# Defining daily space use patterns in Hungary: identification of functional urban centres with a multidimensional methodology

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Some of the literature on catchment areas offers valuable insights into spatial units defined by the various types and functions of urban centres. In addition, a range of functional urban region delineation methodologies contribute significantly to understanding citizens' commuting habits. However, while the former often lacks a complex, multifunctional perspective, the latter typically focuses on labour market areas linked to global megacities. As a result, smaller centres fulfilling a wide range of everyday functions are frequently omitted from regional maps, and they remain hidden in the catchment area of larger cities.

This research aims to address these gaps by proposing a method for identifying urban centres on the basis of multidimensional selection criteria. This approach enables the general mapping of their multifunctional catchment areas and their wider functional urban zones. This analysis extends the range of statistics commonly used: in addition to labour market commuting, it includes commuting for general and vocational education, as well as accounting for the accessibility of everyday commercial centres and frequently used urban-level public services.

Owing to differing spatial organizing principles, this research highlights that everyday centres take on varied structural forms – justifying a multidimensional mapping approach that is in addition to traditional labour market commuting analyses.

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Although this study is grounded in the Hungarian context, its multidimensional approach to mapping functional urban catchment areas offers valuable insights and a flexible framework for international research. By integrating a wide range of everyday spatial behaviour indicators, this analysis not only deepens our understanding of urban networks but also provides urban planning and regional development professionals with a robust tool for identifying gaps in public service provision. In doing so, it can help increase access to essential services, particularly for residents in rural areas far from major urban centres, which are typically the focus of the literature.

**Keywords:**
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use of space,
multifunctional catchment areas,
accessibility,
spatial planning,
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## Introduction

With the rapid development of transport and communication technology, society's everyday use of space has expanded across various territorial levels. In addition to social progress, the complexity of functions fulfilled by urban centres has significantly increased, resulting in increasingly sophisticated systems of urban networks. Moreover, the role of traditional settlements – defined by clear physical boundaries – is increasingly being taken over by dynamically evolving and functionally oriented structures. Efforts have been made worldwide to track these ever-changing, interwoven and overlapping areas to align spatial planning and the provision of public services and administrative units to them. However, the spatial databases and mapping methods needed for delimitation still leave many questions unanswered.

This multidimensional analysis provides a more precise depiction of Hungarian urban centres and their spatial network than the unidimensional EU–OECD functional urban area (FUA) methodology does, thereby improving our understanding of the role of small and medium-sized cities within urban–rural networks.

On the basis of these criteria, our analysis revealed 87 towns, along with Budapest, out of Hungary's 3,155 settlements that simultaneously meet the minimum requirements for urban centres regarding commuting, commercial and public services. An additional 63 towns met at least two of these three criteria. A total of 151 cities were identified as functional urban centres, which roughly corresponds to the number and range of Hungarian settlements classified as cities in a functional sense

according to the most influential Hungarian research conducted over previous decades.

Since the criteria applied in this study focus on citizens' everyday use of space, a picture of a relatively evenly spread system of urban centres emerges in Hungary, where the nearest centre can be reached within a maximum of 15–20 minutes. Although these urban centres show a high degree of homogeneity regarding the fulfilled functions, significant heterogeneity is observed in both the quality and quantity of the functions. Urban centres also display substantial variation in both population size and the number of inbound commuters.

As a next step of our research, we define the catchment areas of the now selected urban centres, covering the territory of Hungary without gaps. As a result of mapping these functional catchment areas, we can better understand the daily space use patterns of Hungary.

The identification of regional centres is a key issue in regional economics and spatial planning (Salamin–Peti 2019), as central settlements play a crucial role in terms of economic, labour market, and public service functions. Distinguishing central settlements is not only of theoretical importance but also has practical relevance in the design of development strategies. As a result of modern urbanisation processes, the role and functionality of regional centres have become increasingly complex, and are significantly important in the development of local knowledge economies and enabling high-skilled workers to enter the labour market (Tan et al. 2017). While earlier models often focused on a dominant central place within a region, more recent approaches emphasise the increasing complexity of spatial organisation and the emergence of multiple centres with complementary or overlapping functions. These changes reflect broader urbanisation trends and the evolving socioeconomic landscape.

A wide range of theoretical and empirical approaches have been developed to identify regional centres. In the Hungarian context, such centres are most often delineated on the basis of commuting flows, service provision, and the presence of administrative or institutional functions. These criteria are being increasingly documented through empirical research relying on mobility data and accessibility indicators, which offer a more functional and data-driven understanding of spatial structure.

Recent Hungarian studies have demonstrated that indicators related to public service provision and commuting patterns are especially suitable for defining regional centres. For example, Faluvégi (2008) developed a typology of centres based on service and organizational functions, whereas Radvánszki–Sütő (2007) introduced the concept of local labour systems (LLS), which was further elaborated (Pénzes et al. 2014). These approaches move beyond normative or administrative classifications and offer a more functional perspective grounded in actual socioeconomic relationships. Functional approaches also recognise that the accessibility and quality

of public services are closely linked to economic development and residents' quality of life. In this respect, Hungarian case studies underscore the importance of public infrastructure and service systems in shaping regional attractiveness and supporting spatial integration (e.g., Faluvégi 2010, Pénzes et al. 2014).

In line with these perspectives, the present study aims to refine the identification of regional centres in Hungary through empirically grounded methodologies. Building on frameworks such as local labour systems (LLSs), service-based centrality models, and network-based community detection, this study provides a multilayered view of spatial organisation. These approaches allow for a more accurate delineation of functional urban areas and contribute to the evidence-based design of territorial development policies.

## Classic theories and their critique

The central place theory developed by Walter Christaller, first published in 1933, represents one of the most influential theoretical foundations for identifying regional centres. The model conceptualises settlements in a hierarchical system on the basis of accessibility and service provision. It assumes that central places organise the distribution of economic activities in a regular spatial pattern. However, the Christaller model has faced several criticisms for presenting an idealised system that fails to account for the asymmetric development of infrastructure and transportation (Faragó–Lux 2014). The dynamic nature of the modern economy – especially the rise of digitalisation and online services – introduces factors that the original theory cannot adequately address (Czirfusz 2009). In addition, current trends of global fragmentation and decentralisation, which are also observable in regional development models, further challenge traditional hierarchical approaches (Parr 2017).

