University of Pannonia
Doctoral School of Business and Management

THESIS BOOKLET

GÁBOR MAYER

An exploratory analysis of Hungary's inter-settlement functional relationships based on complex spatial structure indicators

Theses from a doctoral dissertation

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1. Introduction

1.1. The relevance of the topic and definition of the research problem

By the early 2020s, the rapid development of transport and communication technologies, shifts in household incomes, and the global technological transformation had fundamentally reshaped society's everyday patterns of space use. The processes of urbanisation and suburbanisation have entered a new phase, as a result of which individuals' labour market, consumption and communication patterns have expanded significantly and become more complex. Consequently, settlements in the traditional geographical and administrative sense can increasingly be understood less as isolated units; rather, they appear as interwoven conurbations, whose boundaries no longer follow legal demarcations but are defined by points of functional concentration.

One of the most pressing contemporary issues in regional science and territorial public administration is the phenomenon of territorial misalignment: the deepening divide between rigid, static administrative boundaries and dynamically pulsating, functional spaces. Whilst the mobility of economic actors and the population adapts flexibly to infrastructural conditions, the system of public services and administrative units is often forced into structures based on data that is decades old and now obsolete. In Hungary, this tension is exacerbated by the 'inflation' (its devaluation) (Beluszky and Sikos, 2020): in the period since the change of regime, numerous settlements have been granted city status which, in a functional sense, lack any significant regional organising power; consequently, the conflict between city status and functional reality has become one of the critical issues in development policy.

The situation of small and medium-sized towns, which forms one of the focal points of this research, is also critical because they receive less attention (an 'attention gap') in both academic discourse and policy planning (Porsche et al., 2019). Development strategies typically focus either on globally competitive metropolises or on helping rural areas catch up, whilst the middle tier of the settlement hierarchy – which is responsible for the day-to-day provision of services for a significant proportion of the population – often remains methodologically invisible. The aim of this thesis is to address this shortcoming by developing a multidimensional functional model— —capable of identifying functional units across the entire country that align with the population's daily patterns of land use.

The relevance of this topic is heightened by the paradigm shift in European planning methodology, which is increasingly moving away from rigid administrative boundaries towards flexible, so-called ‘soft spaces’. Whilst the practice of functional planning regions is spreading across Europe, the management of these areas within the Hungarian system is often haphazard and typically tied to the central government’s short-term, top-down development policy objectives (Salamin, 2025). Although the 2023 Spatial Development Act introduced the concept of ‘regions to be managed jointly’, promising the coordination of functional urban regions, in practice there is still a lack of a stable, data-driven methodology that would define these areas not on the basis of political intent, but on the basis of actual socio-economic processes. My research aims to fill precisely this methodological gap.

1.2. Personal motivation and the positioning of the thesis

The choice of topic and approach for this thesis are fundamentally shaped by my professional career and the experience I have gained in the civil service. As a former State Secretary for Regional Development, and during my years spent in policy planning and implementation, I was directly confronted with the challenge posed by the tension between administrative boundaries and socio-economic reality. In my work as a decision-maker, it became clear that effective regional development and increased competitiveness are inconceivable without an in-depth understanding of functional regions and interventions based on that understanding.

I am a committed advocate of a policy approach that is more sensitive to functional regions, one that breaks away from the usual ‘box-based’ thinking and aligns the allocation of development resources and the organisation of services with the population’s daily spatial habits – such as commuting, shopping and accessing public services. My motivation is twofold: on the one hand, to explore Hungary’s actual spatial structure with a scientific rigour, drawing on the latest data (the 2022 census, the Public Education Information System (KIR) / Vocational Training Information System (SZIR) databases, representative surveys) to uncover Hungary’s actual spatial structure; on the other hand, to present results of practical utility that can be directly incorporated into future regional development strategies.

This thesis therefore not only fills a gap from an academic perspective but was also produced with a view to policy relevance. My aim is to bridge the gap between academic

models and government decision-making, demonstrating that a scientifically grounded, data-driven spatial approach is a fundamental prerequisite for more effective state functioning in the public interest.

1.3. The research objectives, practical relevance and novelty

Building on the above background whilst transcending its limitations, the primary aim of this thesis is to develop and apply a multidimensional functional model capable of identifying functional units covering the entire country and aligned with the realities of land use in the 2020s. The theoretical frameworks explored in this thesis and the review of the international literature have highlighted that the dynamics of 21st-century settlement networks can no longer be described solely in terms of static administrative boundaries, nor by traditional catchment area models that focus exclusively on labour market commuting. The transformation of the Hungarian settlement structure over recent decades – characterised by suburbanisation, the expansion of the service sector and changes in mobility patterns – calls for a new approach. Findings from both domestic and international literature suggest that the actual spatial organising power of settlements can only be reliably explored using a multidimensional model which, in addition to workplace connections, also integrates the population's consumption patterns (retail trade) and their access to the state welfare system (public services). The central issue of the study is the presumed structural tension that exists between historically established administrative status and the functional use of space as it manifests itself on a day-to-day basis at the social level.

The academic novelty of this thesis can be identified in four areas:

1. Data update: it is the first study to utilise fresh data from the 2022 census to systematically remap functional relationships, providing seamless coverage of the entire territory of Hungary;
2. Expansion of dimensions: breaking away from an exclusive focus on the labour market, the model integrates mobility for educational purposes (KIR and SZIR data) and access to daily food retail (outlets larger than 1,000 m^2), which together account for the vast majority of the population's travel time expenditure;
3. Residents' priorities: the analysis of public services is based on a nationally representative survey, which focuses on the key services deemed most important by the population;

4. Seamless coverage: it employs an approach that classifies the entire territory of the country into functional catchment areas, thereby also revealing the network of connections in peripheral regions.

1.4. Research questions and hypotheses

Based on the theoretical starting points, and with a view to addressing the identified gaps in the literature and providing a more accurate diagnosis of the Hungarian urban system, I have formulated the following **four main research** questions:

(RQ1) What spatial units and centres, defined by actual land-use patterns, can be identified?

(RQ2) How does the integration of household consumption (retail trade) and public services into the model alter the spatial structure based solely on the labour market (OECD-type)? What spatial patterns does the duality of market-driven commerce and state-driven public services reveal?

