

Article

Parking Policy as a Tool of Sustainable Mobility-Parking Standards in Poland vs. European Experiences

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Abstract: Contemporary cities generally lack the balance between the development of the spatial structure and the communication possibilities of the inhabitants. The high motorisation rate in Poland, as well as in other European countries, and the preferred choice of individual means of transportation have both contributed to a significant increase in congestion over the last 10 years. The aim of this research was to try to establish to what extent a consciously conducted parking policy can help control the mobility of inhabitants of selected Polish cities. The starting point for the analysis was the availability of parking spaces in residential areas, introduced as an imposed indicator in the operative planning documents. As part of the research, the authors of this paper analyzed the legal provisions of the operative Local Spatial Development Plans (MPZP) concerning the parking function for housing estates five of the biggest cities in Poland. The results were confronted with data on selected European cities. Nearly 550 planning documents from the years 2000–2019 and parking standards operating in individual countries were cataloged and analyzed. The research results show that for 20 years Polish cities have mainly been using the possibility of determining the minimum rate of parking spaces. Regulations attempting to limit the number of cars are incidental. However, this is a necessary direction of legislative changes.

Keywords: car parking policy; residential parking rate; mobility; urban design; housing estate; parking standards



Citation: Lower, A.; Szumilas, A. Parking Policy as a Tool of Sustainable Mobility-Parking Standards in Poland vs. European Experiences. *Sustainability* **2021**, *13*, 11330. <https://doi.org/10.3390/su132011330>

Academic Editor: Itzhak Benenson

Received: 14 August 2021

Accepted: 8 October 2021

Published: 14 October 2021

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1. Introduction

The problem of an excessive number of cars moving around the city is growing and has been particularly acute for the last 10 years. Cars present on the streets need parking places, hence a skilful parking policy may affect the degree of road congestion to some extent. In the twentieth century, the approach to this issue was different from that observed today. In order to fully meet the current needs of individual users of the time, efforts were made to provide an adequate number of parking spaces, both for individual investments and street parking lots [1]. Minimum requirements were determined, and they grew as the automotive index increased. This trend is slowly changing. More and more emphasis is put on the application of the policy aimed at eliminating congestion on roads, and at the same time increasing pedestrian, bicycle and public transport [2–4], while also using an appropriate parking policy.

The significance and role of parking policy in large cities that face significant congestion problems is particularly important. It is the parking policy that defines the strategies for managing the mobility of residents in terms of use of individual transportation and the organization of parking areas. In Europe, the parking policy is set at different levels, depending on the country and the city. It can function as a separate document, as a part of a mobility management policy, or as a guideline in Masterplans. Parking policy as the main element of the travel demand management strategy is widely used in cities to achieve

two important goals: reducing the demand for parking in central areas and limiting the use of cars [5].

These tasks are carried out on several levels. One of them is the introduction of the P&R system, which intercepts on the outskirts cars heading to the city center. The system uses special parking lots, from where users can continue their journey using public transportation. The system can be used by residents of peripheral estates and non-urban adjacent areas. An important aspect of an efficiently functioning system is the selection of an appropriate location for the system parking lots within the city structure. Many researchers have dealt with this topic [6–10]. It is also worth paying attention to the fact that freight transportation is also to some extent responsible for the increased road traffic. Hence, the problem of the impact of parking policy on the economy of road transport and the problem of parking trucks is also reflected in the scientific literature [11].

Another level of carrying out tasks aimed at car traffic reduction in the city is the right approach to the parking policy within housing estates which are often located too close to the city center for residents to use the P&R system. The expectations of residents are usually the same—they want to have a safe and accessible parking space near their home. The residential parking system analyzed in this study is a key factor in managing the mobility of residents. The location of parking spaces and their availability have an impact on having and using a car in a household. The parking policy is primarily aimed at changing the mobility of residents towards a more sustainable mobility [12]. Social acceptance of the parking policy is also extremely important. It is a prerequisite for the successful implementation of the new strategy, therefore it is crucial to recognize the expectations of residents and their travel systems [12]. Introducing restrictions on parking on the street generally associated with objections arising from concerns about the deterioration of comfort related to mobility. One of the mechanisms regulating the number of vehicles and the time they are left for on the street is the setting parking fees. Its aim is to achieve balance between the demand and supply of parking spaces. However, the effectiveness of the pricing policy is not always positively seen by the inhabitants, but rather it is perceived as an attempt to get money from them without giving any benefits in return [13].

The factor determining the choice of the means of transportation is, to a large extent, the urban planning of the city. Inhabitants of suburban and central areas face different problems. A wide range of new transportation systems, such as car sharing, ride-sharing and bike sharing, is addressed directly to the residents of individual districts. Hence, the role of city authorities in shaping an appropriate, sustainable mobility policy, including the management of transportation in the city, is extremely important. This policy is carried out on many levels and only taking parallel actions gives a chance for the effect of reducing congestion and limiting the dominant car traffic in cities. These activities relate to various aspects of parking in the city and getting around it. The above-mentioned P&R system is expected to limit the inflow of cars to the city center, moreover, measures are being taken to increase the attractiveness of public transportation by making prices, time and quality of travel appealing to users. Another action focuses on the very urban structure of the city. An interesting idea is the idea of walkable city presented as an alternative approach to urban mobility [8]. It is an attempt to bring back the multifunctional role of public spaces, including street spaces. They are to sustainably serve everyone—both individual car traffic users as well as public transportation users, pedestrians and cyclists. There is also an extreme approach, which plans to designate car-free zones. Vehicle sharing concepts such as ride-sharing and car-sharing are also becoming more and more popular. The importance of the parking space itself is also changing. Due to the successively growing number of cars it becomes more and more difficult to organize sufficiently large parking areas within the city space. They are land-consuming, but also carry an additional threat—they aggravate the urban heat island phenomenon and generate problems with city drainage. Hence, more and more frequent searching for solutions at the construction level—e.g., automatic car parks that take up less space or green parking lots [14,15]. Parking spaces are made using

permeable surfaces. For underground parking lots, a deep enough soil layer is provided to ensure plant vegetation, and the greenery itself is used as a composition element that also gives shade.

