PARKING IN COMPACT MIXED-BLOCK DEVELOPMENT

Hana Fridrichovská*[1]

*hanka.fridrichovska@seznam.cz
[1]Faculty of Civil Engineering Brno University of Technology, Veveří 331/95, 602 00 Brno, Czech Republic

Abstract
The principle of short-distance cities, support for sustainable transportation modes, land prices in large cities, and many other reasons lead urban planners to propose mixed compact block urban structures in newly planned districts. Subjectively, parking may seem to be a stumbling block in historical districts with this structure. The article summarizes the research results addressing objective parking conditions in these types of urban structures, particularly concerning today's parking requirements.

Keywords
Parking requirements, parking minimums, parking policies, sustainable urban mobility plan, parking in compact mixed-block development

1 INTRODUCTION

With the new building law, an update to the implementing decree is also emerging, which should now enable municipalities not only to increase but also to regulate the numbers of mandatory parking spaces. Research indicates that the availability of parking spaces contributes to more frequent car ownership and usage [1], [2], [3], [4]. This is why the reduction of parking requirements is utilized as a tool to fulfil the goals of sustainable mobility plans, which form the transportation policy of a significant portion of Czech municipalities and cities. The focus of this article is on parking in compact mixed block development. The aim is to provide an understanding of the actual number of parking spaces per resident and dwelling, serving as a guideline for setting regulatory coefficients for parking minimums in new construction.

The hypothesis is that, considering the construction period of the observed locations, there are significantly fewer parking spaces in this type of development than required by today's normative standards. Another question that the research should address is the ratio of parking spaces per resident/dwelling in compact mixed block development. Whether the mixed-use of the location results in a more favorable ratio than, for example, in housing estates. Lastly, the research aims to uncover whether these ratios significantly vary between individual locations or whether at least approximate uniform ratios can be estimated for compact mixed block development. The analysis of such a large number of building functions could also highlight potential shortcomings in the current calculations.

The described research is based on working with existing datasets, such as the Building Survey by Kancelář architekta města Brna (KAM) (Brno City Chief Architect's Office) [5], the analysis of parking by Brněnské komunikace a.s. (BKOM) [6], as well as individual data collection for various building uses. The research is part of a broader research task that seeks to describe parking conditions in different characteristic types of development, providing municipalities with sufficient relevant information for making decisions regarding the setting of regulatory coefficients for parking minimums in accordance with the new implementing decree of the building law.

2 METHODOLOGY

Locations

In the first step, locations were selected to well represent compact mixed block development and at the same time form a continuous territorial unit for parking, typically defined by main urban streets, larger areas, and the like. Even so, it cannot be excluded that some residents and users utilize a different location for parking; however, in a compact city, it is not possible to perfectly isolate an area. The locations are not defined as statistical basic

DOI 10.13164/juniorstav.2024.24108

residential units because their definition usually does not correspond to the former. The locations were deliberately chosen only within the city of Brno, due to access to the Building Survey [5], which served as a fundamental basis for this analysis. Only three locations were monitored, primarily due to the challenging gathering of data for the analysis.

Parking – Current Situation

Parking capacities were adopted from the Parking Strategy in the city of Brno [6]. In the analytical part of this project, parking spaces on individual streets were counted in detail, including garage and illegal parking spaces.

While residential parking zones have been established in all the monitored locations in recent years, leading to the reorganization of parking spaces, the overall change is not fundamentally significant (verified in another project). Therefore, data from the mentioned project were used to maintain a uniform methodology. The counts of parking spaces, both legal and illegal, were considered. A significant portion of the illegal parking spaces was indeed legalized through a reorganization process as part of the introduction of residential parking zones. As the project did not directly focus on building surveys and parking spaces integrated into them, garage parking spaces were entirely taken from building surveys, with a conversion of 30 m² of gross floor area (GFA) per one parking space in a garage. An overview of the number of parking spaces is shown in Tab. 1.

Tab. 1 Parking – Current Situation.

	Kpt. Jaroše	Polní	Hybešova
Legal	771	620	678
Illegal	180	90	133
Garage	114	79	203
∑	1065	789	1014

Building Usage and Functional Units

A fundamental resource for determining the various functions and related functional units of buildings was the Building Survey 2018-2020 [5]. The survey data were provided in open GIS format, enabling the identification of usage for each individual building separately. However, it was necessary to simplify the data to some extent and omit certain building uses for which the corresponding functional units could not be determined. An overview of the monitored usages, including their percentage representation in the respective areas, is displayed in Tab. 2.