(RQ3) To what extent do the district boundaries established in 2013 correspond to the actual socio-economic catchment areas of the 2020s? Can any inconsistencies between administrative and functional spaces (systematic administrative-functional discrepancies) be identified, where the daily mobility of the population consistently transcends administrative boundaries?

(RQ4) Is the basic security of service provision in accordance with the '30-minute accessibility' principle guaranteed across the whole of Hungary, or can critical areas with service shortages be identified where territorial cohesion is compromised due to a lack of functional centres?

In line with the above research questions, I set out the assumptions underpinning this thesis in the following hypotheses:

H1: Models based solely on commuting are excessively hierarchical and thus under-represent the internal cohesion of rural areas. In contrast, the inclusion of retail trade and public services reveals a denser, more horizontal network. I hypothesise that the commercial function is far more decentralised than the labour market (with more centres), whilst the public service network plays the most homogeneous, balancing role in the spatial structure.

H2: Although there is a strong overlap between district centres and functional public service centres, significant tensions can be identified along the boundaries of catchment areas. Actual functional spaces – particularly in metropolitan agglomerations and along county boundaries – dynamically transcend rigid administrative boundaries. The district system performs well in terms of public services, but in its current form it provides too rigid a framework for managing market processes (work, shopping).

H3: The functional delineation highlights that a dual spatial structure prevails in the country. Whilst ‘functional concentration’ (competing centres) is characteristic of metropolitan areas and along busy transport corridors, extensive service gaps can be identified in the inner and outer peripheries. In these areas – particularly in the case of commercial services – market-economy rationality (economies of scale) takes precedence over the principle of territorial balance, meaning that some rural areas are only accessible from the city centre beyond the expected minimum travel time.

2. Theoretical background and review of the literature

2.1. Theoretical framework of the research

The theoretical basis of this thesis stems from the paradigm shift in spatial theory that examines the tension between static, administratively based spatial division and dynamic, functional spaces shaped by socio-economic interactions. The traditional administrative spatial structure, operating with rigid boundaries, is increasingly unable to reflect the reality of global urbanisation and a mobile society, where the significance of places is determined not by hierarchy (legal status) but by their position within networks of relationships. Resolving this dichotomy is particularly pressing at the middle level of the settlement hierarchy, where a lack of attention in the literature meets the complexity of spatial processes.

In the mainstream of international urban studies over recent decades, the discourse of 'metropolisation' has dominated, viewing global cities as the sole drivers of economic growth. At the same time, the world of small and medium-sized towns (SMSTs) has been pushed to the periphery of academic interest. This phenomenon is aptly described in the literature as the 'SMST attention gap' (Servillo et al., 2014; Fioretti et al., 2023; Kah, 2024). One of the main objectives of this thesis is to fill this gap, on the assumption that the stability of the Hungarian settlement network depends precisely on the functional performance of this intermediate level.

In examining functional spaces, this thesis pays particular attention to the quality of interactions between the centre and its catchment area, going beyond gravitational models. In polycentric urban systems, two opposing forces shape the development trajectories of settlements: the phenomena of 'agglomeration shadow' and 'borrowing size'.

The concept of the agglomeration shadow refers to the negative competitive situation in which the proximity of a dominant large city drains the resources, functions and population of smaller settlements, thereby degrading settlements with formal urban status into 'dormant towns' or mere residential satellites in a functional sense. In contrast, the theory of economies of scale (Alonso, 1973; Meijers and Burger 2017, 2022) describes a positive network effect: although smaller towns do not, in themselves, possess the critical mass to sustain certain services, they can, through good transport links, benefit from the advantages of a neighbouring large city or the wider urban network, thereby providing

their residents with a higher standard of living than their population size would otherwise suggest.

2.2. The evolution of spatial organisation theories: from hierarchy to networks

The theoretical cornerstone of settlement network research is Walter Christaller's (1933) Central Place Theory, according to which settlements are organised in a strict, hexagonal hierarchical order. In contrast, gravitational models examine the forces of attraction between settlements by analogy with Newtonian gravitational attraction (Reilly, 1929). In modern research, physical distance is replaced by accessibility and the time factor; on this basis, the OECD typically defines regional centres as lying within a 30-minute isochrone (OECD, 2024).

John Friedmann's (1966) centre-periphery model focuses on spatial inequalities, whilst Paul Krugman's (1995) New Economic Geography emphasises increasing returns to scale and agglomeration benefits. In the 21st century, monocentric perspectives based on a single dominant centre are increasingly being replaced by polycentric network approaches (PUR – Policentric Urban Regions), where the links between settlements are not only vertical but also horizontal (Meijers et al., 2018).

2.3. International standards and limitations of functional areas and catchment areas

The international standard for defining functional urban areas (FUA) is provided by the OECD-EU methodology developed by Dijkstra and Poelman (2012, 2019), which defines FUAs as comprising the urban core (an urban centre with a population of at least 50,000) and the commuter zone (where at least 15 per cent of workers commute to the core).

Although the FUA methodology is widely used internationally, it has significant limitations when applied in Hungary:

- Its one-dimensional focus: it relies almost exclusively on labour market commuting, neglecting other lifestyle functions (education, retail).
- The 'blind spots' in rural peripheries: due to the strict threshold of 50,000 inhabitants, a large part of the country's territory remains unclassified, rendering the supply role of small and medium-sized towns invisible.
- Monocentric bias: it fails to capture the internal structure of polycentric agglomerations and the actual role of sub-centres (decentres), as it subsumes everything into the dominant core area.

Domestic evidence (e.g. Tóth and Nagy, 2013, 2024; Tóth, 2024) confirms that the OECD's 15 per cent commuting threshold is too low given the increased level of domestic mobility and does not indicate close integration. For this reason, Hungarian researchers advocate the use of stricter thresholds (e.g. 30 per cent) and road-based time-based accessibility (30-minute isochrone).

3. Materials and Methods

Due to the nature of the phenomenon under investigation, the methodological structure of the research is two-fold; however, its empirical part follows a fundamentally quantitative approach. The theoretical foundation of the thesis rests on the extensive literature review and comparative analysis detailed earlier, which defined the framework of the study.