In this paper, the authors will focus on one aspect of sustainable mobility policy—the parking policy implemented by selected cities towards housing estates. The article presents the results of research focused on five of the largest cities in Poland. During this research, nearly 550 Local Spatial Development Plans (MPZP) were analyzed, focusing on the provisions concerning the regulation of the parking space indicator for housing estates. The aim of the research was to diagnose the methods used so far to regulate the number of cars in the city through the parking policy in Polish cities and to compare the results with the experiences of selected European countries. The parking policy is implemented by defining parking standards for multi-family residential areas. As it has already been mentioned, the results of the research were confronted with the experiences of a few selected European countries, in which the legislative response to the problems with congestion had been much earlier than in Poland, and where in many cases the effects of the actions taken can already be observed.

The following structure of the work was adopted in the article: the first part presents a broader background to the conducted research. The next part presents the methodology and scope of the research. Section 3 introduces the ideas which emerged in Great Britain, Germany and Sweden—for carrying out the transportation policy, with particular emphasis on the parking policy for housing estates. Section 4 presents research based on the analysis of planning documents carried out for local development plans adopted in five major Polish cities—Warszawa, Poznan, Krakow, Wroclaw and Lodz—over the period of 2000 to 2019. The collected data allow for a summary and opening of the discussion on parking standards in Polish cities in relation to the experiences of other European countries.

2. Creating a Parking Policy in Housing Estates

Parking policy is a wider issue covering a number of topics. It is an interdisciplinary question that researchers from various fields deal with. The problem of the lack of classification of parking policy was taken up by Barter [16], who looked at parking strategies in various cities and analyzed them. Barter distinguishes three types of parking policy: conventional, management, market based, as quoted below:

conventional—Avoid parking scarcity, avoid both scarcity and wasteful surplus management—Plan parking to serve wider urban & transport policy goals
market-based—Constraint of car travel (to certain locations). Ensure demand, supply and prices are responsive to each other. Avoid market failure [16].

The most popular system used in Europe is based on determining minimum parking requirements. Actions taken within the adopted strategy include combining free on-street parking with minimum parking rates on the premises of new investments [17]. Under the parking policy regulation, new investments should ensure an adequate number of parking spaces, and the supply of parking lots should be adjusted to meet the demand. Such a system has both supporters and opponents. Critical voices concern the use of minimum rates for investments with simultaneous access to free on-street parking places. This can result in too much supply, in addition, the free parking discourages buying or renting private expensive parking space. Determining the realistic demand for parking spaces is also a problem. Widespread practice of copying records from other jurisdictions that do not translate into the actual parking situation may be observed. Barter considers it crucial to define parking requirements specific to particular areas [16]. Similarly, Fahmy et al. [18] believe that in order to reduce the number of cars in the city, actions at the level of parking policy should be taken. They propose to define flexible parking requirements, depending on the availability of public transportation, and at the same time improving its quality.

Barter and Ding et al. [16,19] also draw attention to the introduction of modest inner-city flexibility in applying parking requirements. The choice of the means of transportation depends on many factors, including the employer's offer. A beneficial solution would be a system that allows a reduction in the number of parking spaces for investments in

exchange for the tenant's actions in the field of mobility management. Such actions would concentrate on reducing the demand for a car, e.g., promoting car sharing, carpooling, extra money for people using bicycles or enabling parking outside the workplace.

Researchers dealing with the subject of parking policy agree on the determinants of the choice of a parking space. The most important factors for drivers are cost and time. These factors are important both for residents who want to reduce their daily expenses, and for developers who want to reduce the cost of the investment (in London, the release of investment from the minimum indicators allowed for cheaper parking lots in the neighborhood [17]). Parking a car is associated with many costs, they can be costs included in the price of a housing investment or cyclical costs, i.e., using a periodic subscription.

The issue of estimating parking costs and their impact on owning a car was taken up by Ostermeijer et al. [20], who confirm that an inexpensive parking lot next to a residential area reduces the cost of having a car and thus increases the demand for it. Similar conclusions were presented by Golias et al. [21], who analyzed the determinants of the choice of a parking space on the street and outside it. Research shows that the cost of parking has the most significant impact on the choice of a parking space. Other important variables are related to time, i.e., time spent on looking for a parking space, parking time and walking time between the parking place and the destination. Moreover, drivers prefer on-street parking due to its availability [22,23], also in such cases as an area of Beijing in China with an insufficient number of cars [24], where 5–17% of drivers decided to park illegally when they approached their destination and they did not find a parking space.

It is worth emphasizing that each type of action to reduce the number of cars in the city and the introduce a consistent price system—will only be successful if the entire spectrum of actions influencing the dynamics of urban mobility is undertaken [13]. These actions may include providing more information on alternative services in important areas (public transportation, P&R system, mobility sharing, walking, etc.) Only the above-mentioned can limit the massive use of private cars and draw attention to the importance of ecology.

Studies show that there is a relationship between the comfort of parking the car in the place of residence and its use in everyday journeys. In a situation where parking is ensured, residents more often choose to travel by their own car [25,26]. Moreover, when parking is very convenient, journeys are even more frequent [26]. Christiansen et al. [27] show the relationship between the number of available parking spaces in a residential investment, the number of daily trips and the frequency of car use. The aim of research of Christiansen et al. was to answer the following question: is there a difference in the ownership and use of a car that could be related to different parking standards for residential buildings?

