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PARKING CONDITIONS IN TRANSPORT DEMAND MANAGEMENT

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Purpose: In today's urban mobility landscape, the increasing number of cars trying to park in the city center is one of the most burdensome problems facing urban transport. Knowing about the impact that individual parking space management strategies and methods - including parking solutions and pricing systems - can have on the efficiency of the urban transport system, may be of key importance for the selection of solutions in this area. This knowledge is the main goal of my research.
Design/methodology/approach: The observations and research presented in this article took place in Bielsko-Biala. As part of the research, the effectiveness of actions implementing the city's parking policy was analyzed. The scope of these activities included, first of all, parking fees and the organization of the so-called parking zones in the city. In the case of parking fees, the effectiveness of parking fees was analyzed. The research was mainly a case study. It also had elements of quantitative research - a questionnaire. The effectiveness of parking fees was assessed on the basis of official and up-to-date data on parking fees and the analysis of the ability (ATP) and readiness (WTP) to pay parking fees by their users.
Findings: This article presents the way in which regulations, including parking fees in the center and suburbs of Bielsko-Biala, influenced the demand for parking space and thus the mobility of the city's inhabitants.
Practical implications: The results presented in the article are the basis for making practical decisions regarding the necessary regulations - in the perspective of the increase in demand for transport in downtown areas - related to parking space. This, in turn, may increase the share of public transport in the transport structure.
Originality/value: The available results of empirical research on the relationship between the parking strategy and transport congestion and its consequences are very poor, while the research itself is often hampered by the lack of data systematically collected before and after the introduction of new tools or changes to the already used parking space management tools. The publication analyzes the data collected at the time when new or modified functioning elements of the municipal transport policy were implemented in the city. Indirectly, the author of the article presents evidence for the thesis that negative actions, such as raising parking fees, only allow for limited in time and space effects of actions related to reducing the demand for transport.

Keywords: transport demand management, mobility management, parking policy.

Category of the paper: research paper.

1. Introduction and current knowledge on the impact of transport policy on urban mobility

The mature transport system of Bielsko-Biala is to potentially enable drivers to reach most destinations in a comfortable, safe and affordable manner. The city's road infrastructure would effectively meet the above criteria in the conditions of traffic intensity recorded in the 1970s or 1980s. The main transport problems faced by most urban communities today are road and parking congestion, low mobility of travelers, as well as high economic, social and environmental costs of car transport. All these problems can be prevented by effectively applying the principles of transport demand management.

Most conventional urban transport management strategies address selected individual travel problems. Moreover, individual ones may, as in the case of induced demand, stimulate an increase in demand for journeys and highlight existing problems (Zhang, Loo, 2021). An example is the widening of roads, which reduces congestion in the short term, but may generate additional vehicle traffic over time. As a rule, such action results in even greater problems resulting from the intensity of transport traffic (Bylinko, 2021).

Given that the main goal of demand management is to influence the individual behavior of urban travelers, the challenge for urban transport policy makers is to find the right mix of incentives and disincentives that will bring about a change in routine travel choices (Meyer, 1999). Urban population growth and the rapidly growing number of vehicles are changing travel patterns in a way that makes demand management strategies more effective at solving transport problems than strategies to increase capacity (Farahmand, Konstantinos, Geurs, 2021). In addition, the inability of transport infrastructure to respond rapidly to changing travel needs, coupled with an increase in the number of travelers, forces more emphasis on demand-side management techniques, rather than solving problems by increasing supply.

Most transport demand management strategies are economically sound, but the magnitude of the effects of single tools is too small to significantly affect overall travel patterns. Many city organizations implement single individual demand management strategies, but virtually none has yet implemented a complete transport demand management toolkit that is technically feasible and economically viable (Mahmood, Bashar, Akhter, 2009).

