



EFFICIENT PARKING – SHARED USE OF PRIVATE PARKING SPACES AS A DRIVER FOR SUSTAINABLE RESIDENTIAL NEIGHBOURHOODS

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Abstract

Privately owned cars park at home for an average of 21 hours a day, yet substantial street space is allocated to their storage, while private parking facilities often remain underutilized. Shared use of private parking, combined with restrictive public parking policies, offers a potential strategy to improve parking efficiency. This study examines the potential to shift parking demand from public streets to private facilities in German urban residential neighbourhoods, the constraints of the built environment on shared parking, and analyses how neighbourhood characteristics affect feasibility. Based on parking data from 36 neighbourhoods synthesized in a neighbourhood typology, as well as surveys of landowners and residents, the study aims to provide empirical evidence to inform shared parking policies under conditions of increasing pressure on urban land.

Keywords: urban residential neighbourhoods, parking management, shared parking, parking allocation

1 Introduction

Privately owned cars in Germany remain unused for an average of 23 hours per day [1], yet valuable street space is dedicated to their storage. This is of particular concern for urban areas, where demand for public (and free) on-street parking is high and conflicts surrounding scarce public space are increasing with a rise in car-ownership and political goals that target greener and safer streets. Residential neighbourhoods lie at the heart of this conflict, as cars are parked at home for more than 21 hours a day on average [1]. Since 2017, the proportion of cars parked on public streets at home has increased by a fifth (to 23 percent) [1]. This implies a need for adequate and flexible parking infrastructure. Residents also have the most to gain from a car-reduced street design, in regard to traffic safety, active and healthy mobility, attractive surroundings and quality of life, as well as resilience against climate change effects. While on-street parking experiences high demand throughout the day, private parking facilities such as those at residential and mixed-use buildings – often remain underutilized [2, 3]. Regardless, property and parking space owners still incur construction and operating costs. Parking as a “companion product” to uses such as living, shopping, or working cannot usually be operated economically [4]. The need for reallocation of street space and thus a shift in demand from public to private facilities is widely acknowledged in research and planning practice [5]. However, decades of car-oriented legislation have shaped the built environment, regulatory frameworks and user expectations. As policymakers have limited influence over existing private parking infrastructure, particularly outside new developments, market-based approaches are gaining importance. One such approach is to open private parking facilities to be shared, often facilitated by digital booking-platforms.

In theory, three modes of shared parking can be distinguished: 1) free choice of parking within a limited user group – meaning residents are not bound to one specific parking space, but can choose flexibly which one to use, which makes a slight “overbooking” of parking spaces possible, 2) the rental of surplus parking capacity to external user groups, e.g. to neighbouring residents and 3) temporally complementary use by different user groups, e.g. residents using parking spaces of a close-by office building during the night. A key prerequisite for the strategic implementation of shared parking is an understanding of parking supply, including the number and types of private parking spaces suitable for shared use. This requires data on both parking supply and demand, differentiated by facility type, as not all private parking spaces are appropriate for shared use [6]. However, studies on the quantity, type, and spatial distribution of parking are resource-intensive, scarce, often unpublished, and they lack common standards (see e.g. [7]). Available evidence points to a highly heterogeneous distribution of parking infrastructure across different districts and neighbourhoods (see e.g. [8]). This paper sets out to answer the question how different types of residential neighbourhoods influence the potential to introduce shared parking. It addresses the challenge of heterogeneity by contextualizing field data on parking supply and demand within a residential neighbourhood typology, enabling an estimation of shared parking potential. Its main contribution lies in its empirical dimension – bridging public and private parking spaces – to make recommendations for the organization of parking management across diverse neighbourhood contexts.

2 Methodology

This study draws on data originally collected within the project “PaNaMo”, that examined the conceptual relationship between public and private parking spaces and their use through extensive empirical data collection [9]. A total of 36 residential urban neighbourhoods in the state of Northrhine-Westphalia (NRW), differing in age, size, building and settlement structure, and location, served as case studies. To systematically address this heterogeneity, an inductive qualitative neighbourhood typology was developed from figure ground plans, and GIS-based data on density and centrality. It is primarily based on structural and settlement characteristics, notably year of construction and a composite of density and centrality, which largely seemed to correlate. This process resulted in six residential urban neighbourhood types with distinct attributes influencing parking infrastructure and usage (figure 1). The term “neighbourhood“, here, refers to clusters of multi-storey residential buildings owned by a single housing company or cooperatives. From a spatial planning perspective, these clusters were part of larger neighbourhoods with a more diverse ownership structure.

