

Parking Survey - Methodology and Case Study

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Key Words: Urban development, parking survey, GIS

SUMMARY

For first time in Sofia, capital of Bulgaria was carried out survey on parking capacity, duration and behavior and in large administrative and residential center. For the purpose of the survey methodology was developed, which in short terms, is as follows: for each parking place by pre-defined parking area can be determined the nature, frequency and duration of use. During the survey, one or more counters for several times, consistent and walk a predetermined route on foot. The counter recognize site of parking place on a map and record the registration number of all vehicles parked. If necessary, you can distinguish the category of car parking (free, paid per hour, service subscription). Also, erroneous and/or illegally parked vehicles may be registered separately.

Methodology was created and then applied in GIS and database for automated mapping of results and generate a series of reports from analysis.

The methodology is appropriate to collect the following information:

- category of use of the parking place;
- use of parking spaces on the street;
- residence time;
- period of cycle parking;
- total number of vehicles in one area during the measurement;
- change and localization of parking capacity
- relevance of the parking category.

Through the methodology can be made for further analysis:
the actual use of parking places and parking it in a category;

how the trend is moving on parking during the day;

Mapping of the parking lot;

The use of additional parking facilities serving;

nature, duration and extent of illegal parking

determining or changing categories in parking area;

Preparation and design of new parking or review existing parking

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1. INTRODUCTION

Socio-political changes in Bulgaria during the past 20 years were marked by economic and demographic crisis, but also of profound social and cultural transformations, changing values, lifestyles and ways of movement in Bulgarian cities. There are actually over the last 2 decades to run two parallel and deep systemic transformations: (a) from a centralized to a market-oriented economic system, (b) closed to open to globalization processes. [Dimitrova, 2009].

There are big changes in the urban area, one of the most significant change is the urban mobility. Extreme increase in the number of private cars is a lasting trend in the Bulgarian cities. The number of private cars owned and the pace of growth in the period 2006-2008 are naturally higher for large cities and reached impressive figures in the capital Sofia - from 400 thousand to 700 thousand cars. This reflects the increased standard of living and growing demands for free choice of lifestyle and movement. Increased mobility of people is important distinctions among the post-socialist Bulgarian cities, but it confronts governing bodies, residents and experts to a series of interrelated challenges of urban daily life.

Urban mobility includes the movement of people, goods and services in the road infrastructure of the city, and placement processes, waiting and parking.

Policies for parking vehicles will have deep significance, if it is supplemented by other transport initiatives to achieve goals, related to accessibility to the central urban areas and maintain cleanliness of the environment.

Problems with travel and parking in Sofia are exacerbated to the extent, that sweeps behind public sentiment increasingly and inevitably intensify the actions of municipal administration

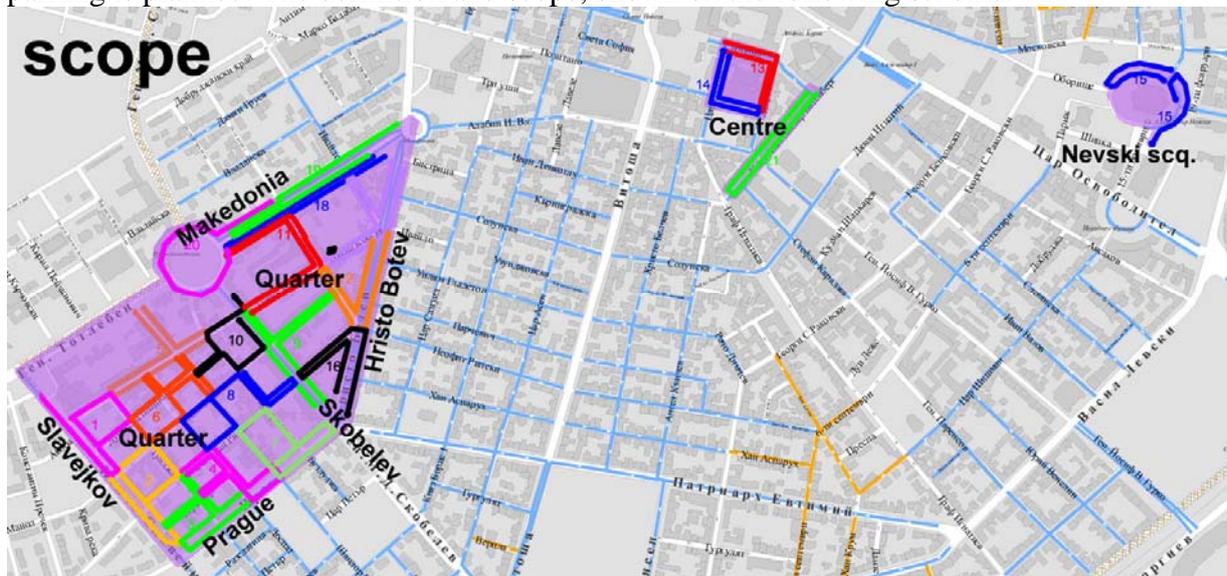
Gradually, over the past 10 years necessitates the introduction of regulated parking rules restrictions. Another branch of the municipal administration - for the management of parking and mobility is established. Municipal regulation is prepared for the introduction of paid areas for short stay called "blue zone" parking spaces giving a subscription etc. Like each functioning company, the municipal company "Parking and Mobility" needs to develop its activity. A sustainable policy implementation through planning, analysis and evaluation, assisted by experts on mobility and new information technologies. In general, measures to tackle the problem of parking are two types: quotas and price mechanisms. For Sofia, Bulgaria's capital priorities are: extension of the "blue zone" outside the Center, the price differentiation between the parking areas, construction of parking lots and garages including based on public-private partnerships and new construction, system integration type "Park & ride".