John Friedmann's regional development model, as part of core-periphery theory, highlights the unequal concentration of economic functions and capital in dominant urban centres, while peripheral areas remain subordinate (Friedmann 1967, Friedmann–Wolff 1982). These models examine how spatial disparities in resources shape regional development and territorial structure (Pénzes 2022, Roberts 2001). Furthermore, these models emphasise the significant role of quasi economic centres in development strategies, while peripheral regions are typically assigned a subordinate status (Csomós 2013).

Paul Krugman's (1995) theory of new economic geography added important conceptual depth to the understanding of centre formation by emphasising agglomeration effects and spatial concentration. However, while this model offers a theoretical backdrop, more recent empirical approaches – particularly in the Hungarian context – offer finer-grained insight into functional urban areas.

While these theoretical approaches provide a useful conceptual background, the present study builds on empirical, Hungary-specific methodologies – such as local labour systems and community detection – to identify functional centres.

While classic models still inform general approaches to centre formation, the increasing availability of detailed data – especially commuting flows and service access – calls for empirical, context-specific methods. In Hungary, several recent studies have responded to this need with innovative methods grounded in local conditions.

Moreover, when regional centres are being researched, the mapping of local conditions and specificities, as well as the accessibility and quality of public services, are critical factors influencing the functional roles of settlements (Elekes 2016, Schneider 2010). Planning that takes into account the needs of local communities not only facilitates the identification of centres but also enhances residents' quality of life, as public services, economic opportunities, and infrastructural development are closely tied to local communities (Roberts 1994).

Another widely known concept relevant to the spatial organisation of economic activity is the growth pole theory, originally formulated (Perroux 1955). This model posits that economic development does not occur uniformly across space but instead around 'poles' of dynamic growth, which then spread their influence to the surrounding regions (Faragó–Lux 2014). In Hungary, the concept has been explicitly incorporated into territorial development policy during various periods, notably in the National Settlement Network Development Concept (OTK) of 1971 and again in the 2005 revision National Spatial Development Concept (OTK 2005). In these contexts, selected cities were designated as growth poles to concentrate investments and stimulate regional catch-up. While the concept provided a strategic framework, critiques have noted that without parallel policies targeting peripheral areas, spatial disparities can persist or even deepen.

## Functional urban areas and centres

The identification of functional urban areas is essential for modern urban planning and regional economics. These areas reflect not only the central cities but also the economic and labour market connections of the surrounding settlements. The OECD's methodologies, which are based on the analysis of commuting data and economic relationships, play a crucial role in the identification of functional urban areas (Obaco–Díaz-Sánchez 2018, Oleshko et al. 2019). On the basis of these methods, functional urban areas are typically defined by considering commuting patterns and the concentration of economic activities through the assessment of interactions between the central city and peripheral areas.

In the Hungarian context, significant methodological development has occurred in recent years. In addition to flow-based approaches, Pálóczi (2016) implemented network-based methodologies, particularly community detection algorithms, to

identify settlement clusters with strong internal cohesion based on commuting interactions. Comparable methods have been used in Slovakia (Halas–Klapka 2024) and the Czech Republic (Klapka et al. 2020), suggesting a broader Central European application of such network science approaches.

The delineation of functional urban areas has also been a key objective of several ESPON projects (e.g., ESPON Programme 2005, 2006), which developed harmonised European methodologies for identifying functional urban regions (FURs). These approaches, which are based primarily on commuting flows and economic connectivity, have produced comparable results across Europe, including Hungary. Although ESPON's typologies sometimes diverge from national delimitations, they highlight major urban centres – such as Budapest, Győr, or Debrecen – as dominant regional hubs within the continental network. In Hungary, the 2001 and 2011 census-based calculations of local labour systems (LLS), conducted primarily by national statistical and spatial planning institutions (e.g., KSH and VÁTI), served as foundational inputs for identifying functional urban areas. These empirical efforts provided the basis for more recent studies that further refined regional centre identification using network and service-based approaches.

Understanding functional urban areas requires the examination of labour market catchment zones. Analyses by Eurostat and the European Commission have emphasised that labour mobility and employment concentration are key in shaping the relationship between central and peripheral areas. Balancing workplaces and residences is vital for the effective operation of urban areas. A lack of such balance can lead to population decline and increased unemployment, adversely affecting regional economies. In analysing labour market dynamics, the attractiveness of economic opportunities offered by central settlements can be observed, encouraging people to commute and thereby increasing the popularity of areas around urban centres (Razzak et al. 2023).

Commuting patterns are key indicators of functional urban areas, as access to transport strongly influences employment opportunities and residential demand. High-quality public transport often supports both labour mobility and urban expansion. In addition to commuting, the consideration of local economic connections is crucial in defining functional urban areas and their centres. Urbanisation and global economic trends, such as digitalisation, have a profound effect on the structure of functional areas within cities. Understanding the spatial distribution of public services and businesses in modern cities, along with complex measurements of centrality (VÁTI 2010), supports the identification of functional urban areas.

Moreover, interactions between various functional urban areas provide insight into economic concentration and labour market dynamism. Increasing population density and concentrated economic activities influence urban development policies and principles of sustainable urban growth. Urbanisation models are continuously

evolving, placing growing emphasis on examining the clearly functional areas of cities and their connections to surrounding peripheries.

## Commercial attraction and market gravity

One key aspect of defining regional centres is commercial attraction, which indicates how well a city can meet the consumption and service demands of surrounding areas (Bodor–Pénzes 2012, Ďurček et al. 2022). To examine the degree of commercial attraction and interregional interactions (Kovács 1987), gravity models are often used (Nagy 2011). These models help reveal the nature of commercial and labour market flows and assist in identifying the catchment areas of central settlements.