Tab. 2 Building Usage.

Building Usage		Kpt. Jaroše	Polní	Hybešova	Kpt. Jaroše	Polní	Hybešova
		GFA in m2			Percentage of GFA		
Living		133324	117977	225178	38.64%	50.46%	59.08%
Estimated Functional Units	**Offices**	77839	11075	13892	22.56%	4.74%	3.64%
	Retail	5913	5636	14515	1.71%	2.41%	3.81%
	Dining	7707	1886	8225	2.23%	0.81%	2.16%
	Gallery	244	0	0	0.07%	0.00%	0.00%
	School	31923	17432	9577	9.25%	7.46%	2.51%
Precisely Identified Functional Units	**Sports Facilities**	0	5107	3880	0.00%	2.18%	1.02%
	Doctor	2019	1550	1896	0.59%	0.66%	0.50%
	Hospital	0	23428	2411	0.00%	10.02%	0.63%
	Theatre	23441	0	0	6.79%	0.00%	0.00%
	Social Services	0	0	4813	0.00%	0.00%	1.26%
	Religious Buildings	0	5224	0	0.00%	2.23%	0.00%
	Accommodation	5612	5245	4137	1.63%	2.24%	1.09%
	University	0	0	23484	0.00%	0.00%	6.16%
	Multipurpose Hall	0	0	6299	0.00%	0.00%	1.65%
Garage		3405	2345	5340	0.99%	1.00%	1.40%
Neglected		53576	36887	57499	15.53%	15.78%	15.09%
Total		345004	233792	381147			

DOI 10.13164/juniorstav.2024.24108

Residential Living and Residents

From the building survey, only the gross floor area for living space is known. To determine the number of parking spaces according to the Czech National Standard, it is necessary to divide the living space into flats with one. room and more, and further classify them into flats with sizes up to 100 m^2 and over 100 m^2. However, no uniform dataset was available for this division, so the values for conversion were estimated from two survey questions in the Research on Housing in Brno 2019 [7]. Based on this data and expert estimation, the GFA for living space was divided according to the following key, as shown in Tab. 3.

Tab. 3 Residential Living Estimation.

Residential Living			**Kpt. Jaroše**	**Polní**	**Hybešova**	**F. U. per Parking Space**	**Kpt. Jaroše**	**Polní**	**Hybešova**
GFA for Residential Living			133324	117976,96	225178				
Functional Unit	**Estimated GFA per Flat**	**Percentage of Flats**	**Revised Number of Flats**					**O_0**	
One Room Flat	30	12%	538	476	908	2	269	238	454
	40	5%	179	159	303		179	159	303
Flats up to	60	31%	687	608	1161	1	687	608	1161
100 m2	80	30%	493	436	833		493	436	833
	95	4%	57	50	96		57	50	96
Flats over 100 m2	110	17%	212	187	358	0,5	424	374	716
Total			2166	1916	3659		2109	1865	3563
						F.U. per Parking Space		**P_0**	
Inhabitants			2018	2464	3980	20	101	123	199

The number of residents was taken from the 2021 Census of Dwellings and Residents according to their usual place of residence and was provided by KAM. The number of residents are also included in Tab. 3.

Purposes for Which Precise Functional Units Were Determined

For the purposes of usage listed in Tab. 4, specific institutions within the area could largely be identified. For these, specific functional units were determined. For those for which this could not be directly obtained from open sources, an effort was made to contact their representatives, who provided this information either precisely or at least approximately. Even in these categories, there was ultimately some simplification, which should not exceed 5% of the observed areas.

This section of data represented the most labor-intensive part of the research. For individual functions, it was necessary to find specific purpose units. The main sources for gathering this data were open building survey data in GIS and maps from mapy.cz and maps.google.com.