For implementing the measures and planning needs of specific actions, there must be made analysis and evaluation of existing parking capacity and parking behavior. The Goal was to develop a methodology and software for the Study of parking.

2. DESCRIPTION OF METODOLOGY

2.1 Scope of the study

For Sofia, the purpose of the study was to analyze the capacity of some parking areas with the recently introduced paid mode and momentary stay, primarily serving the administration, education and business, where during daytime a large number of incoming cars within the working day is gathered and where is the basic range of action of the municipal company "Parking and Mobility". Also examine a large range covering several neighborhoods with mixed functions (residential and business) where an introduction of paid parking is planned. The definition and scope, shown on the following scheme:



- Zone "St. Alexander Nevski Square - a public car park with mostly paid parking brief type" blue zone "and business subscriptions
- Zone "Street Kniaz Alexander Batemberg I "-« blue zone », "Street Tsar Kaloyan, Saborna, Lege Street, Pozitano "- blue zone "with the prevailing local" business subscription
- Zone "Bldv Gen. Edward I. Totleben, Macedonia Blvd, Hristo Botev Blvd ", " Praga "John Doe Blvd and between the sub Blvd Gen. Pencho Slaveikov Street, Lajos Kossuth, blvd Gen. MD Skobelev Boulevard and Prague "- a zone with the impending introduction of paid parking brief type" blue zone "

Such tests can be ordered for different objectives and scope, respectively - a residential neighborhood, commercial and business center, a large public car park, station interlocking spaces, design of future "blue zone" mass tourist sites frequented. Research results are suitable for large cities, when you must decide to change the category of parking spaces in order to pursue a policy of increasing mobility.

2.2 Creation of GIS database and map of parking areas.

Inventory of parking places is done by walking around the site and affixing them to the card, observing and reporting the parking position - parallel to the street, cross at it or angle of 45, parking category". A complete inventory of parking capacity for the zones was made, and we got a real and current picture of the situation with absolute capacity of parking places required

in the venue areas. Census of all the parked cars (regulated or not regulated parked), it is very important for future capacity planning and implementation of parking policy.

Drawing and numbering of all possible locations for parking is particularly important, because we need to consider all parked cars and to indicate the category of parking place.

The categories parking places in Sofia can be classified as follows:

- free parking
- Paid parking - parking lots with paid coupons, tickets
- parking spaces for permit holders (official subscription)
- Reserved parking spaces marked with signs, which clearly show which are the reserved places and for which users - taxis, doctors, people with disabilities or for loading / unloading.
- disabled parking spaces marked with appropriate signs and street markings
- unregulated parking spaces - those which are not specifically prohibited and are not labeled, but there are parked cars, for example: more parked cars than they are ruled cells parking, parking in front of garages, places of disposal, to input / output bus stops on the sidewalk on the lawns and others.

To facilitate the task of the counting, to fill data on the category of a parking place are marked even if vehicle is parked incorrectly. They are classified as category in a GIS environment. Thus, the task remains observer simply to record the registration number of the vehicle without making assessment if it is proper parked or not. Then, in analyzing the results, these data may be de selected by category and therefore be taken into account or not. Also, it should be possible observer if you see a vehicle parked in a place that was not on the card can be noted on the card and be entered in the registration form in addition to some spare identifier.

The numbering of parking spaces is made in the GIS environment, while maintaining the readability of the numbers in the cell and its uniqueness.

There is necessary the provision of suitable map base, which will serve to cause any parking lot, its numbering and most importantly: the observer should be able to identify it on the spot. In this case it is convenient to use the cadastral plan at scale 1:1000 in digital form. Additional processing is needed to enable the map of parking spaces to meet the above listed criteria:

- size A4 (suitable for use by walking observer), M 1:000
- Bold names of streets and extra copy so that they are visible on each sheet A4
- Remove all unnecessary items, such as the number of properties, rank, inscriptions and other information, which impairs the user;
- Retention of topographical features that help the reader to orient the map to a place such as: wells, trees, electrical poles, street lighting.
- Coloring and inscriptions on public buildings: court, theater, community, gallery, business center, a monument, hospital, catering and others.
- Mark North

2.3 Planning the routes. Determination of the period and the counting interval

Route planning is one of the most demanding and labor-intensive task, that requires experience. An important parameter is over what time interval will be counting (15 minutes,

½ hour, 1 hour and so on). The timing depends on the purpose of the study. To achieve better results it is recommended to be smaller than average (actual) presence of parking in the area. It is assumed that the average parking time can be calculated based on the function of parking places (shopping, housing, etc.) or by earlier measurements. Study of [Haringsma, 1988] shows that the relation between the chosen observation time interval, the average time for parking and the percentage of "misses". When the time interval of observation is equal to the average (actual) time for parking in a 1:1 ratio, approximately 37% may be missed. When the relationship between the adopted parking space and the actual stay is 1:2, the percentage is approximately 21%. If you want to rate it a 10% ratio should be 1:5

Naturally, the best option is this happening constantly, to register any vehicle which actually makes the task unreasonably expensive. In this study, because the proportion of tickets sold for one-hour stay is the largest and a paid parking for ½ hour exists, we chose 30 minutes period.

