

ESTIMATION OF EFFICIENCY OF RETAIL CENTERS CAR PARKING-LOTS

Jurgis Zagorskas¹, Vytautas Palevicius²^{1,2}Vilnius Gediminas technical university, Saulėtekio ave. 11, LT-10223 Vilnius, Lithuania.
E-mails: ¹jurgis.zagorskas@gmail.com; ²vytp@vgtu.lt

Abstract. The explosive growth of retail centres during the last decade in East European countries caused many changes in existing town structures and transportation. Big buildings surrounded by huge parking-lots appeared inside previously planned territories with little care of surrounding environment and became the brain-teaser for town planners. This article is our humble attempt to show main problems caused by increased car use for shopping, measure and compare the effectiveness of private cars parking systems in different retail and provision centres. Vilnius city is chosen because it is the best example of such invasion and variety of objects can be found here. Survey data has helped us to find the main problems, define and calculate efficiency attributes to use it in COPRAS decision support method. Developed methodology can help city planners to determine and localize problems caused by big retail centres, to enhance motivation and versatility of decisions.

Keywords: town planning, parking-lots, retail centers, sustainability, efficiency attributes, COPRAS, attribute weight.

1. Introduction

During the last decade in the territory of Lithuania, as well as in all the other east-European countries have survived the boom of building the biggest possible retail and provision centers. It was caused mostly by growth of purchasing power of population in these areas which created a huge business niche, and lack of growth control from recently reformed government.

In the city of Vilnius, Lithuania this growth was such enormous, that in the period from the year 2002 till 2008 the retail area per citizen increased almost three times and the area of retail and provision centers have reached the total value of 1,1 million square meters for the city with around 600 000 citizens. After the start of economic recession in 2008 this boom has ended, but reached numbers stay stable (Fig 1).

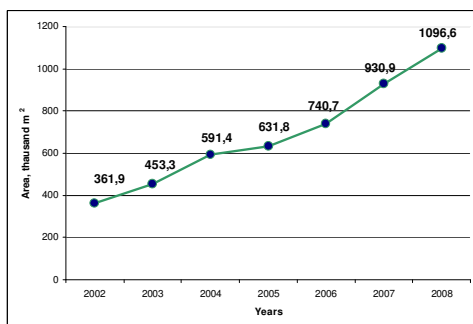


Fig 1. Growth of the total area of retail centers in the city of Vilnius, Lithuania

When the area of retail and provision centers increased, according to local planning regulations, area for car parking increased also. Provided area for car parking-lots in 2002 took 11.4 ha of territory and now, in 2011 it already takes 20.7 ha.

As the level of automobilisation is increasing, cities need more and more territory for car parking. Every car in the city needs at least three places to park: near the living place of cars owner, near the working place of cars owner and near the provision centre. Each parking place takes about 25 square meters of territory. This area is even bigger than the area needed for working place at the regular office building. When people use cars, it means that near the office buildings we need car parking buildings of approximately the same size and volume to meet the needs of workers. This already happened in most of American cities. In the city of Los Angeles parking-lots and streets for motorized transportation take 60% of total city area, nevertheless the problem of traffic jams has not been solved.

The car parking problem is quite new in the countries like Lithuania, when in more economically developed countries this problem was faced few decades before, here the problem was “discovered” only after the year 2000 and was faced not as an actual problem but as a positive alteration, like natural tendency with increase of living standards.

There can be stated an example of Germany in 1970-ies when automobilisation has reached such a high level

that number of scientific investigation were needed there. For the first time these problems and possible solutions were described in Biukenen report (1962). It was mentioned there, that there is no one way to solve all the arising problems and one of the most complicated questions mentioned was the building of a new car parking-lots in existing, already planned town territories. From that time in many west European countries coherent development of car parking infrastructure is taking place, great number of underground and multistory car parking buildings were built as well as in town centers and periphery.

Regarding the automobilisation level in Lithuania, in the year 1979 in the capital city Vilnius there were 29.5 thousand private cars. According to the data provided by department of Statistics in the year 2009 there were 248.6 thousand private cars in this same town. Two decades ago there were no big retail and provision centers and the level of automobilisation was less than 50 cars per 1000 citizens. It was obvious looking at the Vilnius living districts, town center and the streets (Fig 2): car flow was minimal, there were no traffic jams, there was plenty space in the parking-lots and no problems at all.