The empirical analysis, which forms the core of the research, is fundamentally data-driven: I examined the actual land use of the Hungarian settlement network, mapped functional urban centres, delineated their catchment areas, and analysed the gravitational zones of service centres, drawing on extensive statistical databases. The mathematical and statistical methods (normalisation, weighted interpolation, clustering) applied during the processing of the 2022 census data, labour market commuting matrices and geolocation mobility data ensure the objectivity and reproducibility of the results. This quantitative approach ensures that the policy recommendations set out at the end of the thesis are based not merely on normative principles, but on quantifiable facts regarding actual spatial flows.

3.1. Evaluative analysis of relevant domestic research precedents

Several milestones can be identified in Hungarian professional and public administration practice, the methodological insights from which I have incorporated into my own model:

1. Bibó's urban-rural symbiosis (1986): Bibó advocated harmony between administrative boundaries and actual catchment areas. His two key principles were optimal accessibility (delineation aligned with transport routes) and complete coverage ('every rural area should have a town'). Where gaps in coverage arose, he proposed the designation of new centres.
2. The micro-regional system (1994–2004): The original 1994 Hungarian Central Statistical Office (KSH) delineation (138 units) was still based on strict functional principles (full coverage, stability, the catchment area principle, and multi-centredness). However, during the 2004 reform, political considerations and the local government lobby overrode the methodology, leading to distortions in economies of scale, the emergence of 'quasi-cities' without any specific function, and the 'flag with holes' effect, which excludes the pull of major cities.

3. The 2010 study by VÁTI and RKK: The model identifying the 113 Functional Urban Areas (FUA) was based on local labour market systems (LLS) and complex functional indicators. Its limitations were the outdated nature of the data (2001 figures) and the requirement to adhere strictly to county boundaries.
4. The HÉTFA district delineation (2011–2013): The model, which resulted in 175 districts, applied a complex centrality potential indicator and dynamic accessibility modelling, taking into account that journeys exceeding 20 km (approx. 30 minutes) entail significant social costs for the population. Its limitation is that it is optimised primarily for the presence of state and administrative bodies, rather than for the functions of everyday life.

3.2. Criteria for selecting centres with a regional impact

The first step in research aimed at delineating functional urban areas is the identification of potential urban nuclei (centres). Although attempts have been made in the literature to uncover primary attraction links between settlements without prior designation of centres (Stoian et al., 2024), the results of these models – particularly in agglomerated and peripheral areas – proved too fragmented to describe a coherent spatial structure. This experience reinforced the methodological principle that the delineation of regions characterised by strong functional links must begin with the preliminary identification of potential centres.

The model, employing a bottom-up approach, identified urban regional centres along three different functional dimensions:

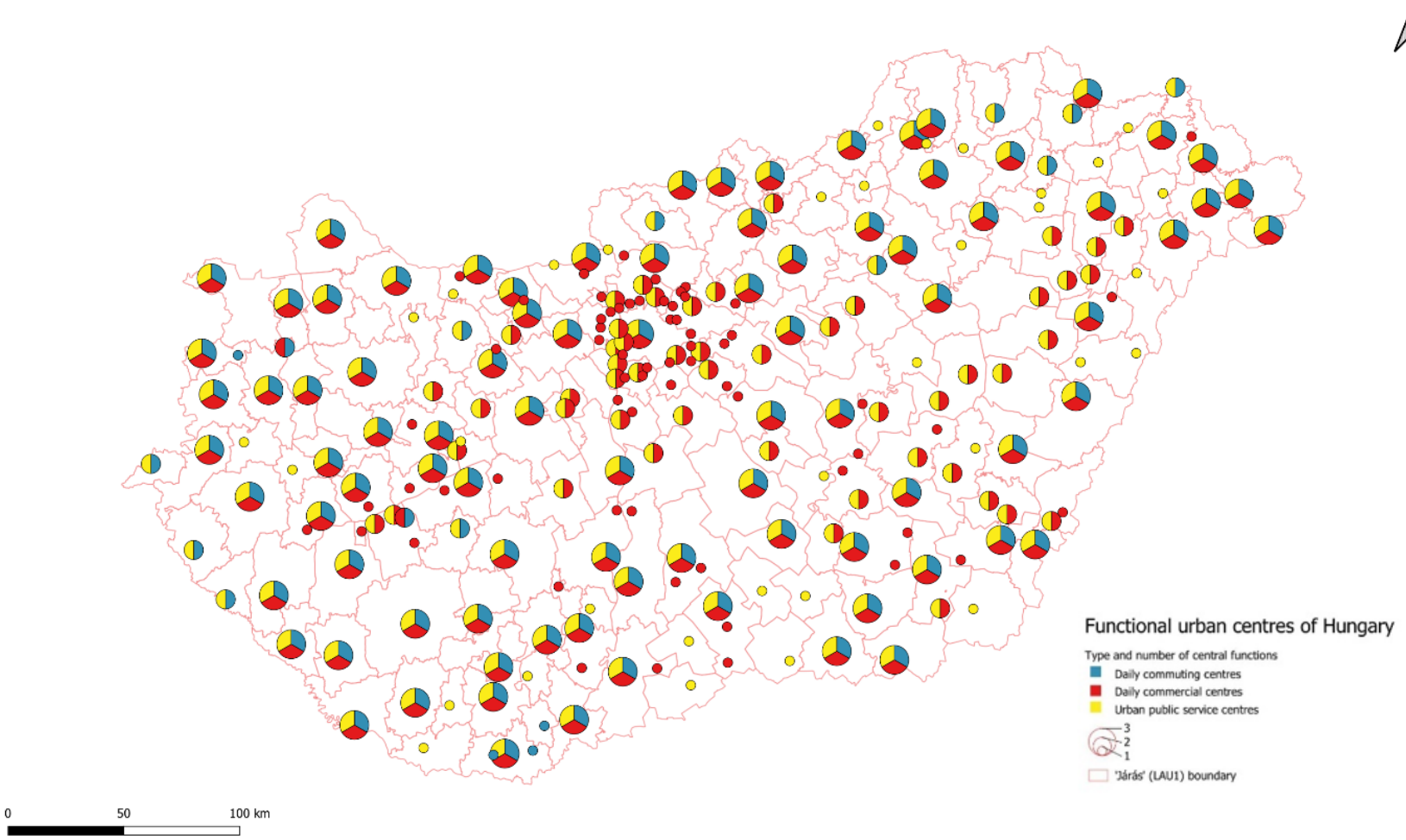
1. **Labour market and educational commuting centrality (Commuting dimension)**
    - Database: The comprehensive inter-settlement commuting matrix from the 2022 census by the Hungarian Central Statistical Office (KSH), combined with the average in-commuting data for three academic years (2020–2023) from the KIR and SZIR databases, which record students' daily mobility.
    - Criterion:
        - Volume: at least 1,000 daily inbound commuters (workers and secondary school pupils).
        - Regional scope: the settlement under investigation must be the strongest (primary) commuting destination for at least five other settlements. This

filters out large but self-contained local markets and classic agglomeration dormitory towns.