The methods of managing the demand for transport are most often classified according to their direct or indirect impact on the nature of urban transport. This criterion allows us to distinguish five groups of strategies for implementing the concept (Hyllenius et al., 2009):

- Improved transport options.
- Incentives to use alternative modes of transport and to reduce driving.
- Strategies for managing parking space and land development.
- Policy tools and institutional change.
- Transport demand management and support programs.

Most transport demand management strategies are economically sound, but the magnitude of the effects of single tools is too small to significantly affect overall travel patterns (Vanoutrive, 2019). Many city organizations implement single individual demand management strategies, but virtually none has yet implemented a complete transport demand management toolkit that is technically feasible and economically viable. The table below (Table 1) presents the instrumentation of methods related to parking space, which are the indirect subject of research interests in this article.

Table 1.
Instrumentation of parking space management

Tool's name	Description
Parking Cost, Pricing and Revenue Calculator	Excel spreadsheet calculates parking facility costs, prices and revenue
Parking Management	Strategies for more efficient use of parking.
Parking Management: Strategies, Evaluation and Planning - Comprehensive	Development of integrated and coordinated plans for the construction and modernization of parking spaces
Parking Pricing	Charging motorists directly for using parking facilities
Parking Solutions	Comprehensive menu of solutions to parking problems
Parking Evaluation	Guidelines for evaluating parking problems and solutions
Shared Parking	Sharing parking facilities among multiple users
Bicycle Parking	Bicycle racks, lockers and changing facilities

Source: Online TDM Encyclopedia Transportation Demand Management. Improved Transport Options, Victoria Transport Policy Institute, https://www.vtpi.org/tdm/index.php#improved.

While most of the individual transport demand management measures contribute to relatively small results that only have an effective impact on a few percent of all urban journeys, their impact is cumulative and synergistic (the total impact is greater than the sum of the individual effects). A comprehensive transport demand management program generally affects a large proportion of all journeys and provides large total benefits (Rowe, 2013).

According to the theory of transport economics, parking fees can have a significant impact on transport demand (transport flexibility). Even small changes in parking fees can affect car travel patterns. The ratio of the use of vehicles for travel to the amount of parking fees varies from -0.1 to -0.3 (a 10% increase in parking fees reduces vehicle journeys by 1-3%), depending on demographic and geographic factors, and means of travel and travel characteristics (Vaca, Kuzmyak, 2005). Parking charges for commuting appear to be particularly effective in reducing travel during peak times. Switching from free parking to parking systems that allow for the reimbursement of parking costs (prices that reflect the full cost of providing parking spaces) usually reduce car journeys by 10-30%, especially if such a change is made from the so-called improved transport options and other complementary transport demand management strategies (Hess, 2001). Experience also shows that setting parking charges in one area only can shift travel to other locations with a slight reduction in the total number of vehicles (Hensher, King, 2001).

This article is based on the considerations presented above. Chapter 2 describes the research methodology and presents changes in the parking policy of Bielsko-Biala in recent years. Chapter 3 reviews the effects of the changes, their analysis and evaluation of activities related to parking regulations and fees and their impact on the mobility of the city's in the future. The last part presents research conclusions related to planning the city's parking policy.

2. Research methodology

The observations and research presented in this article took place in Bielsko-Biala. As part of the research, the effectiveness of actions implementing the city's parking policy was analyzed. The scope of these activities included, first of all, parking fees and the organization of the so-called parking zones in the city. In the case of parking fees, the effectiveness of parking fees was analyzed. The research was mainly a case study. It also had elements of quantitative research - a questionnaire.

The effectiveness of parking fees was assessed on the basis of official and up-to-date data on parking fees and the analysis of the ability (possibilities) and readiness to pay parking fees by their users. The ability to pay (ATP) is the user's ability to pay for the services received based on the income considered optimal, while the willingness to pay (WTP) is the user's willingness to pay fees for issuing rewards for the received services. Ability to pay (ATP) is analyzed on the basis of income, transportation costs, parking fees and parking usage frequency. Meanwhile, willingness to pay (WTP) is the average of the parking fees that users are willing to pay based on their perception of available parking spaces.