Reilly's (1929) gravity model, developed in 1929, posits that a city's area of influence is proportional to its own population and inversely proportional to its distance from other cities (Dusek 2016a, 2016b). This model provides an empirical foundation for identifying regional centres, especially when combined with commuting and economic activity data (Drezner–Zerom 2023, Mitríková–Antoliková 2016, Nagy 1996). The practical application of Reilly's gravity model can be observed in the analysis of retail centre attraction, where commercial opportunities reflect the interactions between central settlements and surrounding regions (Mitríková–Antoliková 2016, Kincses–Tóth 2014).

While gravity models remain useful tools for analysing catchment areas and commercial attraction, their application must be contextualised. Hungarian studies – such as those by Beluszky (1974, 1981) and Nagy (1996) – have applied gravity-based methods to analyse service zones and retail potential in domestic urban systems. Nevertheless, gravity models are not without criticism. Some critiques argue that these models assume a homogenous spatial distribution and attribute dominant significance to geographic distance (Dusek 2016b, Suárez-Vega et al. 2007). In reality, the situation is more complex. Infrastructure, regional economic policies, and cultural factors (Horeczki et al. 2025) all significantly affect trade and service accessibility, indicating that homogeneous modelling may not always provide an accurate picture (Kiss–Bajmócy 2001). Furthermore, the rise of digitalisation and online commerce has reduced the relevance of physical distance in determining market gravity, necessitating new approaches in urban planning and regional economic analysis.

In addition to methodological limitations, gravity models have also been criticised from social and behavioural geographical perspectives. These models often assume that individuals act as rational agents ('homo economicus'), basing decisions solely on distance and population. However, real-world spatial behaviour is shaped by a broader set of factors, including social ties, habitual routines, value systems, and even emotional attachments to places. As a result, models purely based on economic logic may overlook critical aspects of human spatial decision-making.

In the analysis of modern urban structures, the accessibility of public services and commuting patterns can illustrate the attractiveness of urban centres. Research suggests that proximity to workplaces and the quality of transport options play key roles in defining urban attraction and influencing local economic activity (Holden–Deller 1993, Suárez-Vega et al. 2017). Thus, gravity models and their critical analysis not only serve as tools for identifying centres but also help to map the challenges faced by modern cities.

## Functional region or catchment area?

The methodologies for delineating functional regions and catchment areas are based on different perspectives, even though they often overlap. The delimitation of functional regions is primarily based on economic, labour market, and social relationships, which examine the interactions between a given centre and its surrounding area. In contrast, catchment areas are typically defined by mapping the 'gravity' of a centre in terms of services, commerce, or transport – essentially assessing the extent to which a centre attracts the population and economic actors of the surrounding region (Kincses 2017).

The basis of catchment area delineation lies in the existence of an already established centre, and the task is to assess its sphere of influence – the distance from which it draws in economic actors, services, commerce, and people. Conversely, the first step in delineating functional regions is identifying the centre itself. This means that, at the initial stage of analysis, no dominant centre is assumed; instead, it must be determined through empirical methods, such as examining labour flows, economic activity, and the spatial concentration of services.

Regional centres can be defined not only by economic or demographic factors but also through indicators of sustainable development (György et al. 2025). One classic Hungarian example of catchment area analysis is Beluszky's (1974) study, which examined the structure and inter-settlement relationships of Nyíregyháza's catchment area. Later, Beluszky (1981) addressed methodological issues in defining urban catchment areas, giving particular attention to interactions between cities and their surrounding areas.

While the delineation of functional regions examines long-term structural processes, the definition of catchment areas is based on interactions present at a specific moment in time. Functional region delineation emphasises the degree of integration between regions, cities, and centres, whereas catchment area analysis reflects the spatial distribution of consumer and societal choices. The combined application of these two approaches offers a more comprehensive understanding of a region's relational structure, enabling the exploration of long-term development trends and the optimisation of short-term economic decisions.

Although the approaches to delineating functional regions and catchment areas differ, significant overlaps can be identified between them. The long-term, structural processes of functional regions complement the short-term dynamics captured by catchment areas. Thus, the integrated application of both approaches can provide a more complete picture of regional networks and support the optimisation of development trends and economic decisions.

## Data and methodology

### Mapping the determinants of functional urban centres

As part of a broader research objective aimed at delineating functional urban regions, the identification of potential central urban cores begins by applying internationally accepted methodologies. This phase of the research is presented within the scope of this article. Although attempts have been made to reveal the primary attraction relationships between settlements without prior identification of urban centres (Stoian et al. 2024), these primary catchment areas have proven to be overly fragmented, particularly in agglomerated and peripheral areas. This finding confirmed the necessity of first delineating potential urban region centres before further spatial analysis.

This concept aims to identify a network of urban areas or potential urban areas, preferably covering the entire country, with at least small town-regional, quasi district (LAU1 [local administrative units]) scale units. Therefore, ensuring the accessibility of daily or frequent economic, commercial, (public) service functions within 15 minutes may determine the distribution of centres, similar to the goals of centre determination methodologies based on the minimisation of travel distance (Barancsuk et al. 2013).

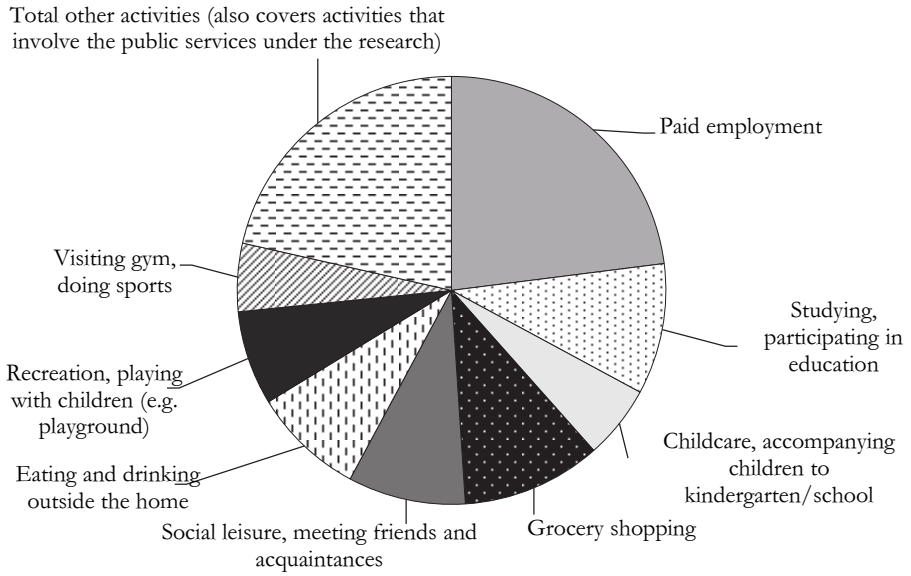
A key element of the mapping of potential urban centres is the identification of commuter (work, study), public service and commercial (shopping) centre functions, similar to previous methodologies that established the development of new Hungarian districts (Szalkai 2012), but without considering population size. According to a nationwide representative survey ordered by the Ministry of Public Administration and Regional Development in 2023, an average Hungarian citizen spends less than a quarter (223 hours per year[1]) of the total time spent on commuting for paid work – approximately one-tenth to access education and another tenth to access daily grocery shopping – as measured by international time use surveys (EC 2004, KSH 2010). By analysing regular travel patterns associated with these activities, it is possible to cover the majority of travel time expenditures on a societal level (see

