URBAN SPACE RESERVES: OPPORTUNITIES FOR INFILL HOUSING DEVELOPMENT IN CENTRAL BRNO

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In addition to his academic work, Jakub Mikel is also active in practice, co-leading his own architectural and design office. By combining academic research with professional experience, he contributes to the application of theoretical insights in concrete projects and solutions.

ABSTRACT: The paper addresses the possibilities of urban densification as one of the potential solutions to the housing crisis. It focuses on the identification and analysis of underutilized spaces, such as vacant lots, underbuilt structures, and attics, which may represent reserves for new residential development. The research conducted in a district of Brno assessed these areas in terms of their physical and legislative suitability for redevelopment. The paper highlights densification as a key instrument of sustainable urban development, offering economic, environmental, and legislative advantages. A more efficient use of the existing urban fabric allows the transformation of unused resources into new housing capacity and contributes to the optimization of urban space without the need for urban sprawl into the surrounding landscape. At the same time, the paper outlines the main barriers to densification, including technical, legislative, and social constraints, which may complicate the implementation of such projects.

KEYWORDS: urban densification; housing crisis; urban space reserves; vacant lots; underbuilt structures; attics; sustainable urban development

INTRODUCTION

The current lack of housing affordability in the Czech Republic ranks among the highest in Europe. According to research conducted in 2023, the average Czech had to spend 13.3 average annual salaries to purchase an average 70 m² dwelling (Deloitte, 2023). Compared with other countries—where, for example, Denmark's coefficient is 5.0 and geographically closer Poland's is 8.1—this figure appears very high. It is also necessary to consider the actual mortgage repayment period: in 2023 the average loan maturity was 26.6 years (Česká národní banka, n. d.). These data suggest that housing affordability has a significant impact on overall quality of life, as households pay a substantial share of their disposable income on mortgage repayments throughout most of their economically active years. For instance, in 2021 the average housing affordability index was 61.5% (Golem Finance, 2021). In other words: if the average Czech household purchased a dwelling at the average price level, it would spend 61.5% of its net monthly income on the mortgage instalment.

The situation in the property market is further reinforced by the fact that the current young generation prefers independent living—both rental and owner-occupied (Eurostat, n. d.). However, they often cannot afford it and are ultimately forced to use shared housing or remain with their parents. Once they are able to cover the costs of owner-occupied housing, they choose that option. Likewise, throughout the Czech Republic, owner-occupation is preferred over renting (RE/MAX, 2024). This strong demand for housing further deepens the imbalance between supply and demand, leading to a growing disequilibrium in the real estate market. Building new homes would seem to be the solution to restore balance between demand and supply. Yet the current trend is the opposite: the number of newly built apartments is decreasing, with a year-on-year decline in completed new dwellings reaching 60.1% (Český statistický úřad, 2025). The reasons for this can be identified in several key factors, with a dominant role played by a high degree of regulation associated with a time-consuming permitting process, the complexity of amendments to land-use plans often required for larger residential schemes, and complicated property-rights relations. Another crucial aspect is that new construction often results in the take-up of agricultural land, the protection of which is enshrined in Czech law—justifiably making development more expensive, slower, or in some cases impossible in certain areas. In this context, the question arises whether there is a way to expand the housing stock that would minimise environmental impacts such as the loss of arable land and the need to build new transport and utility infrastructure.

A possible answer—alongside brownfield regeneration—is the densification of urban centres. This is a process that enables the efficient use of available space in already urbanised areas while contributing to improvements in urban design quality and the long-term sustainability of cities. The approach focuses on city centres that exhibit high housing demand, thereby creating dwellings where demand is real and economically justified. Densification is also conceptually anchored in theories of decision-making by urban development actors, particularly developers, who, when deciding on an investment, consider a combination of expected return, the complexity of permitting procedures, and regulatory barriers (Brueckner, 2011; Henderson & Ioannides, 1983). Institutional and behavioural factors also play a significant role, such as neighbour opposition (the NIMBY—"Not In My Backyard"—effect), fragmented ownership, or a lack of incentives for owners to activate underused spaces (Monkkonen, Lens & Manville, 2020).

Despite this potential, capacities for densification often remain underutilised. One reason may be the lack of municipal strategies aimed at activating internal development potential and regulatory frameworks that fail to reflect the changing needs of the city (Gechter & Tsivanidis, 2023).

The benefits of this process can be divided into three categories:

1. Economic:

• Eliminating the need to build new transport and utility infrastructure. Higher population density allows more efficient use of existing infrastructure and reduces the costs of public services (Ahlfeldt & Pietrostefani, 2019).

