VEHICLE PARKING STANDARDS AS A SUPPORT TO SUSTAINABLE TRANSPORT SYSTEM: BELGRADE CASE STUDY

Nada Milosavljevic[1], Jelena Simicevic[2] and Goran Maletic[3]

University of Belgrade, Faculty of Transport and Traffic Engineering,
Vojvode Stepe 305, Belgrade, Serbia
E-mail: [1]n.milosavljevic@sf.bg.ac.rs

Abstract. Vehicle parking standards are related exclusively to parking in connection with: planning, construction, development and/or extension and change of use of the existing developments. On the other hand, vehicle parking standards are the key measure for managing the level of traffic and they should be an integral part of the urban transport policy. This would allow the parking standards to be applied also to the land use management in accordance with accessibility to the urban zones by means of travel other than by car. This implies that in the course of producing vehicle parking standards the level of parking restrictions is to be defined depending on the Public Transport Accessibility Level. If Public Transport Accessibility Level of a zone the subject development belongs to is high, the number of parking spaces to be provided is restricted and customers are encouraged to shift to alternative transport modes. Thus defined parking standards assist in the development of sustainable transport system. This paper will present the methodology for calculation of parking standards depending on the accessibility of the zone the subject development is located within.

Keywords: parking standard, public transport accessibility level, degree of attractiveness, sustainable transport system, land use, Belgrade

1. Introduction

The White Paper which defines the European Transport Policy sets out the basic principles of transport policy which, among other things, promote the changes in procedure policy and transport planning (Commission of the European Communities 2001). The modern concept encourages development of sustainable urban mobility which is dependent upon achieving the best possible balance between all modes of transport by prioritizing non-car modes: public transport, pedestrian traffic, cycle traffic, etc.

In view of the fact that parking policy represents a particularly efficient instrument for urban mobility management, the change in the concept of parking solutions in cities and built-up areas has found its place. The majority of the European Union countries and the member countries of the "International Association of Public Transport" (UITP) chose to define the framework for achieving improved integration of traffic and urban land use. For this purpose local authorities are expected to adopt maximum parking standards as an incentive measure to support sustainability through limitation of the number of parking spaces when new developments, extensions or change in use of the already existing developments are in question (International Association of Public Transport 2000). This approach is an attempt to apply a different set of standards to new developments depending upon the degree of attraction of the urban zones, but also upon the Public Transport Accessibility Level (hereinafter referred to as: PTAL). Presently in Belgrade the urban standards for some uses are specified by the Belgrade Master Plan which represents the main planning document of the City. For other uses, Master Plan provides that it is required to perform adequate analyses of parking demands and it also provides the way of their solution (Institute of Urbanism Belgrade 2003). The existing practice indicates that the consultants that produce planning documents and even the institutions that issue planning permissions use a range of sources, primarily foreign ones.

Such application of standards is not reliable and it does not contribute to solving the highly pronounced parking problem in the city, particularly in the central zones and the zones of high attractiveness (Milosavljevic *et al*. 2007b). Namely, exclusivity of some contents and their position in the urban tissue require completely altered approach to parking provision planning.

In connection with this the City Administration, namely the Belgrade Land Development Public Agency, commissioned the Institute of the Faculty of Transport and Traffic Engineering from Belgrade to produce the Study on Vehicle Parking Standards for parking conditions in the City of Belgrade (Milosavljevic *et al*. 2007a), with the objective to redefine the existing standards, specify procedure for their monitoring and adjustment in order to provide sufficiently updated standards for the given time. The area covered by this Study is the area covered by Master Plan and it is divided into twenty two zones with identical general spatial characteristics.

Since this issue has not yet found its place in the transport policy of the City of Belgrade, the authors chose to promote the approach which puts the standards into the function of attractiveness and accessibility of the space the subject use is located within.

This paper presents the procedure for calculation of parking standards for the previously performed area zoning according to attractiveness and according to PTAL.

This paper is organized as follows: Section 2 presents recent studies related to vehicle parking standards. Section 3 presents statement of the problem. The proposed solution to the problem is given in Section 4. An example of calculation of standards according to applied methodology (culture: cinemas and theatres) is shown in Section 5. Finally the Section 6 presents the Final Considerations.

2. Literature

After 2000 in many European countries, parking standards have provided a shift in emphasis, away from seeking minimum levels of parking associated with new developments and

towards maximum levels, but imposing minimum standards that must be achieved for cycle/motorcycle parking to encourage alternative means of travel other than by car (Rushmoor Borough Council 2003; ODPM 2002). This concept has also been supported by the papers of American authors published in the last decade of 20th century. (Shoup 1995, 14-28; Shoup 1999: 549–574). Maximum vehicle parking standards indicate the typical reduction in the amount of parking required for 10–30% (Litman 2010). In addition, it is important to note that there is no systematic evidence to suggest that either lax parking standards encourage or that strict standards discourage economic growth (Marsden 2006). Thus maximum standards contribute to sustainable urban development without negative effect on local economy.

Nowadays many authors recommend an approach to parking standards for the zone the subject development is located within to be based on PTAL (Beaumont 2002; Finch *et al.* 2002). Besides introducing PTAL, defining parking standards based on the degree of attractiveness of the zone the subject development belongs to is also suggested (COST Secretariat 2001; Valley *et al.* 1997). The degree of attractiveness refers to the degree of traffic congestion in CBD and economic sustainability.