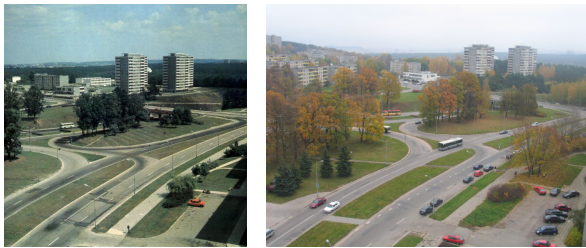


Fig 2. Lazdynai district. On the left – image taken at 1980, on the right – the same place, image taken at 2007

With the fall of Soviet Union and rapid economical growth, the situation in Lithuania has changed and practically for every average working person the possibility to own a car appeared. The cars were usually taken already used from western countries. These cars very quickly filled the streets and the yards of multifamily housing blocks. The car became not a luxury item as it was decade before (Burinskiene M.; et. al.; 2003).

2. Case study investigation details

For the research seven most visited and biggest parking-lots of retail centers in Vilnius town were selected:

- 1) Retail center “Ozas”;
- 2) Retail center “Akropolis”;
- 3) Retail center “Europa”;
- 4) Retail center “Panorama”;
- 5) Retail center “BIG”;
- 6) Retail center “Mandarinai”;
- 7) Retail center “Senukai” in Ukmergės street.

The methods of natural observation, survey of users and expert method were used in research.

Natural observation was performed three times: 1) on the June 2009 (during the summer season); 2) on the

October 2009 (during the autumn season); 3) on the March 2010 (during the spring season).

Using digital equipment there were collected series of data which provided the information about functionality of parking-lots:

- Dynamics of used space in parking-lots.
- The length of parking (rotation).
- Total number of user cars in specified parking-lot.
- Circulation of users in specified parking places, etc.

At the stage of elementary analysis, according to delineation, the number of car parking places was defined. At periods 9:00 – 14:00 and 15:00 – 20:00 in one hour intervals number of free parking places was recorded. Each time the number of cars, parked illegally, i.e. not according to the layout of parking-lot, was recorded also.

To define the average time of stay in parking place appropriate analysis was made also.

The survey of retail center’s clients was made to get more specific information. 436 clients were involved of 18 to 60 years age. The survey consisted of following short questions: How long usually it takes to make shopping? How often are you visiting retail centers? What problems do you see with car parking near the retail centers? Which retail center has the most comfortable parking-lot? Some additional questions were asked to define more details about free places to park etc.

Experts were consulted to estimate the technical parameters of parking-lots and rationality of plan. They gave their ratings in 10 points for each parking-lot. Other technical parameters were rated also: lighting, rain drainage etc.

3. Methodology

The main object of research was the functioning of car parking-lots at the main city retail and provision centers.

The main research goals are to define the level of efficiency of parking-lots, predict possible problems and give proposals. To meet these goals appropriate methodology was chosen.

The workload of parking-lot is defined by the following formula:

$$p_{st.} = a - l + n \quad (1)$$

The fill-up of parking-lot coefficient is used to show the relation between number of cars and total number of places in parking:

$$k = \frac{p_{st.}}{a} \quad (2)$$

where:

$p_{st.}$ – number of parked cars,

a – total number of parking places in a parking-lot,

l – number of unused places,

n – number of cars, parked illegally.

For the normal functioning, the coefficient k must not exceed the value of 0.80. When this value is exceeded

the functioning becomes aggravated, the safety problems start to appear. When the value is more than 1.00 car parking process in most cases is becoming uncontrollable.

Length of stay in parking is also a very significant value, showing the details of analyzed process. It is absolutely necessary to describe the circulation of cars in parking-lot.

4. Applying COPRAS method to evaluate efficiency of retail centers car parking-lots

Multi-attribute analysis is widely used in selecting the best alternative from a finite set of decision alternatives with respect to multiple, usually conflicting attributes.

COPRAS method was invented by Vilnius Gediminas Technical University scientists E. K. Zavadskas and A. Kaklauskas. According to this method the priority of alternatives (different parking-lots) and their efficiency is directly and proportionally relative to the defined attribute system, the values of attributes and the attribute weights (Zavadskas E.K. et al.; 1999).