2. **Centrality in relation to daily food shopping (Retail dimension)**
   - **Database:** The Hungarian Central Statistical Office's (KSH) database of retail outlet networks by settlement, as at 31 December 2023.
   - **Criterion:** The presence in the settlement of at least one food-related large retail outlet (hypermarket, supermarket or discount store) **with a gross floor area of 1,000 m² or more**. This size threshold guarantees a market presence of regional significance, offering a wide selection and strong appeal.
3. **Centrality of public services (Service dimension)**
   - **Database:** The Ministry of Transport and Communications' policy databases and the 2023 nationally representative survey by Századvég Zrt., which identified the range of services considered most important by the population.
   - **Criterion: The presence of at least six of** the **12** designated **key urban public services** in the settlement.
     - Healthcare*:* ambulance station, specialist outpatient care, district-based GP out-of-hours service.
     - Education: grammar school, other secondary educational institutions (vocational secondary school/technical college).
     - Law enforcement and public administration: police station, professional/municipal fire brigade, government service centre.
     - Social care: family and child welfare centre, day care for people with disabilities, care home for the elderly, long-term/temporary residential care.
4. **Synthesis of complex functional urban centres**

Based on a cross-tabulation analysis of the three dimensions, the **151 settlements** that **meet at least two** of the above three criteria **simultaneously** are classified as complex functional urban centres (FUCs). This definition ensures the identification of stable regional anchors and uniform national coverage (Figure 1).

Figure *1*: The 151 identified functional urban centres and other settlements with a single-type central character (treating the 23 districts of Budapest as a single unit)



Source: Mayer et al., 2026

3.3. Methodology for delineating and combined weighting of catchment areas

The delineation of catchment areas is based on the principle of the strongest link, ensuring seamless coverage: each settlement is assigned to the functional urban centre (FUC) with which it exhibits the most intensive functional link.

- Commuting catchment area: Based on normalised (Min-Max) commuting ratios, the strongest labour market/education direction can be identified by analysing a total of 6,269 inter-settlement relationships.
- Retail catchment area: The normalised and inverted value of the fastest road travel time (based on GeoX-OSRM modelling) within a 30-minute travel time limit. Where multiple centres are accessible, the pull is distributed amongst the competing chains (reallocated weighting).
- Public service catchment area: An additive model that measures how many of the 16 extended public services the given centre represents as the fastest destination from the settlement under investigation in terms of accessibility. (In addition to the 12 services listed above, the 16 services include a GP, a dentist, a chemist and a post office, in order to avoid the distortion caused by forced assignment).

The composite attractiveness index (FCA_i)

The three distinct dimensions are combined by the **composite attractiveness index (Functional Connection Assessment – FCA_i)**:

$$FCA_i = I_w * I_i^* + R_w * R_i^* + S_w * S_i^*$$

where:

$$I_i^* = \frac{\left(I_{\text{i}} - \min(I)\right)}{\max(I) - \min(I)}$$

$$R_i^* = \left[1 - \frac{Ri - \min(R)}{\max(R) - \min(R)}\right] \times \frac{R_{\text{i}}}{\sum R}$$

$$S_i^* = \frac{(S_{\text{i}} - \min(S))}{\max(S) - \min(S)}$$

I_i, R_i, $S_i$are the normalised values for commuting, retail and services, falling within the range [0,1], in relation to the town centre.

The weights of the components (I_w , R_w , S_w) reflect the actual social weight (time spent) of the activities, which I have calibrated on the basis of nationally representative time-use and behavioural surveys as the product of *mass* (m_x), *frequency* (f_x) and *average travel time* (a_x):

$$w_x = m_x * f_x * a_x/100$$

In the case of Hungary, the weight values are as follows: $I_w = 3.74$, $R_w = 1.02$, and $S_w = 0.36$, which result in FCA scores falling within the range [0; 5.12] for the 8,391 analysed settlement–centre of attraction relationships.

The complex inter-settlement attraction values obtained in this way provide a much more nuanced picture of the actual lines of force within the Hungarian urban network than previous studies.

As the average Hungarian settlement is linked to 2.66 functional centres to some extent, the model is also capable of revealing overlapping, network-like patterns. However, identifying the primary centre of attraction (the strongest link) for each settlement is essential for public administration planning.

