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REGIONAL ACCESSIBILITY OF UTILITY NETWORKS ON BROWNFIELDS: IMPLICATIONS FOR BUSINESS DEVELOPMENT

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Abstract:

The study examines the relationship between the accessibility of municipal infrastructure and the potential for brownfield regeneration in Czechia. The aim is to analyse how the level of infrastructure differs across regions, how these differences influence the business attractiveness of territories, and what implications arise for public policies supporting development. The Accessibility of Municipal Infrastructure (AMI) index was constructed from CzechInvest's National Brownfields Database to quantify regional disparities in the connection of brownfield sites to five categories of utility networks: electricity, potable water, sewage, gas, and telecommunications. The results show pronounced differences between industrially developed and peripheral regions, confirming that infrastructural accessibility strongly determines both redevelopment feasibility and regional competitiveness. Regions such as Pardubice, South Moravia and Pilsen display the highest AMI values, while South Bohemian and Liberec regions remain structurally disadvantaged. The findings highlight that infrastructure represents not only a technical but also an institutional and strategic determinant of territorial development. Improving infrastructural readiness in lagging regions should therefore be a priority for Czech regional policy, as it directly enhances investment attractiveness, innovation potential, and the efficiency of public support instruments. The AMI framework provides a replicable tool for evaluating regional disparities and designing evidence-based development strategies.

Key words: Brownfields, Engineering infrastructure, Regional development, Business attractiveness, Infrastructure accessibility

JEL: R11, O18, Q01

1 Introduction

The regeneration of brownfields has become one of the key topics of regional and spatial development over the past two decades, not only in Europe but also in the Czech Republic. It represents both a major challenge and an opportunity in the context of sustainable economic growth, reduction of spatial inequalities, and more efficient use of existing land resources. Brownfields, abandoned or underutilized sites formerly used for industrial, agricultural, military or other purposes, are not merely

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a physical problem in the landscape. They constitute a complex socioeconomic phenomenon reflecting changes in economic structures, institutional settings and policy priorities of regional development (Rizzo et al. 2015; Thornton et al. 2007). In the Czech Republic, which underwent a profound industrial transformation after 1989, brownfields have become a permanent feature of the regional landscape. Their regeneration is therefore not only a matter of technical interventions but also a strategic challenge linking regional development, the business environment and environmental policy (Frantal and Martinat, 2013; Klusacek et al. 2018).

One of the main factors determining the success of regeneration and the potential for new use is the availability of technical infrastructure. This includes connection to water supply, sewerage, energy and transport systems, which affects not only the cost of land redevelopment but also its economic attractiveness to investors and entrepreneurs. Thornton et al. (2007) add that without adequate infrastructure, most brownfields remain outside market interest because they require high initial investment and carry an increased risk of failure. This problem is particularly evident in regions with low population density and a historical dependence on heavy industry, where extensive sites remain outside the main development axes (Martinat et al, 2018; Skrabal, 2020).

In the Czech context, the issue of infrastructure accessibility also has a strong regional dimension. Data from the National Brownfields Database (CzechInvest, 2024) show that more than half of the registered sites are located outside core urban areas. This means that a large part of potential development land faces infrastructure deficits that significantly reduce its market value and the possibility of economic regeneration. Studies by Frantal et al. (2015) and Tureckova et al. (2018) demonstrate that regions with more developed transport and technical networks exhibit higher rates of regeneration and greater investor interest. In contrast, peripheral regions such as Karlovy Vary and Vysocina have long remained outside the main investment stream. Klusacek et al. (2018) explain this situation by differences in administrative capacity and institutional quality among regions, which determine their ability to plan, coordinate and draw financial resources to support regeneration.

The motivation for a detailed analysis of regional differences in the accessibility of technical infrastructure lies in the fact that infrastructure is not only a technical factor but also an economic and social determinant. Ni et al. (2024) demonstrated that the quality of infrastructure directly affects the efficiency of public spending, environmental impacts and the long-term sustainability of projects. Zhang et al. (2025) add that there is a strong positive relationship between the level of infrastructure and the resilience of regional systems; well-equipped regions can adapt more quickly to economic changes and attract new investment. In this sense, infrastructure can be understood as an indicator of regional competitiveness as well as a tool of just transition. Frantal et al. (2024), in a recent study on the recycling of coal-mining regions, emphasize that regeneration without adequate infrastructure may become only a formal process without real economic effects.

International experience also shows that network accessibility and the institutional environment represent mutually interrelated conditions for successful regeneration. Chen (2022), in an analysis of Shanghai port brownfields, describes how a strong fiscal and financial infrastructure enabled the renewal of otherwise unattractive areas, while Peric et al. (2024) emphasize the role of deliberative planning in the transformation of military sites in Serbia. Both studies confirm that the combination of physical infrastructure and institutional coordination forms a fundamental precondition for economic efficiency. From the perspective of the European Union, the issue of infrastructure is directly linked to the objectives of the European Green Deal, which promotes the so-called green regeneration of industrial areas and the creation of sustainable industrial zones (Sessa et al. 2022).

From a practical perspective, the availability of technical infrastructure has a fundamental impact on the business environment. Kuiper et al. (2025) demonstrated that investment in the renewal of urban buildings generates measurable effects on the local labor market, particularly in areas with well-developed infrastructure. These findings are also relevant for Czech regions, where regenerated brownfields often serve as foundations for new business zones and service centers. Tureckova et al. (2018) point out that small and medium-sized enterprises are the most frequent users of regenerated sites when they are easily

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accessible, not only in terms of transport but also in energy and digital connectivity. Conversely, poorly accessible locations remain outside long-term business interest and require significant public intervention.