[1] The average annual value per capita was calculated from the proportion of those performing the given activity within the total population (mass), the average regularity (frequency) of the activity, and the average travel time associated with the activity.

Figure 1). Mapping the locations and catchment areas associated with these key activities provides a robust approximation of Hungary's socially embedded spatial structure – its characteristic centres, spatial trajectories, and system of national spatial use.

Figure 1

**Spatial relevance of activities based on the average annual hours per capita dedicated to access time (in hours)**




*Source:* author's own compilation based on the 2023 nationally representative survey of 2,000 respondents conducted by Századvég Zrt., commissioned by the Prime Minister's Office.

## Daily commuting to functional centres

Using data from the labour market as well as from public and vocational education, the first step of this analysis was to examine the likely patterns of daily inbound commuting for each settlement. Multiple threshold scenarios were tested for both the minimum number of inbound commuters and the number of settlements for which a given town functions as the primary commuting centre.

While scenarios with minimum thresholds of 1,500 and 2,000 inbound commuters were also assessed, these would have resulted in the exclusion of several towns in peripheral areas that nonetheless play a relatively significant role in commuting. For settlements with territorial extents comparable to LAU1-level units, additional filtering conditions were also analysed – such as varying the minimum number of settlements served as a primary centre or applying constraints on total area or population. However, these versions would have led to a disproportionately high

number of agglomeration towns and large rural towns in the Great Plain being included among the centres.

Ultimately, a settlement was considered a commuting centre if it had more than 1,000 inbound commuters. Notably, in this research, we examined the total number of inbound commuters to a given settlement, as opposed to the number of those employed locally. This approach focuses on the regional characteristics of these settlements more strongly than the methodology of urban network studies carried out in recent decades (Radvánszki–Sütő 2007, Pénzes et al. 2014). Unlike the other criteria used in the cited research, we ultimately considered only those settlements as commuting centres that served as the primary commuting destinations for at least five other settlements (excluding itself). The application of the stricter entry threshold is also justified by the stronger emphasis on the regional role. Ideally, a settlement providing regional services would have six immediate neighbours in the ideal hexagonal system according to the theory of central places.

However, in practice, unlike this pattern, fewer settlements often surround a centre, so somewhat more permissive criteria were set accordingly. Owing to the national geographic focus and the limited data available, the study was not able to cover cross-border commuting, either inwards or outwards.

Labour market commuting data were sourced from the 2022 national census conducted by the Központi Statisztikai Hivatal (KSH [Hungarian Central Statistical Office]), while educational commuting figures were derived from the KIR and SZIR databases. These were calculated by averaging the number of inbound students across three academic years (from 2020 to 2022, based on October 15th headcounts), using the settlement of residence and the location of the educational institution.

## Accessibility of shops related to daily grocery shopping

In research on commercial centres, examining the presence of specialist shops that specialize in certain customer groups is generally accepted (Beluszky–Sikos T. 2020). Indeed, certain specialty stores are good indicators of the urban central character (based on their institutional density and number), but at the same time, they are tied to specific and rare customer needs (e.g., bookstores and computer specialty stores). That is why we found it more appropriate to examine the existence of store types that simultaneously meet the criteria of urban institutional density and mass frequency. Therefore, we looked for commercial units that are typically found only in cities and that can be identified as centres of almost daily shopping activity that affects the majority of society.

As part of the analysis of the commuting data, we mapped out commercial centres and grocery stores that play a significant role in social space usage. The analysis considered both the size and spatial distribution of these stores.

Several variables were examined during the study. Hypermarkets form a distinct category with relatively even nationwide coverage and typically operate on an urban–regional scale. However, following the introduction of the 'plaza stop' regulation in 2012, discount store chains expanded rapidly and have since become dominant in the daily consumer goods market (Sikos T.–Kovács 2020). For this reason, the analysis was extended beyond hypermarkets to include supermarkets and discount stores as well.

A key consideration was that, according to legal classifications, stores as small as 400 m² could fall into the supermarket or discount store category. If this criterion had been applied, many smaller municipalities would have been classified as retail centres, distorting the analysis.

Therefore, we identified municipalities as retail centres only if they had at least one hypermarket, supermarket, or discount store with a minimum floor area of 1,000 m². The data source was the KSH municipal report of December 31, 2023. The evaluation considered only stores selling daily consumer goods with a gross floor area of at least 1,000 m².

The application of the criterion was also confirmed by the fact that, on the basis of statistical data, the number of commercial units over 1,000 m² has tended to increase in recent years, whereas the number of smaller stores has been decreasing by several percent per year (KSH 2020).

Since the examined store types account for the majority of Hungarian food retail trade on the basis of revenue statistics (Sikos T.–Szendi 2024), a similar share can be assumed in terms of the number of purchases and the spatial movements associated with them.

## Accessibility of public services at the catchment area level

The methodology also included a mapping of public services – operated by the state or other public sector actors – that fundamentally influence quality of life.