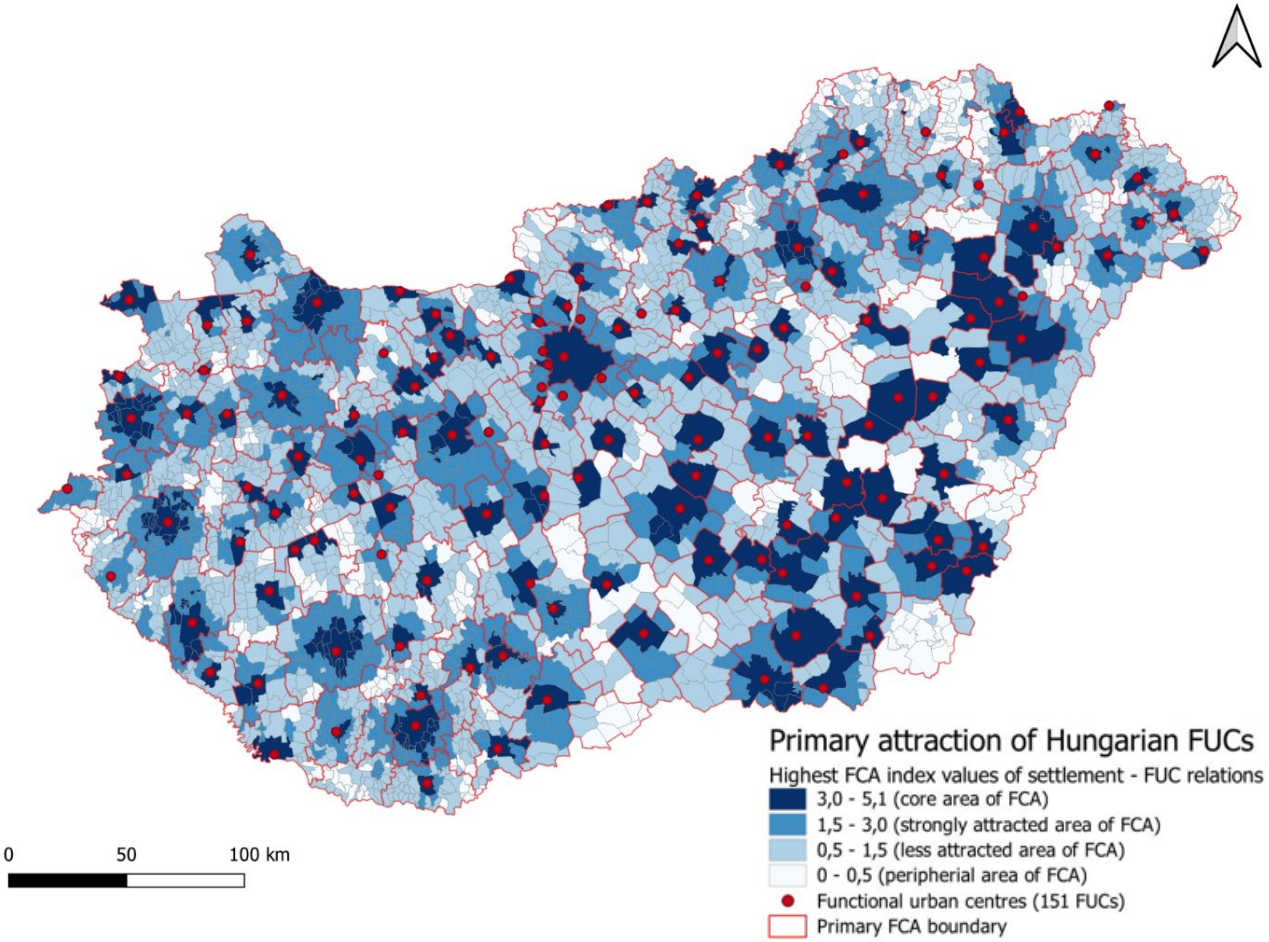
Based on the FCA values (attraction index), four distinct qualitative levels of urban–rural interactions emerge (Figure 2).

1. **core areas (FCA > 3.0)**: this level indicates complete and organic integration. Where the index reaches this value, commuting typically exceeds 50 per cent, and residents can access almost all services most quickly in the centre. In areas with small villages, this zone denotes a settlement that spans administrative boundaries but is functionally unified;
2. **classic agglomeration (FCA > 1.5)**: these connections delineate the true suburban rings. They are characterised by commuting rates of over 30 per cent and rapid access to most services. It is at this level that the scale-changing extent of stronger economic centres (e.g. Győr, Debrecen) becomes apparent. It is noteworthy that Budapest's gravitational pull is less dominant at this level than expected, as its catchment area is successfully shared by the surrounding sub-centres (e.g. Érd, Gödöllő) and neighbouring economic centres;

3. **functional catchment area (FCA > 0.5):** this level marks the boundary of the catchment area in the broader sense. Commuting here still reaches the 15 per cent threshold, but the commercial and public service orientation is already becoming dispersed (directed towards multiple centres). This is the most balanced zone, where the distorting effect of the 'big players' is mitigated;
4. **peripheral zones (FCA < 0.5):** areas with weak ties delineate those regions that have not (yet) been organically integrated into urban systems. The pattern of these zones partly coincides with the spatial characteristics of complex underdevelopment, though the relationship is not linear. Whilst in north-western Hungary the functional periphery often encompasses developed (self-sufficient) rural areas, in south-western and north-eastern Hungary the peripheral, underdeveloped villages often display stronger functional cohesion (dependence) on local small-town centres than settlements in more developed regions.