• Utilising existing structures—such as roofs and foundations—when creating attic conversions. Efficient use of the existing building fabric can reduce construction costs and accelerate urban regeneration (Brueckner, 2011).

2. Environmental:

• Eliminating the take-up of agricultural land. Densification helps to curb urban sprawl and thereby protect farmland (Bertaud & Brueckner, 2005).

• Shortening travel distances. A more compact urban layout leads to shorter trips and thus to lower emis-

sions (Carozzi & Roth, 2023).

3. Social:

• Leveraging existing cultural and civic amenities. Denser development supports the efficient use of public facilities and services without the need to expand them (Institut plánování a rozvoje hl. m. Prahy, 2020).

Among the still insufficiently explored aspects of the densification of urban centres are, above all, the scale of its potential to create new dwellings and to increase population within a stabilised urban structure. This study focuses on identifying reserves for housing construction in these areas and examining the possibility of using available space efficiently. The key research question is: how much potential for residential development is embedded within a stabilised urban fabric?

Delimitation of the study area

The research analysed a selected district of Brno as a model area to assess the amount of available land within stabilised development (Figure 1). Specifically, the area was Zábrdovice, chosen for its suitable location, urban structure, and data availability. The area represents a typical example of a stabilised inner-city zone, enabling the method to be verified under conditions common to most large Czech cities. The method as a whole is designed to be transferable to other areas with similar characteristics while maintaining sufficient precision and relevance of results.

Fig. 1.: Graphic interpretation of the delineation of the research area (author's own work).

Zábrdovice is a medium-sized urban district that forms a separate cadastral area [610704] with a total area of 1.64 km². In 2021, it had 12,632 inhabitants (Český statistický úřad, 2021). The district directly adjoins the city centre and forms a transition between the historic core and other neighbourhoods, making it a sought-after location. Zábrdovice is connected to central urban zones by major transport infrastructure, including public transport and principal road arteries, enabling efficient links to the broader regional and urban network.

Zábrdovice is characterised by a relatively dense perimeter-block structure formed primarily in the 19th and 20th centuries, with most buildings constructed during periods of industrialisation and urban change, when urban functions expanded significantly. This structure still represents a typical urban fabric with a high share of residential uses alongside smaller commercial premises and public buildings. The area contains several historical and cultural landmarks, which creates pressure to preserve the specific character of the built environment during regeneration and transformation.

The area is served by complete utility and transport infrastructure—including sewerage, water and gas networks—and a relatively diverse range of amenities such as schools, kindergartens, shops, restaurants, and healthcare facilities. This makes it a suitable environment for further urban development without the need for extensive investment in basic public services and transport connections. These characteristics make Zábrdovice an apt location for assessing densification potential within a stabilised urban structure.

METHODOLOGICAL APPROACH

The aim of the research was to design and test a pilot approach to identifying and quantifying development capacities within stabilised urban areas, and then to evaluate these data in the context of potential additions to the housing stock.

Although existing approaches to capacity assessment of stabilised areas—such as the IPR Prague methodology (Institut plánování a rozvoje hl. m. Prahy, 2020) or the approach of Monkkonen et al. (2020)—provide a useful framework for strategic planning at the city or regional level, the method presented here differs in its emphasis on the micro-scale. It focuses in detail on a specific locality through a combination of map layers, field surveys, and individual classification of each potentially developable site. This brings greater spatial accuracy and more realistic results for applied practice.

Compared with existing approaches that often operate at the city-wide macro-level or rely solely on typological analyses (e.g., brownfields), this method tracks specific blocks within a stabilised urban structure and yields detailed quantitative data on usable development potential (Institut plánování a rozvoje hl. m. Prahy, 2020; Hudeček et al., 2019).

The pilot approach builds on prior research into urban development and capacities, such as Prague's Territorial Analytical Data (Institut plánování a rozvoje hl. m. Prahy, 2020) or quantitative analyses of how urban structure affects public expenditures in Czech cities (Hudeček et al., 2019).

The analytical framework combines spatial identifi-

cation of underused sites with basic urban, legal, and demographic inputs, with the aim of testing the feasibility of using these areas for residential purposes.

For the purposes of the study, three types of sites with development potential were defined:

Unused attics (NS) — spaces suitable for creating residential units.

Unbuilt gaps (VP) — plots enabling the construction of new apartment buildings.

Underbuilt stock (PV) — buildings whose height or footprint fails to utilise their maximum potential. In these cases, rooftop extensions for residential use were considered. If an extension proved technically unfeasible, demolition and replacement with a new building was considered, while calculations only included the net additional area compared to the original state. Schematic: (Figure 1)

Fig. 2.: Interpretation of the methodology for defining the examined phenomena (author's own work).