Christiansen et al. [27] show that access to someone's own parking space (either reserved or purchased) triples the probability of owning a car. Research has also shown that—regardless of whether an individual owns a car—people make practically the same number of daily journeys. Meanwhile, Gunnarsson-Östling [28] notes that mobility convenience should be defined as the ability to move around in a different way than with a private car and parking spaces at the house should not be a determinant of quality, because the house is a place designed in a way that facilitates staying, not moving.

3. Materials and Methods

Legislation in Poland consists of several levels. Pursuant to Article 87 of the Constitution of the Republic of Poland, the sources of universally binding law of the Republic of Poland are:

- Constitution;
- Legal Acts;
- Ratified International Agreements
- Regulations
- Acts of Local Law (in the area of operation of the bodies that established them).

The legislative process for town planning and construction also follows the above hierarchical structure. At the lowest, local level, decisions are made regarding the development of the city structure, its communication facilities, etc. These decisions are announced in the form of a resolution on the implementation of the Local Spatial Development Plan (MPZP) adopted by an appropriate governing body (e.g., City Council). It is a legal act that defines such important arrangements as: the function of the land and its development. These broad terms cover a number of defined development parameters, ratios and indicators. At this level, decisions are also made regarding the communication and parking facilities in particular areas. Hence, the analysis of MPZP of selected Polish cities can show trends in shaping the parking policy in the selected time period in the most realistic way.

As part of the research, the provisions of the applicable Local Spatial Development Plans (MPZP) for selected five major Polish cities: Warszawa, Krakow, Lodz, Wroclaw and Poznan were analyzed. Their location is shown in Figure 1.

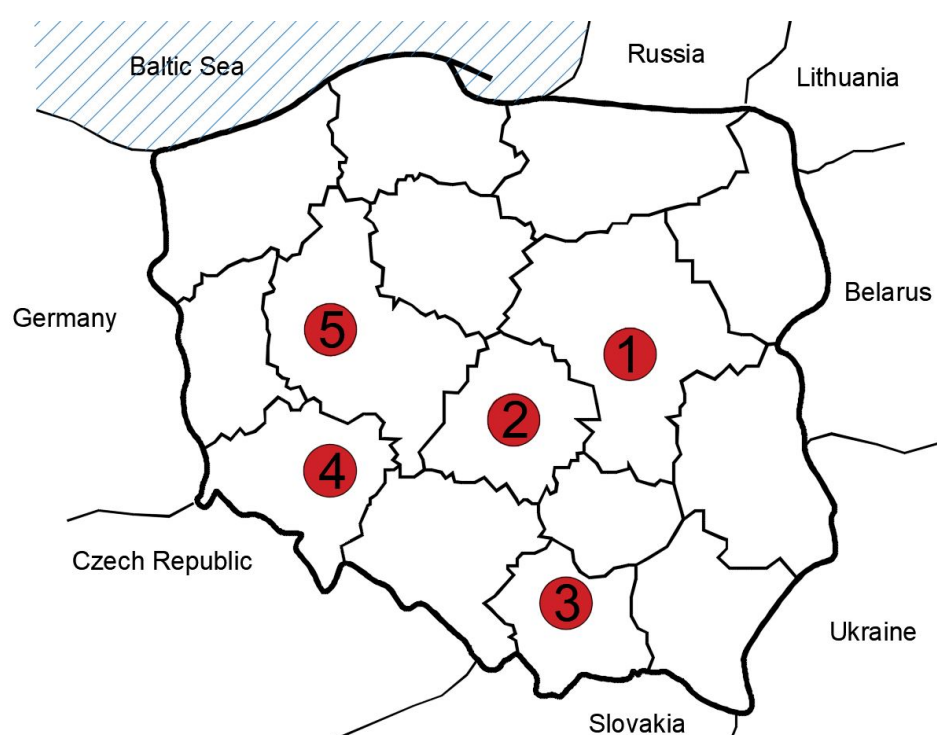


Figure 1. The location of the selected large Polish cities: 1-Warszawa, 2-Lodz, 3-Poznan, 4-Wroclaw, 5-Krakow.

As part of the research the records of all Local Spatial Development Plans which covered areas intended for multi-family housing development or allowed multi-family housing function in areas with other basic purposes, have been cataloged and analyzed. The time scope of the research covered the years 2000–2019. Out of all 1480 plans adopted at that time, 547 meet the adopted criteria becoming subject to a detailed analysis (Table 1).

Table 1. A summary of the number of cataloged MPZP in the 5 biggest cities in Poland.

	Warszawa	Krakow	Lodz	Wroclaw	Poznan
The number of binding MPZP (2000–2019)	296	199	133	471	381
The number of binding MPZP containing areas intended for multi-family housing	167	79	57	169	75

The next stage of the study consisted of literature research on the experience of Western European countries in the context of parking standards for residential buildings. Taking into account the rapidly growing number of cars, as well as the intensive expansion of the housing sector in these cities, the main research question and supporting questions posed before starting the research work are shown in Figure 2.