Methodology for calculating parking standards could not be replicated from Parking Generation (Institute of Transportation Engineers 2004) for several reasons: (1) peak parking demands were used to set minimum parking standards (Shoup 1999: 549–574); (2) parking standards for the entire city area were defined using only surveyed developments located at suburban sites (Willson: 1995: 29–42); (3) for some land uses parking demand was unrelated to the floor area in the sample; nevertheless parking standard for these land uses was defined by floor area (Shoup 1999: 549–574).

An interesting recent approach from the Chinese cities define parking standards according to zones based on the characteristics of parking demand and the directions of parking development policies (Zeng *et al.* 2009).

For determining parking standards, "local aspect" is the most important: car ownership, land use, etc. (Al-Masaeid *et al.* 1999: 79–84; Bond 2002); as well as choosing the adequate parameter which would define the parking standard in the best way possible (Dorsett 2007: 40–43); therefore, calculated parking standards and methodologies for their calculation are not to be directly replicated (Willson 1996).

3. Statement of the problem

Vehicle parking standards for parking conditions in the City of Belgrade for the specific-use developments are defined depending upon:

– Degree of attractiveness of the zone the subject development belongs to. Degree of zone attractiveness is defined as the number of movements of citizens per day by all means of transport and for all purposes reduced to one hectare of the zone area, and

– PTAL of the zone the subject development belongs to. PTAL contains density of public transport network, connectivity of public transport network and the perceived quality of service. Density of public transport network is defined as the ratio between the length of corridors on which public transport lines operate in one zone and the total area of the zone. Connectivity of public transport network is related to the number of zones

the subject zone is connected with by public transport. Perceived quality expresses the level of customers' satisfaction with the public transport system (Filipovic *et al.* 2009).

Ranking of Belgrade zones covered by this Study according to degree of attractiveness is presented in Figure 1, and classification of zones according to PTAL is presented in Figure 2.
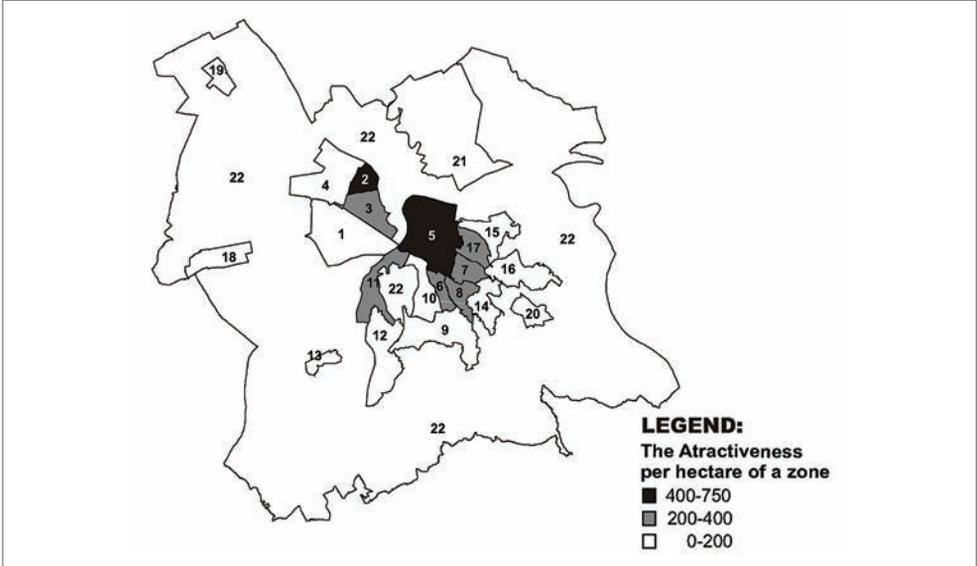

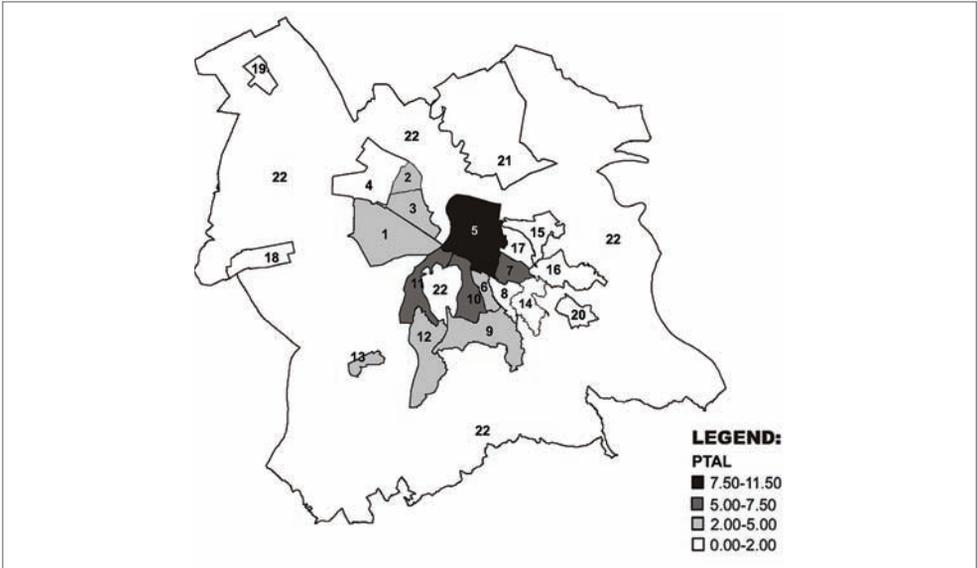**Fig. 1.** Ranking of zones covered by the Study according to attractiveness

Fig. 2. Ranking of zones covered by the Study according to accessibility

From the aspect of attractiveness the zones are classified into three ranks: zones of "high attractiveness", zones of "medium attractiveness" and zones of "low attractiveness", and from the aspect of PTAL into four accessibility levels: "very high", "high", "medium" and "low" accessibility.