Research into the centrality of cities in terms of public services is typically conducted using a listing method, which is based on a summary of the existence of public services at many different levels (Beluszky–Sikos T. 2020). However, the territorial scope of public services at different levels varies widely in terms of the area and population to be served. It is therefore necessary to select those types of public services that have regional relevance but still have an institutional density within the typical access time of everyday space use; thus, they cannot be considered national, regional or county centre functions.

Another important aspect was to select public services that are frequently used by significant social groups (e.g., government service centres, outpatient specialist care) or are connected to the everyday care of non-negligible social groups (e.g., nursing

homes, secondary schools) or to vital activities and functions (e.g., ambulance stations, fire stations, police headquarters).

On the basis of their mass (social proportion of service users), frequency (frequency of service use) and accessibility (access time of service), 11 essential public service types were identified at the urban–regional scale (i.e., within a 15–20 minute access time) from 48 services studied by the Ministry of Public Administration and Regional Development.

The list of relevant public services was confirmed by a representative survey conducted by Századvég Zrt. in April 2024, involving three samples of 2,000 respondents each. The 11 service types selected were those rated as most important by the population (receiving a score above 8.5 on a 10-point scale). Additionally, a twelfth service – 'district-level out-of-hours general practitioner service' – was included, even though it was too recent to be part of the basic list and the questionnaire. This inclusion was justified on the basis of its urban–regional relevance and the generally high importance of health care services indicated by the respondents.

Notably, the 'public transport hub' service, which is also socially important at the urban–regional scale, was excluded solely because of the lack of accessible spatial data.

Public services expected at the urban-area level:

- ambulance station,
- fire station (at least at the municipal level),
- outpatient specialist care,
- police headquarters,
- other secondary schools (e.g., vocational secondary education),
- family and child welfare centre,
- day-care services for people with disabilities,
- residential home for the elderly,
- long-term or temporary institutional care,
- gymnasium (general secondary school),
- government service centre,
- district-level out-of-hours general practitioner service.

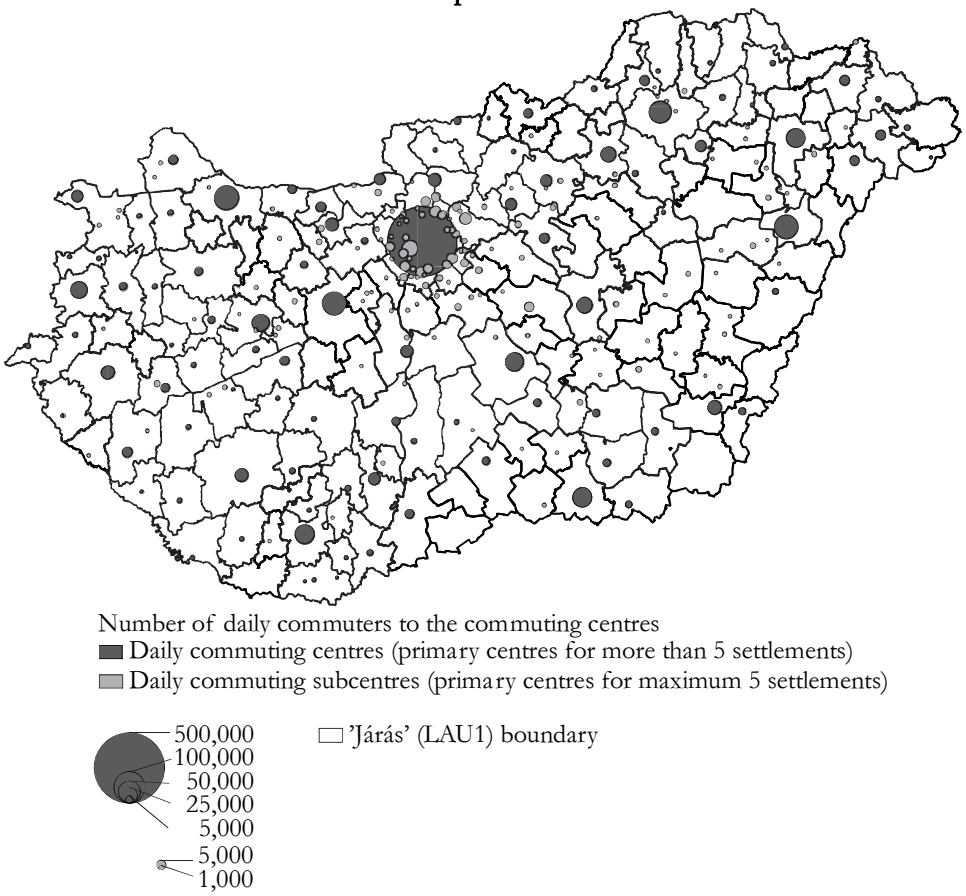
Since each of the 12 selected public services was available in only 60 cities and it is understandable that not all central cities can be expected to provide the full spectrum of all specialized functions, on the basis of numerous version tests, the existence of at least half of the examined functions was set as a criterion. A settlement was classified as a potential urban–region-level public service centre if it provided at least 6 of the 12 listed public service types.

## Identified functional urban centres

As a result of the analysis of daily commuting patterns to functional centres, the most significant commuting hubs have been identified. In total, there are 247 settlements in Hungary where more than 1,000 individuals commute daily. However, only 105 of these are towns that serve as the primary commuting destinations for at least five other settlements, excluding themselves (see Figure 2). Applying the two criteria that define the regional labour market role excludes several towns from agglomeration zones and large rural towns with extensive territories on the Great Plain from being considered commuting centres. These typically serve only a few neighbouring settlements, functioning more as local rather than regional hubs. Nevertheless, owing to their importance in other functional categories examined in the study, many of these relatively central towns were still classified as functional urban centres.