For educational institutions, purpose units were generally found in the annual reports of the respective institutions. Basic art schools have significantly higher numbers of students due to their specific operation than can be expected from the basic capacity of the building. Therefore, basic art schools were omitted from the analysis. For the university, data on the maximum number of students accepted at the Faculty of Education, Masaryk University (PF MUNI) were used. While it can be expected that some of these students attend classes in other school buildings, PF MUNI also provides education to students from other faculties. It can be assumed that the total number of students may not correspond to the capacity (not all students attend lectures simultaneously), but this inaccuracy was disregarded.

The capacities of sports facilities were not freely available on the internet, so facility managers or sports club managers were contacted to provide at least approximate data. In future calculations, it would be worth considering re-evaluating the strict division into sports facilities with/without spectators. For example, the table tennis hall at Vojtova also has seating for spectators, but the primary demand for parking comes from players.

There are a large number of medical practices in the observed locations. These were searched for on the internet, and the number of medical staff was extracted or estimated from the websites. There is only one hospital in the Polní locality, which is the Milosrdných bratří Hospital. The necessary data is directly available on their website.

DOI 10.13164/juniorstav.2024.24108

Tab. 4 Purposes with Determined Precise Functional Units.

According to Building Survey	According to Czech National Standard	Functional Unit	Kpt. Jaroše	Polní	Hybešova	F.U. per Parking Space	Kpt. Jaroše	Polní	Hybešova
			Functional Units				P0		
Schools	**Maternity School, Nursery**	**Child**	44	75	82	5	9	15	16
	Primary School	**Pupil**	140	735	750	5	28	147	150
	Secondary School	**Student**	2640	600	0	10	264	60	0
University		**Student**	0	0	4573	6	0	0	762
Sports Facility	**Bowling Alley**	**Track**	0	4	0	2	0	2	0
	Sports Facility with Spectators	**Seats for Spectators**	0	600	0	13	0	46	0
	Sports Facility without Spectators	**Visitors**	0	200	75	2	0	100	38
Clinics		**Clinic**	14	8	15	0,5	28	16	30
		Medical Staff	23	18	30	3	8	6	10
Hospitals		**Medical Staff**	0	460	0	3	0	153	0
		Beds	0	466	0	3	0	155	0
Theatre		**Seats**	1020	0	0	4	255	0	0
Social services	**Retirement Home**	**Beds**	0	0	46	5	0	0	9
Religious Buildings		**Seats**	0	80	0	8	0	10	0
Accomodation	**Hotel*** **	**Beds**	206	66	115	3	69	22	38
	Dormitory	**Beds**	0	150	0	4	0	38	0
Multipurpose Hall		**Seats for Spectators**	0	0	7200	11	0	0	655
Total							**661**	**770**	**1708**

The theatre is only represented in the Kpt. Jaroše area. The number of seats was provided by a theater staff member based on a phone consultation.

The capacity of the retirement home in the Hybešova locality was provided by the facility manager over the phone.

The only religious building is the Church of St. Leopold. The number of seats was estimated from photos on the parish's website.

Accommodation is another sector that encounters the current method for determining parking minimums. The current calculation does not account for apartment accommodation, which cannot be classified into today's categories. The "hotel***" category was chosen for these apartments. Data for accommodation was obtained either from the booking.com server or through phone consultations with hotel and hostel receptions in Havlenova street.

The "Multipurpose Hall" category includes the so-called Rondo or Winning Group Arena. Given that it is an architecturally significant building, its capacity was easily found on the internet.

Purposes for Which Functional Units Were Estimated

For some of the observed purposes, it was not possible to determine the necessary functional units. These are purposes for which such information is generally not known to the owners/operators of individual businesses, and it would be necessary to extract them from the technical documentation of the buildings. An overview of these purposes is shown in Tab. 5.

Tab. 5 Purposes with Estimated Functional Units.

	Functional Unit	Estimated GFA	Kpt. Jaroše	Polní	Hybešova	F.U. per Parking Space	Kpt. Jaroše	Polní	Hybešova
			Number of Functional Units				P_0		
Office	**Office Area**	45%	35028	4984	6252	35	1001	142	179
Retail	**Sales Area**	70%	2661	2536	6532	50	53	51	131
Dining	**Guest Area**	70%	3468	849	3701	5	694	170	740
Gallery	**Guest Area**	70%	110	0	0	50	2	0	0
Total							**1750**	**363**	**1050**

DOI 10.13164/juniorstav.2024.24108

For offices, the conversion was estimated as the average ratio of GFA to office area from three mixed-use buildings (documentation for the reconstruction of the KAM building at Zelný trh 13, the Documentation for the Polyfunctional Building at Železniční, and the Documentation for the Cejl 76 complex). For retail, it was based on an advertisement for the sale of a retail unit in the Eden shopping centre in Královo Pole, and similarly for dining, it was based on an advertisement for the sale of the Vingl restaurant near Brno Reservoir. For the gallery, the ratio was derived from the House of Arts of the city of Brno.