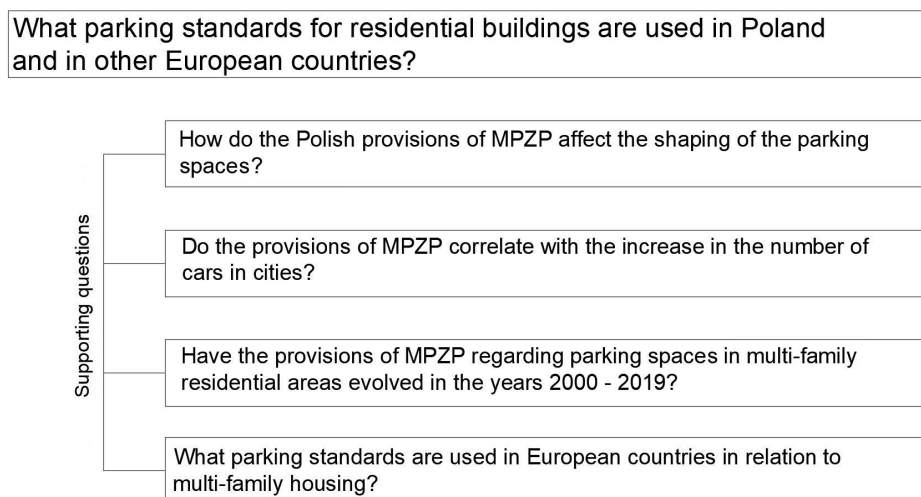


Figure 2. The main and supporting research questions.

Answering the above-mentioned questions was possible after a detailed analysis of the collected material in the form of provisions of MPZP and the analysis of the way the evolution of the provisions of the parking policy in Poland evolved in comparison with several other European countries.

The research steps in the adopted methodology are shown in Figure 3:

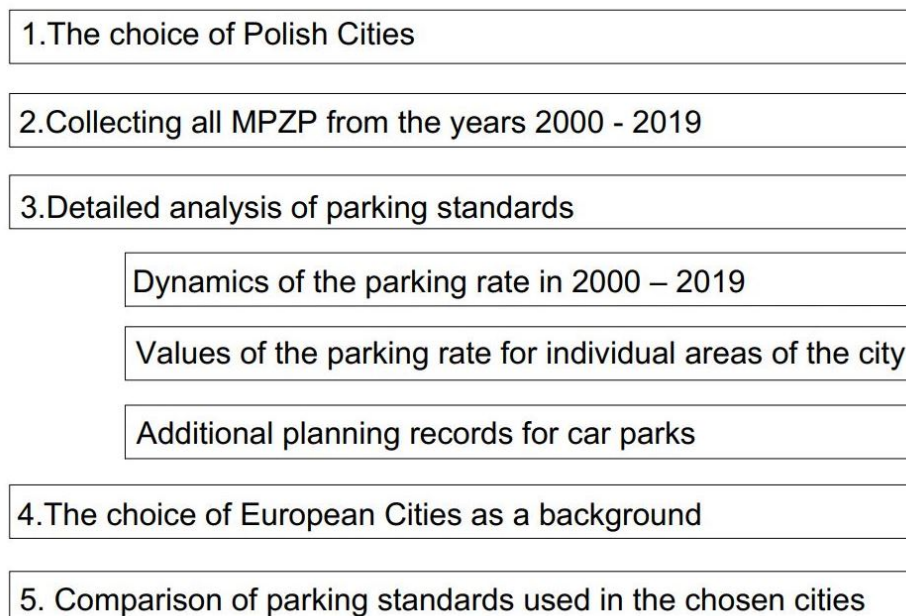


Figure 3. The research steps of the methodology.

4. Examples of Parking Standards for Residential Areas Drawn from the Experiences of Selected European Countries

Several cities from three European countries—Great Britain, Sweden and Germany—were selected as a comparative background for the analysis of Polish parking standards for

residential areas over the period 2000–2019. The search for suitable comparative examples was preceded by establishing the selection criteria which were: climatic similarity, similar urban and cultural conditions. This narrowed the selection down to the countries of Western and Central Europe which are in the same climatic zone as Poland (moderate climate) and are characterized by similarities in the development of urban structures. Among the European countries meeting the above conditions, the selected ones were those in which the sustainable mobility policy has been implemented for several decades, and the parking standards exceed the conventional ratio of number of parking spaces/number of apartments. Due to the fact that this article is not a review (in which case the base of countries would have to be larger) but rather shows parking standards for residential areas in Poland and confronts them with a wider background, three countries—Great Britain, Sweden and Germany—have been chosen for analysis. They all meet the adopted criteria and are more experienced than Poland with regard to implementing the sustainable mobility system.

4.1. The Case of London as an Example for Great Britain

In Great Britain, parking standards are defined at the local level. Each city makes its own arrangements. Legislation in London is developed on two levels—at the general level, in the form of The London Plan document, and at the local level—as The Local Plan which follows the guidelines of the superior document in detail. The current Local Plan was adopted in 2015, but since then The London Plan has been updated in 2021. The city's approach to cars is evolving, which is noticeable in subsequent changes introduced to the documents. Already in 1976, a new trend began to emerge—a change in thinking about parking standards. From the original practice of imposing minimum parking rates, the city has evolved to determine the maximum indicators in the city center area [29]. In the course of time, the problem of car congestion only grew and became more and more acute, hence, a much stronger tendency to reduce car traffic in the city using legal regulations can be currently observed. In The London Plan 2021, the city authorities emphasize the inconvenience caused by the dominance of vehicles on the streets, which constitute an obstacle to pedestrian and bicycle traffic, reduce the attractiveness of streets as public places and have an impact on the reliability and travel time of buses [30]. The solution is to ensure, among others, strict control of the parking structure of newly built housing estates. Much emphasis is placed on reducing the number of parking spaces, which is to facilitate the development of a city with a greater population density and, consequently, to support the formation of vibrant places with a mix of functions. The number of parking spaces, as well as their design and completion, should take into account the need to promote active modes of transportation and the use of public transportation [30]. Hence, The London Plan 2021 specifies the maximum rates of parking spaces per housing unit, which depend both on the size of the apartment and its location. In the Outer London area, slightly higher indicators were adopted than in the Inner London area. Moreover, in both cases the detailed guidelines also depend on the PTAL usage class. The list of parking indicators introduced in London is presented in Table 2.