In this study, questionnaires were used, which were sent to 240 motorized parking users. They were both car and motorcycle users. The respondents were also user groups, both regularly and irregularly parking on the streets of Bielsko-Biala.

In an attempt to maintain the adequacy of the data included in the study, factors that may affect the willingness to pay (WTP) were taken into account, namely: understanding the need to manage the mobility of city residents, perceiving the benefits of efficient parking space management, determining the proportion of total expenses to expenses related to parking and the method of payment for parking.

The method will be used to assess the public's willingness to pay, namely: the contingent valuation method. Contingent valuation method is a survey technique that attempts to obtain information about the preferences of the individual/household for a product or service (Raffel et al., 2015). These methods fall into the category of direct method, a method that directly ask how much the price that the user wants to pay for the product used. Respondents in this survey were given several questions about how much they value a good or services.

3. Analysis and evaluation of changes in the parking policy in Bielsko-Biala

Pursuant to Resolution No. VIII / 101/2015 of the City Council of May 26, 2015, a Paid Parking Zone (PPZ) was established in Bielsko-Biala, where a fee is charged for parking vehicles on public roads. The above-mentioned zone was designated in the city due to the significant deficit of parking spaces in the city center, in order to, among others, increasing the rotation of parking vehicles. The compact development of the downtown makes it impossible to designate new parking spaces, while the number of vehicles continues to increase, which in turn leads to an increased demand for a limited number of parking spaces.

The functioning of Paid Parking Zones theoretically shortens the parking time in the areas with a shortage of parking spaces to the necessary minimum, improves parking conditions for downtown residents, reduces the traffic of vehicles looking for parking spaces, reducing noise and exhaust emissions, which directly improves the living conditions of residents.

In the first shape, the Paid Parking Zone and its area were delimited by streets and squares, which were presented in comparison with the zone area enlarged in 2022 in the Figure 1. It should also be added that originally the fee for parking vehicles in the zone was collected on business days, from Monday to Friday, from 8:00 to 16:00.