Degree of attractiveness of a zone or classification of each of 22 zones into certain attractiveness rank is taken over from the Transport Model of Belgrade (Jovic *et al.* 2006). Pertaining of a zone to certain PTAL is taken over from the Study done by Milosavljevic *et al.* (2007a), Table 1.

Table 1. Accessibility coefficients per zones of certain PTAL

Zone per PTAL	Zone	PTALs
Very high (I)	5	11.50
High (II)	7, 10, 11	6.15
Medium (III)	1, 2, 3, 6, 9, 12, 13	3.38
Low (IV)	4, 8, 14, 15, 16, 17, 18, 19, 20, 21, 22	1.09

Standards are calculated depending on the coefficient of accessibility of the zone the subject development is located within, and they may be interpreted in different ways depending upon zone attractiveness: in the zone of high attractiveness the calculated standard represents maximum, in the zone of medium attractiveness optimally and in the zone of low attractiveness minimum permitted number of parking spaces.

The developments are classified according to their basic uses: culture, education, administrative and business-financial, retail, residence, hospitality, services, manufacture, leisure/entertainment, health, sport and other.

During calculation of standards the following assumptions were taken into account:

– Parking standard depends on PTAL. As accessibility level of the zone increases the standard decreases (becomes less stringent).
– The standard should satisfy peak parking demand from the group of the surveyed developments belonging to the 95 percent confidence level.
– Peak parking demand for some specific development is determined by conducting the survey in which special methodology is applied.
– Calculated standard should be, to a certain degree, correlated with the current one (not higher than the one established on the basis of the surveyed demands).

4. Proposed solution to the problem

The procedure includes two basic phases:

Phase 1: Definition of correlation between standards per zones.
Phase 2: Definition of standards per zones with certain PTAL.

A development sample has been surveyed in order to collect the data necessary for definition of parking standards.

4.1. Methodology of survey

The aim of the survey was to estimate parking demands generated by the subject development as well as to collect the data on development's parameters.

The survey included developments in different zones per PTAL and attractiveness (Willson 1996; Levine and Lawrence 2007: 255–274).

The survey was carried out on the development in its normal operating mode (during an ordinary day). Working hours of the development were chosen for the survey.

Parking demands were determined as follows:

– Users entering or exiting the subject development were counted in 15-minutes intervals. In this way the number of the users inside the development in 15-minutes intervals (which is considered as concurrent) was determined.
– Percentage of users who come to the development as car drivers was obtained by an interview.

Parking demands generated by the development in 15-minute intervals were calculated by use of these survey results.

The "competent" parking demand represents maximum 15-minute parking demand in the survey period.

The development's owner provided us with the information about development's characteristics (GFA, number of employees, number of rooms, etc.).

Approximately 1300 developments were surveyed applying this methodology. The study was completed in 18 months.

4.2. Definition of correlation between standards per zones

As already mentioned, modern concept of transport management involves restriction of car use which is directly related to parking capacity availability. However, the level of restriction should depend on availability of alternative transport modes, especially public transport (Burinskienė and Paliulis 2003).

In this regard, in the definition of parking standards, the first step is to define the correlation between percentage of users who are travelling as car drivers and PTAL per zones. This includes the following steps:

1. Developments are grouped into "use classes", and then into groups of developments within the scope of a specific use.
2. The surveyed developments within the same use class are grouped per zones with certain PTAL.
3. Average percentage of users who are travelling to the surveyed developments by car as the drivers (% car driver) is calculated for each PTAL (Beaumont 2002).

4. Average percentage of car drivers obtained by surveying the developments in the zone with the lowest level (coefficient) of accessibility is considered the "basic value". Average values of % car driver in the remaining zones are recalculated related to the basic value (hereinafter referred to as: relative % car driver), as follows:

　　If average % car driver obtained in the survey is marked as:
　　　"a" for the I zone per PTAL
　　　"b" for the II zone per PTAL
　　　"c" for the III zone per PTAL, and
　　　"d" for the IV zone per PTAL
　　then "relative % car driver" will be: a/d, b/d, c/d and 1 respectively, Table 2.