In this context, the issue of infrastructure also gains importance for regional policy and fiscal instruments. Thornton et al. (2007) point out that brownfield regeneration is economically unsustainable without public support, as private actors are unable to bear the high initial costs. Rizzo et al. (2015) add that the key factor of efficiency lies in the coordination of financial, environmental and institutional policies. This implies that infrastructure should not be understood merely as a technical item in the budget but as a strategic component of economic policy that influences the long-term capacity of regions to sustain economic activity.

The motivation of this article is to contribute to a deeper understanding of the relationship between the availability of technical infrastructure, regional disparities and the economic potential for brownfield regeneration in the Czech Republic. The aim is to analyse how the level of infrastructure differs across regions, how these differences influence the business attractiveness of territories, and what implications arise for public policies supporting development. The analysis is based on data from the CzechInvest National Brownfields Database, regional statistics and literature from both Czech and international research. The results aim to provide an empirical basis for more effective targeting of public interventions and for the formulation of policy instruments that link technical infrastructure with the economic transformation of regions.

The structure of the paper is as follows. Section 2 provides a review of the relevant literature on infrastructure accessibility and brownfield regeneration. Section 3 describes the data sources, preprocessing procedures and the methodological framework, including the construction of the AMI index. Section 4 presents the empirical results and discusses regional patterns of infrastructural accessibility across Czech regions. Section 5 concludes the paper, summarising the main findings, policy implications, limitations of the study and directions for further research.

2 Literature Review

The availability of technical infrastructure is identified in the academic literature as one of the key factors determining the success of brownfield regeneration and its economic utilization. Thornton et al. (2007) describe infrastructure as the main determinant of the economic attractiveness of an area, influencing the return on both public and private investment. Ferber et al. (2006) emphasize that high-quality technical networks constitute a fundamental precondition for the spatial integration of brownfields into the urban environment and enable their long-term use. Rizzo et al. (2015) highlight that the success of regeneration is closely linked to the coordination of planning and investment strategies that also include network modernization. Tonin (2020) and Longo and Campbell (2017) demonstrate that the physical renewal of an area without adequate infrastructure does not lead to sustainable development, as technical constraints hinder further economic use.

Contemporary literature understands infrastructure not only as a technical system but also as a key factor of regional competitiveness, resilience and social stability. Ni et al. (2024) emphasize that network accessibility increases the efficiency of public resource use and reduces the environmental burden of regeneration projects. Zhang et al. (2025) point out that regions with developed networks are better able to respond to economic shocks and exhibit more stable economic growth. Ravaz et al. (2024) and Kuiper et al. (2025) demonstrate that the development of transport and technical infrastructure supports the formation of business clusters and increases regional employment. Pizzol et al. (2016) and Bottero et al. (2019) add that the technical readiness of an area is a necessary condition for environmental efficiency and the reduction of ecological risks. Sessa et al. (2022) note that network modernization is an essential component of European sustainable development strategies, as it links economic objectives with climate policy. Research by Hammond (2023) and Williams (2022) confirms that infrastructure forms the structural foundation for innovation, diversification and overall regional stability.

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In the Czech context, the issue of infrastructure has a similar significance, while pronounced spatial differences are evident. Frantal et al. (2013, 2015) and Martinat et al. (2018) demonstrated that regions with well-developed transport and technical networks show higher levels of brownfield regeneration and a greater ability to attract investors. Tureckova et al. (2018) confirmed that network accessibility determines not only the return on investment but also the character of subsequent land use. Klusacek et al. (2018) and Navratil et al. (2022) emphasize that the key role is played by the administrative capacity of regions, the coordination of public investments and the ability of strategic management. Frantal et al. (2024) add that in transforming industrial regions, investments in infrastructure represent a fundamental prerequisite for economic diversification and the development of new sectors. These studies confirm that the quality and extent of networks are not merely technical indicators but reflect institutional maturity and the ability of regions to capitalize on development opportunities.

The findings from the Czech context are further developed in the studies by Skrabal and Vybiral (2025a, 2025b), who conducted a detailed analysis of regional differences in the accessibility of technical infrastructure using data from the CzechInvest National Brownfields Database. The authors identified significant disparities among regions and demonstrated that infrastructure directly influences the success of business utilization of land. Regions with more developed networks achieve higher levels of regeneration and exhibit a more diversified structure of economic activities. At the same time, it appears that infrastructure accessibility is strongly linked to institutional capacity, as the effective use of networks requires a functional administrative framework and the ability to coordinate between public and private actors. These findings correspond to international studies by Tonin (2020), Ravaz et al. (2024), Ni et al. (2024) and Lin (2024), which confirm that strategic infrastructure planning enhances productivity and the resilience of regional economies.

Infrastructure also plays a crucial role in the business environment and innovation. Valdaliso and Andres (2023) analyzed the transformation of science and technology parks in Europe and demonstrated that the integration of physical and digital infrastructure enhances the innovative capacity of regions. Park et al. (2025) showed that spatial accessibility of networks fosters cooperation among enterprises and increases their competitiveness. Willett et al. (2025) point out that regions with insufficient infrastructure remain long-term marginalized and lose their ability to attract foreign direct investment. Peric and Miljus (2021) emphasize that the effectiveness of public investment in networks depends on participatory planning, while Hagen and Higdem (2024) and Hanssen et al. (2023) highlight the need for an integrated approach that links infrastructure with housing, transport and social policy. Hudson (2024) adds that high-quality infrastructure contributes not only to economic growth but also to greater social cohesion. This body of literature shows that technical infrastructure forms the backbone of innovation processes and determines how regions can respond to technological and environmental challenges.

The environmental and cultural dimensions of infrastructure are addressed in the works of He et al. (2024) and Yildirim (2023), who analyze the impacts of network modernization on the renewal of urban and industrial areas and demonstrate that the technical preparedness of land supports ecological stability and adaptation to climate change. Bottero et al. (2019), Sessa et al. (2022) and Pizzol et al. (2016) emphasize that investments in infrastructure represent a key instrument of environmental policy, linking energy efficiency with economic performance. Willett et al. (2025) as well as Ravaz et al. (2024) add that the development of networks improves access to services, supports employment and contributes to the reduction of regional inequalities. In this sense, infrastructure is understood as part of broader sustainable development strategies that integrate economic, social and environmental objectives.