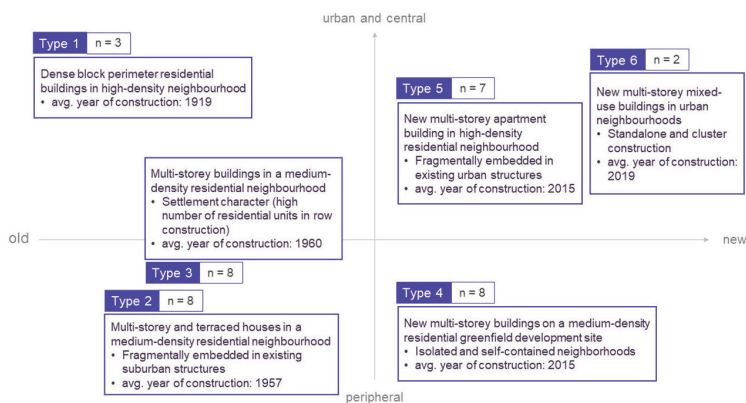


Figure 1 Neighbourhood Typology

To capture parking infrastructure, management practices, and residential parking demand, a survey of 18 housing companies and cooperatives covering all 36 neighbourhoods provided data on the size, type, and allocation of private parking spaces, including rental to residents and external users. This was complemented by an online household survey in 28 neighbourhoods (n = 403) inspecting perception of parking infrastructure, mobility choices and attitudes. The parking situation in all neighbourhoods was systematically surveyed, documented, and mapped. Parking spaces in both public and private areas were recorded, classified, and assessed in terms of occupancy. To capture structural and usage-related differences, parking spaces were classified according to four characteristics: location (public or private), marking (marked or unmarked), management regime, and structural features. This classification resulted in eleven distinct parking space types.

3 Findings

3.1 Patterns of parking supply across neighbourhood types

A total of 7,660 parking spaces were recorded in the neighbourhoods surveyed, which corresponds to a supply ratio of 1.03 parking spaces per residential unit. Of these, approximately 60 percent are private parking spaces. An analysis of parking supply across neighbourhood types reveals substantial heterogeneity. The average total supply ranges from 0.95 parking spaces per residential unit in post-war housing estates (type 3) to 1.37 in residential green-field developments (type 4). In addition, the distribution of parking spaces differs notably between private (blue and purple) and public (red) parking facilities (figure 2).

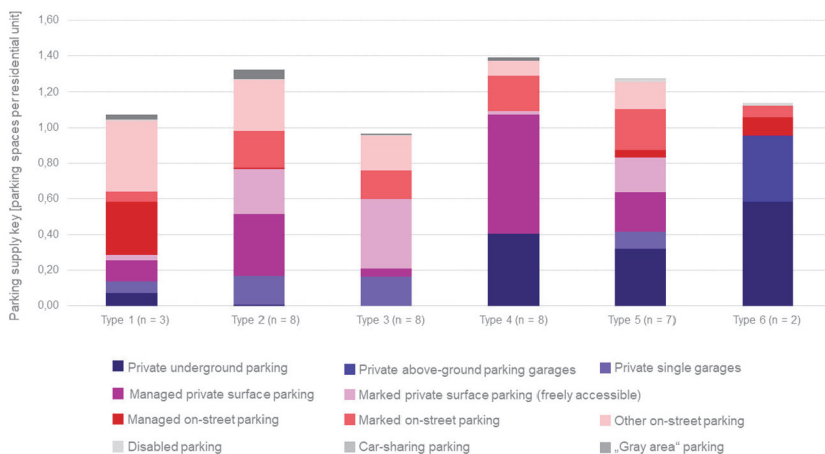


Figure 2 Parking supply differentiated by neighbourhood types

In public space, free and unmarked on-street parking is particularly prevalent in the older neighbourhoods (types 1, 2, 3). In contrast, newer neighbourhoods (types 4 to 6) feature a higher share of marked parking bays, while public parking accounts for a smaller proportion of overall supply. Managed on-street parking is significant only in neighbourhood types 1 and 6, which are close to city centres. Even in these type 1 neighbourhoods, resident permits currently cost just 22 € per year (with potential increases under discussion). In urban neighbourhoods built between 1,949 and 1,983 (types 2 and 3), as well as in more recent developments located on the outskirts (type 4), construction tended to be space-intensive, with ground-level surface parking accounting for most private supply.