The selection of locations and data collection drew on the applicable land-use plan, the Building Act, and basic urban and architectural principles—rules that preserve spatial continuity, urban scale, the building line, the proportions of public spaces, and residential quality. These principles correspond to the tenets set out, for example, in the Czech Republic's Policy of Architecture and Building Culture (Ministerstvo pro místní rozvoj ČR, 2015).

Within Zábrdovice, blocks designated as "stabilised" in the land-use plan were selected (Statutární město Brno, 2024a). In total, 29 such blocks were identified (Figure 3). The blocks were analysed using aerial imagery, cadastral maps (ČÚZK, 2024), and field surveys to

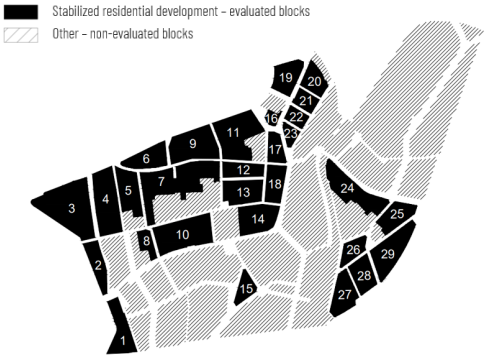

Fig. 3.: Map of the division of the assessed blocks (author's own work

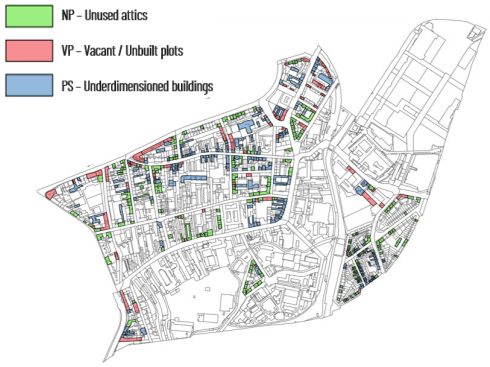

Fig. 4.: Map of available development areas (author's own work).

compile a detailed inventory of available sites. These sites were assigned IDs and colour-coded in a custom map of available development areas (Figure 4).

For all identified sites, data were collected on type, footprint area (m²), and potential number of floors. To increase the accuracy of calculations, the footprint area was adjusted using reduction coefficients—0.8 for standard floors and 0.7 for attic spaces—allowing conversion to net floor area without the thickness of structures and shared/common spaces.

The total usable area for dwellings was then calculated as the product of the reduced footprint and the estimated number of floors. To reflect requirements for public amenities, the resulting area was further reduced by a 0.9 factor, creating a 10% reserve for potential public facilities. The remaining area was divided by the average dwelling size—assumed at 75 m²—to estimate the potential number of new apartments. Based on average household size (2.4 persons/apartment), the expected population increase associated with each identified site was then derived (Český statistický úřad, 2022).

ID	Type of Area	Ground Plan Area (m²)	Area Reduction Coefficient (Usability)	Net Floor Area per Storey (m²)	Area Reduction Coefficient (Amenities)	Potential Number of Residential Storeys	Total Net Floor Area (m²)	Number of Apartments (75 m²)	Number of Inhabitants (2.4 persons/apartment)
Block 1									
1	VP	1445	0,8	1156	0,9	5	5202	69	165,6
2	PS	459	0,8	367,2	0,9	2	660,96	9	21,6
3	PS	440	0,8	352	0,9	2	633,6	8	19,2
4	PS	420	0,8	336	0,9	2	604,8	8	19,2
5	NP	685	0,7	479,5	0,9	1	431,55	6	14,4
6	NP	245	0,7	171,5	0,9	2	308,7	4	9,6
7	VP	1191	0,8	952,8	0,9	7	6002,64	80	192
8	NP	154	0,7	107,8	0,9	1	97,02	1	2,4
9	VP	825	0,8	660	0,9	5	2970	40	96
10	PS	654	0,8	523,2	0,9	5	2354,4	31	74,4
						Celkem:	**19265,67**	**256**	**614,4**

Tab. 1.: Block 1 – Collected data and calculation procedure (author's own work).

These data were subsequently aggregated by block (Table 1) and overall, yielding an estimate of how many new apartments could be created within Zábrdovice's stabilised areas and how many potential new residents the locality could accommodate.

