respect to transport demand, the measures with the greatest effect on modal split shift from passenger car to other modes of transport are parking tariffs, i.e. cost of parking, limiting the parking space occupancy, and stringent parking control and monitoring measures. Of particular importance for successful development and implementation of these measures is the method of the so-called integrated city transport management [13, 14, 15, 16].

Following two studies on parking characteristics in Novi Sad city centre, conducted in two different time periods, two very different 'pictures' of parking indicators in this district emerged. The first study relates to the period before the introduction of parking zones with limited duration of occupancy, and the second to the conditions following the implementation of those measures.

Comparative analysis of the datasets these studies yielded revealed a significant reduction in the number of parking spaces occupied by commuters to work. As expected from the parking characteristics analysis that compared the conditions before and after the introduction of the new tariff system, it could be concluded that parking system parameters have a direct and measurable effect on the mode of transport used by commuters to work that terminate their journeys in the zones where new parking regime is in place.

The study results have met the expectations in terms of utilizing the empirical data for developing a model for determining the distribution of passenger car commuting trips as function of limited duration of parking space occupancy. Model parameters meet all statistical conditions necessary for its reliability, suggesting that the hypothesis on statistical significance of the identified parameters can be accepted. Hence, it can be concluded that the mathematical method used has proven the hypothesis that the transport mode used for commutes to work that terminate in the zones with limited duration of parking space occupancy is interrelated with the parking system regime implemented in those zones. To summarize, the study indicates that the parking system measures can be used to manage the modal distribution of transport demand.

Further studies should focus on the impacts of parking system measure relative to the usage of public transport and non-motorized travel modes, bicycle use in particular. Alternative means of transport, primarily public transport, must create conditions that can meet the growing demands, and provide the level and quality of service that would motivate the users to make the modal shift. Secondly, partial implementation of any transport policy or land usage measure cannot yield adequate results. In other words, limiting passenger car access to certain zones is insufficient. Economic sustainability, as one of the aspects of transport system sustainability, implies the right to accessibility, as a precondition for competitiveness and economic viability. The following measures have proven to make a significant impact on transportation demands, especially at peak hour periods: quality of public transport service and various aspects of parking management policy, such as parking fares, limiting duration of stay, limiting available parking spaces etc. In addition to the application of different regulative and economic measures that proved particularly influential in reducing car usage, the implementation of so-called "soft measures" within the last decade has started to gain in significance. Hence, in addition to analyzing and modelling the effects of other parking policy elements, such as parking tariffs, on the modal shift, developing a new model that would enable integrated transport system management in cities will be the next challenge.

Finally, future research should be based on producing a city demand model in order to test different combinations of city transport policies against the total scope of travelling and modal split at peak periods.

ACKNOWLEDGMENTS

This work is a part of the research project "Models of integration of the transport system", No.TR 36024, funded by the Ministry of Education and Science of Serbia and the project "Models of the sustainable development of the traffic in Vojvodina" No. 114-451-2273/2011, funded by The Provincial Secretariat for Science and Technological Development.

VALENTINA BASARIĆ, Ph.D.
E-mail: plast@uns.ac.rs
JELENA MITROVIĆ, M.Sc.
E-mail: mjelena@uns.ac.rs
ZORAN PAPIĆ, Ph.D.
E-mail: njele@uns.ac.rs
University of Novi Sad, Faculty of technical sciences,
Trg Dositeja Obradovića 6, 21000 Novi Sad, Serbia