The day of the counting depends on the specific purpose. For example shopping center is sufficient to hold between 15 and 18 o'clock, but on Friday and Saturday within a short time interval (15.min). In the case of this contract and this scope is appropriate to choose a normal working day, for example in the middle of the week. To obtain reliable results and quality it was very important to start before the beginning of the workday and stop after it ended. Naturally it would be better to counts and in the evening hours when the second wave comes from incoming cars for other purposes (shopping, restaurants, cinemas and theaters). In this case, due to limited resources, this group will be removed from the analysis. In Bulgaria, the normal working day starts between 8.00 and 9.00 o'clock and ended between 17.00 and 18.00, that's why the counting period was fixed from 7.30 to 19.30.

It is generally accepted, that norms to crawl route for 1 hour is about 1 km. In better planning of the route and selecting the right people (good physical condition and experience in reading maps), can travel between 600 and 800 meters for 30 minutes. We shaped 22 routes with varying degrees of difficulty (longer routes or more intense zones). If certain areas are compact, for example, parking a few lines, parking on both sides of the street, or very long zone along the street, it can introduce additional sections for easier orientation observer. For example, Route 10, section 1, section 2, etc.

Card and a form are prepared for each route:



Маршрут 10

Име: _____ дата: _____

Улица /Street	място /place	7h	8h	9h	10h	11h	12h	13h	14h	15h	16h	17h
Ивайло	946											
Ивайло	947											
Ивайло	948											
Ивайло	949											
Ивайло	950											
Ивайло	951											
Ивайло	952											
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Ивайло	955											
Ивайло	956											
Хр. Ботев	957											

On the map are marked parking places, their numbers and the exact route (thick-line arrow direction, start and end) which should be walked by the observer for 30 minutes.

Form given to each observer, a street name, identification number of the parking lot, which is best to be unique to the locality, the start time of each cycle and an empty box, in which the observer writes the registration number of the vehicle.

2.4 Counting

Prior joining the counting, there must be conducted instruction for tellers and detour route along with some of those responsible for counting. Great challenge and also very important for the quality of the analysis is that observer should be able to "carry forward" correctly identify the location of the parking lot of the map on the real terrain and to enter it in the appropriate form. It is therefore necessary short learning what landmarks are used on the map (power poles, serial number, start at junctions, iconic buildings, etc..) To indicate its beginning and end of the route, he pointed to the importance of the task perform and the hours in which to start the observation.

The responsible for the counting task has to go round all the routes to explain the matter and monitor the process. After completion of counting, the operator collects material from all observers together and discuss any additional data or questions.

The observers passed periodically on certain routes in 30 minutes and registered the four digits of each parked car on parking space for that.

2.5 Processing the results

The questionnaire forms were introduced in an electronic format to enable subsequently analyzed in the database. Depending on the required results, the introduction of data follows established principles - separation of parking places in separate sections (streets, parks, squares) and zones (groups of sections with similar characteristics). For greater clarity and systematic analysis, the results of the routes were regrouped, and were divided to 8 zones with 23 sections.

Results are accumulated in 8 files, for each zone and section. Additional database was developed in an environment of MS Access, so that it can be based on appropriate requests to the analysis of results, and automatic creation of thematic maps in GIS environment.

Processing of data collected in an environment of relational database gave the following results throughout the surveys for different sections or zones and for different categories of parking places

- Parking capacity – number of parking places and parking category;
- average occupancy rate – what percentage of the places were occupied;
- Parking duration survey by interval - at what time of day, what percentage of the parking places were occupied;
- average parking duration - average length of time spent on one car per parking space;
- parking duration distribution - what proportion of the length of stay is occupied by short, medium and long-term parking;
- Parking turn-over - how many cars per parked in one parking lot during the counting period;
- Parkingcount – how many cars parked during the counting period.