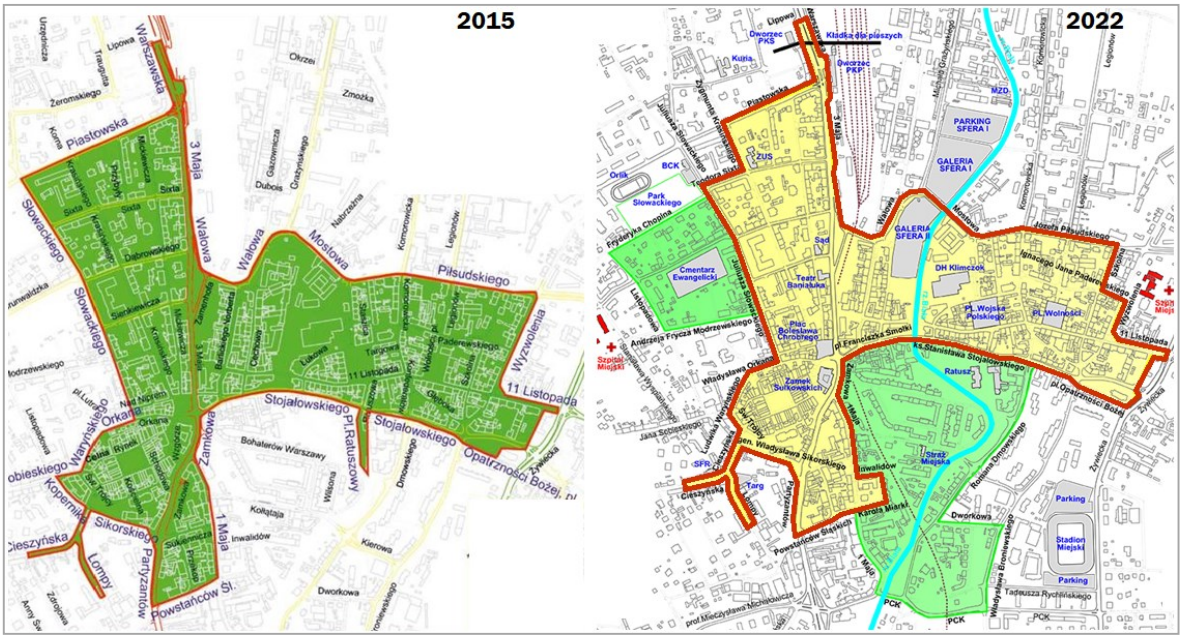

Figure 1. The range of the Paid Parking Zone in Bielsko-Biala in 2015 (left) and in 2022.
Source: Miejski Zarząd Dróg w Bielsku-Białej, https://mzd.bielsko.pl/o-strefie-platnego-parkowania/.

The Table 2 presents a summary of the number of parking spaces in car parks in the Paid Parking Zone and on streets in Bielsko-Biala in 2015 and 2022. The number of parking spaces intended for disabled people has also been taken into account.

Table 2.
List of parking spaces in the Paid Parking Zone (PPZ) in 2015 and 2022

Type of parking spaces	Year 2015	Year 2022	Change 2015-2022 [%]
Ordinary parking spaces	1001	1337	+34%
Parking spaces for disabled people	87	101	+28%

Source: Miejski Zarząd Dróg w Bielsku-Białej, https://mzd.bielsko.pl/o-strefie-platnego-parkowania/.

The payment of parking fees on public roads results directly from the Act of March 21, 1985 on public roads (Journal of Laws of March 31, 2015, item 460), according to which the City Council, at the request of the Mayor of roads, may introduce Paid Parking Zones in areas with a shortage of parking spaces.

From January 1, 2022, there were, inter alia, extending the payment hours for parking and increasing the fee for using the zone. Parking in the zone is paid for an hour longer - until 17.00. It was a tribute to the drivers living in the zone - the extension of paid time was to make it easier for residents returning by car from work to find a free place in the afternoon. Basically, the rotation in the zone was to be ensured by the increase in the amount of fees. From January 1, 2022, you have to pay PLN 3.50 for the first hour of parking, however the minimum fee for the first 30 minutes is PLN 2.00. The rate for the second hour is PLN 4.00, for the third hour - PLN 4.50, and for each subsequent hour - PLN 3.50. Changes in the amount of parking fees are presented in the Table 3.

The amount of the penalty for non-payment has changed, i.e. the additional fee and the method of its calculation. A driver who does not pay for his stoppage in the zone receives an order to pay the additional fee. It amounts to PLN 150. However, if he/she pays the payment himself within 7 days from the date of issuing the order, he/she will receive a 50% discount, i.e. he/she will pay only PLN 75. At this point, it should also be added that in the Paid Parking Zone in Bielsko-Biala, it is possible to make e-payments for parking vehicles based on three mobile applications: mobiParking, SkyCash, moBILET and mPay. The use of mobile applications seems to have a strong impact on the efficiency of fees, including their compliance with the table presented above.

Table 3.
Differences in the amount of basic and additional fees (penalties) for parking in the Paid Parking Zone in Bielsko-Biala between 2015 and 2022

Type of payment	Year 2015	Year 2022	Change 2015-2022 [%]
Initial 0,5 hour	1	2	+100%
Initial full hour	2	3.5	+75%
2nd hour	2.30	4	+74%
3rd hour	2.50	4.5	+80%
Subsequent hour (each)	2	3.5	+75%
Monthly fee for local inhabitants	100	150	+50%
Monthly fee for business	140	200	+43%
Penalty	50	150	+200%

Source: Miejski Zarząd Dróg w Bielsku-Białej, https://mzd.bielsko.pl/o-strefie-platnego-parkowania/.