In post-war districts (types 2 and 3), parking structures mainly consist of single garages, whereas newer developments (types 4 to 6) rely increasingly on underground garages or above-ground neighbourhood garages.

3.2 Facility-specific constraints on shared parking

About two thirds of private parking spaces in urban neighbourhoods are located behind gates or garage doors, restricting access [6]. Enabling shared use typically requires retrofitting these barriers with digital access solutions [6]. Most types of parking facilities, including surface lots, courtyards, carports, and underground or above-ground garages – making up more than 78 to 100 percent of the total private parking supply – can be activated for shared parking use, while single garages generally lack standardized access, making retrofitting economically unviable [6]. Shared parking may be further constrained by fire protection regulations, which set stricter standards for enclosed and underground garages, and by noise regulations, which impose strict requirements on open or surface parking, both of which can limit use by external users alongside building tenants [6].

3.3 Parking demand, utilization and rental practices

Public and private (parking) space shows a clear connection: In the densely populated, centrally located neighbourhood types 1 and 6, private parking is nearly fully utilized, with public space serving primarily as a buffer. Parking demand in public space and freely accessible private areas is likely underestimated, as on-site surveys could not consistently be carried out during peak demand periods. Conversely, demand for managed private parking was approximated using rental data, which likely overestimates actual utilization. In other neighbourhood types, private parking occupancy averages 70 to 80 percent, while on-street parking spaces reach 55 to 65 percent occupancy. Neighbourhoods with more generous public parking supply tend to show lower utilization of private spaces overall – albeit with a certain degree of variation between neighbourhoods. Managed private parking spaces (for rent) make up two thirds of the private parking supply. In the older neighbourhood types (1 to 3), as well as in centrally located type 6, rental rates are high and vacancies do not occur (type 1) or only to a small extent due to typical tenant turnover (figure 3).

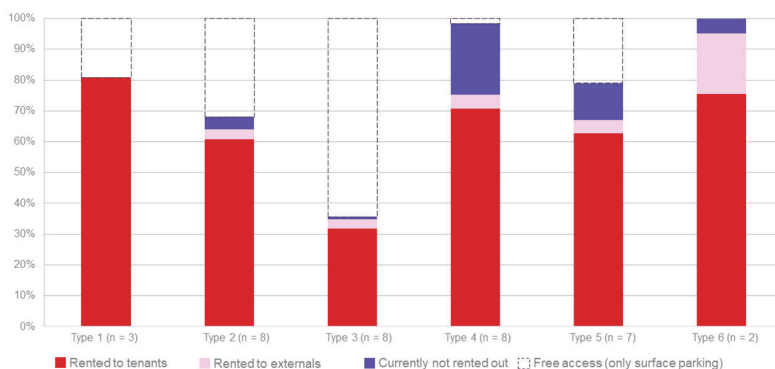


Figure 3 Rental of private parking spaces differentiated by neighbourhood types

Lower parking demand from residents is met by landowners through three main strategies. First, particularly in newer, urban neighbourhoods with attractive central locations, up to 20 percent of unoccupied parking spaces are rented out to external users, reflecting additional demand from residents of neighbouring buildings or daytime user groups like commuters.

Second, in most neighbourhoods, parking space costs are partially subsidised through residential rents [4], as parking fees are typically well below cost-covering levels (10 € to 80 € per month) and do not offset the high construction and operating costs of parking facilities (200 € per month) [10]. To reduce vacancies, housing companies and cooperatives therefore rely on comparatively low parking rents. Third, predominantly cooperatively managed neighbourhoods in small and medium-sized towns, use bundled parking arrangements, in which parking spaces are rented together with apartments regardless of household demand to cover construction and operating costs. Across all neighbourhood types, residents report widespread parking scarcity. More than half of surveyed households rent fewer parking spaces than the number of cars they own and consequently rely on on-street parking or alternative parking options. Around ten percent of respondents indicate unmet demand for private parking spaces or are on waiting lists. These households in particular express dissatisfaction with current allocation practices, citing administrative barriers and an uneven distribution of available private parking spaces.