Structure and justification of the analytical procedure
Site typology. The delineation of development potential in stabilised areas—including unused attics, gap sites, and underbuilt stock—follows approaches recommended in planning documents, such as the Ministry's methodological guidance on assessing the need for developable land (Ministerstvo pro místní rozvoj ČR, 2022).

Area delimitation. The analysis focused exclusively on areas designated as stabilised in the land-use plan. Although generally considered spatially "built-out," they may still contain latent capacities. The approach builds on planning documents such as Prague's Territorial Analytical Data, which point to possible internal reserves even within stabilised areas (Institut plánování a rozvoje hl. m. Prahy, 2020).

Data collection and spatial identification. A combination of aerial imagery, cadastral data, and fieldwork enables the identification of sites that would not be captured using GIS tools alone. A similar approach is used in city-centre regeneration (e.g., Auckland—Murphy, 2012).

Calculation of usable floor area. Reduction coefficients of 0.8 for standard floors and 0.7 for attics were applied. These reflect common practice in urban analyses for estimating net floor area after deducting common/technical spaces and structural thicknesses. In the case of attics, the coefficient also reflects unusable portions under slopes and therefore uses a stronger reduction. Allowance for public amenities. A 10% reserve for public amenities was included as a methodological estimate based on common planning practice whereby residential development areas allocate a share to civic facilities.

Conversion to dwellings and population. Based on the 2021 Census, where average dwelling sizes are most commonly in the 60–80 m² band and the average occupancy is roughly 2.3 persons per dwelling (Český statistický úřad, 2022). The values used here (75 m², 2.4 persons/dwelling) therefore reflect a slightly optimistic yet realistic urban scenario.

FINDINGS

A total of 412 development sites were identified, of which 167 were unused attics, 60 were unbuilt gaps, and 187 were underbuilt sites.

Total net floor area after applying the coefficients: 245, 864 m²; number of dwellings at 75 m² net floor area: 3, 278 units; population (2.4 persons/unit): 7, 868.

For better comparison, results can be normalised per hectare (10,000 m²).

Net floor area: 4,867 m²; number of dwellings (75 m²): 65 units; population (2.4 persons/unit): 156.

Shares of net floor area: 13.64% unused attics, 41.86% unbuilt gaps, and 44.49% underbuilt stock.

Graphical representation: (Figures 5 and 6)

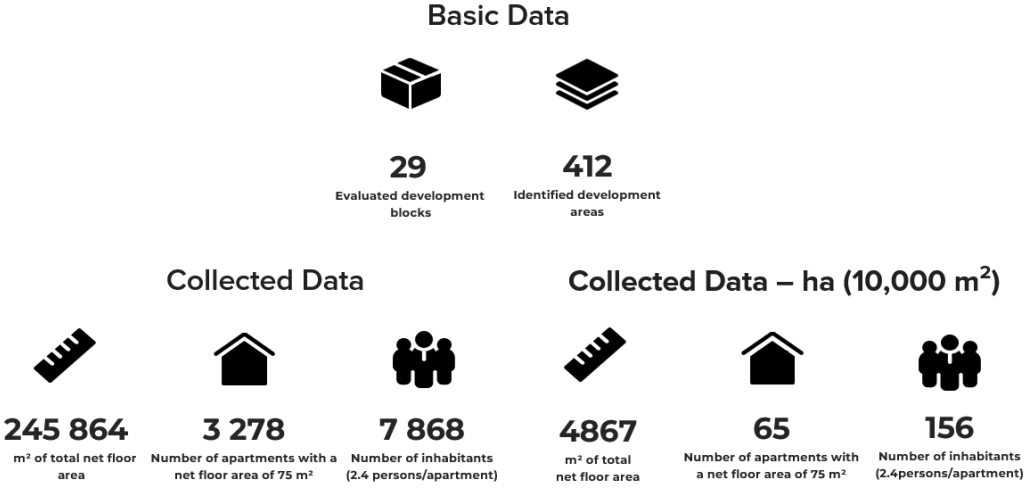

Fig. 5.: Graphic interpretation of results 1 (author's own work).