The analysis of data related to parking in the paid parking zone shows (Table 4) that the increase in negative tools did not reduce the load on the parking lots in the zone. A slight increase of 2% was observed here. On the other hand, the number of cars looking for parking spaces in the outskirts of the zone has increased significantly, by as much as 6%. There has also been an increase in vehicles that break the road traffic regulations, including those related to parking fees. On this basis, it can be concluded that the increase in the so-called additional parking fee (penalties) did not affect the number of vehicles violating the parking restrictions.

Table 4.
Changes in selected numbers of parking cars 2021-2022

Year	2021	2022
Use of parking lots in the Paid Parking Zone	82%	83%
Use of parking lots in the close neighborhood of PPZ	85%	91%
Vehicles violating parking regulations	2%	4%

Source: Miejski Zarząd Dróg w Bielsku-Białej, https://mzd.bielsko.pl/o-strefie-platnego-parkowania/.

In the context of the parking policy and mobility of the inhabitants of Bielsko-Biala, the analysis of the growing demand for transport is important, which allows to conclude that the increase in demand for transport, caused mainly by the overflow of urbanized areas, also includes medium-sized and small cities. Bielsko-Biala is an administrative unit with approx. 170 thousand residents. The Bielsko-Biala agglomeration, which is made up of the Bielsko County together with the city of Bielsko-Biala, is an area inhabited by 335,000 people. In recent years, a two-track trend, typical of most similar urban structures in Poland, has been maintained: a decrease in public transport passengers (Figure 2) and a rapid increase in the number of private cars (Figure 3).

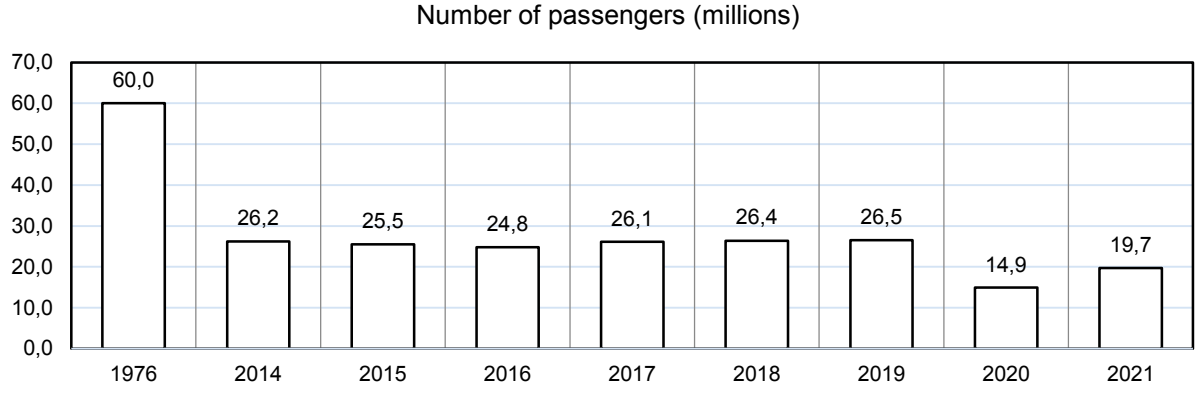

Figure 2. Number of public bus passengers in the years 1976 – 2021 in Bielsko-Biala.
Source: Miejski Zakład Komunikacyjny w Bielsku-Białej, http://www.mzk.bielsko.pl.