Figure 2

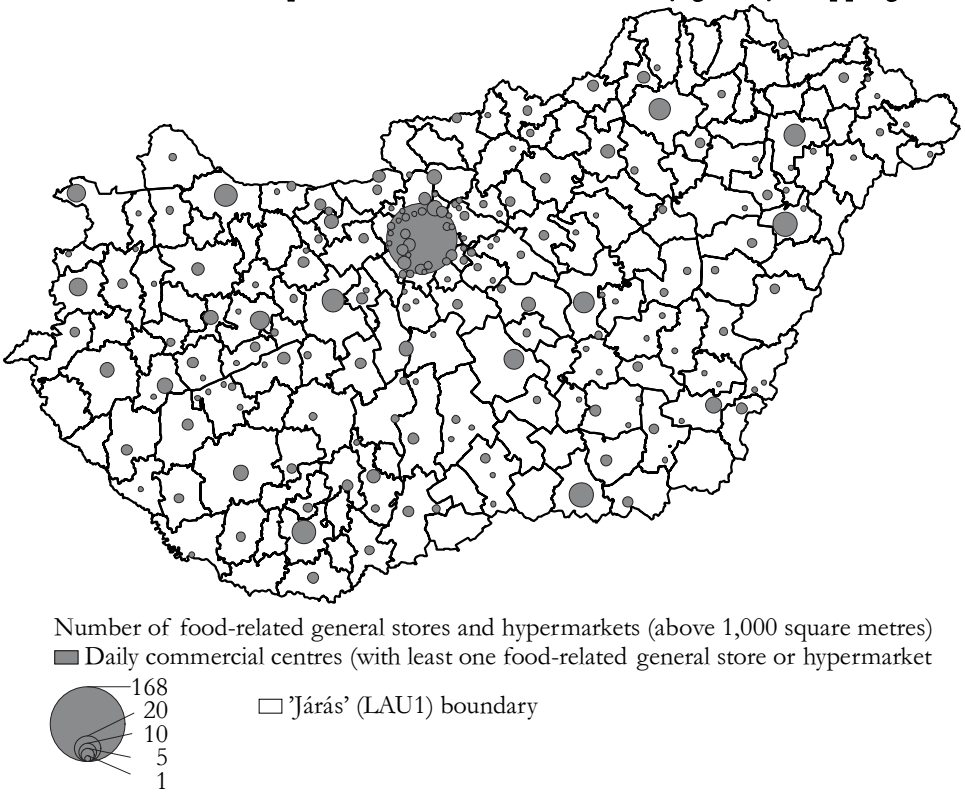
**Daily commuting centres in Hungary based on the number of labour market and public/vocational education commuters**



According to the applied criteria, a total of 204 settlements host shops related to daily grocery shopping. Given that the primary factor in the location choice of commercial centres is the size of the accessible customer base – i.e., population size – the spatial distribution of shops with a minimum floor area of 1,000 m² is highly uneven (see Figure 3). In sparsely populated peripheral areas, such stores may be accessible only at distances of several tens of kilometres, whereas in the agglomerations of more densely populated towns, a large proportion of settlements possess central retail functions.

Figure 3

**Daily commercial centres in Hungary based on the number of shops over 1,000 m² related to daily grocery shopping**

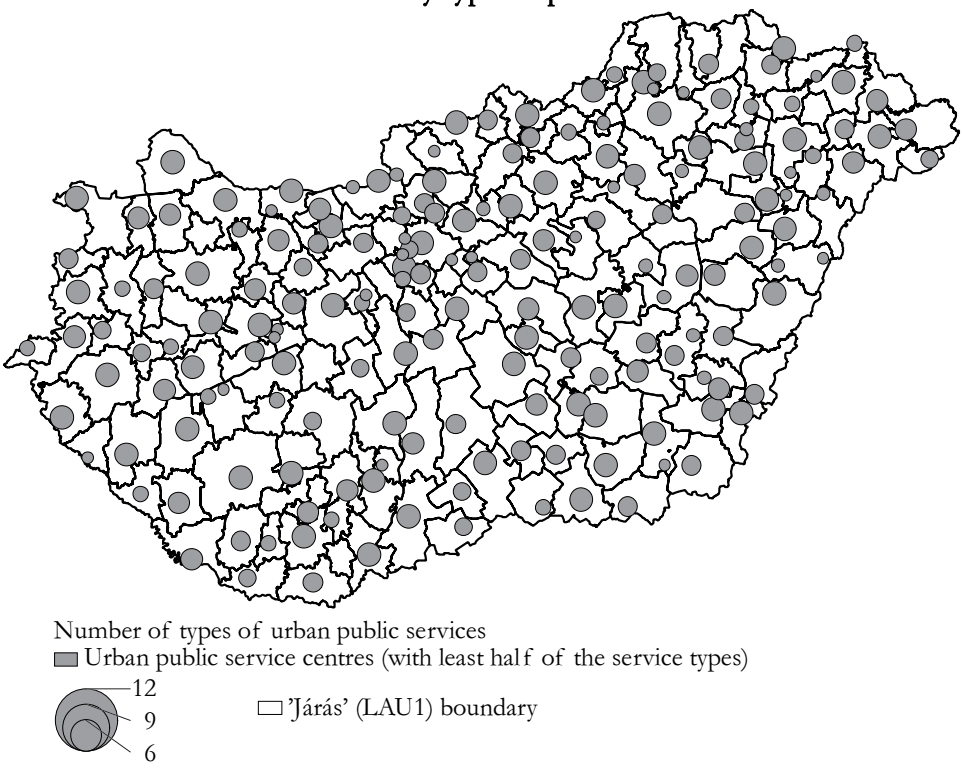



When the provision of urban–region-level public services was examined, 183 towns were identified that offered at least half of the 12 public service types considered. Owing to the territorial obligation for public service provision and constraints on service response times (e.g., ambulance and fire service response), these public service centres cover the country relatively evenly. Owing to the organisation of public services structured to the territorial administrative units, there

is approximately one such centre per district. The only exceptions are a few agglomerations and extremely peripheral district seats lacking essential functions (see Figure 4). Given the relatively limited number of public service types considered, there is correspondingly low variation in the total number of services offered per centre.