REZIME

KORIŠĆENJE AUTOMOBILA ZA ODLAZAK NA POSAO U FUNKCIJI OGRANIČENJA DUŽINE ZADRŽAVANJA NA PARKIRALIŠTIMA

Analizom iskustva u primeni pojedinih mera saobraćajne politike evropskih gradova, nesumnjivo se može izvući zaključak da mere politike parkiranja imaju dominantan uticaj na izbor automobila kao vida prevoza. Taj uticaj je najveći na radna putovanja za koja su karakteristična najveća zadržavanja na parkiralištima. Imajući u vidu navedena iskustva u razvijenim evropskim gradovima, osnovni cilj istraživanja prikazanih u ovom radu je bio utvrđivanje zavisnosti između ograničenja dužine zadržavanja vozila na parkiralištima centralnog distrikta u Novom Sadu i krajnje odluke korisnika da li za odlazak na posao da korsite putnički automobil ili ne. Na osnovu utvrđene zavisnosti između parametara, formiran je matemartički model za izračunavanje očekivanog broja dolazaka putničkim automobilom u centralnu zonu kao funkcija ograničene dužine zadržavanja vozila na parkingu.

KLJUČNE REČI

politika parkiranja, korišćenje putničkog automobila, radna putovanja, matematički model

REFERENCES

[1] **Malić, A.**, **Pušić, M.**, **Gudelj, M.**: *Analytic approach to resolving parking problems in downtown Zagreb*, Promet – Traffic, Vol. 17, No. 1, 2005, pp. 55-63

[2] **Malić, A.**, **Brčić, D.**, **Krasić, D.**: *Parking measures in travel demand management*, Promet – Traffic, Vol. 12, No. 5-6, 2000, pp. 301-309

[3] **Van der Waerden, P.**, **Borgers, A.**, **Timmermans, H.**: *Attitudes and Behavioral Responses to Parking Measures*, European journal of transport and infrastructure research, Vol. 6, No. 4, 2006, pp. 301-3012

[4] REPORT on COST Action 342, *Parking policies and the effects on economy and mobility*, August, 2005

[5] COST 342/18/CH, *Parking policy measures and their effects on mobility and the economy*, Swiss Case Studies, May 2001

[6] COST 342/19-A Rev.1, *Parking policy measures and their effects on mobility and the economy*, Overview of

national/regional parking policies – Austria, December 2000

[7] **Basarić, V.**: "*Uticaj sistema parkiranja na raspodelu putovanja na vidove saobraćaja*", Master Thesis, Faculty of Technical Sciences, Novi Sad, 2006

[8] "*Saobraćajna studija grada Novog Sada sa dinamikom uređenja saobraćaja - NOSTRAM*", JP "Urbanizam", Novi Sad, 2009

[9] **Koppelman, F. S.**, **Bhat, C.**: *A Self Instructing Course in Mode Choice Modeling: Multinomial and Nested Logit Models*, U.S. Department of Transportation, Federal Transit Administration, 2006

[10] **Ben-Akiva, M.**, **Lerman, S.R.**: *Discrete Chioce Analysis: Theory and Application to Travel Demand*, The MIT Press, Cambridge, 1985

[11] **McFadden, D.**: *Conditional logit analysis of qualitative choice behaviour*, Frontiers in Econometrics, Volume 1, No. 2, 1974, pp. 105-142

[12] "*Projekat odvijanja javnog gradskog i prigradskog prevoza putnika u Novom Sadu*", JP "Urbanizam", Novi Sad, 2004

[13] **Tennoy, A.**: *Why we fail to reduce urban road traffic volumes: Does it matter how planners frame the problem?*, Transport Policy, Vol. 17, Issue 4, 2010, pp. 216-223

[14] **Owens, S.**: *From 'predict and provide' to 'predict and prevent'?: pricing and planning in transport policy*, Transport Policy, Vol. 2, Issue 1, 1995, pp. 43-49

[15] **Owens, S.**, **Cowell, R.**: *Land and Limits: Interpreting Sustainability in the Planning Process*, Routledge Taylor & Francis Group, London and New York, 2002

[16] **Stantchev, D.**, **Menaz, B.**: *Third Annual Thematic Research Summary – Land Use Planning*, Deliverable D2.E-4.7 from the EXTR@Web Project, Transport Research Knowledge Centre, 2006