DETERMINING THE COMPETITIVE ADVANTAGES OF TECHNICAL-MUNICIPAL INFRASTRUCTURE AND PUBLIC SERVICES IN THE CITIES OF THE NORTHERN DEVELOPMENT REGION OF THE REPUBLIC OF MOLDOVA.

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Abstract: *This article evaluates the competitive advantages of technical-municipal infrastructure and public services in the cities of the Northern Development Region of the Republic of Moldova. The research utilizes data from the 2024 Census, focusing on the accessibility of utility networks, street infrastructure, and green spaces. The methodology applies statistical distance analysis (Euclidean, Manhattan, Gower, Chord, and Mahalanobis) to determine the degree of proximity to the municipality of Bălți. The results, processed in JASP, highlight major territorial disparities, ranking the localities according to their level of infrastructural equipment. Gower indicators confirm a high convergence for the cities of Drochia and Otaci, while Lipcani and Mărculești show significant structural gaps. The study demonstrates the efficiency of statistical methods in evaluating urban competitiveness and providing a foundation for regional cohesion policies.*

Keywords: *technical-municipal infrastructure, public services, Northern Development Region, statistical distances, urban competitiveness, regional cohesion .*

JEL: R11, R58, H54.

Introduction

In the specialized literature, urban infrastructure is approached as a complex system of interconnected networks and services that support the functionality and development of cities [4]. Within this system, technical-municipal infrastructure and public services represent essential elements that sustain urban functionality, economic development, and the population's quality of life [3]. In the context of contemporary regional development strategies, urban infrastructure is no longer perceived exclusively as the physical support of the city, but as a strategic factor that contributes to increasing investment attractiveness and strengthening territorial competitiveness. The development level of technical-municipal networks and public services reflects the degree of urban modernization and the capacity of local administrations to respond to the needs of the population and the economic environment. Access to water supply infrastructure, sewerage, natural gas, public lighting, street infrastructure, and green spaces directly influences housing conditions, urban mobility, and the socio-economic development potential of cities.

In the Northern Development Region of the Republic of Moldova, the existing differences between cities regarding the level of municipal equipment generate significant territorial disparities and influence their capacity to capitalize on development opportunities. In this context, evaluating the

competitive advantages of technical-municipal infrastructure and public services becomes necessary for identifying structural imbalances and providing a foundation for regional development policies.
The present research aims to conduct a comparative analysis of the cities in the Northern Development Region by assessing the level of infrastructural development and identifying urban competitive advantages based on relevant statistical indicators.

Materials and Research Methods

The research is based on a multivariate quantitative analysis of technical-municipal infrastructure, defined as a set of interconnected structures and services necessary for the functioning of the urban environment. To evaluate competitive advantages, five key indicators were selected: green spaces (m^2/inhabitant), street density (km/km^2), public lighting rate (%), connection to the sewerage service (%), and access to network natural gas (%) [1,2]. Since these indicators have heterogeneous units of measurement, the values were standardized using the range normalization method (Min-Max scaling), thus ensuring the full comparability of the va The assessment of the development level was performed by calculating the degree of proximity to the polarizing center (the municipality of Bălți), employing a complementary set of statistical metrics: Euclidean, Manhattan, Gower, Chord, and Mahalanobis distances. This approach allows for the triangulation of results and the elimination of interpretation biases inherent to a single calculation method. The data were processed in the JASP statistical environment, generating a distance matrix that underpins the identification of competitiveness clusters and areas requiring strategic interventions to mitigate territorial imbalances.riables.

The infrastructural profile of the cities within the Northern Development Region exhibits a high degree of heterogeneity. The data presented in Table 1 highlight major territorial disparities among the analyzed urban centers. The municipality of Bălți, serving as the benchmark unit, records maximum values across most indicators, particularly regarding sewerage connection rates (98.1%) and public lighting.

Table 1. Infrastructural indicators of urban settlements in the Northern Development Region

Urban Settlements	Green spaces (m^2/inhab.)	Street density (km/km^2)	Illuminated streets (%)	Dwellings connected the public sewerage service (%)	Housing equipped with network gas (%)
mun. Bălți	35,8	10,1	93,6	98,1	71
Briceni town	77,2	8,2	100,0	71,2	53,1
Lipcani town	91,2	5,2	100,0	48	14,1
Dondușeni town	33,9	9,5	79,5	71,6	86,5
Drochia town	79,0	11,4	90,2	82,5	70,9
Edineț town	38,7	7,7	43,0	63,5	67,7
Cupcini town	57,2	4,7	57,7	67,7	48,9
Fălești town	25,9	14,3	95,9	68,6	24,5
Florești town	118,4	14,3	62,2	76,7	59,3
Ghindești town	23,4	19,5	95,1	65,6	59,3
Mărculești town	116,5	14,1	100,0	41,4	35,5
Glodeni town	93,7	8,0	29,8	62,4	75,5
Ocnița town	31,2	15,7	74,3	79,5	66,4
Frunză town	8,5	14,8	36,4	99,4	87,9
Otaci town	17,0	10,6	83,2	95,7	44,7
Rîșcani town	24,5	9,0	53,9	73,6	65,6
Costești town	41,6	2,5	96,7	46,1	13,5
Sîngerei town	38,3	10,1	80,2	52,2	39,3

Biruința town	34,5	13,8	97,5	72,8	49,6
Soroca town	32,9	12,6	69,5	76,8	37,4

Source: elaborated by the authors based on source [1,2].