Figure 4

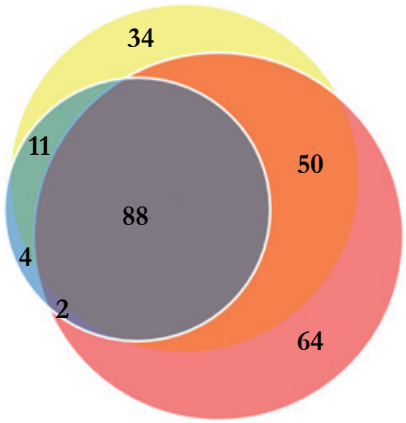
**Functional urban public service centres in Hungary based on 12 key types of public services**




On the basis of the combined results of the sub-analyses, a total of 88 towns are centres of commuting, retail, and public services. These towns are the main reference points in Hungary's functional urban structure. This research identified an additional 63 cities that can be considered centres in terms of two factors, and 102 settlements in Hungary meet the criteria of only one of the examined dimensions. As a result, a total of 253 cities have a central characteristic based on at least one factor, and 151 cities can be considered functional centres according to at least two types (see Figure 5 and Appendix).

Figure 5

**Number of Hungarian settlements by the type and number of centralities**



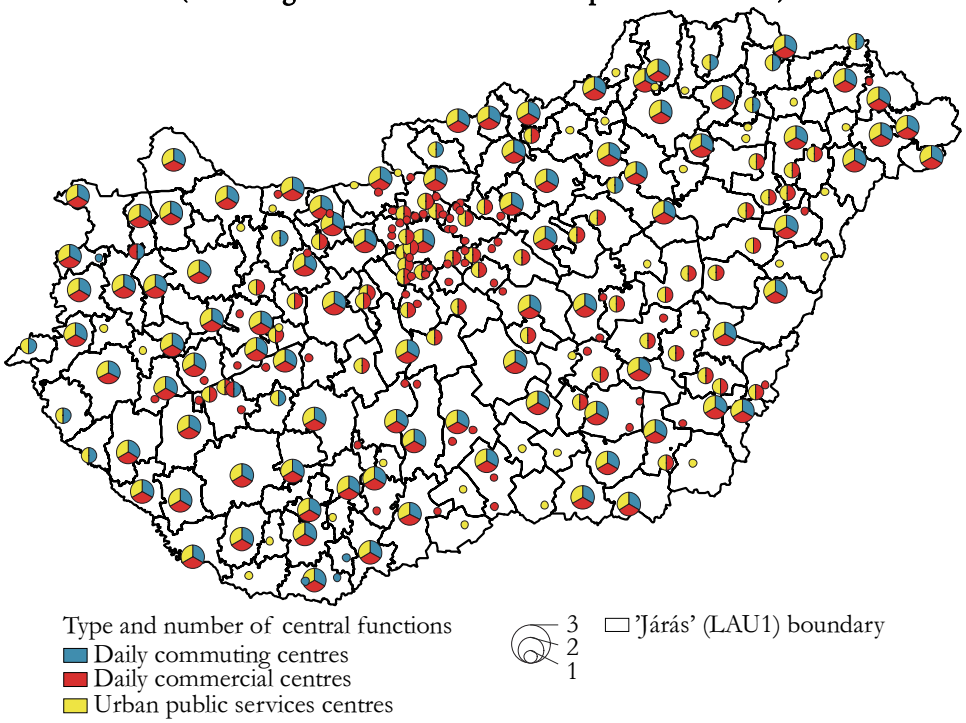

| Type of centre | Number of centres |
|---|---|
| Commuting only | 4 |
| Commercial only | 64 |
| Public service only | 34 |
| Commuting and commercial | 2 |
| Commuting and public service | 11 |
| Commercial and public service | 50 |
| Commuting, commercial and public service | 88 |
| Least one type | 253 |
| **Functional urban (least two types)** | **151** |

On the basis of key research on the Hungarian urban network, the number of settlements with a functional urban character and some degree of regional centrality can be estimated between 130 and 210. Drawing on the National Settlement Network Development Concepts (OTK), Bibó's (1986) urban district model identified 141 settlements as centres or subunit centres. Later, (VÁTI 2010) indicated 210 'functional centres', whereas Beluszky–Sikos T. (2020), using 2020 data, identified 131 'cities with a clear urban role' and an additional 54 'village towns' functioning as oscillating centres (Beluszky–Sikos T. 2020).

Additionally, given that one of the key aims of spatial development policy is to ensure relatively even national coverage – particularly with regard to public services – for the purposes of further analysis, any town functioning as the centre of at least two studied aspects was classified as a functional urban centre. Thus, a total of 151 settlements function as functional urban centres (Figure 5), which serve as the basis for mapping functional urban catchment areas in the next stage of the research.

Figure 6

**The 151 identified functional urban centres and other settlements with monotype central characteristics (counting the 23 districts of Budapest as one unit)**




## Main characteristics of the identified functional urban centres

The primary objective of the methodology applied in this research was to map the centres of spatial use related to everyday social functions. Accordingly, the identified functional urban catchment centres exhibit significant similarities, as defined by the minimum thresholds of the applied criteria. These centres have a well-articulated qualitative baseline, a meaningful urban–regional role, and a territorial catchment area roughly corresponding to the LAU1 scale.

The centres display a remarkable degree of functional homogeneity and spatial evenness in terms of the types of urban–regional public services considered. Although a few towns offer a below-average number of functions, the vast majority of centres provide nearly all the key public services expected at the urban–regional level, albeit with varying quantities, capacities, and levels of quality.

The relative similarity of the centres is also observable in their roles as commuting and retail hubs, particularly when focusing on the qualitative features of their central functions and their spatial patterns. While 11 of the identified centres do not have a

retail establishment larger than 1,000 m², those that do meet the minimum area threshold tend to offer a comparable standard of retail service, largely because of the standardised offerings of national retail chains. In terms of accessibility to workplaces, as well as general and vocational education centres, most identified centres show similar characteristics – typically offering 15–20 minutes of access time on average.

Nevertheless, it is clear that the centres differ considerably in terms of the scale, quantity, and hierarchical level of their functions. In the absence of upper thresholds, they display a wide spectrum of qualities and capacities across multiple scales. The centres vary significantly in both population size and number of inbound commuters. With respect to population, the smallest town (Répcelak, 2,598 inhabitants) and the largest (Debrecen, 199,725 inhabitants) differ by nearly a factor of one hundred. For commuting, the range is somewhat narrower, from 1,057 inbound commuters in Répcelak to 58,891 in Győr – representing a more than fiftyfold difference, not including the outlier values of Budapest.