Finally, the academic literature suggests that infrastructure connects the physical, economic, institutional and social dimensions of regional development and represents one of the most complex factors of territorial transformation. Radulescu et al. (2025) emphasize that collaboration among institutions, investors and the public creates a framework for effective decision-making and transparent project implementation. Peric and Miljus (2021) demonstrate that deliberative planning based on communication and shared responsibility strengthens the legitimacy of development strategies. Willett et al. (2025) and Williams (2022) show that regions with modern networks achieve higher innovation

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performance and better integration into international value chains. Hanssen et al. (2023), Hagen and Higdem (2024) and Hudson (2024) add that infrastructure also has a significant social dimension, as it improves access to services and supports community cohesion. Frantal et al. (2024) and Skrabal and Vybiral (2025b) confirm that investments in networks represent a key instrument of economic transformation and diversification. Tonin (2020), Rizzo et al. (2015), Zhang et al. (2025), Ni et al. (2024) and Kuiper et al. (2025) further argue that strategically managed infrastructure enhances regional adaptability, productivity and the capacity to generate long-term economic value. In the context of this article's objective, infrastructure thus represents more than a technical precondition; it is an indicator of institutional quality, regional adaptability and the ability of territories to generate sustainable economic and social benefits.

3 Methods

The methodological framework of this study was developed to examine how the accessibility of municipal infrastructure affects the redevelopment potential of brownfield sites in Czechia. The research is based on the premise that the physical accessibility of basic utilities such as electricity, potable water, sewage, gas, and telecommunications plays a decisive role in determining whether previously used land can be transformed into productive assets. From the perspective of regional development, these infrastructural conditions are closely linked to the capacity for new entrepreneurial and investment activities. The aim is to analyse how the level of infrastructure differs across regions, how these differences influence the business attractiveness of territories, and what implications arise for public policies supporting development. The analysis is based on data from the CzechInvest National Brownfields Database, regional statistics and literature from both Czech and international research. The results aim to provide an empirical basis for more effective targeting of public interventions and for the formulation of policy instruments that link technical infrastructure with the economic transformation of regions.

The analysis is structured as a regional comparison (NUTS III) that highlights the spatial inequalities underlying the regeneration process. Previous studies have shown that infrastructural and locational disadvantages often reinforce economic marginalization, limiting both private investment and the success rate of public regeneration projects (Frantal et al. 2024; Skrabal and Vybiral, 2025b). By focusing on accessibility, this study seeks to provide a quantitative foundation for understanding how infrastructure availability conditions the feasibility, cost, and timing of redevelopment, and ultimately how it shapes the business environment in different regions. The following sections describe in detail the data sources, preparation procedures, and analytical framework used to construct a synthetic indicator of infrastructural accessibility the Accessibility of Municipal Infrastructure (AMI) index.

3.1 Data Source and Preprocessing

The empirical data were derived from the National Brownfield Database, administered by the CzechInvest agency, which serves as the official nationwide inventory of previously used or abandoned sites with redevelopment potential. The dataset was fixed as of 20 December 2024, comprising 649 brownfield sites recorded across the Czech Republic. Each record includes detailed geographic coordinates (GPS), the regional classification according to the NUTS III system, and information about the availability and distance to five categories of municipal infrastructure: electricity, potable water, sewage system, gas supply, and telecommunications. These infrastructure indicators were selected because they represent the fundamental physical preconditions for both economic and mixed-use redevelopment. Similar datasets have been applied in international research to measure urban regeneration capacity and investment readiness (Bardos et al. 2016; Wan et al. 2024; Zhang et al. 2025).

For analytical purposes, the dataset was divided into 14 regional subsets, each corresponding to one NUTS III region. The Capital City of Prague was excluded from the sample because the national database

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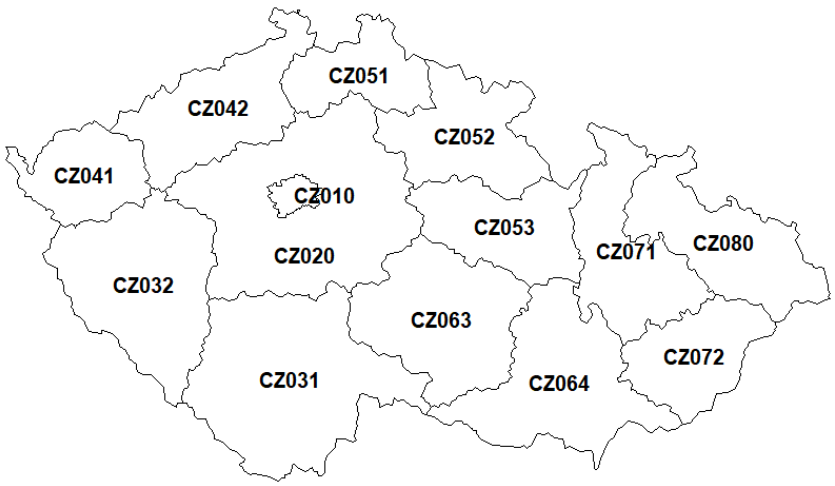
lists only four brownfield sites within its boundaries. This figure is not representative of the true extent or diversity of post-industrial areas in the metropolitan context and would distort interregional comparability. The analysis therefore focuses on the remaining 13 regions, which collectively capture the full spatial, demographic, and economic diversity of Czechia.

Before the computation of indicators, all datasets underwent a detailed process of data cleaning and standardization. Inconsistent entries and missing distance values were corrected or removed. Regional areas were converted from hectares to square metres (1 ha = 10,000 m²) based on data from the Czech Statistical Office (2024). This conversion made it possible to normalize the subsequent AMI results relative to total regional area and brownfield density. Additional checks were applied to identify duplicate coordinates, eliminate incomplete records, and verify outlier distances. These preprocessing steps ensured that the datasets were internally consistent and comparable across all regions, providing a reliable empirical basis for quantitative analysis.