5. Correlation between "relative % car driver" and PTAL of the zone is calculated, Figure 3.

6. Based on correlative curve, "relative % car driver", is adjusted (Figure 3) as follows:
   – "relative % car driver" for certain zone which, in the existing state, is higher than the value obtained through correlative relation is adjusted to the value obtained by correlation (decreases).
   – "relative % car driver" which, in the existing state, is lower than the value obtained through correlative relation remains at the same level which was established on the basis of the surveyed maximum parking demands (not increasing). This step allows application of one of the basic principles "proposed maximum standards should be, to a certain degree, connected with the currently realized ones (not higher than the ones established on the basis of the surveyed demands)".
   – "relative % car driver" for the zone with lower PTAL must have the value which is higher than or identical to the zone with higher PTAL. If this is not the case, the value of relative % car driver for the zone with higher PTAL is adjusted to the value of the zone with lower PTAL. This step secures observance of the first principle from the statement of the problem stating that the number of parking demands decreases with the increase in zone accessibility.

Table 2. Procedure of defining correlation between standards per zones with certain PTAL

Zone per PTAL	PTAL	% car driver	Relative % car driver (p)		Correlation between standards per zones
			actual	adjusted	
I	11.50	a	a/d	p_1	p_1
II	6.15	b	b/d	p_2	p_2
III	3.38	c	c/d	p_3	p_3
IV	1.09	d	1	1	1

7. Adjusted relative % car driver per zone is correlation between standards per zones with certain PTAL, Table 2.
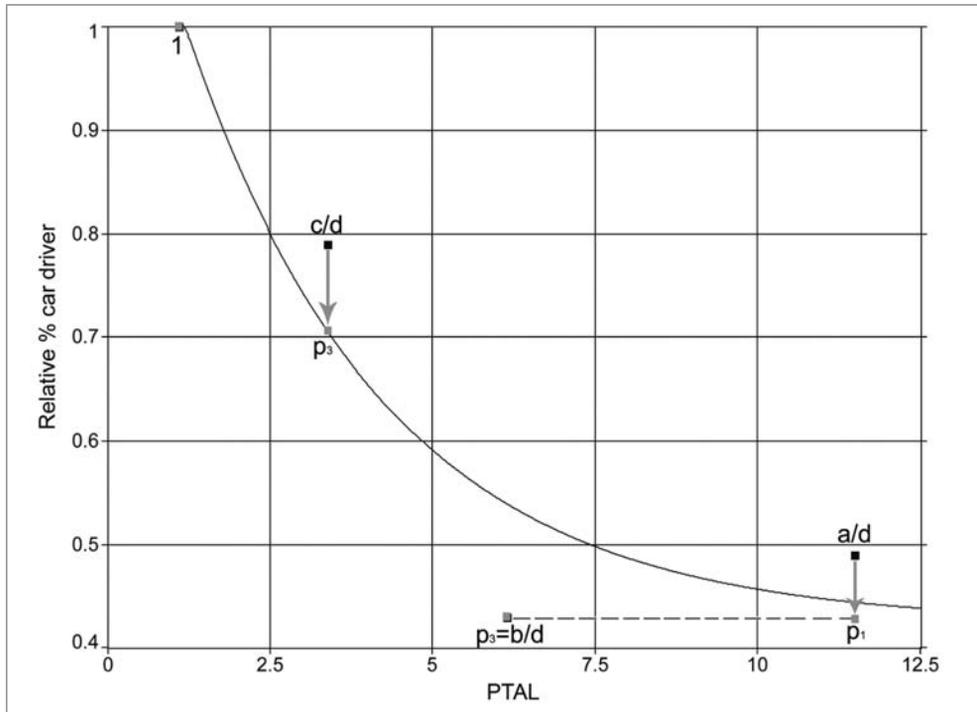
Fig. 3. Definition of adjusted relative % car driver

4.3. Definition of standards per zones

1. For the surveyed developments belonging to the same use class, correlation between peak parking demand (y axis) and adequate parameter (GFA or number of employees or number of rooms or…) (x axis) is calculated and the 95 percent confidence level is determined.

2. For every surveyed development belonging to the 95 percent confidence level, ratio between peak parking demand and adequate parameter is calculated (S_i).

3. "Basic standard" (S_0) represents minimum value of ratio between peak parking demand and adequate parameter, Figure 4:

$$S_0 = \min(S_1, S_2, S_3, S_6).$$

4. After establishing the accessibility level of the zone within which the development which serves as the basis for specifying the basic standard is located, the standard is to be recalculated for the zones with other PTALs. Table 3 presents the method for recalculating the standards for the case when the basic standard belongs to I, II, III or IV zone per PTAL.
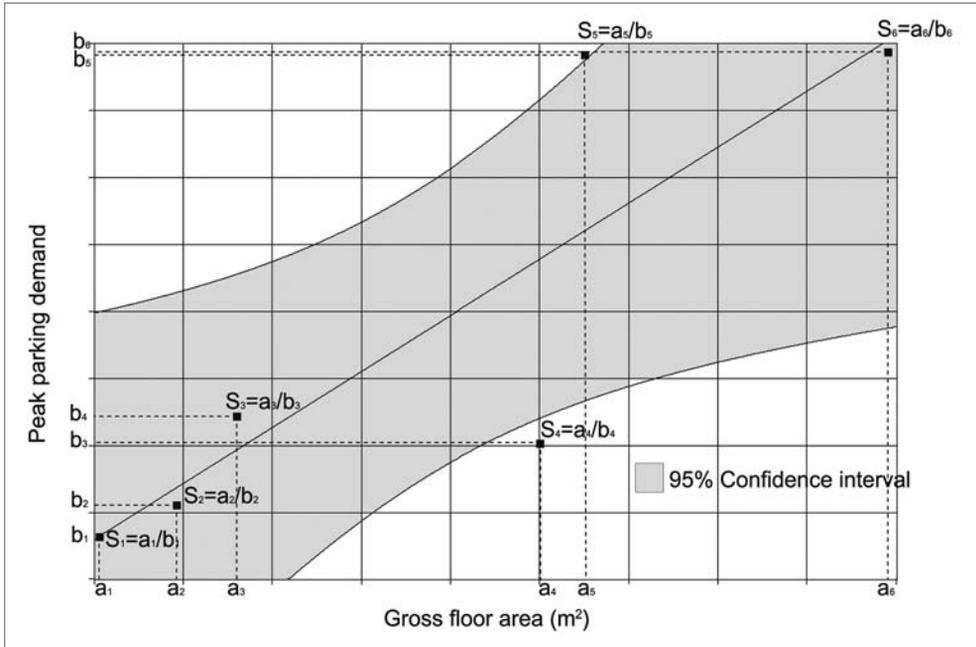
Fig. 4. Example of selected surveyed developments which will
serve as the basis for defining the basic standard