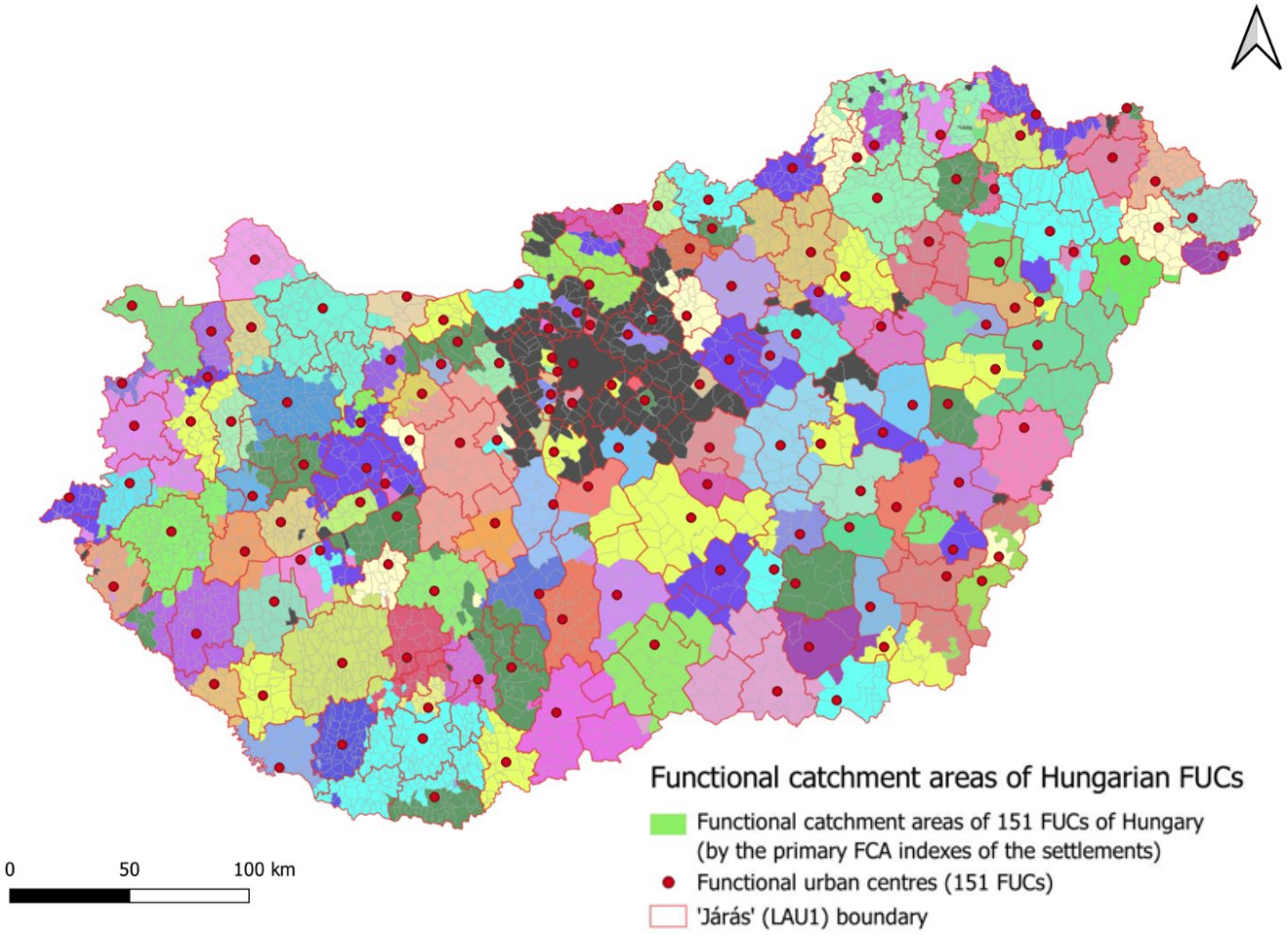
If we map all settlements based on their primary pull, we obtain a seamless network covering the entire country (Figure 3).

Figure 2: Primary attraction values of the 151 identified centres of attraction



Source: Own calculations, based on a complex dataset (provided by the Hungarian Central Statistical Office (KSH), relevant ministries and the Lechner Knowledge Centre) (Orbán et al., 2026)

Figure 3: Hungary’s primary functional catchment areas



Source: Compiled by the authors based on data from the Hungarian Central Statistical Office (KSH), the relevant ministries and the Lechner Knowledge Centre (Orbán et al., 2026)

4. New findings

4.1. Key findings of the empirical research

The research revealed the dual nature of Hungary's spatial structure: the integration of labour market, retail and public service functions has resulted in 151 genuine functional urban areas in Hungary, which significantly nuances previous models based solely on commuting. The results confirm that whilst the network of state-run public services exhibits relative territorial stability and balance, the concentration of market-driven functions – namely trade and employment – deepens the centre-periphery divide. The study quantified the systematic inconsistency between the district boundaries established in 2013 and actual social mobility in the 2020s, particularly in dynamic agglomeration areas. Thanks to the research findings, it has become possible to identify those district-seat towns that do not adequately fulfil their central role, as well as those towns that are not district seats but whose functional central role is clear. The phenomena of agglomeration shadow and borrowed size have been mapped out in Hungary, presenting a significantly more sophisticated picture of the domestic urban network. Finally, the model identified those critical service shadow zones where the principle of 30-minute accessibility is currently not met for market and infrastructural reasons, thereby jeopardising the retention capacity of rural areas.

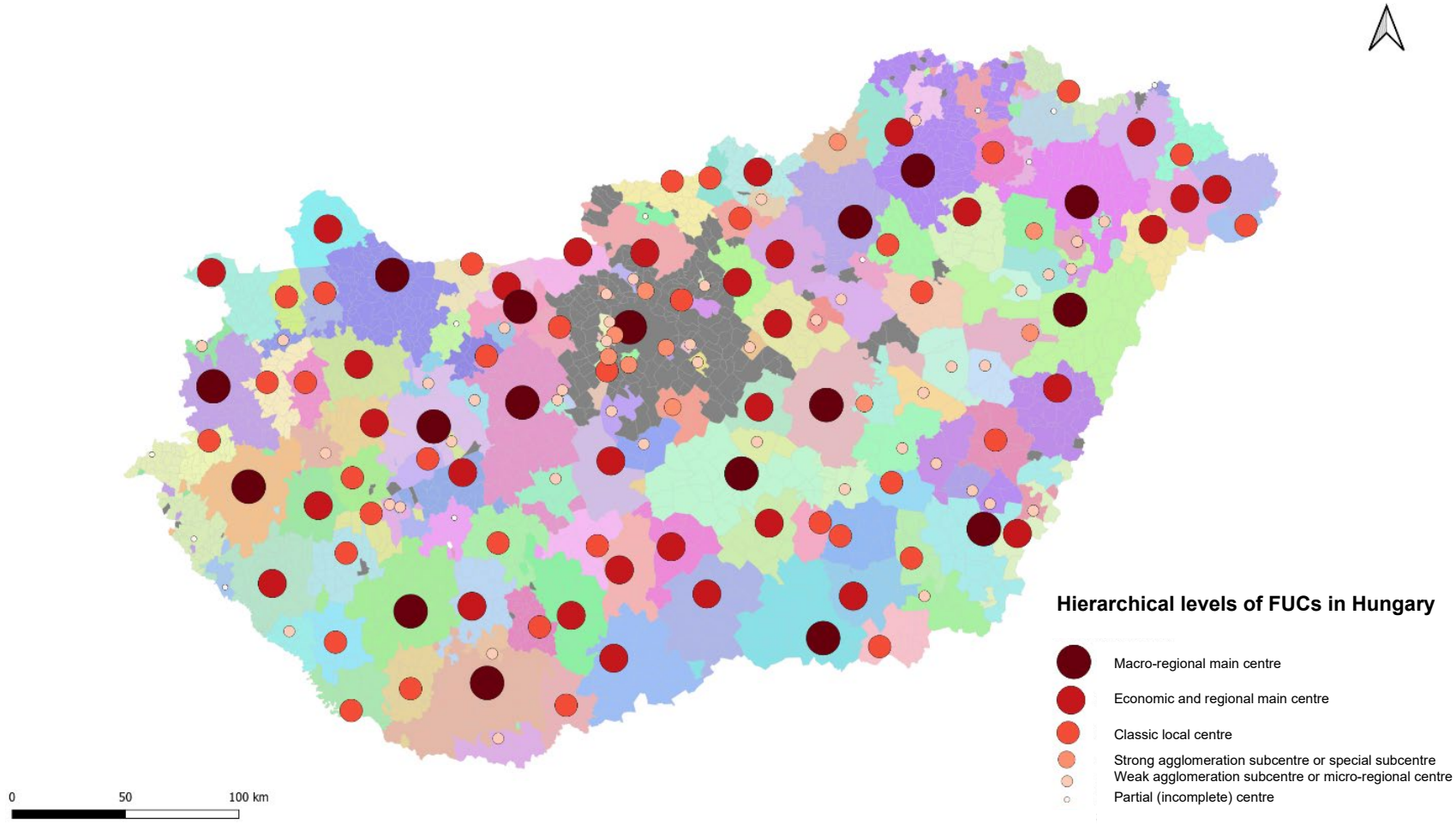
Neither a mere listing of the 151 identified functional centres of attraction nor their classification into categories based on the fulfilment of research dimensions (commuting, commercial and public service centrality) provides an answer to the deeper inequalities in the country's spatial structure. Although each of these settlements possesses regional attractiveness, the gaping demographic, economic and labour market divides between them highlight the need to establish a system of functional categories based on objective indicators. In this phase of the research, the classification of centres took place in two stages, during which the initial model—which applied purely statistical threshold values—was replaced by a refined, multivariate 'waterfall model' that also accounts for spatial anomalies.

