

The Effect of Parking Pricing on Key Parking Performance Characteristics in Public Garages

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ABSTRACT

A sound parking policy is crucial for sustainable urban mobility. Since mostly fixed public garage supply often makes up a significant proportion of urban parking supply, matching it to demand becomes a challenge. This paper researches the impact of changes in parking pricing on key parking performance characteristics in urban garages. Compared to previous research, this paper focuses on user composition for daily parking with data obtained from parking system management. For the study area, two public garages in the City of Zagreb were chosen. This paper offers a solution for managing garage parking in urban areas sustainably. Based on user composition and key parking performance characteristics, this paper argues for introducing dynamic parking pricing based on occupancy. The results of analyzing key parking performance characteristics and user composition showed that the impact of price changes affected the observed public garages differently. Based on the analysis, solutions will be able to be offered for a more rational urban parking policy.

1. Introduction

The last two decades saw an increasing importance of car parking in urban planning, because car ownership and usage are continuously increasing, and urban space becomes scarcer. This is more emphasized among the residents of city centers, who usually park their cars in the vicinity of their homes, often blocking sidewalks and roads (Kodransky & Hermann, 2011).

The research on parking has been dominated for several decades by "grey literature" – reports and unscientific papers published by parking experts. Scientific publications were comparably rare until the end of 1990s (Mingardo, van Wee, & Rye, 2015). Despite being a relevant factor in urban transport demand management, compared to other traffic fields, parking is still insufficiently researched.

Parking demand management is a set of policies and measures resulting in more efficient usage of parking resources. If parking demand management is

implemented rationally, the number of offered parking spaces can be significantly reduced, enabling several economic social and ecological benefits. Improved parking demand management is often the best solution to problems with parking (Litman, 2021).

Previous work researched optimal parking policies in urban areas (Arnott, 2006), and some authors focused on the financial aspect (Verhoef, Nijkamp, & Rietveld, 1995) (Calthrop, Proost, & van Dender, 2000) (Button, 2006). The base of arguments for parking policies were considered, concluding that more research should be done to fully understand the impact of parking on availability and city attractiveness (Marsden, 2006). The cities could manage parking facilities more efficiently to improve public well-being by setting higher occupancy as a goal instead of higher incomes. This was proven by a good practice example from San Francisco, where the SF Park program was used to manage public off-street parking, such that parking prices were reduced, garage occupancy was increased, with unchanged income for the city (Pierce, Willson, & Shoup, 2015).

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Since parking pricing is an important parking demand strategy (Litman, 2021) (Willson, 2015), this paper analyses changes on key parking performance characteristics (KPPC) in public garages (Milosavljević & Simićević, 2019) in case of increased prices. Just price changes do not completely contribute to a rational parking policy, so this paper introduces user composition to see the impact of price changes on short-term users and long-term users.

2. Research methodology

The research was conducted on two public garages in the City of Zagreb – Gorica and Kvaternikov trg. The observed garages are positioned in close vicinity (Figure 1). The Kvaternikov trg garage is an underground public garage with 354 spaces. The Gorica garage is a combined overground and underground public garage with 353 parking spaces. The garages are located on the eastern edge of the city center. At the beginning of 2023, parking prices in both garages became higher. To better understand the means of price changes influencing garage users, user composition was determined for garage parking spaces before and after price changes, divided into two major categories:

- Short-term users, who pay for parking by hour,
- Long-term users, who pay for parking with pre-paid parking tickets.



Figure 1. Public garages Kvaternikov trg and Gorica – aerial view
Source: (Google LLC, 2005)

The research was conducted by collecting data from the parking management system. An entire day was separated into 24-hour intervals, such that the starting number of vehicles in garages was measured at the beginning of the observation period. The parking management system provided the number of parking tickets registered at entering and exiting for every hourly interval.