Analyzing the adopted indicators, presented in Table 2, the following relationship can be noticed—the better the communication by public transportation, the smaller the permitted number of parking spaces, up to establishing the car-free area for PTAL at the level of 4–6 for central areas. Such a high PTAL means very efficient public transportation. An interesting dependence on the size of flats was introduced for the equivalent PTAL values. For flats inhabited by a larger number of people, a higher rate of parking spaces is allowed. This seems to be highly justified, in the case of families with children, especially on the outskirts of the city, where everyday functioning is much easier with a car than without, especially when it is impossible to have all the necessary services provided locally.

Table 2. Maximum residential parking standards from The London Plan 2021—example of regulations.

Location	The Number of Beds	Maximum Number of Parking Spaces
Central Activities Zone	All	Car free
Inner London Opportunity	All	Car free
Inner London PTAL 3	All	Up to 0.25 spaces per dwelling
Inner London PTAL 0–1	All	Up to 0.75 spaces per dwelling
Outer London PTAL 4	1–2	Up to 0.5–0.75 spaces per dwelling
Outer London PTAL 4	3+	Up to 0.5–0.75 spaces per dwelling
Outer London PTAL 2–3	1–2	Up to 0.75 spaces per dwelling
Outer London PTAL 2–3	3+	Up to 1 spaces per dwelling
Outer London PTAL 0–1	1–2	Up to 1.5 spaces per dwelling
Outer London PTAL 0–1	3+	Up to 1.5 spaces per dwelling

4.2. Germany

The German experience shows that it is possible to implement solutions limiting car traffic in cities. In Germany, such efforts were already undertaken in the 1970s [31]. Extensive car-free zones and the integration of various public transportation modes within the metropolitan area, regional area and on national level make public transportation in Germany acceptable to residents and willingly used.

In Germany, regulations on parking spaces for residential areas are set out by individual federal states (Bundesland). For the area of Baden-Württemberg, the regulations are part of the building regulations of the Landesbauordnung für Baden-Württemberg § 37 Stellplätze für Kraftfahrzeuge und Fahrräder, Garagen. According to the regulations, a parking space should be provided for each apartment. These places should be located within the investment area or, with the consent of the authorities, on another selected property. Apart from parking places for cars, the investor is obliged to locate a parking lot for bicycles. The investor has some freedom to replace a quarter of the necessary parking spaces for cars with spaces for bicycles. Parking spaces for bicycles must be convenient and easily accessible from the public road area. They must also be secured against theft and must protect the bicycles against weather conditions.

The provisions contained in the state construction law can be regulated in the Local Development Plans. The Masterplan can thus reduce the number of parking spaces for areas located in the center, which are well connected and have good access to services, or increase it for suburban areas by assuming, for example, 2 parking spaces per housing unit. On the other hand, there are cities such as Waldbronn, for which a different document was proposed, i.e., the regulations for parking spaces, is Waldbronn. In Waldbronn, areas with increased demand for parking spaces were designated. The number of parking spaces depends on the size of the apartment. It is recommended to create 1.5 or 2 parking spaces for apartments with an area of 90 sq m.

4.3. Sweden

According to the Swedish Planning and Building Act, a plot of land must be constructed in a way that “adequate and suitable space is available, on the site or nearby it, for parking, loading and unloading of vehicles;” [32] (Chapter 8, Section 9). At the same time, a consciously shaped trend aimed at minimizing car traffic and freeing the centers of Swedish cities from cars can be noticed. Cities transformation process is successively taking place in such a way that the distances to key facilities are short, and the priority is pedestrian and bicycle mobility as well as high availability of convenient and cheap public transportation. As a result, it can already be observed that car traffic in the city center has halved compared to the traffic volume in 2012 [33]. It is connected with deliberate large-scale actions at the level of both making collective travels more attractive and discouraging individual travels. The car is now bearing the full cost of its impact on the environment and public health, parking and road costs, while the price of fuel continues to rise. Meanwhile, public transportation means better punctuality, higher frequency of

services, greater comfort and easy connections, and to top it all—ticket prices get lowered. All this means that many more people decide to use public transportation [33]. In addition, Swedish authorities have noticed that access to parking spaces is a factor that has a big influence on how people choose their means of transportation and what their travel patterns are [28]. Municipalities often have parking requirements that can be maximum, minimum or flexible. Flexibility in this case implies a dialogue with builders, property owners and developers about parking needs. They are encouraged to reduce inhabitants' needs for their own car by offering other mobility solutions. Thanks to this approach, it is possible in Sweden to construct buildings and facilities with no parking spaces whatsoever, like in Malmö, Sundbyberg and Upplands Väsby. Each of these cities has different forms of defining parking requirements. In Malmö, the parking rate is usually in the range of 0.7–1.0 space per apartment in multi-family buildings (excluding guest parking lots) but if the houses are connected to carpool facilities or if exceptionally good connections by public transportation exist or are being made, the value may be lowered to 0.5 car parking space per apartment [28].

In Sundbyberg, the rules for parking spaces are introduced in an interesting way. The city is an example of a flexible approach, making the proportions of parking spaces dependent on other communication decisions, including innovative ideas proposed by developers and agreed upon at the design stage. The basic rates of parking spaces adopted in the city for multi-family housing are as follows: for flats ≤ 45 sq m—0.4, for flats in the range of 50–70 sq m—0.55 and for large flats (≥ 70 sq m)—0.7. When basic mobility measures are applied, these values will decrease correspondingly to: 0.3; 0.45 and 0.6. It is possible to further reduce the values of the coefficients by additional means such as, e.g., car-sharing, car-pooling, bike-pooling. Additionally, each apartment (regardless of size) requires 0.05 parking space for visitors [28].