3.2 Analytical Framework and Rationale

The methodological design builds upon European research traditions that combine spatial analysis, quantitative indicators, and composite indices to evaluate redevelopment potential and territorial inequalities (Preston et al. 2023). While many previous studies have focused on environmental contamination or ownership issues, this research emphasizes physical and locational accessibility, which has a direct influence on both the cost structure and technical feasibility of regeneration. As Radulescu et al. (2025) and Williams (2022) highlight, infrastructure accessibility also acts as a proxy for institutional capacity and investment readiness - regions with well-developed networks typically exhibit greater attractiveness for business development and stronger integration into national policy frameworks. To operationalize this concept, a synthetic indicator the Accessibility of Municipal Infrastructure (AMI) was designed to quantify the infrastructural readiness of each brownfield site.

Figure 1: Regional division of the Czechia at the NUTS III level



Source figure: authors' own elaboration, 2025.

The spatial distribution of brownfield sites across the thirteen Czech regions (NUTS III) was derived from the CzechInvest National Brownfields Database. The dataset includes information on the total area of each region and the number of registered brownfield sites as of 2024. Table 1 provides an overview of the regional datasets and their spatial extent, illustrating significant variation in both the total area and the concentration of brownfields.

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Tab. 1: Overview of regional brownfield datasets and their spatial extent

Name of Regions	CZ-NUTS	Area of the region in (m²)	The number of brownfield sites (n)
Karlovy Vary Region	CZ041	3,310,400,000.0	44
Pilsen Region	CZ032	7,649,000,000.0	53
Usti nad Labem Region	CZ042	5,338,700,000.0	91
South Bohemian Region	CZ031	10,058,100,000.0	33
Vysocina Region	CZ063	6,795,800,000.0	40
Central Bohemian Region	CZ020	10,928,500,000.0	64
Pardubice Region	CZ053	4,519,300,000.0	33
Hradec Kralove Region	CZ052	4,759,200,000.0	41
Liberec Region	CZ051	3,163,400,000.0	63
Moravian-Silesian Region	CZ080	5,430,700,000.0	83
Olomouc Region	CZ071	5,271,600,000.0	37
Zlin Region	CZ072	3,962,900,000.0	18
South Moravian Region	CZ064	7,187,700,000.0	49
Total	CZ0	78,375,300,000.0	649

Source table: authors' own elaboration based on CzechInvest data.

3.3 Computation of the AMI Index

The Accessibility of Municipal Infrastructure (AMI) index was constructed to provide a synthetic and comparable measure of how well brownfield sites in Czechia are connected to essential technical networks. For each brownfield i in region j, distances to five key categories of municipal infrastructure (k = 1,…,5) were recorded in metres (d_{ijk}). These categories electricity, potable water, sewage system, gas supply, and telecommunications represent the basic prerequisites for the reuse of previously developed land. Their availability has repeatedly been identified as a decisive condition for the feasibility and cost of regeneration (Papangelis et al. 2012; Thornton et al. 2007; Bardos et al. 2016; Preston et al. 2023). Within Czech regional studies, the same infrastructural factors are linked to investment attractiveness and brownfield marketability (Frantal et al. 2024; Skrabal & Vybiral, 2025a).

Because absolute distances vary substantially between networks and regions, min–max normalization was applied to remove scale effects and ensure comparability among variables (Ni et al. 2024; Hammond et al. 2024). All distance values were rescaled to a unit-free interval ⟨0, 1⟩ according to

$$x_{ijk} = \frac{d_{ijk} - \min(d_k)}{\max(d_k) - \min(d_k)}, \quad (1)$$

where 0 denotes the shortest and 1 the longest recorded distance for a given network. The normalized scores were then aggregated to obtain the composite AMI value as the complement of the mean normalized distance across all five categories:

$$AMI_{ij} = 1 - \frac{1}{5}\sum_{k=1}^{5} x_{ijk} \quad (2)$$

Higher AMI values indicate better infrastructural accessibility and greater readiness of a site for redevelopment. This approach corresponds to methodologies used in international research assessing spatial accessibility and regeneration readiness (Radulescu et al. 2025) and to Czech analyses evaluating infrastructure as a driver of regional competitiveness (Skrabal & Vybiral, 2025a).

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Each network was assigned an equal weight (1/5), reflecting the assumption that all five utilities are equally essential for enabling productive reuse. Equal weighting supports methodological transparency and neutrality, avoiding subjective prioritization of specific networks (Frantal et al. 2024). In cases where a network was fully available on site ("connected"), the recorded distance was set to zero; when missing, the distance represented the nearest existing node in the infrastructure network, following the procedure recommended by Thornton et al. (2007). The resulting AMI values thus range between 0 and 1, where 0 indicates complete absence of infrastructure and 1 represents full on-site connectivity.

Beyond its numerical function, the AMI index offers a diagnostic interpretation: it reveals which regions face structural infrastructural deficits and where targeted investment could most effectively stimulate business renewal. Composite indicators of this type are now widely applied in sustainable land-use and regional development studies as transparent tools for comparing territorial disparities (Sessa et al. 2022; Zhang et al. 2025; Williams, 2022). By converting technical distances into a normalized accessibility score, the AMI index integrates physical, economic, and planning dimensions of brownfield regeneration in a single quantitative framework.