The focus of the research is the impact of price changes on KPPC, provided by mandatory literature [11], before and after the price changes for one workday in each garage, and they are:

- Average occupancy (O_a),
- Average accumulation (A_a),
- Number of vehicles parked in the garage (V_p).

Previous methodologies usually had a survey to collect data regarding user composition and determining optimal parking pricing in garages (Simićević, Milosavljević, & Maletić, 2012). The methodology of this study is based on determining user composition by a detailed analysis of the data obtained from the parking management system. However, the difficulties of the research emerged in data processing because the system is not well-adjusted to calculate KPPC automatically, so additional data transformations had to be done.

3. Research results

At the beginning of 2023, the prices in both garages rose (Figure 2). Because of rising prices, vehicle occupancy was reduced (Figure 3) (Figure 4). Before the price increase, the period of overcapacity was from 09:00 to 14:00 in Gorica garage, and from 08:00 to 15:00 in Kvaternikov trg garage. After the price increase, the problem with overcapacity resolved. The results of the analysis showed that the price changes had an impact on KPPC differently (Figure 5) in 24-hour period. For both garages, higher prices resulted in less average accumulation and average occupancy throughout the observed day. Higher prices also influenced the number of vehicles parked, with decrease in Gorica garage and increase in Kvaternikov trg garage. The price change also had an impact on user composition (Figure 6) in 24-hour period. The analysis showed that there was a decrease of short-term and long-term users in Gorica garage. Consequently, the number of available spaces increased by 10%. In Kvaternikov trg garage, the number of long-term users decreased; however, the number of short-term users increased, but this also resulted in 10% more parking spaces.

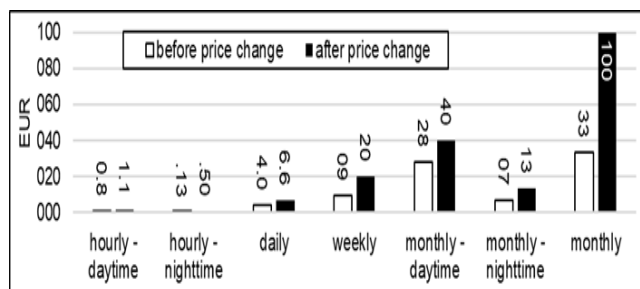


Figure 2. Parking prices in both garages
Source: by authors

The increase in the number of parked vehicles in Kvaternikov trg garage is related to the amount of short-term parking, because the number of long-term users occupying parking spaces in peak periods decreased, thus enabling short-term users the opportunity to occupy additional parking spaces.