The third city in question, Upplands Väsby, introduced the parking standard in the form of guidelines rather than precise directives. The exact number of parking spaces can be adapted to the contextual conditions in specific cases. Examples of such specific situations include flats with good access to a car pool, student flats, flats for the elderly and flats for people with more or less cars than the average. The statutory number of parking spaces varies from 0.5 to 1.4 spaces per apartment (plus 0.07–0.1 spaces per flat for visitors) [28].

5. Parking Standards for Multi-Family Residential Areas in Polish Spatial Planning Documents

5.1. Parking Spaces Rates for Multi-Family Housing Areas in MPZP of Large Polish Cities

The minimum parking rate is the basic and most important parameter informing about the number of parking spaces of the investment. This ratio is specified in MPZP, therefore the investor must take into account its value when completing the investment. In order to determine the parking standards for housing estates, several hundred MPZP (546) covering multi-family housing developments were analyzed. These plans were dated from 2000 to 2020 and concerned the largest cities in Poland: Warszawa (1,765,000 inhabitants), Kraków (766,683 inhabitants), Łódź (696,708 inhabitants), Wrocław (638,659 inhabitants), Poznań (540,365 inhabitants). The analysis of the collected material allowed to distinguish three groups of plans:

1. Group I—minimum parking rate imposed: 87% of examined MPZP. The vast majority of cataloged MPZP have a defined minimum value of the rate ranging from 0.2 to 2.0 or depending on the size of the flat, e.g., in MPZP in Warszawa, a popular way of setting the ration is by using the following rule:
for multi-family residential buildings and residential premises—not less than 1 parking space per apartment, and not less than 1 parking space per 60 sq m of usable floor space of residential premises [34]

There are also MPZP where the number of parking spaces depends on the number of inhabitants (not flats). Such a provision is applied, for example, by the City of Poznań;

2. Group II—no parking rate imposed: 6% of examined MPZP. A small percentage of the cataloged MPZP do not include the requirements for developing the parking area. These are mostly residential and service areas or investments in historical areas. Several plans contained provisions explaining the lack of a rate; they informed, for example, that due to the existing investment status of the area, parking rates for individual types of facilities were not defined;
3. Group III—binding minimum and maximum rate imposed: 7% of examined MPZP. Dozens of cataloged MPZP have defined not only the minimum, but also the maximum parking rates. Half of the plans belonging to the third group covered high-density areas of the city, mainly in the city center. While in the years 2000–2010 plans specifying the maximum parking rate appeared sporadically, after 2016 their number in cities increased significantly.

5.2. Dynamics of the Parking Rate in He Years 2000–2019

An important part of the research was the analysis of the parking rate in the context of its dynamics. The research period was 20 years, its evolution and dynamics in the light of the growing importance of individual transportation is a particularly important issue.

For each of the five selected cities, the annual average parking rate for multi-family housing was calculated (the number of parking spaces per apartment), and then individual results for subsequent years were compared. The results are presented in Figure 4. There are differences in the size of the rate for specific cities. Definitely the highest minimum rates were adopted in Poznan, since 2000 the rate has remained stable at the level above one parking space per apartment. In Wroclaw and Warszawa, the rate hovered around 1.0, and the trend line shows a slight decrease. On the other hand, Krakow is a city with an increase in the minimum rate in the years 2000–2010 and the stabilization that follows. On the basis of the collected material, it is not possible to establish trends in the value of the minimum rate in subsequent years. It should also be noted that the scope of the rate in the analyzed five cities covered a relatively narrow range. However, there are visible differences resulting from the parking policy of individual cities.

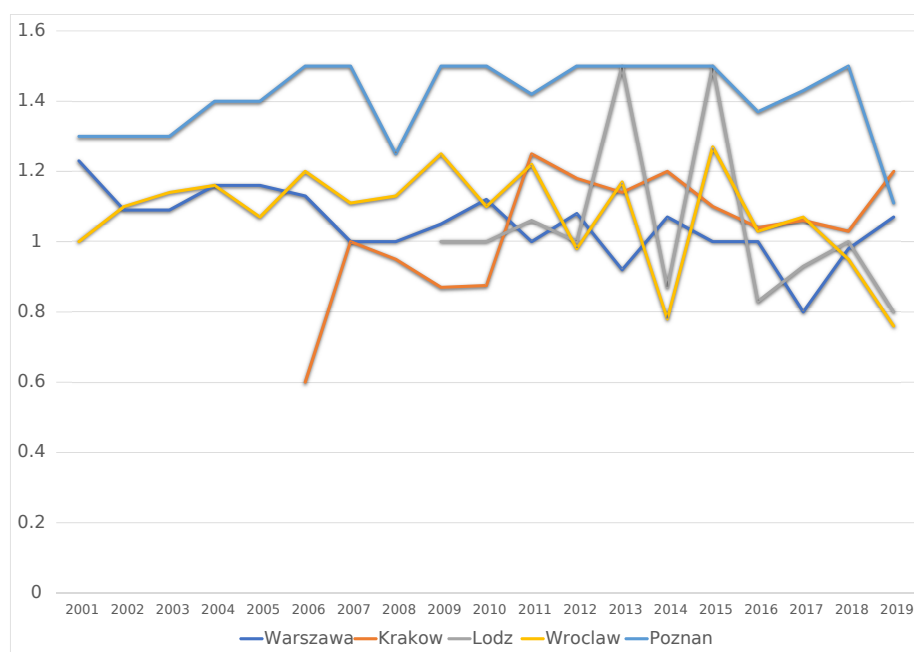


Figure 4. The value of the average parking rate in selected major Polish cities, adopted in the currently binding MPZP.