3.4 Software Environment and Analytical Workflow

All computations, data standardization, and visualization were conducted using R (version 4.4.1, The R Foundation for Statistical Computing, Vienna, Austria), an open-source statistical software widely applied in spatial and quantitative research in regional development studies. The analytical scripts were created and managed in RStudio (version 2025.09.1+401, Posit Software, released October 1, 2025), which provides an integrated environment for coding, visualization, and reproducible data processing. The combination of R and RStudio ensures full transparency, replicability, and transferability of analytical results a key prerequisite for scientific publication and applied policy analysis. The chosen setup enabled a fully automated workflow, from data import to summary statistics and graphical outputs. The *readr* and *tidyr* packages were used for data import and reshaping, *dplyr* for data transformation and calculation of composite indicators, *RCzechia* (Lacko, 2023) for integration of regional and spatial data, and *ggplot2* (Wickham, 2016) for visualization and mapping.

Each NUTS III dataset was imported as an individual data frame, standardized to UTF-8 encoding, and checked for consistency, missing values, and incorrect delimiters. The standardized datasets were merged into a single consolidated data frame, which served as the empirical basis for computing the Accessibility of Municipal Infrastructure (AMI) index. Data quality was verified using descriptive statistics and graphical diagnostics such as histograms, boxplots, and scatter plots.

The analytical scripts were fully documented and archived to guarantee replicability and long-term transparency of the research process. This approach follows the principles of open reproducible science and aligns with best practices in spatial data analysis and regional modelling (Hammond et al. 2024; Pebesma, 2018). The computed AMI values were subsequently aggregated and compared across regions to identify spatial disparities in infrastructural accessibility. The results are presented in the following section.

4 Results and Regional Patterns of Brownfield Infrastructure Accessibility

This section presents the empirical results of the analysis of infrastructural accessibility of brownfield sites across Czech regions (NUTS III level). The results summarize the calculated values of the Accessibility of Municipal Infrastructure (AMI) index and provide a comparative view of regional disparities. The AMI index expresses the degree to which brownfield sites are physically connected to five categories of municipal networks electricity, potable water, sewage system, gas supply, and telecommunications. Higher AMI values indicate better infrastructural readiness and thus greater potential for redevelopment and business utilization.

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4.1 Regional variation in the Accessibility of Municipal Infrastructure (AMI) index

Table 2 presents the regional comparison of AMI values for all thirteen Czech regions included in the analysis. The regional comparison shows substantial variation in infrastructural accessibility across Czechia. The Pardubice Region achieved the highest mean AMI value (0.677), followed by the South Moravian (0.611) and Pilsen Regions (0.601). These regions are characterized by relatively compact settlement structures and high levels of utility coverage, reflecting long-term industrial and urban development. In contrast, the South Bohemian (0.279), Liberec (0.471) and Vysocina (0.496) regions recorded the lowest mean values, indicating significant infrastructural deficits and a more dispersed pattern of development.

Median values further confirm that in several regions (e.g. Pardubice, South Moravian, Pilsen, and Moravian-Silesian) a large share of brownfields are fully connected to basic infrastructure (median = 1). Conversely, in peripheral regions such as Vysocina and Liberec, the very low median values (0.039 – 0.020) indicate that most sites lack direct network access and would require substantial investment prior to reuse. These findings highlight persistent regional disparities that are likely to influence both investment attractiveness and the feasibility of brownfield regeneration. Table 2 displays the mean and median values of the AMI index across all Czech NUTS III regions.

Tab. 2: Mean and median values of the AMI index by region

Region	AMI – mean value	AMI – median value
Pardubice Region	0.677	1.000
South Moravian Region	0.611	1.000
Pilsen Region	0.601	1.000
Moravian-Silesian Region	0.594	1.000
Olomouc Region	0.556	1.000
Karlovy Vary Region	0.555	1.000
Central Bohemian Region	0.543	1.000
Hradec Kralove Region	0.522	1.000
Zlin Region	0.520	0.520
Usti nad Labem Region	0.515	1.000
Vysocina Region	0.496	0.039
Liberec Region	0.471	0.020
South Bohemian Region	0.279	0.059

Source table: authors' own elaboration based on CzechInvest National Brownfields Database (2024), processed in R 4.4.1.

The spatial differentiation of the AMI index (Figure 2) confirms substantial disparities in the infrastructural readiness of brownfields across Czech regions. The highest average AMI values are recorded in the Pardubice, South Moravian and Pilsen Regions, which share long-term industrial traditions, a compact urban fabric and a dense network of technical infrastructure. In these areas, brownfield regeneration is supported by well-developed utility systems, enabling relatively low-cost reconnection to essential services. Conversely, the South Bohemian, Vysocina and Liberec Regions exhibit low AMI scores, reflecting dispersed settlement structures, limited historical industrialization and persistent infrastructural deficits. These patterns correspond with findings reported by Tureckova et al. (2018), Frantal et al. (2024) and Skrabal and Vybiral (2025a), who emphasize that infrastructural coverage remains a key determinant of the spatial feasibility of redevelopment in Czechia's peripheral regions. In this sense, the AMI index provides a quantitative reflection of territorial inequalities that have been described qualitatively in previous brownfield typologies and regeneration studies.