Based on the results of the model and the synthesis of the dimensions, the new, functional spatial structure of Hungary can be summarised as follows:

- Major regional centres (17 towns): Budapest and the most significant rural economic and administrative centres (catchment population > 90,000, commuters > 15,000).
- Major economic and regional centres (32 towns): The stable pillars of the rural spatial structure (attracted population > 40,000, positive net commuting balance).
- Classic local centres (36 towns): Traditional small-town anchors (attracted population > 15,000, positive net commuting balance, serving at least two settlements).
- Strong agglomeration satellite centres or specialised sub-centres (10 towns): Substantial service and employment bases in the shadow of metropolitan centres, mostly with a negative or balanced commuting balance (e.g. Érd, Budaörs, Gödöllő, Hajdúszoboszló).
- Weak agglomeration sub-centre or micro-regional centre (45 towns): Units with a smaller population but which nevertheless play an important supply role at the local level.
- Partial (incomplete) centres (11 towns): Small towns, mostly serving as district centres, which lack a retail function (units larger than 1,000 m^2), but still play a certain regional role from an administrative or educational perspective (e.g. Encs, Letenye, Sárospatak).

The classification of the 151 functional centres, based on a multidimensional functional approach, reveals a complex, multi-tiered spatial structure interwoven with interactions between the different levels (Figure 4).

Figure 4: The 151 functional centres by category



Source: compiled by the author

4.2. Research Theses

THESIS POINT T1

The integration of retail and public service dimensions into spatial models – going beyond international standards that focus exclusively on commuting (e.g. OECD FUA) – reveals a significantly denser, more horizontal network structure that more accurately describes the population's actual, lifestyle-based use of space.

Models based purely on labour market commuting are overly selective and hierarchical, with the result that the cohesive power of small towns and rural areas remains invisible. The model demonstrated that the inclusion of market-driven retail and state-coordinated public services balances this picture.

Empirical data confirmed that the network of retail centres (204 settlements) is the most decentralised, closely following residential purchasing power and population density. In contrast, the public service network (183 settlements) – due to territorial service obligations and regulatory requirements – exhibits the most even distribution, forming a largely homogeneous safety net across the country's rural hinterlands.

The complex model resulting from the synthesis of these three dimensions has highlighted those small towns in peripheral locations that act as anchors in the provision of services to the countryside (e.g. Sátoraljaújhely, Szentes, Mohács), which, despite their more moderate appeal as commuter destinations, are indispensable local hubs for everyday services.

THESIS POINT T2

Within the Hungarian settlement network, the status of 'town' has been functionally devalued (legal inflation): of the 348 officially designated towns, only 151 possess genuine spatial organising power. The inconsistency between administrative boundaries and functional spaces is also evident in the 2013 district system: 36 district centres have become functionally hollowed out, whilst 12 settlements that are not district centres operate as clear regional centres.

The research has quantified the widening gap between formal legal status and actual spatial organising capacity. Of the 348 towns with legal status, nearly 200 are unable to exert any

meaningful pull on their surrounding areas, as they lack even a minimal commuter volume (1,000–), at least five sending settlements, or an adequate concentration of retail and public services.

Administrative inconsistency is also evident in the district system. The 36 ‘excluded’ district centres (e.g. Baktalórántháza, Kistelek, Mezőkovácsháza, Tiszakécske), whilst meeting the administrative and public service criteria well through the establishment of state institutions (often scoring 10/12 on the index), have failed the market (retail) and labour market tests. These settlements are therefore centres maintained solely through administrative means, lacking any real socio-economic appeal.

In contrast, 12 towns that are not district centres (e.g. Budaörs, Százhalombatta, Törökbálint as decentralised centres within agglomerations, or Balatonboglár, Balatonlelle as tourist hubs) have, through market-driven and organic development, built up such complex functional potential that they have become indispensable, multi-dimensional regional anchors.

THESIS POINT T3

Hungary’s spatial structure is characterised by a deepening duality: extensive ‘white spots’ in terms of service provision (peripheral shadow zones) can be identified along monocentric, primary axes of attraction, however, the population’s flexible, polycentric use of space (the utilisation of secondary centres) acts as a kind of functional safety net, mitigating market-based territorial inequalities by drawing the vast majority of the population into a secure supply zone within a 30-minute travel time.