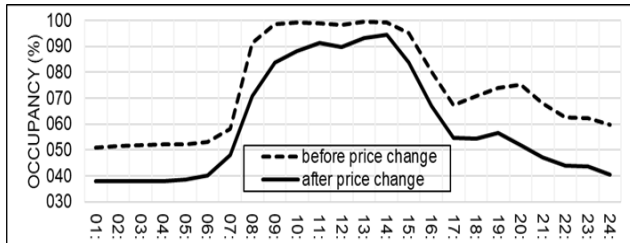


Figure 3. Occupancy in Gorica garage before and after price change

Source: by authors

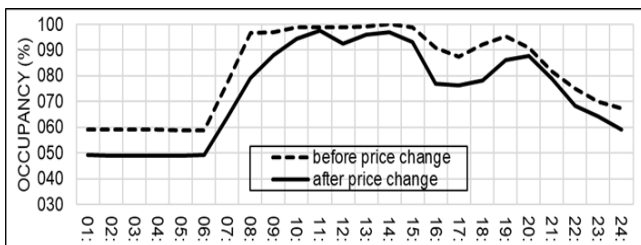


Figure 4. Occupancy in Kvaternikov trg garage before and after price change

Source: by authors

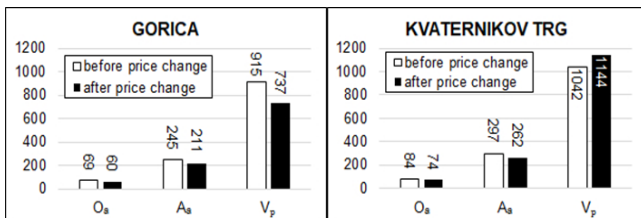


Figure 5. Key parking performance characteristics – comparison

Source: by authors

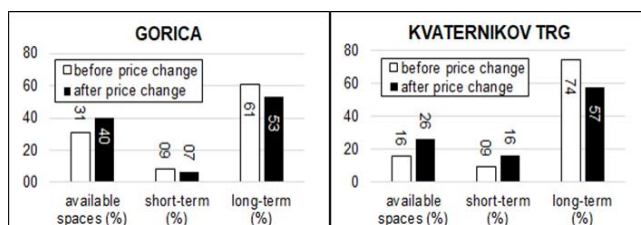


Figure 6. User composition – comparison

Source: by authors

4. Discussion

The results of the analysis showed that each parking area needs to be approached individually. When there are problems with parking in specific areas, besides the data obtained from the field, the corresponding user composition also needs to be analyzed. This creates more rational guidelines for sustainable parking management for the area. In this example, parking policy creators saw the problem with overcapacity in garages, so they decided to change parking policy with price increase. Although overcapacity resolved, the implementation of this strategy does not mean it will always have the same impact on user behavior. Therefore, the problem needs to be tackled in the same manner as in San Francisco (Pierce, Willson, & Shoup, 2015) to use the capacity optimally and to manage parking spaces sustainably. The solution to the problem should include:

- Determining and monitoring hourly key parking performance characteristics (O_a , A_a , V_p),
- Determining and monitoring hourly user composition for both short-term and long-term users,
- Depending on hourly O_a and user composition, increasing or decreasing parking fees every hour or limiting the number of long-term users by not allowing monthly ticket purchases.

Table 1. Proposed dynamic parking prices based on occupancy

Occupancy	Hourly tickets, 08:00 to 18:00	Hourly tickets, 18:00 to 08:00
below 40%	0.80 €	0.30 €
40% to 85%	1.10 €	0.50 €
above 85%	1.40 €	0.80 €

Source: by authors

A proposal of the solution is shown in Table 1, where parking fees change according to occupancy. According to the analyzed data in this research, considering occupancy and user composition:

- In Gorica garage, daily monthly fees should be increased to remove corresponding users from the garage in peak periods, and nightly monthly fees should decrease, and this type of parking should be popularized,
- In Kvaternikov trg garage, the nightly monthly fees should decrease, and this type of parking should also be popularized.

Additionally, rational guidelines regarding user composition should be proposed, such that the composition is monitored throughout the day. This could prove to be the best way to manage parking capacities. Since the garages have identical capacity and are very close to each other, it is necessary to investigate why the user composition differs. The solution could imply the Kvaternikov trg garage being more recent with wider parking spaces. Certainly, a user survey should be conducted to provide the actual predictors.

5. Conclusion

Urban areas have many traffic-related problems, with parking being one of them. A great challenge in resolving parking problems is matching parking supply to parking demand. This paper researched the impact of price changes on KPPC in public garages. The research results showed that changes in pricing influence differently on each KPPC, despite the garages being very close to each other. To better understand the impact of price changes, in addition, the relationship between prices and user composition was also analyzed. The results show that price changes have a different impact on user composition in each garage. This implies that every parking area should be approached differently when introducing new models and strategies for improving parking policies.

The research lacks a user survey to investigate the reasons why the users park their cars more in one garage than the other, although the prices are the same and the garages are very close to each other. The paper presented a parking management model where prices are dynamic based on occupancy. This model should enable more rational parking space management. The goal is to have as high as possible occupancy, accumulation, and the number of vehicles, but to prevent overcapacity at the same time. This would enable a more sustainable parking space management, which is certainly favorable to any administrative body.

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