Parking – Requirements

The required number of parking spaces was considered the number that would need to be constructed if the location were being built at the present time. It is based on Decree No. 501/2006 Coll., § 20 paragraph 5 [8], which refers to the relevant standard, in this case, ČSN 73 6110 Projektování místních komunikací [9]. The basic number of parking and parking spaces was determined according to Table 34 ČSN 73 6110. The reduction factor for the number of spaces, k_p, was chosen as $k_p = 0.25$, considering the character of the area and good public transportation access for all locations. The factor for the degree of motorization, k_a, was chosen as $k_a = 1.25$, based on the current requirements of the city of Brno [10].

Additionally, the number of required spaces was calculated with $k_a = 1$ and $k_p = 1$, meaning without the coefficient that, according to current legislation, is used to increase the required number of spaces based on the transportation policy of the municipality or city and without taking into account the influence of the area‘s character and public transportation.

The number of required parking spaces is shown in Tab. 6.

Tab. 6 Required parking spaces.

	O_0	P_0	k_a	k_p	N	k_a	k_p	N
Kpt. Jaroše	2109	5024	1.25	0.25	**4206**	1	1	**7133**
Polní	1865	2512	1.25	0.25	**3116**	1	1	**4377**
Hybešova	3563	5914	1.25	0.25	**6302**	1	1	**9477**

3 RESULTS

Tab. 7 Results.

	Location	Parking Spaces /Flat	Parking Spaces /Resident	Ex. Par. Sp./Req. Par. Sp.	Ex. Par. Sp./ Req. Par. Sp. Without Coef.
1	**Kpt. Jaroše**	0.49	0.53	0.25	0.15
2	**Polní**	0.41	0.32	0.25	0.18
3	**Hybešova**	0.28	0.25	0.16	0.11
	Average	0.39	0.37	0.22	0.15
	Median	0.41	0.32	0.25	0.15

4 DISCUSSION

Before interpreting the results, it is necessary to first name the most significant limitations of this analysis. The analysis focuses on mixed-block development, which inherently contains a large variety of uses. However, many of them cannot be assigned to common characteristics according to the Czech National Standard, or their functional units could not be determined. At least 15% of the total GFA was neglected for each of the locations. Some simplification was introduced into the analysis in the form of estimated usable areas for certain uses. These estimates are based on a relatively small number of examples and, therefore, introduce a considerable degree of inaccuracy into the calculations. Another significant limitation is the comparison with the number of residents. Although the analysis considers the usual number of residents, it must also be acknowledged that the number of students/employees does not provide the address of their short-term rental as their usual residence. Given the complexity of the analysis, there could be many more limitations, but these were found to be the most significant.

DOI 10.13164/juniorstav.2024.24108

The results for the observed locations shown in Tab. 7 show that in compact mixed-block development, despite the diversity of uses in the observed buildings, the proportion of all existing parking spaces to flats is relatively low. This ratio is significantly lower than the average (0.69) and median (0.52) determined in fourteen observed housing estates [11]. According to the assumption, it can also be observed that the proportion of required spaces to existing spaces is significantly lower. This significant difference can be attributed to the time of construction of most buildings in the observed locations, i.e., the period when parking minimum requirements were not yet in place, and therefore, most existing spaces consist of street parking spaces and inner-block spaces. The results also show a relatively large discrepancy between the proportions for the location Hybešova and the other two observed locations. This disparity can be attributed to a higher proportion of residential use in that location, lower street density (larger blocks in the observed location), or generally the differences in the observed locations.