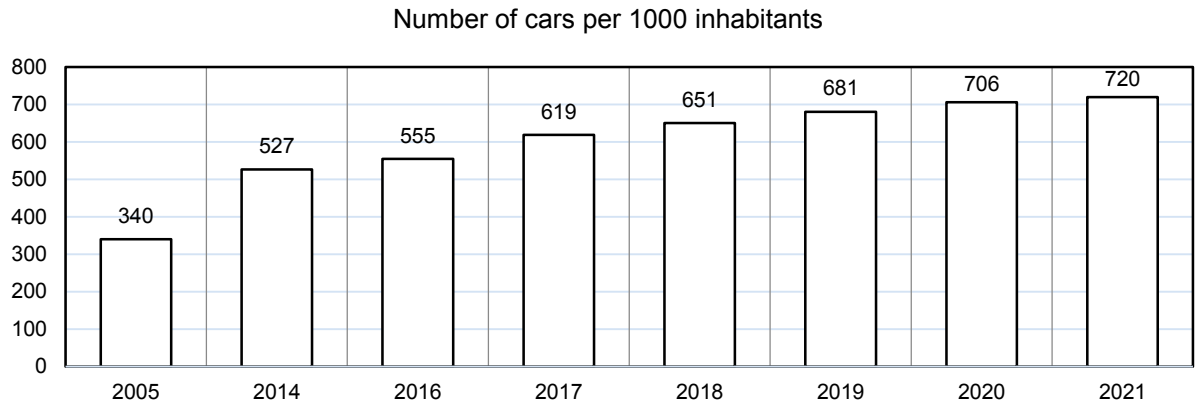

Figure 3. Number of registered cars per 1000 inhabitants in 2005 – 2021 in Bielsko-Biala.
Source: Urząd Miejski w Bielsku-Białej, http:www.um.bielsko.pl.

The data on the number of inhabitants of Bielsko-Biala and the Bielsko agglomeration (Table 5) are an indirect evidence of the suburbanization described above. Despite the fact that in the last 22 years, the number of inhabitants of the city of Bielsko-Biala, as shown in Table 4, has decreased by almost 11 thousand. inhabitants, the number of inhabitants of the Bielsko County increased by 22 thousand. residents. Until recently, such a tendency was observed almost exclusively in large and very large cities (with at least 500,000 inhabitants). At the present time, it can be stated that a similar phenomenon is also characteristic of medium-sized cities, which poses a greater risk as it constitutes the basis for the claim that the phenomenon of suburbanization applies to urban centers, regardless of their size or location in the local system.

Table 5.
Population of the city of Bielsko-Biala and Bielsko County in the years 1999-2021. Own study based on data from www.um.bielsko.pl, 20.09.2022

Years	Bielsko-Biala	Bielsko County	Bielsko-Biala and Bielsko County together
1999	178,936	144,922	323,858
2000	178,611	145,772	324,383
2004	176,987	149,361	326,348
2007	175,690	152,695	328,385
2010	174,755	157,119	331,874
2016	172,407	162,495	334,902
2017	171,505	164,003	335,280
2018	171,259	165,000	336,259
2019	170,663	165,960	336,623
2020	169,553	166,348	335,901
2021	168,319	166,498	334,817
difference 1999-2021:	*-10,617↓*	*21,576↑*	*11,422↑*

Source: Own study.

The results of the so-called Ability to Pay (ATP) and readiness to pay fees by residents of various city zones for effective and convenient parking (Willingness to Pay - WTP). The study shows that the fees applied in Bielsko-Biala are not very effective, which means they do not meet the real possibilities and expectations of the inhabitants.

This may be the result of dualism in thinking about cars parked in the center. On the one hand, we want to be able to park easily in our cities, and on the other hand - we would prefer not to have more cars parked there.

Table 6 allows for the comparison official and current fees with ATP and WTP values. It shows that the value based on the user's willingness to pay depends on the place of residence and ranges from PLN 3.14 to PLN 6.62. While the value based on the user's ability to pay is at PLN 1.56 to PLN 4.24.

Table 6.
ATP and WTP values in individual parts of the city of Bielsko-Biala [PLN]

Variable factor	Inhabitants of PPZ	Inhabitants of PPZ vicinity zones	Inhabitants of the suburbs
Willingness to Pay (WTP)	4.24	3.53	1.56
Ability to Pay (ATP)	6.62	5.39	3.14

Source: Own study.