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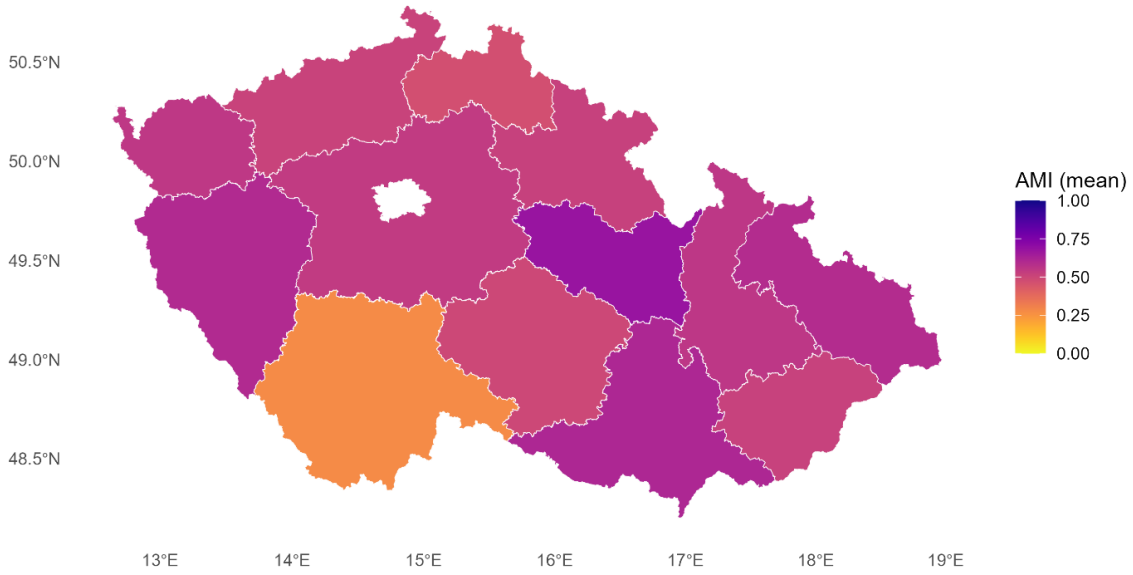
From a broader perspective, the observed regional patterns align with international research on the relationship between infrastructure, land reuse and business competitiveness. Studies such as those by Papangelis et al. (2012) and Preston et al. (2023) demonstrate that the accessibility of utility networks directly shapes the investment attractiveness and market absorption of regenerated sites. Similarly, Willett et al. (2025) and Radulescu et al. (2025) point out that coordinated planning of technical and social infrastructure fosters both economic and environmental sustainability in post-industrial territories. In the Czech context, the results highlight that brownfield regeneration cannot rely solely on financial incentives but must be accompanied by systematic investment in the reconstruction of technical networks, particularly in structurally weaker regions. The convergence between the AMI-based results and recent literature confirms the robustness of the index as a diagnostic tool linking physical infrastructure to regional business development potential.

Figure 2: Regional Accessibility of Utility Networks on Brownfields in Czechia



Source figure: authors' own elaboration, processed in R 4.4.1.

The comparative results displayed in Figure 3 illustrate a distinct stratification of infrastructural readiness among Czech regions. The Pardubice, South Moravian and Pilsen Regions occupy the upper tier of the ranking, with the highest average AMI values, confirming their long-term infrastructural investment and compact urban structures that favour redevelopment. Conversely, the South Bohemian, Liberec and Vysocina Regions show considerably lower AMI levels, indicating structural deficits in the coverage of utility networks. This contrast reflects enduring territorial inequalities that mirror patterns of economic marginalisation. Willett et al. (2025) describe similar mechanisms of peripheralisation, in which cumulative disadvantages weak infrastructure, limited accessibility and demographic decline reinforce regional disparities. The Czech results correspond with these findings, showing that infrastructural gaps correlate closely with lower business attractiveness and slower regeneration dynamics.

Beyond these spatial differences, the AMI ranking also reveals how institutional and planning capacity influences the feasibility of brownfield redevelopment. Tonin (2020) demonstrated in the Italian case of Porto Marghera that infrastructure quality and coordinated planning are decisive for overcoming technical and financial barriers. Radulescu et al. (2025) further emphasise that effective co-creation among public authorities, investors and communities enhances project outcomes by integrating formal and informal interactions. Williams (2022) argues that regions capable of linking infrastructure investment with circular development strategies achieve greater resilience and long-term competitiveness. Taken together, the Czech data confirm that high AMI values are not merely a technical measure but also a reflection of institutional maturity and strategic coordination. Regions with robust infrastructure thus

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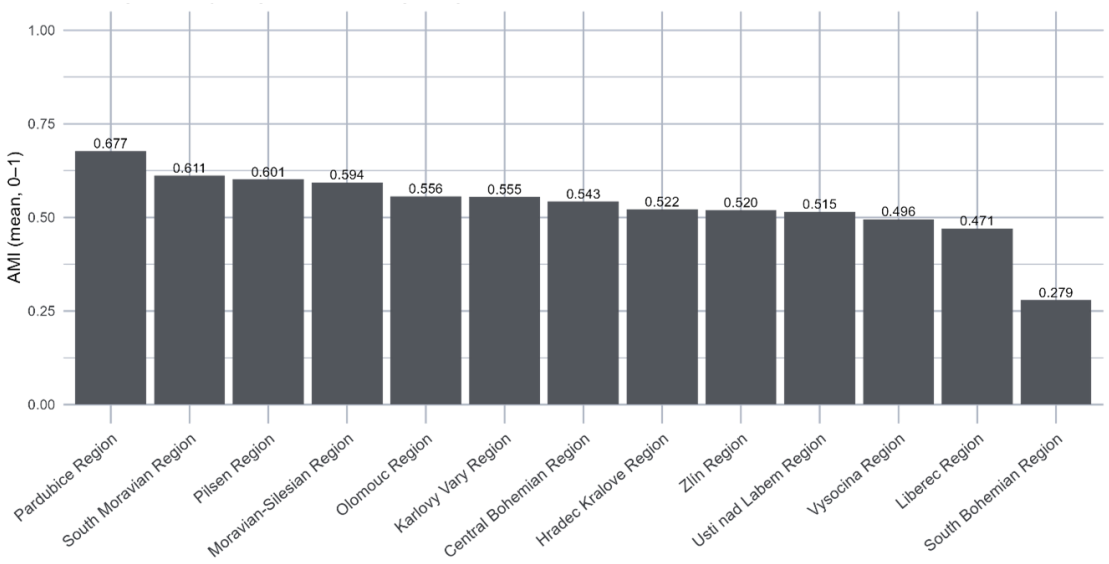
stand at the forefront of sustainable brownfield regeneration and business-oriented territorial development.