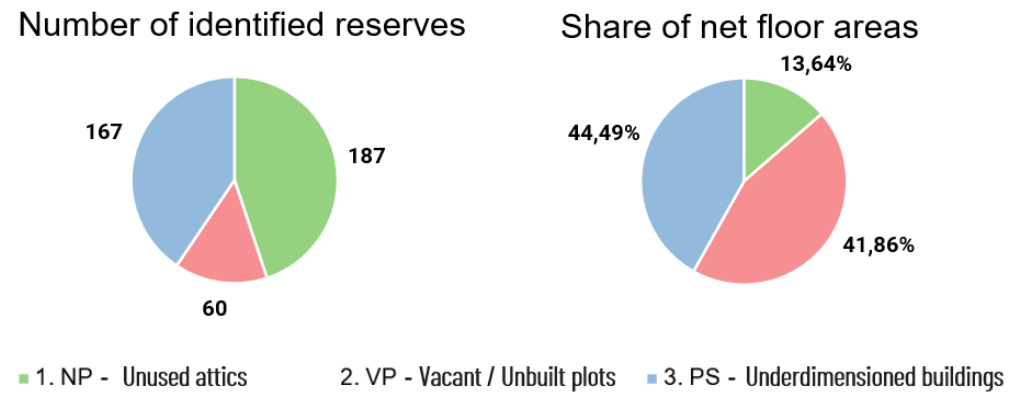

Fig. 6.: Graphic interpretation of results 2 (author's own work).

ANALYSIS OF RESULTS

The data indicate that within the assessed stabilised areas of Zábrdovice—which represent approximately half of the district's total area—reserves were identified that, after considering applicable legislation and an allowance for civic amenities, could provide housing for roughly 7,910 new residents. This suggests potential for a substantial population increase, given that the last census (2021) recorded 12,632 inhabitants in Zábrdovice (Český statistický úřad, 2021). The potential increase thus reaches 62.62%, which can be considered significant for this locality.

It should be noted that the 62.62% increase is based on the number of residents officially registered as of the 2021 census. In urban districts with a higher share of rental housing, there are often more residents without permanent registration (e.g., students, foreign workers, etc.), suggesting the actual number of people living there may be higher. The true relative increase could therefore be somewhat lower when compared to this more realistic baseline. Even with this caveat, the identified capacity remains substantial.

Why has the potential for densification not been utilised more widely? Its use is constrained by a number of regulatory hurdles that slow implementation and reduce the economic advantage compared with projects outside the built-up area. The high regulatory burden—linked not only to a complex and time-consuming permitting process but also to strict general technical building requirements—slows the process considerably and often leads to project abandonment in city centres. A regulatory framework originally designed to protect public interests can, in practice, hinder adaptation to changing needs—such as the need to increase the supply of affordable housing. In addition, complicated ownership structures and neighbour opposition constitute further barriers, with the NIMBY ("Not In My Backyard") pattern often at play: people support densification in general but oppose it in their immediate vicinity, which complicates and slows implementation.

Public authorities can play a role not only by lowering regulatory barriers through adjustments to building codes and streamlined permitting, but also by introducing positive incentives—such as grants for creating new dwellings within stabilised areas—or negative incentives, for example through tax instruments that motivate owners of underused spaces to develop them for housing. Although first positive steps are emerging—such as the adoption of Brno's building regulations (Statutární město Brno, 2024b), which to some extent reduce regulatory burden, or subsidies under the Affordable Rental Housing programme (Státní fond podpory investic, 2025)—these measures still appear insufficient relative to the severity of the housing affordability problem.

In light of the findings, a comprehensive assessment of all Brno districts would be advisable to obtain more accurate and representative data for the entire city. This would provide a more integrated view of Brno's urban and spatial characteristics. Given the time intensity of such a process, automation offers an efficient alternative for collecting and analysing data. Another option would be to assess characteristic fragments of each district and then extrapolate them to the whole district and, progressively, to the entire city using appropriate mathematical methods. This would allow comprehensive and legible data for Brno without a substantial extension of the research timeline.

CONCLUSION

The results confirm that densifying the stabilised urban fabric in Zábrdovice represents significant development potential for new dwellings that can materially improve housing affordability not only locally but also in Brno more broadly. This approach can be regarded as an effective urban development strategy combining the economic, environmental, and social aspects of sustainable urbanisation.

Densification enables maximum use of existing transport and utility infrastructure, generating savings both in acquisition and in ongoing maintenance. Environmentally, it reduces the need to convert agricultural land and helps curb urban sprawl, benefiting ecosystems and landscape character. At the same time, it leads to more efficient use of the existing built-up area and strengthens the functional cohesion of the urban structure.

However, the identified potential can only be fully realised if key barriers are removed or substantially mitigated—especially complex and lengthy permitting, low incentives for owners of underused spaces to develop them, and often negative public attitudes toward nearby new construction. If these hurdles were reduced—e.g., through streamlined legislation, targeted support to municipalities, or better public engagement—a larger share of the potential could be realised. Without such steps, only part of it is likely to materialise in practice. Even so, the results indicate that meaningful gains in new housing within the existing urban structure are achievable even with partial uptake.

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