Notably, the exceptionally high figures for larger metropolitan agglomerations could be moderated through a more detailed examination of subcentres and intraurban catchment areas (e.g., at the district or neighbourhood scale). A stronger emphasis on population proportionality – balanced with the primacy of territorial organisation – could in turn support a more nuanced interpretation of partial-function peripheral or agglomeration centres as co-centres, contributing to a reduction in functional disparities among the identified urban centres. The analysis of such specialised catchment area types may serve as a next step in this research and contribute to the development of a typology of functional urban regions.

It is important to emphasize that the methodology for identifying functional urban catchment centres presented in this study constitutes only the first, foundational phase of the broader delineation process. In the next stages of the research, the catchment areas – defined by the settlements primarily attracted to the identified centres – will be mapped on the basis of the centres outlined in the present partial methodology.

## Conclusion

Accurately mapping a society's everyday spatial behaviour is crucial for developing effective regional development policies. This approach is increasingly relevant, as technological and social transformations make daily movement and commuting patterns increasingly complex and dynamic – often diverging significantly from administrative boundaries.

Internationally established methodologies for delineating functional urban areas are typically characterised by two key features:

1. They focus on internationally relevant agglomerations with large populations.
2. They rely primarily on labour market commuting data.

Therefore, these methods tend to overlook sparsely populated areas and fail to capture the subcentre roles of smaller towns within larger urban regions. Additionally, assigning large and heterogeneous areas to major urban centres solely on the basis of commuting trends (reflecting only one aspect of the daily life of a subset of the population) does not fully depict the complexity of urban networks and their service provision patterns.

The novelty of the methodology presented in this study lies in its multidimensional approach, which seeks to identify potential functional urban catchment centres on the basis of patterns of citizens' everyday spatial behaviour. This method lays the foundation for a more comprehensive understanding of the complexity of functional urban catchment areas.

In addition to analysing commuting patterns towards labour market centres with significant employment levels, the study also involves data on commuting to public and vocational education institutions. Furthermore, two additional factors are taken into consideration:

- retail centres related to everyday shopping habits, and
- public services most frequently used by citizens.

By integrating these factors, this analysis captures spatial data on the accessibility of daily consumer goods and essential public services, which are particularly relevant for small and medium-sized towns.

This multifactor approach provides us with a more nuanced picture of Hungarian urban centres. The results allow for the identification of centres and subcentres in peripheral areas, as well as the delineation of subcentres within larger functional urban areas.

A key feature of the functional urban centres identified in this study is their relatively even and dense distribution across the country, making them potentially suitable for integration into administrative and public service systems. This, in turn, can support the effective implementation of a new functional territory-focused development approach.

By applying a clearly defined set of minimum criteria, the identified centres are generally capable of providing core urban–regional functions with relatively uniform accessibility and quality. However, adjustments may be necessary to ensure proportional public service provision, particularly by identifying functional subcentres in more populous cities. Additionally, for smaller, typically mono-functional centres that do not meet efficiency or population size thresholds, the methodology could benefit from introducing a category for secondary or co-centres.

While the framework developed in this study is rooted in Hungary's urban network, its methodology and findings offer valuable insights for researchers examining urban structures across diverse national and international settings. By integrating multiple dimensions of citizens' spatial behaviour, this approach provides a versatile and adaptable framework that informs both researchers and

regional development professionals. It contributes to a more territorially balanced provision of services and promotes an inclusive approach to service accessibility in rural areas, which serves as an essential factor in enhancing liveability and overall well-being.

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## Appendix

### Functional urban centres of Hungary

Ajka
Baja
Balassagyarmat
Balatonfüred
Barcs
Békéscsaba
Berettyóújfalu
Bicske
Bonyhád
Budapest
Cegléd
Celldömölk
Csenger
Csorna
Csurgó
Debrecen
Dombóvár
Dunaújváros
Edelény
Eger
Esztergom
Fehérgyarmat
Gyöngyös
Győr
Gyula
Hatvan
Hódmezővásárhely
Jászberény
Kalocsa
Kaposvár
Kapuvár
Kazincbarcika
Kecskemét
Keszthely
Kiskőrös
Kiskunfélegyháza
Kiskunhalas
Kisvárda
Komárom
Komló
Körmend
Kőszeg
Makó
Marcali
Mátészalka
Mezőkövesd
Miskolc
Mohács
Mór
Mosonmagyaróvár
Nagyatád
Nagykanizsa
Nyírbátor
Nyíregyháza
Orosháza
Ózd
Paks
Pápa
Pásztó
Pécs
Salgótarján
Sárvár
Sátoraljaújhely
Siklós
Siófok
Sopron
Sümeg
Szarvas
Szécsény
Szeged
Szeghalom
Székesfehérvár
Szekszárd
Szentes
Szerencs
Szigetvár
Szolnok
Szombathely
Tamási
Tapolca
Tata
Tatabánya
Tiszafüred
Tiszaújváros
Vác
Vásárosnamény
Veszprém
Zalaegerszeg

Aszód
Balatonalmádi
Balatonboglár
Balatonlelle
Balmazújváros
Bátonyterenye
Békés
Budakeszi
Budaörs
Csongrád
Dabas
Dunakeszi
Encs
Érd
Fonyód
Füzesabony
Gárdony
Gödöllő
Gyomaendrőd
Gyömrő
Hajdúböszörmény
Hajdúhadház
Hajdúnánás
Hajdúszoboszló
Heves
Jászapáti
Karcag
Kisbér
Kisújszállás
Kunszentmárton
Kunszentmiklós
Lenti
Letenye
Mezőberény
Mezőtúr
Monor
Nagykálló
Nagykáta
Nagykőrös
Oroszlány
Pilisvörösvár
Püspökladány
Ráckeve
Répcelak
Rétság
Sárbogárd
Sarkad
Sárospatak
Százhalombatta
Sentendre
Szentgotthárd
Szigetszentmiklós
Tab
Tokaj
Tótkomlós
Törökbálint
Törökszentmiklós
Újfehértó
Várpalota
Vecsés
Velence
Záhony
Zirc

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