Figure 3: Average Accessibility of Municipal Infrastructure (AMI) by Region



Source figure: authors' own elaboration, processed in R 4.4.1.

The distribution illustrated in Figure 4 reveals a clear negative relationship between the number of brownfield sites and the average level of infrastructural accessibility (AMI). Regions such as Ústí nad Labem and Moravian-Silesian concentrate the largest brownfield inventories but show only moderate AMI values, reflecting the structural burden of past industrialization. In contrast, the Pardubice, South Moravian, and Pilsen Regions demonstrate smaller stocks of brownfields coupled with significantly higher accessibility, suggesting that infrastructure investment and compact settlement patterns support the technical readiness of redevelopment sites. These findings are consistent with Skrabal et al. (2021), who found that the density of brownfields correlates negatively with the level of technical infrastructure and institutional capacity, especially in post-industrial and peripheral territories.

Beyond the quantitative relationship, the data indicate that infrastructural accessibility moderates the overall feasibility of brownfield regeneration. Rizzo et al. (2015) emphasize that the coordination between infrastructure investment and governance mechanisms determines the efficiency of redevelopment, while Tonin and Bonifaci (2020) show that even technically suitable sites fail without long-term planning and stakeholder cooperation. The Czech pattern confirms this interdependence: regions with both lower brownfield density and higher AMI values tend to benefit from clearer institutional frameworks and better integration into national infrastructure networks. Conversely, peripheral regions face a compound disadvantage high remediation need combined with limited technical connectivity which amplifies fiscal dependence on public support.

From a broader theoretical perspective, the relationship between brownfield density and AMI also captures the balance between resilience and spatial inequality. Willett et al. (2025) and Zhang et al. (2025) argue that infrastructural and socio-ecological resilience are mutually reinforcing: areas with robust networks are more adaptable to structural change and capable of sustaining investment cycles. The Czech results align with this notion, showing that infrastructural readiness functions as both a cause and a consequence of regional development trajectories. Hence, Figure 4 encapsulates the dual nature of brownfield dynamics regions with extensive but under-serviced sites represent the legacy of industrial decline, while those with fewer yet well-connected sites illustrate the emerging model of balanced, infrastructure-driven redevelopment.

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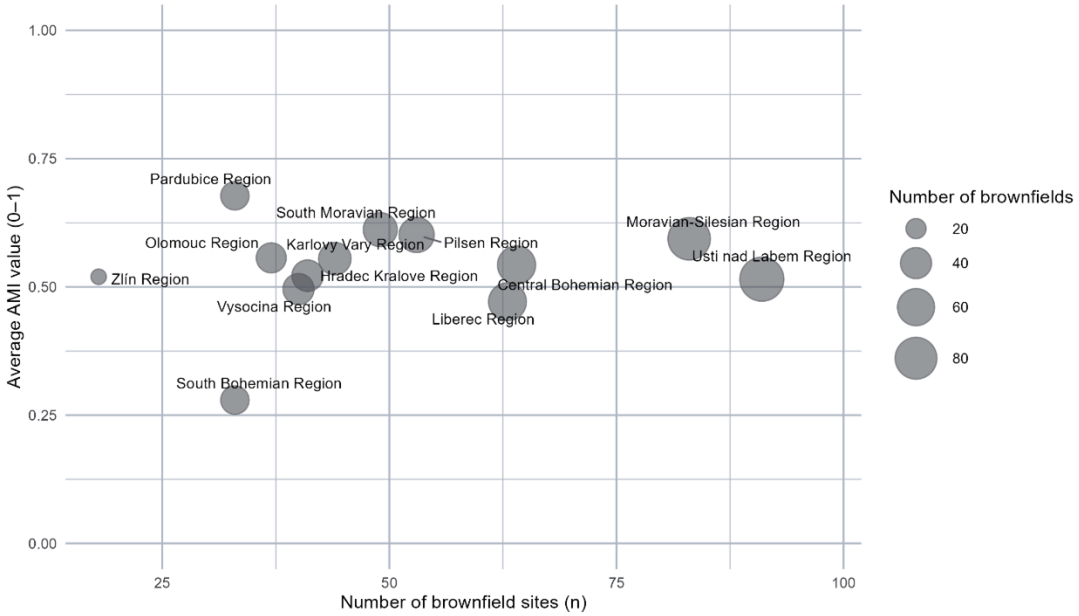
Figure 4: Relationship between the Number of Brownfield Sites and the Average AMI Value



Source figure: authors' own elaboration, processed in R 4.4.1.

4.2 Regional variation in the Accessibility of Municipal Infrastructure (AMI) index

The regional distribution of the AMI index indicates persistent structural disparities in infrastructural accessibility across Czechia. Regions such as Pardubice, South Moravian and Pilsen demonstrate the highest AMI values, supported by dense settlement networks and continuous infrastructure development. Conversely, South Bohemian, Vysocina and Liberec Regions remain below the national mean, reflecting weaker institutional and technical capacities. These spatial contrasts echo the long-term differentiation identified by Skrabal and Vybiral (2025a), who linked regeneration success to regional governance quality, and by Klusacek et al. (2018), who observed that economically weaker regions often compensate for low market attractiveness by adopting participatory and transparent decision-making frameworks.

The findings also confirm that infrastructural accessibility and brownfield density are inversely related, as visualised in Figure 4. Regions burdened by the legacy of heavy industry (Usti nad Labem, Moravian-Silesian) exhibit both high numbers of brownfields and lower AMI values. This relationship supports the argument of Tonin and Bonifaci (2020) that regeneration efficiency depends on the intersection of technical, institutional and financial capacities. At the same time, the environmental efficiency dimension highlighted by Ni et al. (2024) underscores that peripheral regions, despite high remediation needs, often operate under resource constraints that limit their ability to absorb investment. In contrast, high-AMI regions with fewer brownfields tend to attract private investment and demonstrate faster conversion rates.