5 CONCLUSION

The analysis of detailed data on land use and parking spaces confirmed the hypothesis that, given the construction period of the observed locations, there are significantly fewer parking spaces in this development than required by current regulatory standards. The ratio of parking spaces to residents or flats in compact mixed-block development is lower than in analyses conducted in housing estates, even though the observed type of development has a significantly lower proportion of residential functions than housing estates. The analysis also showed that the observed ratios vary significantly in the studied locations, and thus, at least from the conducted analysis, it is not possible to estimate the average ratio for this type of development. During the analysis, a problem with the detailed definition of the purposes of individual buildings in ČSN 73 6110 became evident, which can never cover all types of uses. This fact is evident in the difficulties with choosing the use, for example, for accommodation in the form of apartments or for sports facilities that also allow visitors, but the primary need for parking spaces is created by the athletes. The analysis results also indicate that the current requirements, in comparison to normative standards, are nearly a quarter. Due to the lack of parking occupancy data, an objective assessment of the situation at the surveyed locations, in terms of meeting satisfactory conditions or aligning with urbanistic requisites for short-distance cities and support for sustainable transportation modes, unfortunately cannot be derived from the analysis. This subject matter would be pertinent for further exploration within subsequent research endeavours. However, if we assume that increased parking availability leads to more frequent car usage in a given locality, we may infer that compliance with ČSN (Czech National Standards) could result in significantly higher generated traffic than what we are accustomed to from the current urban development.

Further research should focus on deepening this topic in more locations. However, this recommendation faces one of the fundamental limitations of this analysis, which is the availability of sufficiently detailed data for, if possible, uniform territorial units with compact mixed-block development.

Acknowledgement

The research was conducted with the support of the Junior Specific Research FAST-J-22-8048 and FAST-J-23-8357. Special thanks to the Kancelář architekta města Brna (Brno City Chief Architect's Office) for providing the necessary data.

References

[1] Petter Christiansena, Nils Fearnleya, Jan Usterud Hanssena, Kåre Skolleruda. Household parking facilities: relationship to travel behaviour and car ownership. World Conference on Transport Research – WCTR 2016 Shanghai. 10–15 July 2016 [online]. 06/2016.. Available at: https://www.witpress.com/Secure/elibrary/papers/UT11/UT11012FU1.pdf

[2] Astrid De Witte, Joachim Hollevoet, Frédéric Dobruszkes, Michel Hubert, Cathy Macharis, Linking modal choice to motility: A comprehensive review, 1/2013. [Online]. Available at: https://dial.uclouvain.be/pr/boreal/object/boreal%3A145987/datastream/PDF_01/view#page=1.

[3] R Balcombe, TRL Limeted a kol., „The demand for public transport: a practical guide," 2004. [Online]. Available at: http://www.trpa.org/documents/rseis/New%20References%20for%20Final%20EIS/Balcombe%2.

[4] Nico Muzi, „Does sharing cars really reduce car use?" [Online]. Available at: https://www.transportenvironment.org/publications/does-sharing-cars-really-reduce-car-use.

[5] Kancelář architekta města Brna, Průzkum budov v Brně, Brno: Provided in open data, 2018–2020.

[6] Brněnské komunikace a.s., Strategie parkování ve městě Brně, Brno, 2013.

[7] FOCUS - Marketing & Social research, Výzkum Bydlení v Brně 2019, Brno, 2018. [Online]. Available

at: https://data.brno.cz/documents/mestobrno::v%C3%BDzkum-bydlen%C3%AD-v-brn%C4%9B-2019-research-housing-in-brno-2019/explore

[8] MMR ČR, Vyhláška č. 501/2006 Sb. [Online]. Available at: https://www.zakonyprolidi.cz/cs/2006-501

[9] Český normalizační institut, ČSN 73 6110 Design of urban roads, UNMZ, 2006. [Online]. Available at: https://mmr.gov.cz/cs/ministerstvo/stavebni-pravo/pravo-a-legislativa/prehled-platnych-pravnich-predpisu/dalsi-predpisy/norma-csn-73-6110-projektovani-mistnich-komunika

[10] Brněnské komunikace a.s., ROČENKA DOPRAVY 2022, Brno, 2023. [Online]. Available at: https://www.bkom.cz/informacni-centrum/rocenky-dopravy-brno-15/rocenka-dopravy-brno-2022-pdf-225

[11] Kobzová Hana, PARKING ON HOUSING ESTATES, Brno: Juniorstav 2023.

DOI 10.13164/juniorstav.2024.24108