5.3. Values of the Parking Rate for Individual Areas of the City

Spatial analysis is a supplement to the statistical analysis concerning the value of the parking index in the consecutive years. The collected several hundred MPZP were transferred onto maps and assigned to individual housing estates or districts of the city, then the average minimum rate for specific areas was calculated. Such operation allowed to determine whether the parking rate is different in particular areas of the city and in which city zones its value is the lowest and in which the highest. The value of the indicator is divided into four groups:

1. 0.5–0.99
2. 1.0–1.25
3. 1.26–1.59
4. 1.6–2.0

The situation in each of the analyzed cities followed a different pattern. However, there are some similarities between two groups of cities:

1. Warszawa, Poznan
2. Wroclaw, Krakow, Lodz

In Warszawa and Poznan, the average parking rate for individual areas is practically the same. For Warszawa, apart from two districts, it ranges from 1.0 to 1.25. Poznan plans have the highest index, which is characteristic of the statistical summary and is shown in Figure 5. Outside the city center, the rate ranges from 1.26 to 1.59. In other cities (Wroclaw, Krakow, Lodz), a decrease in the rate is visible in the quarter development zone which covers the city center and an increase in other further housing estates. In Wroclaw, the highest rate was adopted for peripheral estates, where access to an efficient public transportation system needs to be developed. An interesting example is also Lodz, which is the only city that allows a minimum parking rate of a high value of 1.6–2.0. The summary is presented in Figure 5.

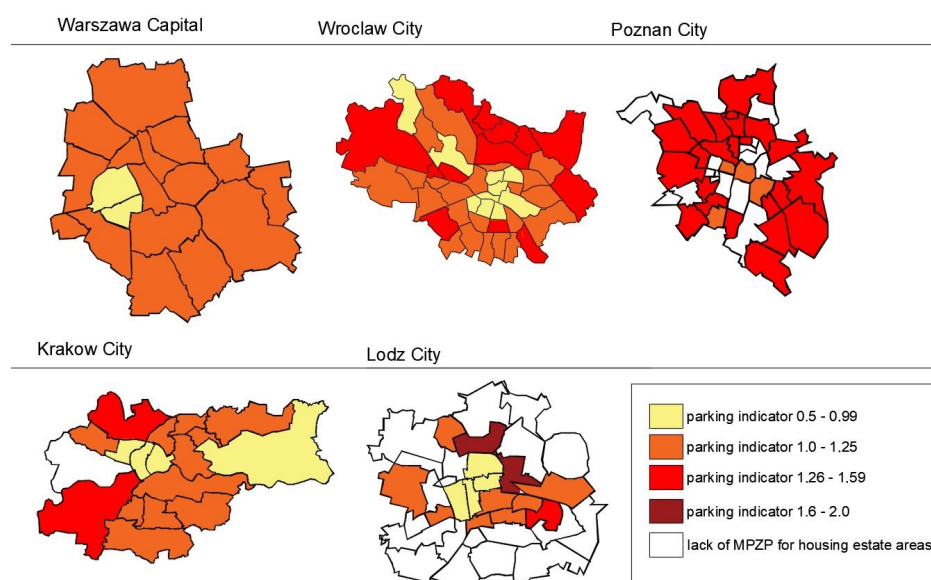


Figure 5. The average value of the parking rate for individual sections of the cities.

5.4. Additional Planning Regulations for Parking Lots

At the beginning when the Polish Act of 27 March 2003 on Spatial Planning and Development (Journal of Laws 2003 No. 80 item 717) came into effect, the planning provisions mainly defined the minimum parking rate. However, in the following years more detailed requirements began to appear. Yet it should be noted that in the vast majority of cataloged documents for the years 2000–2019, the planning still included the minimum

number of parking spaces per apartment and required the investor to balance parking spaces on the investment site. Nevertheless, there were also other regulations, and they were not based on a simple ratio. These provisions were introduced for areas with specific features, e.g., including historic buildings or protected areas. As a result, the following forms appeared:

- Designating areas with a reduced development index;
Areas with a parking rate in the range of 0.5–0.99 mostly include city centers or social housing areas. The analyzed documents also include several plans allowing for the lack of parking spaces for a given investment. These plans include an explanation for such decisions (e.g., buildings entered in the register of monuments or an established investment property in the city center).
- Balancing the needs for parking spaces outside of the site;
In several Lodz MPZP, it has been permitted to provide the required number of parking spaces for cars in the area outside the area covered by the plan. It was assumed that the parking spaces will be located no more than 400 m or 200 m (depending on the plan requirements) from the investment site. Additionally, these plans allow for an increase in the maximum number of parking spaces in the case of the construction of parking lots for the neighboring areas. However, in one of Poznan's MPZP the parking rate depends on the distance to the tram stop. For each apartment in a multi-family building, for which the access length between the existing tram stop and the entrance to the building does not exceed 500 m, according to the plan, 1 parking space should be provided. For flats located further—1.5 parking spaces.
- An attempt to regain the space dedicated to parking lots
There are also plans that define the method of building an off-road parking lot and the development of the slab above the underground parking lot by introducing greenery and soil layers to enable vegetation of plants. Some documents allow for the location of parking spaces for cars on the ground floors of residential buildings, while others require the location of the garage only on the underground storeys. There are also some restrictions on the parking area (e.g., 20% of the area). More than a dozen plans (mostly for Wroclaw) contain provisions specifying the number of parking spaces necessary to be built in the underground parking lot, the number being defined as a percentage between 30% and 90% of all required parking spaces, depending on the MPZP.