3. ANALYSIS OF CAPACITY AND PARKING BEHAVIOR

3.1 Parking capacity

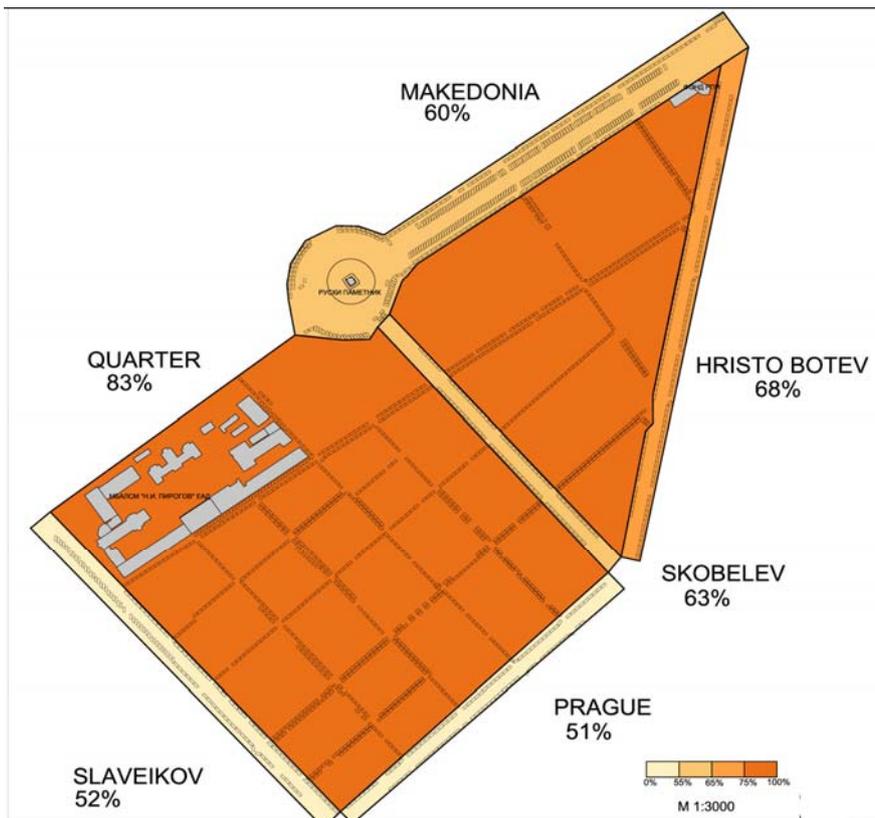
The study area is divided according to different characteristics of parking places, the class of the street and location of the 8 zones, which consist 23 sections (streets and squares) and 2337 parking spaces. Generated are a total 56 088 records.

Zone with the largest number of parking places and the most specific characteristics have zone "Quarter" - an internal neighborhood streets, where analysis revealed significant differences from other areas.

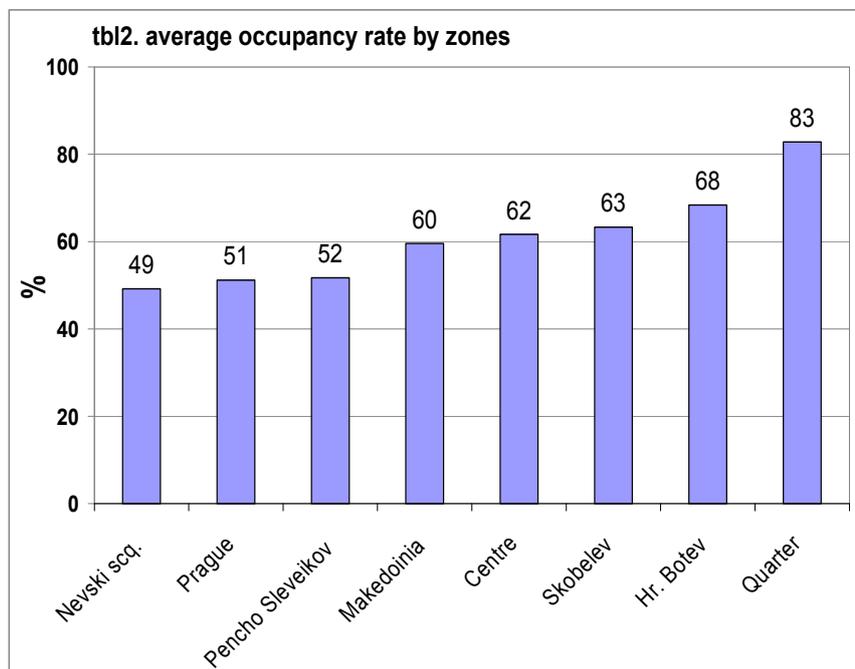
The largest number of places in the "blue zone" 820 (36%), and which has a large influence on the survey results. Only 4 places are for individual people with disabilities, which has a negligible impact on results.

tbl1. Parking Capacity	Parking space types						Total for zones
	Blue zone	free	private	for persons with disabilities	Individual for persons with disabilities	illegal	
Zone							
Nevski square	86 52%		45 27%	3 2%		31 19%	165
Centre	136 42%	21 7%	108 33%	9 3%		49 15%	323
Macedonia	322 80%		20 5%	6 1%		53 13%	401
Bul. Hristo Botev	82 54%		15 10%	9 6%		45 30%	151
Quarter		478 47%	5 0,5%		2 0,5%	518 52%	1003
Blv Prague	58 60%			1 1%		37 39%	96
Blv Slaveikov	92 77%		3 3%	4 3%		21 18%	120
Bul. Skobelev	44 56%		3 4%	3 4%	2 3%	26 33%	78
Total for parking space types	820 36%	499 21%	199 8%	35 1,9%	4 0,1%	780 33%	2337