Table 3. Calculation of standards per zones

Zone per PTAL	Correlation between standards per zones	Standard per zones			
		if S_o is in Zone I	if S_o is in Zone II	if S_o is in Zone III	if S_o is in Zone IV
I	p_1	S_0	$S_0{}^*p_2 / p_1$	$S_0{}^*p_3 / p_1$	S_0 / p_1
II	p_2	$S_0{}^*p_1 / p_2$	S_0	$S_0{}^*p_3 / p_2$	S_0/ p_2
III	p_3	$S_0{}^*p_1 / p_3$	$S_0{}^*p_2 / p_3$	S_0	S_0 / p_3
IV	1	$S_0{}^*p_1$	$S_0{}^*p_2$	$S_0{}^*p_3$	S_0

5. Numerical example

Application of the procedure described in the section "Proposed Solution to the Problem" of this paper will be presented in the example of the development intended for Cultural Uses. This use comprises the following groups of developments: cinemas and theatres, children's theatre, galleries, museums, cultural centres, libraries and congress centres. Twenty seven developments were surveyed. Correlation between standards per zones with certain PTAL is specified for the entire use class. The basic standard, i.e. the standard per zones per PTAL is

separately calculated for each group of developments in the observed use class. An example of defining the basic standard, i.e. the standard per zones per PTAL will be presented for the group of developments "Cinemas and Theatres".

5.1. Definition of correlation between % car drivers and PTAL

Table 4 presents the data obtained in the survey: number of users and % car driver. For all developments classified into Cultural Uses the following is to be calculated:
- Average % car driver in the surveyed developments per zones per PTAL and relative % car driver, Table 5,

Table 4. % car driver in surveyed developments per zones per PTAL

Number of development	Development	Zones per PTAL	Number of users (concurrently)	% car driver
1	Library 1	I	854	11.38
2	Cinema 1	I	528	17.27
…	…	…	…	…
19	Cinema 3	II	397	25.08
…	…	…	…	…
22	Cinema 4	III	3883	22.89
23	Conference facility	III	204	36.27
…	…	…	…	…
27	Theatre 6	IV	580	30.19

- Correlation between relative % car driver and zone accessibility coefficient, Figure 5.
 Based on the curve obtained by correlation $y^2=1.01-0.31\ln x$, and the procedure described in the Secton 4.2. of this paper, relative % car driver is adjusted, i.e. relative % car driver (adjusted) is adopted, Table 5.

Table 5. Definition of relative % car driver

Zones per PTAL	PTAL	% car driver	Relative % car driver	
			calculated	adjusted
I	11.5	14.60	0.48	0.48
II	6.15	21.61	0.72	0.66
III	3.38	22.76	0.75	0.75
IV	1.09	30.19	1.00	1.00

Relative % car driver (adjusted) represents correlation of standards per zones per PTAL.
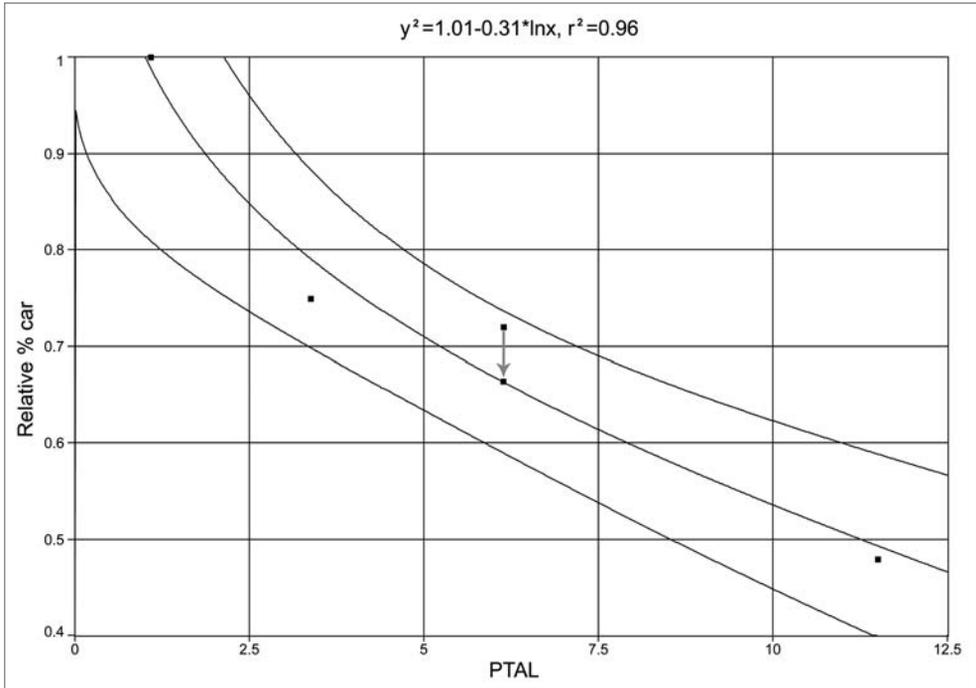
Fig. 5. Correlation between relative % car driver and PTAL