4 Discussion

4.1 Estimating the potential of shared parking

It is generally presumed that around four percent of residential parking spaces remain vacant at night because residents are away from home [11]. However, in line with current literature [3], the results indicate substantially greater shared parking potential, with average vacancy rates of 20 to 30 percent of private parking spaces and diverse strategies for managing low private parking demand. Nevertheless, the suitability of different modes of shared parking vary.

4.2 Modes of shared parking across neighbourhood types

It is important to consider the capacity of private parking infrastructure, as well as user groups in the surrounding areas. Neighbourhood type 1 is characterised by a very limited supply of private parking (< 0.3 parking spaces per residential unit) and no vacancies; consequently, shared parking should be implemented exclusively for residents of the respective properties. As neighbourhood types 2 and 3 consist of larger residential estates or are closely embedded within surrounding residential areas, shared parking would primarily serve residents across different properties, thereby helping to structure and alleviate locally heterogeneous parking demand. Greenfield developments of neighbourhood type 4 show the highest rates of parking spaces that are not rented out (on average > 20 percent). Public-space conflicts are comparatively limited due to managed on-street parking, pedestrian and cycling infrastructure, although high on-street parking demand still causes occasional conflicts. In this context, shared parking could primarily increase transparency by making vacant spaces visible to residents, thereby improving utilization, particularly of underground parking. Neighbourhood types 1 to 4 could therefore benefit from expanding flexible paid access to the entire private parking supply for all (respective) residents (mode 1), while introducing control mechanisms or access barriers, which work together to address parking shortages, reduce allocation conflicts, and improve distribution efficiency. In residential neighbourhoods with a substantial share of vacant parking spaces, surplus parking capacity can be rented out to external users (mode 2). This practice already occurs in five of the six neighbourhood types, particularly in centrally located areas with a high share of underground or above-ground parking garages, which are costly to construct and maintain – as in type 6. Neighbourhood type 5 is also well suited to this mode of shared parking, as most parking facilities are amenable to retrofitting, the neighbourhoods are closely integrated with their surroundings, and on average more than ten percent of private parking spaces remain vacant.

Where surrounding land uses are diverse, merging temporally complementary parking demand among different user groups represents the most effective strategy for shared use (mode 3). This especially applies to residents of urban mixed-use neighbourhoods, like type 6, who could make use of parking spaces associated with office or retail buildings during the night, when these facilities are typically used only by employees and customers during the day.

4.3 Operationalizing shared parking in residential contexts

In many neighbourhoods, shared use of private parking is already practiced out of economic necessity or following a lack of access control and freely available private parking infrastructure – just without a digital platform mediating it. Even though shared parking was solely discussed for the purpose of spatially shifting demand, it can be very effective at expanding the parking supply, if not monitored and controlled sufficiently. Increasing the availability and visibility of off-street parking spaces may in the long term make parking more comfortable, thus risking increased car use and car ownership of residents. To mitigate these effects and to face the low willingness to pay for parking, it is recommendable to 1) strictly reduce on-street parking [11], 2) introduce mandatory, coordinated and cost-reflective pricing regulation across public and private parking spaces [4], 3) enforce parking regulation consistently, 4) visually re-distribute space for preferred uses and 5) to accompany this process in an active dialogue with local residents.

5 Conclusion

Vacant parking spaces, particularly in private underground garages, are often invisible to both municipal stakeholders and the public [6, 7]. This lack of transparency makes reliable data on parking supply and demand not only politically significant and critical for urban land-use planning, but also the single biggest barrier to realizing shared parking as a tool for more efficient parking management. While public parking space is increasingly being repurposed in line with sustainable urban development, the inclusion of non-public parking is becoming a strategically important component of modern parking concepts. Shared parking is often assumed to be relevant only in dense, high-demand, mixed-use urban centres, yet it is already more widespread in residential neighbourhoods than it appears and offers substantial potential to 1) reduce allocation conflicts within and between groups of residents and other users, 2) address parking shortages through improvements in distribution efficiency, and 3) reduce the financial burden on car-free households while generating additional income for property owners. The feasibility and benefits of shared parking depend strongly on neighbourhood structure, parking supply characteristics, and demand patterns, underscoring the need for context-sensitive implementation strategies. Due to the variety of neighbourhoods analysed, transferability is given for most residential areas containing multi-storey buildings. Transferability to other housing types, e.g. detached single family homes and rural settings is limited. Future studies should examine residential parking preferences and adoption of new parking routines, map integrated public-private residential parking demand patterns, and assess economic conditions for shared parking adoption by property owners.

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