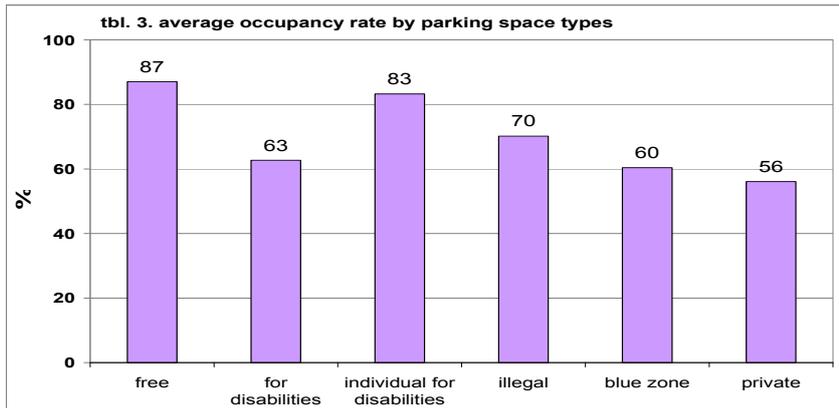
3.2 Average occupancy rate



The average occupancy of all parking lots is 69%. This is below the agreed threshold of 85% [Dominique, 2009], where difficulties in parking occur. However, at certain times of day and in some areas this figure close to or even exceeds the value of 85%



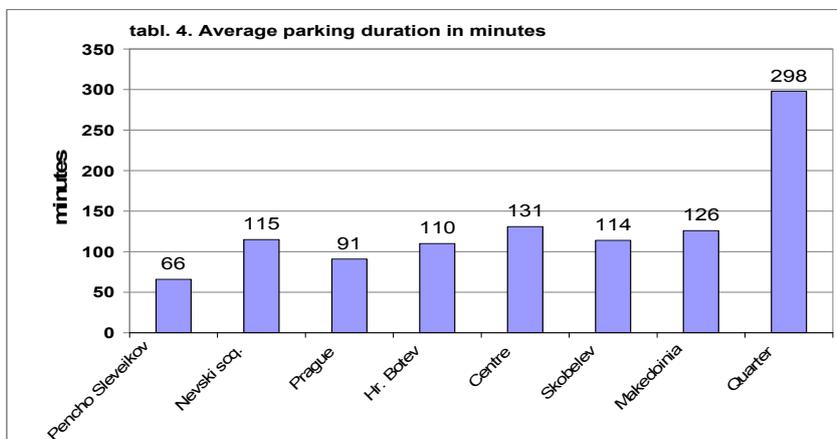
The average occupancy rate in various areas is ranging from 49% to 83%, the lowest value recorded is in the area of Alexander Nevsky and the highest in the zone "Quarter", where parking places are free or unregulated. Employment of parking areas in the boulevards and center zone are normal, as drivers have more problems with parking on blvd. Hristo Botev, and the load is low on blvd Prague.



The average occupancy by category of parking places is as expected highest in the free and unregulated sites. Occupancy in the blue area is lower because of the paid nature of parking. Overall, drivers prefer free, even banned parking spaces in the small streets foresail "blue zone".

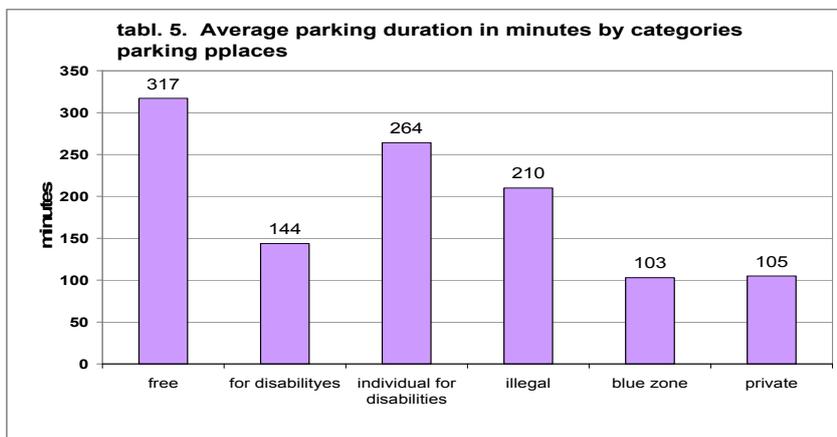
3.3 Average parking duration in minutes

The average length of stay for the whole area is 2 hours and 45 minutes, this indicator has significant differences in the various categories of areas and parking lots. In the recording interval of 30 minutes, so the length of stay means that the percentage of missing records is lower than 10



Like the previous indicator, vehicles parked in that area "Quarter" spend much more time on average - nearly 5 hours, unlike the cars in other areas that remain for about 2 hours - 131 to 115 minutes. Only the average parking duration on blvd. Pencho Slaveikov was significantly shorter.

Analyzing the index by category of parking lots – we are noticing again the greatest length of stay of free places. Despite the danger of putting brackets or evacuation of improperly parked vehicles, presence of unauthorized sites is an average of 2 hours. Interesting is the fact that cars parked in the "blue zone" on average spend 43 minutes more than the set 1 hour.