5.2. Definition of standards for cinemas and theatres

Table 6 presents the basic data on cinemas and theatres relevant for calculation of standards. The survey covers 10 developments.

Table 6. Basic data on developments for definition of standards

Development	Zones per PTAL	Number of seats	Peak parking demand
Theatre 1	I	489	120
Theatre 2	I	802	140
Theatre 3	I	840	175
Theatre 4	I	350	73
Cinema 1	I	522	91
Cinema 2	I	1601	234
Cinema 3	II	387	100
Theatre 5	III	510	136
Cinema 4	III	3850	889
Theatre 6	IV	550	175

The basic standard is defined on the basis of the minimum value ratio between the peak parking demand and adequate parameter for the group of the surveyed developments which belongs to the 95 percent confidence level (Figure 6, Table 7).
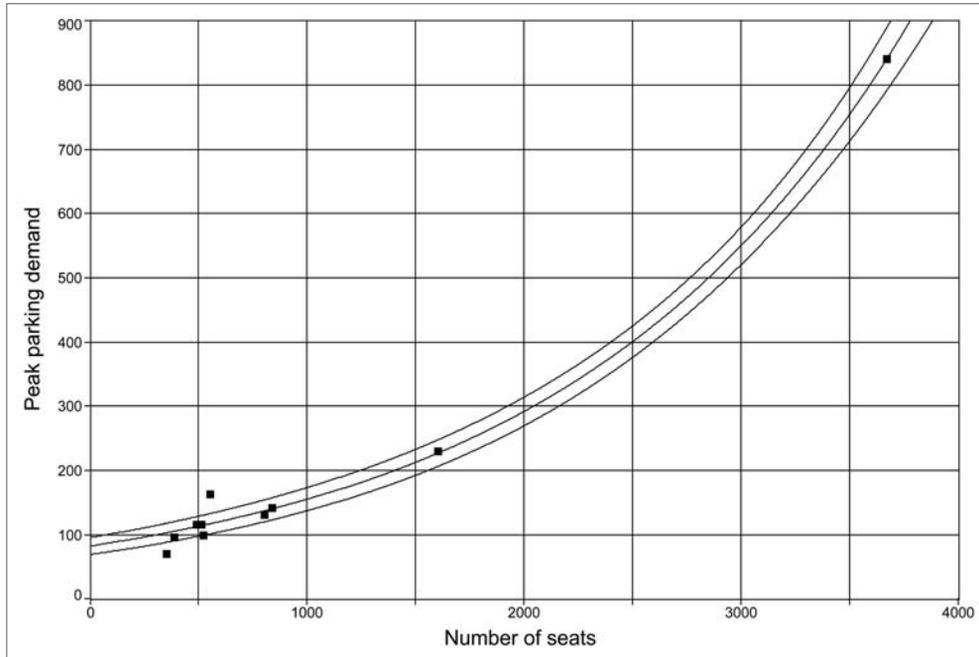

Fig. 6. Dependence of peak parking demand upon number of seats (selection of surveyed developments which will serve as the basis for definition of basic standard)

Table 7. Definition of basic standard

Development	Zones per PTAL	1 parking space per "*x*" seats
Theatre 1	I	4.08
Theatre 2	I	5.73
Cinema 2	I	6.84
Cinema 3	II	3.87
Theatre 5	III	3.75
Cinema 4	III	4.33

☐ Basic standard

Basic standard is realized in III zone per PTAL. Standard for other zones is calculated on the basis of relative % car driver. Table 8 shows calculated standards per zones per PTAL.

Table 8. Standard for cinemas and theatres

Zones per PTAL	Relative % car driver	1 parking space per "*x*" seats
		Calculated standard
I	0.48	5.85
II	0.66	4.26
III	0.75	3.75
IV	1.00	2.81

For the final choice of standard (encircling), an analysis of the number of parking spaces was performed. For the surveyed developments per zones such number was obtained by applying the calculated standard and peak parking demand obtained during the survey, Table 9.

Table 9. Analysis of obtained parking spaces per zones

Zones per PTAL	Number of seats	Peak parking demand	Calculated standard (1 parking space per "*x*" seats)	Number of spaces for calculated standard
I	4604	833	5.85	787
II	387	100	4.26	91
III	4360	1025	3.75	1163
IV	550	175	2.81	196

Based on the data presented in Table 9 it can be concluded that application of calculated standard would provide a higher number of parking spaces in the zones III and IV. The criterion for final choice of the standard was that the number of parking spaces obtained by applying the calculated standard should not be higher than the peak parking demand determined in the survey (see Basic Assumptions). The adopted standard was defined according to this criterion, Table 10.