If we examine land use within a strict, monocentric model (assigning each settlement exclusively to its strongest link), extensive service ‘white spots’ can be identified on the inner and outer peripheries, lying outside the 30-minute accessibility zone. In these areas, market rationality and economies of scale override the principle of territorial balance, threatening the viability of rural areas.

However, actual social land use is flexible and multidirectional. When I incorporated secondary functional links (but within a 90-minute travel time) into the model, the stabilising role of polycentric land use was demonstrated. In the flexible model, the proportion of the

population with a functional link to their own district centre rose from 7.46 million to 8.12 million , confirming that district centres remain decisive as secondary anchors.

Taking flexible use of space into account, areas with a shortage of services have decreased dramatically: the number of people living outside the extreme 90-minute accessibility zone fell from 18,000 to barely 50, whilst several hundred thousand peripheral residents were brought into the safe 30-minute accessibility zone, confirming the hidden social safety net function of the multi-tiered urban network.

5. Directions for future research on this topic

5.1. Policy relevance of the research findings

The findings of this thesis provide direct policy-making ammunition for regional development and spatial planning in Hungary. In recent years, a kind of return to technicality has been observable in Hungarian practice, in which physical investments and resource allocation (allocative planning) dominate rather than the substantive management of socio-economic processes. This 'thin learning' model favours formal compliance with European principles (window dressing) over genuine structural reforms (Salamin and Péti, 2025).

The multidimensional model presented in this paper demonstrates that the actual viability of settlements and the quality of life of their inhabitants depend on the quality of functional networks at the urban agglomeration level. The findings can be directly applied in the following areas:

1. Delimiting 'regions to be managed jointly': This new category, introduced by the 2023 Spatial Development Act, can be given substantive meaning and precise boundaries based on the functional catchment areas identified by the FCA index, moving away from the ad hoc priority regions born of political deals.
2. Rational organisation of public services: The cases of the 36 district centres that are to be removed and the 12 non-district centres that are to be included highlight that, when locating services, the actual 30-minute accessibility and consumer habits of the population should be taken as the basis, rather than rigid administrative boundaries.
3. Targeted regional resource allocation: Understanding the differing spatial logic of market-based and state functions helps in the development of targeted, place-based development programmes, particularly in addressing peripheral service-deprived areas.

5.2. Future research directions

Although this thesis provides a reliable and data-driven picture of Hungary's spatial structure, it also identifies the methodological and theoretical areas that require further research:

1. An examination of local authorities' 'capacity to act'

The existence of the 151 statistically identified functional centres does not in itself guarantee their sustainability. A key task for future research is to assess whether these centres – particularly small towns in peripheral locations – possess the necessary institutional capacity to fulfil their regional service provision and coordination roles (Böhme et al., 2022). The assessment of capacity for action must cover:

- Financial and external resource mobilisation capacities.
- The framework of decision-making autonomy and legal powers.
- Cross-border and local-level cooperation capacities.
- The strategic and adaptive decision-making management of local leadership in the era of the green and digital transitions.

2. The use of mixed-methods approaches

Actual patterns of attraction and the depth of attachment to a centre are more sophisticated social phenomena than can be fully described by mere commuting volumes or statistical data on institutional provision. Future research should combine quantitative models with qualitative in-depth analysis (in-depth interviews, case studies, and surveys of residents' attitudes and sense of place). This will also enable an assessment of residents' subjective perception of space and *the* actual *quality* and responsiveness of services.

3. Examination of accessibility via public transport

Within the scope of this thesis – due to the research's focus and the constraints on the scope of data modelling – the analysis deliberately focuses on the shortest road (private car) journey times. Based on this, the model illustrates the most direct mobility potential within contemporary Hungarian society. The inclusion of public transport could represent a complex shift in perspective, as it is not only spatial distance but also temporal constraints (timetables, transfer times, service frequency) that critically alter the matrix.

This future development would have numerous policy implications in terms of the green transition. By superimposing road transport and public transport matrices, it would be possible to identify areas where the minimum territorial requirements for public transport are not met – that is, those regions which are connected to their centre by private car within a 30-minute travel time but are isolated when it comes to public transport.

Such a supplementary analysis could indeed provide direct, data-driven support for domestic decisions on sustainable spatial and rural development and public transport organisation (service procurement) that are aligned with the objectives of the EU Green Deal, outlining a spatial structure for spatial and rural development that is more sustainable, socially just and ensures the rural area's capacity to retain services

4. Analysis of functional regions beyond Hungary's national borders

Perhaps one of the most relevant future extensions of this research is the integrated examination of functional regions beyond the borders, since the once-integrated catchment areas, split in two by the Trianon borders (where, for example, Esztergom lost 65 per cent of its potential catchment area, or the Komárom region was split into two half-catchment areas), are today being organically revitalised through EU integration and open borders, through the daily use of space by the population (bottom-up processes).

6. List of candidate's publications

The research findings forming the basis of the doctoral thesis—which detail the development of a multidimensional methodology, the identification of centres and the delineation of catchment areas—have been published in the internationally recognised journals ***Regional Statistics* and *Deturope***, both indexed in the Scopus database:

Mayer, G., Orbán, K., Berkes, J., Mezei, K., & Navracsics, T. (2026). Defining daily space use patterns in Hungary: Identification of functional urban centres with a multidimensional methodology. *Regional Statistics*.

Orbán, K., **Mayer, G.**, Mezei, K., Berkes, J., & Navracsics, T. (2026). Defining daily space use patterns in Hungary: Mapping functional catchment areas. *Regional Statistics*.

Mayer, G., and Mezei, K. (2025). Old and New Challenges in Regional Development – Comparative Analysis of European Regional Development Policy Approaches to Identifying Beneficiary Regions. DETUROPE – The Central European Journal of Regional Development and Tourism, 17(3), 50–74

Statement: The theoretical and methodological developments presented in the above co-authored publications were produced under the candidate's conceptual guidance and with their lead authorship or significant contribution. The conclusions presented in the thesis, the independent testing of the hypotheses and the policy synthesis of the results obtained are the candidate's own intellectual output.

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