6. Discussion: Directions for Development of the Parking Policy in Poland

For many years, the parking policy in Poland has consisted in imposing requirements to ensure an adequate number of parking spaces for individual functions by specifying the minimum parking ratio. In this matter, decisions in Poland are made locally—each city independently decides on the adopted mobility policy—including the parking policy. These decisions are implemented in the form of legal provisions of local law, in Local Spatial Development Plans (MPZP). After examining the 547 MPZP binding in the five selected major Polish cities, the Authors of this work noticed only a few new concepts of provisions, aimed at reducing the number of cars in the city. When analyzing the 20-year period, no significant changes have been noticed in relation to establishing the value of the parking rate for residential buildings. Indicators of 1.0–1.5 were usually adopted, which was to fully meet the real needs of residents in terms of parking their private vehicles. This means that there is still a relation in the provisions of the MPZP—the more cars, the higher the rate of parking spaces. The parking policy with reference to residential areas in Poland consists mainly in applying minimum parking standards for new investments with free on-street parking. Meanwhile, the number of cars is growing steadily, traffic is increasing, and the phenomenon of congestion is felt more and more acutely. In the planning documents that are superior to MPZP, such as Studies on the Conditions and Directions for Spatial Development (SUiKZP), prepared for individual cities, it is already possible to notice provisions introducing certain restrictions for parking rates. For example,

in SUIKZP for the city of Wrocław, in the downtown zone, a restriction has been introduced on the parking rate—no more than 1 place per flat. All newly adopted MPZP will have to comply with this provision, which means the provisions of the MPZP will evolve in the near or distant future. As of today, however, such changes have not yet been observed. The subject is important and in some cities attempts to introduce new forms of provisions regulating the target number of cars by controlling the number of parking spaces can be observed.

This trend emerged after 2016. There are MPZP, which were the first in Poland to set more requirements for a parking lot than just the determination of the minimum number of parking spaces. These plans define the maximum number of parking spaces, set requirements for the composition of the investment area, allow parking outside the estate and determine the number of parking spaces, e.g., depending on the distance to a public transportation stop. Such a trend, although new in Poland and incidental, finds its justification in the experiences of other European countries. Sweden managed to achieve a significant effect thanks to a similar approach. Car traffic in city centers has halved compared to traffic in 2012. This is the result of steps taken simultaneously on several levels. Cities are gradually being transformed in such a way that the distances to key objects are kept short. Walking and cycling mobility as well as the high availability of convenient and cheap public transportation are to be a priority. In addition, Sweden has started to recognize that access to parking spaces is a factor that has a large influence on the choice of means of transportation. Hence, at the level of individual Swedish municipalities, a conscious parking policy aimed at reducing the number of parking spaces is implemented. Next to the provisions regarding minimum requirements, there are also maximum or flexible requirements. Flexibility in this case opens up the field for discussion and some kind of negotiation with construction companies. It can even lead to the construction of a facility or an entire estate, without cars, but with very good access to public transportation. The provisions of the parking policy in London are formulated in a similar way—the required number of parking spaces per 1 flat depends on several factors: the location of the premises (center or outskirts), their size measured by the number of beds and the availability of public transportation (measured by the PTAL indicator).

Among the selected countries, Germany has settlement structure of cities most similar to the Polish one. Additionally, the spatial planning system is also similar. Regulations on parking spaces for residential areas are issued in Germany for individual federal states in the form of Masterplans. They may be the equivalent of the Polish MPZP, which means that the German planning scheme will be the easiest to translate into Polish law. German experiences, which started in the 1970s, also show that it is possible to limit car traffic in cities. In this case, it is also the effect of the synergy of various actions—the introduction of car-free zones, the integration of various means of public transportation in the metropolitan and regional area or on national level, and an appropriately conducted parking policy for housing estates. Assuming as a rule one parking space per apartment, Masterplans introduce appropriate modifications depending on other factors, such as, for example, the availability of public transportation, distance from the center or the size of the apartment itself.

The processes related to car traffic in Polish cities are shifted in time compared to the countries of Western Europe. Solutions aimed at limiting individual transportation have been used in Europe for several years. They are just beginning to appear in Poland. Sharing knowledge and learning from the experiences of other countries is particularly important. It will allow to avoid mistakes of predecessors and to rely on best practices.

The subject of vehicle parking in housing estates is an important issue, beyond the scope of the parking policy. Hence, in further research, we want to take two main directions. The first is the further collection of data on ways of shaping the parking policy in other countries in order to diagnose recording methods and their synergies. The second is the modeling of parking spaces for housing estates using artificial intelligence methods. Another interesting thread in the first group that deserves further investigation is the

possible impact of the COVID-19 pandemic on parking standards in residential areas. This is, of course, a topic to observe in the coming years, as creating planning documents is a long process. Nevertheless, some symptoms of changes that may suggest further processes can already be noticed. In the city of Manchester, half of the population wants to walk and cycle more after the pandemic is over. In Great Britain, sidewalks are widened, new pedestrian zones and safe bicycle paths are created. In many cities there are also parklets where people can relax in the fresh air. The concept of a 15-min city is also gaining in importance. It consists of organizing space in such a way that everyone can get from home to work, school and shop in 15 min on foot. All these actions are related to the lower share of car usage in everyday journeys, which may translate into parking standards. This is a potential process that is also worth following in the coming years.

Author Contributions: A.L. and A.S. contributed equally to this work. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Data are not publicly available.

Conflicts of Interest: The authors declare no conflict of interest.

Abbreviations

The following abbreviations are used in this manuscript:

MPZP Local Spatial Development Plan
 SUiKZP Studies on the Conditions and Directions of Spatial Development

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