Table 10. Analysis of obtained parking spaces per zones

Zones per PTAL	Number of seats	Peak parking demand	standard (1 parking space per "*x*" seats) adjusted	Number of spaces for standard	Current standard (1 parking space per "*x*" seats)
I	4604	833	6	767	
II	387	100	4.5	86	7
III	4360	1025	4.5	969	
IV	550	175	3.5	157	

Compared to the current parking standard, the new parking standard requires more parking spaces to be provided. This is because the current standards were replicated from foreign literature instead of calculating them for specific conditions in Belgrade. The current standard has the same value in the entire urban structure. Contrary to the current value, the value of the new parking standard depends on the accessibility of the zone the subject development is located within.

6. Final considerations

By applying above procedure vehicle parking standards were calculated for all uses and groups of developments within the same use class, for which it was confirmed that there is correlation between "relative % car driver" and PTAL.

Updating of vehicle parking standards is required always when considerable change in PTAL in certain zone occurs. In such case, the standard prescribed for adequate PTAL the zone belongs to after such change is applied to the specific zone. In the case when PTAL remains unchanged it is necessary to conduct periodical surveys of the share of car drivers in modal split of journeys in the direction of a certain use class. In such case it is sufficient to conduct surveys on the sample of specific-use developments only in one zone. For other zones adjustment is made directly by recalculation based on the already established correlation between standards per zones.

7. Conclusions

In this paper methodology for calculation of vehicle parking standards has been developed in accordance with the sustainable urban transport development. Although the methodology was developed for the parking conditions in Belgrade, it could be applied to any other city.

To apply this methodology, an extensive research of current parking demand for the developments of different use classes is needed, as well as the division of urban area into zones according to PTAL and the level of attractiveness.

Vehicle parking standards should vary according to zones per PTAL, where developments within zones with higher level of PTAL should have higher parking standard, i.e. less amount of required parking, and vice versa. Relation between standards and zones per PTAL is defined for the whole use class, based on the percentage of the users travelling as car drivers and a PTAL.

The "basic standard" represents minimum value of the ratio between peak parking demand and adequate parameter of all surveyed developments from associated group of developments. The standard for all zones per PTAL is determined on the basis of relation between standards per zones per PTAL and the basic standard. This parking standard is to be set as maximum, minimum or optimum, depending on the degree of the zone's attractiveness.

As regards the methodologies that can be found in literature, the presented methodology has several advantages. First, current parking demands are not surveyed for the developments located at suburban sites, but the developments throughout the city territory, belonging to different zones per PTAL. Next, while the existing methodologies define the same parking

standard for the entire city territory or are depending only on either PTAL or level of attractiveness of the zone the subject development belongs to, in this methodology both of these factors are employed. And finally, special attention was paid to choosing the appropriate parameter which expresses the parking demands in the best way, instead of using GFA as a "universal parameter". Selection was carried out through the analysis of a large number of possible parameters.

References

Al-Masaeid, H.; Al-Omari, B.; Al-Harahsheh, A. 1999. Vehicle parking demand for different land uses in Jordan, *ITE Journal on the Web*, 79–84.

Beaumont, H. 2002. *Maximum Parking Standards-Derivation of PTAL-Based Parking Restraint*. Greater London Authority, City Hall.

Bond, R. 2002. *Shopping Centre Parking: How Much is Enough*?, The Parker, 4th Quarter, p 202.

Burinskiene, M.; Paliulis, G. 2003. Consistents of car's parking in Lithuanian towns, *Transport* 18(4): 174–181.

Commission of the European Communities, 2001. White paper: European transport policy for 2010: time to decide. COM (2001)370, September 2001. Brussels.

COST Secretariat, 2001. Parking Policy Measures and their Effects on Mobility and the Economy – Finland Case Studies.

Dorsett, J.W. 2007. Parking requirements for Medical Office Buildings, *ITE Journal* 77(8): 40–43.

Filipovic, S.; Tica, S.; Zivanovic, P.; Milovanovic, B. 2009. Comparative analysis of the basic features of the expected and perceived quality of mass passenger public transport service in Belgrade, *Transport* 24(4): 265–273. doi:10.3846/1648-4142.2009.24.265-273

Finch, P.; Wallace, C.; Hardie, T. 2002. The Impacts of Maximum Parking Standards Including Inward Investment Implication, in *European Transport Conference*, Homerton College, Cambridge 09/09/2002 – 11/09/2002.

Institute of Transportation Engineers, 2004. Parking Generation, Institute of Transportation Engineers, 3rd edn. Washington, D.C.

International Association of Public Transport, 2000. Parking Policies, Position paper.

Jovic, J.; Popovic, M.; Djoric, V. 2006. *Transportni model Beograda* [Transport Model of Belgrade]. Institute of the Faculty of Transport and Traffic Engineering, Belgrade.

Levine, J.; Lawrence, D. 2007. Transportation and land-use preferences and residents neighbourhood choices: the sufficiency of compact development in the Atlanta region, *Transportation* 34: 255–274. doi:10.1007/s11116-006-9104-6

Litman, T. 2010. *Parking Pricing Implementation Guidelines*. Victoria Transport Policy Institute.