In this case study the system of 9 attributes (or 9 criteria) was defined. Some of attributes resulted from the survey data, some from the rating of experts and some were obtained by investigation of car flow. The weights of attributes were defined according to the urban transportation experts. To compare the efficiency of alternatives the calculations were made in following steps (Banaitiene N. et. al.; 2008, Ginevicius R. et. al. 2008, Kanapeckiene L. et. al. 2010):

First step. Normalized decision assumption matrix D was created to obtain the normalised values without dimensions for comparison. Following formula was used:

$$d_{ij} = \frac{x_{ij} \cdot q_i}{\sum_{j=1}^n x_{ij}}, \quad i=1,m; \quad j=1,n. \quad (3)$$

Second step. For each alternative j the sum of minimizing S_{-j} and maximizing S_{+j} normalized criteria is calculated using the following formula:

$$S_{+j} = \sum_{i=1}^m d_{+ij}; \quad S_{-j} = \sum_{i=1}^m d_{-ij}, \quad i = 1, m; j = 1, n. \quad (4)$$

Third step. Comparison of effectiveness of different alternatives is calculated according to positive S_{+j} and negative S_{-j} characteristics:

$$Q_j = S_{+j} + \frac{S_{-min} \cdot \sum_{j=1}^n S_{-j}}{S_{-j} \cdot \sum_{j=1}^n \frac{S_{-min}}{S_{-j}}}, \quad j = 1, n. \quad (5)$$

Fourth step. The priority line of alternatives is calculated.

Fifth step. The level of effectiveness of alternatives are calculated according to formula:

$$N_j = \frac{Q_j}{Q_{max}} \times 100. \quad (6)$$

Table 1. Effectiveness of selected parking-lots – calculation results

Criteria describing the alternatives	*	Weight	Compared alternatives						
			RC "Ozas"	RC "Akropolis"	RC "Europa"	RC "Panorama"	RC "BIG"	RC "Mandarin"	RC "Senukai" Ukmergės st.
Convenience	+	0.6	0.0778	0.0889	0.0667	0.1	0.0778	0.0889	0.1
Rationality of plan	+	0.9	0.0964	0.1446	0.1125	0.1607	0.1125	0.1286	0.1446
Informativeness	+	0.9	0.0882	0.1412	0.1412	0.1765	0.1059	0.1235	0.1235
Time loss	+	0.8	0.1231	0.1077	0.0615	0.1385	0.0923	0.1385	0.1385
Traffic security	+	1	0.1765	0.0882	0.1471	0.1765	0.1765	0.0882	0.1471
Fill-up level	-	0.5	0.0463	0.0926	0.0741	0.0833	0.0833	0.0648	0.0556
Visual effect on environment	+	0.8	0.0348	0.313	0.0348	0.0348	0.1739	0.1043	0.1043
Lighting	+	0.8	0.1167	0.1333	0.1333	0.1333	0.1167	0.05	0.1167
Drainage	+	0.7	0.1105	0.0982	0.1105	0.1105	0.086	0.086	0.0982
The sums of weighted normalized maximizing indices of the alternative			0.824	1.1151	0.8076	1.0308	0.9416	0.808	0.9729
The sums of weighted normalized minimizing indices of the alternative			0.0463	0.0926	0.0741	0.0833	0.0833	0.0648	0.0556
Significance of the alternative			0.8918	1.1659	0.8725	1.091	1.0033	0.8854	1.0599
Priority of the alternative			5	1	7	2	4	6	3
Utility degree of the alternative (%)			76.49%	100%	74.83%	93.57%	86.05%	75.94%	90.91%

5. Investigation results

The average stay at retail centre parking plane was 1-2 hours approximately. Maximum load was observed at

period from 17:00 to 18:00. The biggest car flow was observed at retail center "Panorama" – 579 cars per hour.

Survey has shown that the most quickly clients find car parking place in retail centers “Panorama” and “Ozas”.

Table 1 shows the selected alternatives, describes criteria system and shows comparison of effectiveness of different parking-lots.

6. Conclusions

The car parking for retail centre clients is problematic in Vilnius city. It is difficult to find the parking place; there is lack of security measures for pedestrians, lack of infrastructure, and poor visual integration in townscape.

To enhance the level of service strict measures for meeting normative planning acts must be taken.

Investigation has shown that if the parking is filled-up more than 80 %, the functioning becomes aggravated, the safety problems start to appear. When the value is more than 1.00 cars parking process is most cases is becoming uncontrollable.

The recommendation is to charge car parking users, according to many successful examples in European cities. However the problem with this is that mostly the retail center administration is taking care of their parking-lots and it is impediment to their business to put charge on clients. Another proposed option is to adapt modular car parking system, which is adaptable to changing demands. The result is achieved by changing the configuration of parking area.

The results have shown that much improvement can be achieved by installing intellectual management system as in retail center “Panorama”.

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