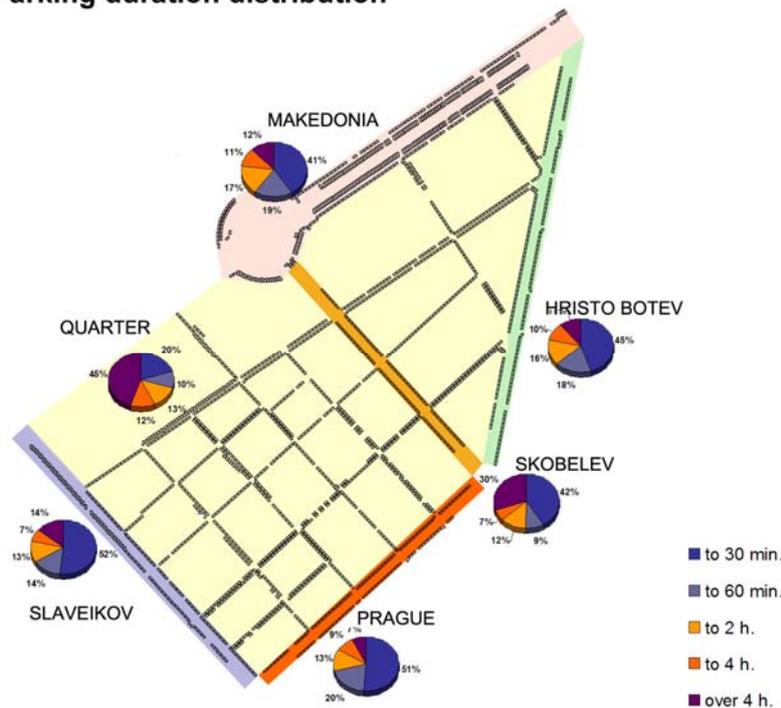


The average length of stay in the "blue zone" and the service areas differ by only 2 minutes.

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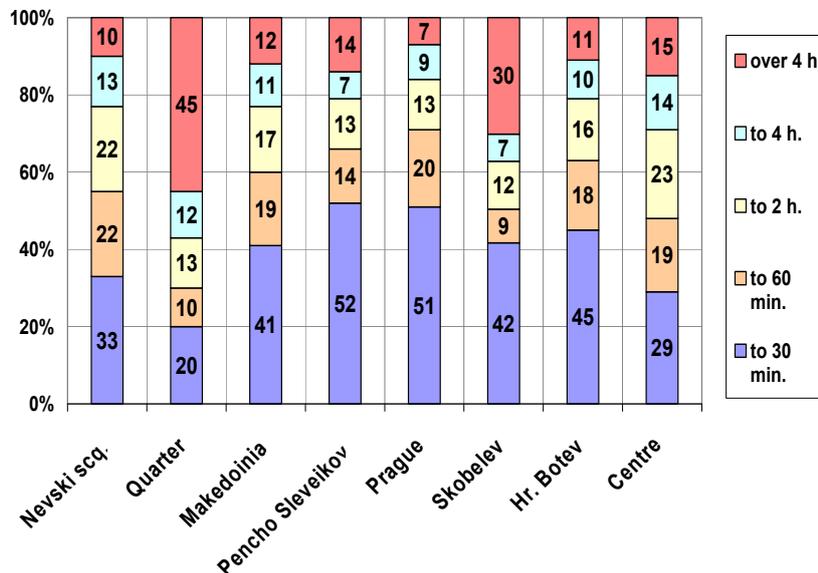
3.4. Parking duration distribution

Parking duration distribution



Another indicator showing more detail than the average duration is allocating parking stay: how cars are parked a half-hour, one hour, two hours, three hours, etc. In this analysis, for example, cars that were registered once considered as a short term stay (up to 30 minutes), so depending on the number of identical records divide parked cars parked within 30 minutes to 60 minutes to 2 hours to 4 hours and more than 4 hours.

tabl. 6. parking duration distribution

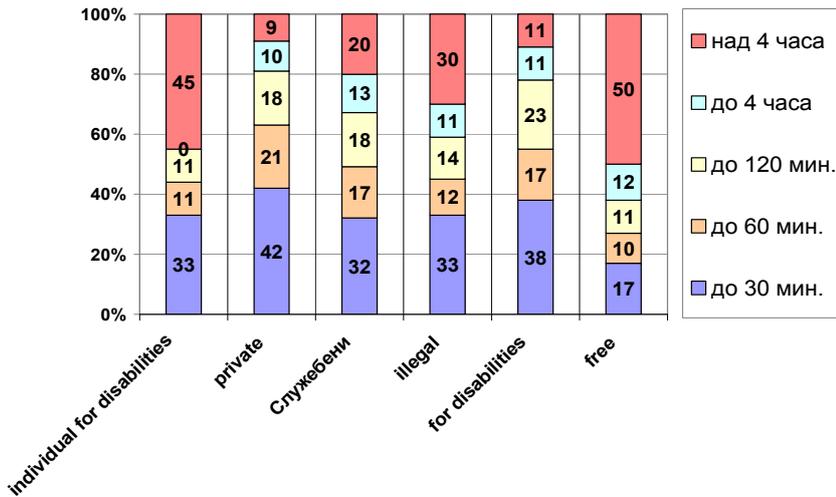


In different zones are observed considerable difference - in the zone "Quarter" only 20% of cars are left parked for a short time - while more than half the cars parked during the day boulevard of Prague and Slaveikov remained 30 or less minutes

Remarkable is the difference in the percentage of cars had more than 4 hours, probably due to the vast category of places and use of adjacent buildings. As part of the cars had more than 4 hours in one place leads area "Quarter" (45%), where many cars stay

overnight and their owners live in adjacent buildings.

tabl. 7. Parking duration distribution by categories



precedence short stay (33%), but a large proportion (30%) of the cars have spent over 4 hours - despite the ban on parking of such places.