Marsden, G. 2006. The evidence base for parking policies – a review, *Transport Policy* 13: 447–457. doi:10.1016/j.tranpol.2006.05.009

Milosavljevic, N.; Culjkovic, V.; Krstic, P.; Maletic, G.; Simivecic, J. 2007a. *Urbanistički normativi za parkiranje* [Vehicle Parking Standards]. Institute of the Faculty of Transport and Traffic Engineering, Belgrade.

Milosavljevic, N.; Maletic, G.; Simicevic, J. 2007b. Uticaj režima vremenskog ograničenja trajanja parkiranja na saobraćajnu potražnju [Influence of time-limited parking regime on transport demand], in I *savetovanje sa međunarodnim učešćem Savremene tendencije unapređenja saobraćaja u gradovima*, 44–49. Novi Sad.

ODPM, 2002. Delivering Planning Policy for HOUSING: ppg3 Implementation Study. Office of the Depute Prime Minister, London.

Rushmoor Borough Council, Planning Services, 2003. Parking Standards and Strategy, Supplementary Planning Guidance. Available from Internet: <http://www.rushmoor.gov.uk/index.cfm?articleid=3418>.

Shoup, D. 1995. An opportunity to reduce minimum parking requirements, *Journal of American Planning Association* 61(1): 14–28. doi:10.1080/01944369508975616

Shoup, D. 1999. The trouble with minimum parking requirements, *Transportation Research Part A* 33: 549–574. doi:10.1016/S0965-8564(99)00007-5

Urbanisticki zavod Beograd, 2003. Generalni plan Beograda [Institute of Urbanism Belgrade, 2003. Belgrade Master Plan].

Valley, M.; Jones, P.; Wofinden, D.; Flack, S. 1997. *The Role of Parking Standards in Sustainable Development*. European Transport Conference .

Willson, R. 1995. Suburban Parking Requirements: a tacit policy for automobile use and sprawl, *Journal of the American Planning Association* 61(1): 29–42. doi:10.1080/01944369508975617

Willson, R. 1996. *Local jurisdiction parking requirements: a survey of policies and attitudes.* Working Paper, Department of Urban and Regional Planning, California State Polytechnic University, Pomona, California.

Zeng, Y.; Changping, L.; Ning, G. 2009. Research on different parking supply in Beijing, *Journal of Transportation Systems Engineering and Information Technology* 9(6): 47–51. doi:10.1016/S1570-6672(08)60087-2

AUTOMOBILIŲ AIKŠTELIŲ STANDARTAI KAIP DARNIOS TRANSPORTO SISTEMOS PALAIKYMO PRIEMONĖ: BELGRADO ATVEJIS

N. Milosavljevic, J. Simicevic, G. Maletic

Santrauka. Transporto priemonių stovėjimo vietų standartai numato naujų automobilių aikštelių planavimą ir statybą, esamų statinių išplėtimą ar pakeitimą. Kita vertus, automobilių aikštelių standartai yra pagrindinė priemonė, padedanti valdyti transporto srauto lygį. Jie turėtų būti neatsiejami nuo miesto transporto politikos. Tai leistų į įvairias miesto zonas vykti ne automobiliais. Tai reiškia, kad automobilių aikštelių apribojimai turi būti suderinti su miesto viešojo transporto sistema. Jei viešojo transporto prieinamumo lygis konkrečioje miesto zonoje yra aukštas, automobilių aikštelių skaičius turi būti ribojamas, o miestiečiai turi būti skatinami naudotis alternatyviomis transporto rūšimis. Taip automobilių aikštelių standartai padeda plėtoti darnią transporto sistemą. Šiame straipsnyje pateikiama automobilių aikštelių skaičiavimo metodologija, įvertinanti atskirų miesto zonų pasiekiamumą.

Reikšminiai žodžiai: automobilių aikštelių standartas, viešojo transporto prieinamumo lygis, patrauklumo lygis, darni transporto sistema, žemėnauda, Belgradas.

Nada MILOSAVLJEVIC works as a full professor at the Faculty of Transport and Traffic Engineering in Belgrade, Serbia, where she earned her BSc, MSc and Ph.D. In the last ten years she has been the author of numerous studies and projects, among which the most important are the following: Study on Vehicle Parking Standards for Parking Conditions in the City of Belgrade; Project of Introducing Park and Ride System in Belgrade; An Analysis of Parking Tariffs as an Element of Parking Management; Parking Management in cities: Smederevo, Beograd, Kragujevac, Nis. The results of these studies have been implemented and are giving positive effects. She has published many text-books and articles (for example: Milosavljević N. et al. A Fuzzy Sets Theory Approach to the Vehicle Assignment Problem, Journal of Transportation Planning and Technology 20: 33-47).

Jelena SIMICEVIC. Ph.D. student, works as a teaching assistant at the Faculty of Transport and Traffic Engineering in Belgrade, Serbia, where she received her BScs. She is interested in parking management, parking demands planning and parking research. She has participated in many studies related to these topics.

Goran MALETIC works as a research assistant at the Faculty of Transport and Traffic Engineering in Belgrade, Serbia, where he earned his BScs. His interests are parking management, parking demands planning and parking research. He has participated in numerous studies related to these topics.