From a policy perspective, these outcomes align with the systemic insights of Rizzo et al. (2015) and Bardos et al. (2016), who emphasize the importance of stakeholder coordination and "soft re-use" strategies for sustainable land management. The AMI-based classification captures not only physical accessibility but also the institutional readiness that underpins effective reuse. This multidimensional interpretation is consistent with the resilience-based approach of Zhang et al. (2025), where infrastructural and ecological systems co-evolve to sustain regeneration cycles. As Williams (2022) and Sessa et al. (2022) argue in the context of circular and green urbanism, infrastructure quality functions as both an enabler and a consequence of sustainable economic transition. The Czech evidence thus reinforces the view that regional brownfield policies must integrate physical infrastructure investment with adaptive, circular and governance-oriented strategies.

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5 Conclusions

The analysis confirmed that regional disparities in the accessibility of technical infrastructure remain one of the most significant barriers to the economic reuse of brownfield sites in the Czech Republic. The aim was to analyse how the level of infrastructure differs across regions, how these differences influence the business attractiveness of territories, and what implications arise for public policies supporting development. The AMI index revealed marked differentiation between industrially developed regions with high network density and peripheral territories suffering from infrastructural deficits. These findings are consistent with the conclusions of Ni et al. (2024), who demonstrated that the quality and efficiency of public investment in networks strongly influence the environmental and economic outcomes of regeneration. Similarly, Zhang et al. (2025) identified infrastructure resilience as a structural determinant of regional adaptability and innovation capacity. In the Czech context, regions such as South Moravia, Pilsen and Vysocina exhibited a higher degree of infrastructural readiness, while Karlovy Vary and Olomouc lagged. This spatial pattern aligns with previous observations by Skrabal and Vybiral (2025a), who documented that regions with advanced utilities and diversified ownership structures tend to reach higher regeneration success rates. The results therefore empirically validate the initial assumption that the availability of municipal infrastructure significantly shapes the entrepreneurial attractiveness of brownfield sites and reinforces the uneven geography of regional development.

The broader interpretation of these findings suggests that infrastructural capacity must be understood not only as a technical precondition but as an institutional and strategic asset. Rizzo et al. (2015) and Klusacek et al. (2018) showed that the success of regeneration depends on governance quality and coordination among public, private and civic actors. Where institutional mechanisms are weak, even strong physical networks fail to generate economic returns. This duality is evident in several Czech regions, where limited administrative capacity constrains the efficient use of national and EU support. Similar arguments were raised by Radulescu et al. (2025), who demonstrated that co-creation and multilevel collaboration are indispensable for spatially complex projects. From a European perspective, Sessa et al. (2022) placed infrastructure at the centre of the Green Deal agenda, where it acts as a bridge between climate objectives and industrial policy. Studies by Willett et al. (2025) and Chen (2022) further underline that regions with modernized infrastructure and fiscal instruments are better positioned to attract investment and mitigate peripherality. For Czech regional policy, this implies that infrastructure should no longer be treated as a neutral background variable, but as a dynamic lever of competitiveness that determines the capacity to absorb and transform investment flows.

Despite the robustness of the AMI index and the comparability of data, certain limitations of this study must be acknowledged. The analysis relied on the CzechInvest database, which, while comprehensive, may not fully reflect the current physical state of networks or informal connections that influence real investment decisions. The method also assumes spatial homogeneity within regions, yet evidence from He et al. (2024) and Yang et al. (2025) suggests that environmental and infrastructural heterogeneity can vary substantially even within single administrative units. Hudson et al. (2022) highlighted that local environmental risks, such as flood exposure, can offset the apparent benefits of technical accessibility. Another limitation lies in the absence of longitudinal data; the AMI index captures the situation at one point in time and does not yet evaluate temporal changes or investment trajectories. Furthermore, while the normalization procedures ensured cross-regional comparability, they inevitably simplify the complex interplay between infrastructure, ownership, and socio-economic context. These methodological constraints should be considered when interpreting the results and designing follow-up analyses.

The findings nonetheless provide a sound foundation for practical recommendations. First, public authorities should treat infrastructure as a key determinant of regional entrepreneurship and innovation capacity. Strategic investment in networks particularly electricity, digital connectivity, and wastewater systems should prioritize regions identified by this study as structurally disadvantaged. Following Kuiper et al. (2025), targeted regeneration can stimulate local labour markets and create measurable spillover effects when embedded in broader development frameworks. Second, policy design should integrate

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fiscal and participatory instruments. Chen (2022) demonstrated that innovative financialization mechanisms, such as municipal investment funds and land-based finance, can unlock underused assets when accompanied by transparent governance. Third, regional administrations should adopt the principles of "good governance" identified by Klusacek et al. (2018) and Radulescu et al. (2025): participatory planning, cross-sectoral coordination, and long-term monitoring of outcomes. Finally, future research should combine the AMI framework with advanced spatial and efficiency methods, such as DEA or CBA (Ni et al. 2024; Hammond et al. 2024), to assess not only accessibility but also the performance and cost-benefit dynamics of infrastructure investment. For students and practitioners, the presented methodology offers a replicable model applicable to other types of regional assets industrial zones, innovation districts or rural redevelopment areas where accessibility, governance and sustainability intersect.

This study demonstrates that the regeneration of brownfields cannot be decoupled from the infrastructural and institutional foundations of regional development. Infrastructure determines the physical feasibility, economic viability and environmental sustainability of redevelopment, while governance and fiscal policy define its long-term success. Strengthening these linkages should therefore be a strategic priority for Czech and European regional policy. The empirical framework developed here combining spatial data, normalization procedures and regional classification provides both analytical precision and applied value. It can serve as a reference for academic research, policy evaluation and student projects focusing on regional disparities and business development potential. Ultimately, the results reinforce the view that equitable access to modern infrastructure is not merely a technical condition, but a cornerstone of sustainable economic transformation and social cohesion across regions.

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