Length of stay in different categories parking spaces shows the expected high rates of cars, that stayed over 4 hours in one place of free places (50%). 27% of cars parked in the blue area spend more than 1 hour, although regulated length of stay. Individual places for people with disabilities also showed a large share of employment of other cars over 4 hours. Distribution by duration of stay of illegal sites is relatively evenly, has

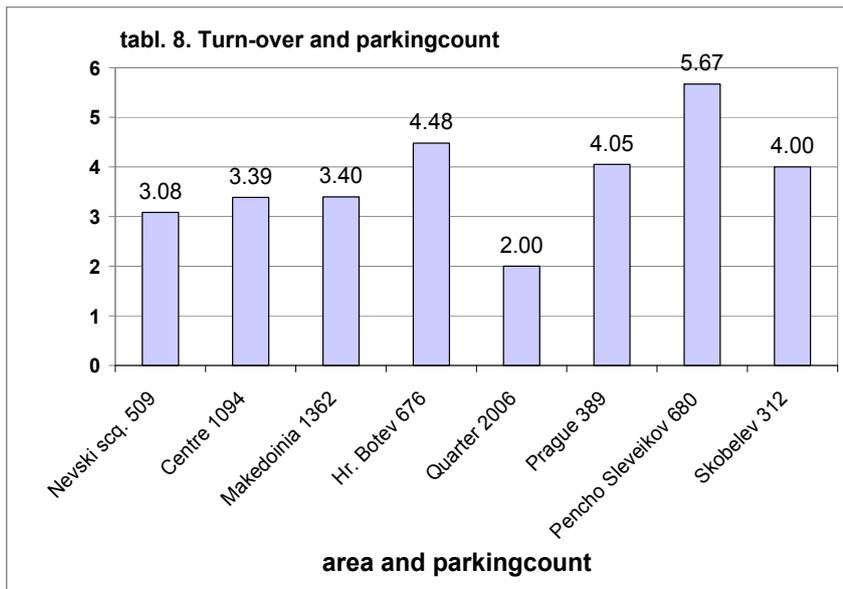
3.5. Turn-over and parking count



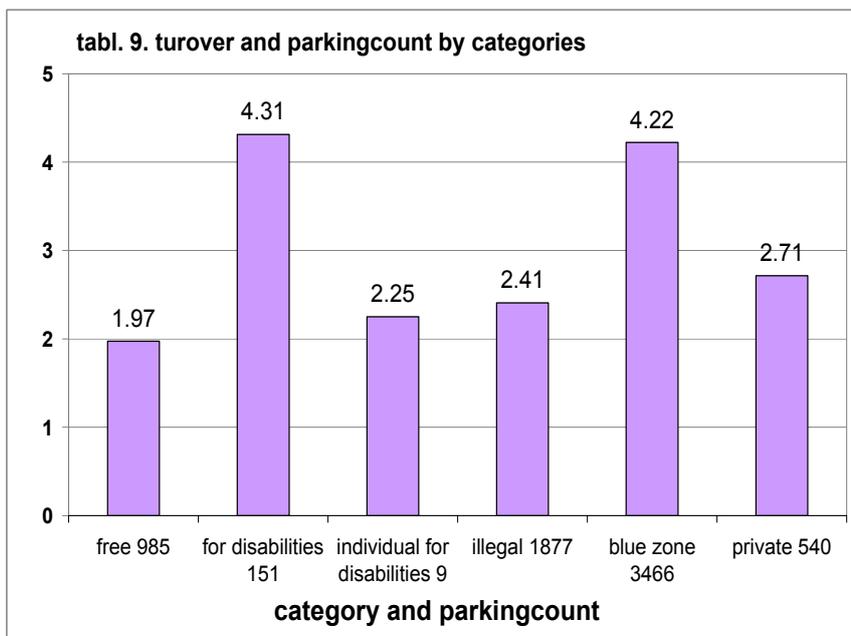
Turnover is a quantitative indication of how much is the average time of use of one parking space for a specified period. In general, higher turnover means better use of parking capacity: more cars will be serviced in the same capacity.

Turnover is in combination with other indicators – occupancy and duration of parking. If occupancy is higher, more cars using the parking capacity, respectively, and turnover increases. If the period of stay is decreasing, more cars can use the same place and turnover will increase.

In a study throughout the day in total 7028 cars parked, average number of cars parked at 1 place is 2,6. Distributed under the various categories of parking areas and there are significant differences in average turnover.