Based on average ATP and WTP value, it finds that the ideal fee should be at PLN 3.11 to PLN 5.05. It is a basic fee - per hour of parking. The official fee is lower than the ideal fee (Figure 4).

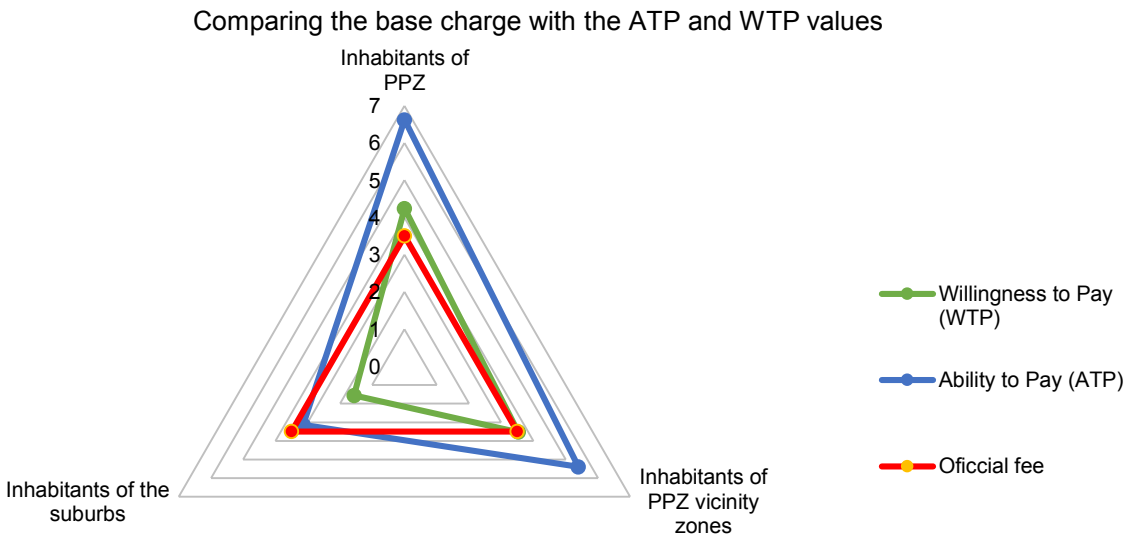

Figure 4. ATP, WTP values [PLN] and official based fee (initial full hour).

Source: Own study.

The results of the estimated values of WTP and ATP can be used as a reference material for determining parking rates. The necessary condition here is to ensure the conditions in which this parking will not be as big a problem as it is today and the parking spaces will simply be more accessible.

The change in the rate of rotation of parking in the paid parking zone is also characteristic of the observed system. Increased rotation at all parking fees suggests that the main driver of this trend is the change in parking fees. Instead of parking in the PPZ, car owners who have been looking for places in the center of Bielsko-Biala often move their vehicles to areas outside the zone, where parking on the street is still free.

4. Conclusions of research

Research and experiences of other cities, such as London, shows that most of the individual measures related to transport demand management contribute to relatively small results, which effectively affect only a few percent of all city commuting. Their proper selection can make their effect cumulative and synergistic (the total effect is greater than the sum of the individual effects). A comprehensive transport demand management program generally affects a large proportion of all journeys and provides large total benefits.

The paid parking system in Bielsko-Biala is not effective and requires thorough changes as part of the overall system of managing the demand for transport in the city.

This article analyzes the impact of the parking policy, including parking fees, on the transport behavior of road users in Bielsko-Biala. A characteristic feature observed during the analysis of the research results is the adaptive behavior of people who want to park in the city center or in its immediate vicinity. The lack of fees for parking in the areas directly adjacent to the paid parking zone means that the effects achieved in the PPZ, consisting not so much in reducing the number of parked vehicles as in greater rotation, extend their negative impact to the outskirts of the PPZ.

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