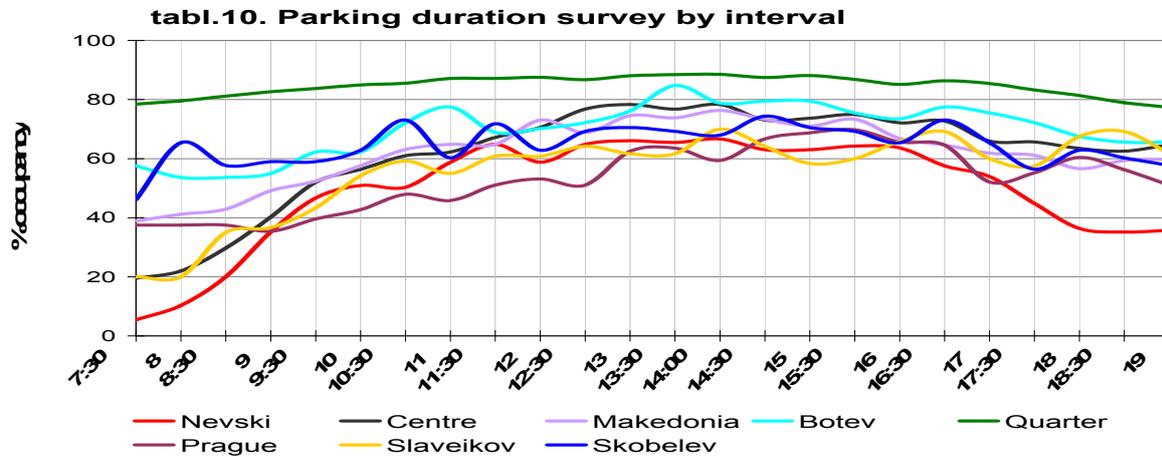
There is a noticeable difference in the turnover referred to the various zones, while in the zone "Quarter" it is falling by 2 cars parked per place in an area Slaveikov accounted is average 5.67 cars per parking place. Influence of turnover has increased the availability of parking spaces and a blue zone category



Places for people with disabilities and the "blue zone" have an average turnover of over 4 cars per day while the free sites in one place is used by 1.97 per car for the day. 1877 cars were parked unauthorized, illegal turnover of such places is also very low. Overall, the difference in the category of sites has a major impact on parking turnover. Cars to remain longer in the region prefer to park free of charge or on unregulated place

3.6. Parking duration survey by interval

Including hour periods in the processing of data, we get more details on the daily fluctuations in the employment of parking places, depending on the activities in adjacent areas - such as labor, maintenance and habitation



7:30	8	8:30	9	9:30	10	10:30	11	11:30	12	12:30	13	zone
5%	10%	20%	35%	47%	51%	50%	59%	65%	59%	65%	66%	Nevski
20%	22%	30%	40%	52%	56%	61%	62%	67%	71%	77%	78%	Centre
39%	41%	43%	49%	52%	58%	63%	65%	65%	73%	69%	75%	Makedonia
58%	54%	54%	55%	62%	62%	72%	77%	69%	70%	72%	76%	Hr. Botev
78%	80%	81%	83%	84%	85%	86%	87%	87%	88%	87%	88%	Quarter
38%	38%	38%	35%	40%	43%	48%	46%	51%	53%	51%	63%	Prague
20%	20%	35%	37%	43%	54%	59%	55%	61%	61%	64%	62%	Slaveikov
46%	65%	58%	59%	59%	63%	73%	60%	72%	63%	69%	71%	Skobelev

13:30	14:00	14:30	15	15:30	16	16:30	17	17:30	18	18:30	19	zone
65%	67%	63%	63%	64%	64%	58%	54%	45%	36%	35%	36%	Nevski
77%	78%	73%	74%	75%	72%	73%	66%	66%	63%	63%	65%	Centre
74%	76%	73%	71%	73%	67%	65%	62%	61%	57%	59%	60%	Makedonia
85%	79%	79%	79%	75%	74%	77%	75%	72%	68%	66%	66%	Hr. Botev
88%	89%	87%	88%	87%	85%	86%	85%	83%	81%	79%	77%	Quarter
64%	59%	67%	69%	70%	66%	65%	52%	55%	60%	56%	51%	Prague
62%	70%	64%	58%	60%	66%	69%	60%	58%	68%	69%	62%	Slaveikov
69%	68%	74%	71%	69%	65%	73%	65%	56%	63%	60%	58%	Skobelev

Again in the internal neighborhood streets have the biggest difference from other areas, occupancy was relatively unchanged throughout the day as the difference between the least-busy hour (19:00 - 77%) and peak (14:00 - 89%) is only 12%. Parking spaces in the zone "Quarter" are preferred by drivers and therefore there is the greatest problem with parking, from 10:00 to 17:00 the average employment rate is over 85. There are problems with parking for short period on Hristo Botev Boulevard - where occupancy reaches 85% at 13:30. In zone "Center", "Alexander Nevsky Square" and boulevard Slaveikov occupancy early in the morning on is extremely low - at 20% and gradually increased to over 60%, but at the end of the day occupied places on Nevsky Square again decreased, while in Center area and boulevard parking spaces Slaveikov continue to be busy.

4. CONCLUSIONS

As a conclusion from the survey, here we can add that the paid nature of the most of the parking places creates relatively good conditions for parking. Occupancy of local business by subscription, the places for people with disabilities and the individual ones is in compliance. Problem with parking is only visible in a zone "Quarter" and at peak times at noon on Hristo Botev Blvd. Increased occupancy of unauthorized sites is also problematic point is further necessary adjustments to improve the regulation and control.

Possible measures that can improve conditions for parking are:

- Passage of Paid mode in zone "Quarter"
- Existing capacity could be used better by increasing the turnover in the blue zone - improved control over the length of stay

No particularly large opportunities to increase parking capacity, because of the nature and complexity of the development of ways to use space.

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