The comparative analysis indicates significant differences between cities of similar rank. Towns such as Drochia and Florești exceed the regional average in terms of municipal utilities and green spaces. In contrast, localities like Lipcani and Costești exhibit structural deficiencies in their gas and sewerage networks. This uneven distribution of infrastructure suggests fragmented competitive advantages, influenced by administrative status or proximity to transport axes.

To analyze these gaps, a matrix of normalized values was utilized (Table 2). The values, ranging from 0 to 1, allowed for the identification of each city's position relative to the maximum regional standard.

Table 2: Matrix of Normalized Values for Technical-Municipal Infrastructure Indicators in the cities of the Northern Development Region (2024)

Urban Settlements	Green spaces (m^2/inhab.)	Street density (km/km^2)	lluminated streets (%)	Dwellings connected to the public sewerage service (%)	Housing equipped with network gas (%)
mun. Bălți	0,249	0,447	0,909	0,978	0,773
Briceni town	0,625	0,336	1,000	0,514	0,532
Lipcani town	0,753	0,157	1,000	0,114	0,008
Dondușeni town	0,231	0,412	0,708	0,521	0,981
Drochia city	0,641	0,523	0,860	0,709	0,772
Edineț town	0,275	0,308	0,188	0,381	0,728
Cupcini town	0,443	0,129	0,397	0,453	0,476
Fălești town	0,159	0,693	0,942	0,469	0,148
Florești town	1,000	0,692	0,461	0,609	0,616
Ghindești town	0,135	1,000	0,930	0,417	0,616
Mărculești town	0,982	0,684	1,000	0,000	0,296
Glodeni town	0,775	0,323	0,000	0,362	0,833
Ocnița town	0,207	0,776	0,633	0,657	0,711
Frunză town	0,000	0,722	0,093	1,000	1,000
Otaci town	0,077	0,478	0,761	0,936	0,419
Rîșcani town	0,146	0,381	0,343	0,555	0,700
Costești town	0,301	0,000	0,954	0,081	0,000
Sîngerei town	0,272	0,448	0,718	0,186	0,347
Biruința town	0,237	0,665	0,964	0,541	0,485
Soroca town	0,223	0,593	0,565	0,610	0,321

Source: Calculated by the authors using JASP software based on the data from Table 1.

This normalized database serves as the foundation for calculating statistical distances (Euclidean, Manhattan, Gower, Chord, and Mahalanobis), which reveal the actual degree of similarity or disparity between the urban infrastructure of localities in the Northern Development Region of the Republic of Moldova.

The multidimensional assessment of competitiveness was conducted by quantifying the degree of proximity of urban centers to the benchmark model, utilizing statistical distance metrics. The results presented in Table 3 provide a clearer insight into the competitive advantages of each locality through the lens of municipal infrastructure.

Table 3: Matrix of Statistical Distances of Urban Centers in the Northern Development Region Relative to the Benchmark Model

Urban Centers	Euclidean Distance	Manhattan Distance	Gower Distance	Chord distance	Mahalanobis distance
Briceni town	0,660	1,283	0,257	0,413	0,789
Lipcani town	1,295	2,514	0,503	0,867	1,576
Dondușeni town	0,542	0,919	0,184	0,327	1,322
Drochia town	0,484	0,787	0,157	0,300	0,732
Edineț town	0,948	1,528	0,306	0,529	1,696
Cupcini town	0,874	1,846	0,369	0,399	1,374
Fălești town	0,848	1,503	0,301	0,537	1,612
Florești town	0,993	1,970	0,394	0,622	1,764
Ghindești town	0,812	1,406	0,281	0,508	1,830
Mărculești town	1,336	2,516	0,503	0,832	1,986
Glodeni town	1,225	2,235	0,447	0,820	1,915
Ocnița town	0,541	1,030	0,206	0,328	1,252
Frunză town	0,925	1,589	0,318	0,575	1,491
Otaci town	0424	0,747	0,149	0,225	1,011
Rîșcani town	0,721	1,231	0,246	0,324	1,359
Costești town	1,268	2,214	0,443	0,865	1,720
Sîngerei town	0,920	1,433	0,287	0,515	1,662
Biruința town	0,570	1,010	0,202	0,347	1,087
Soroca town	0,693	1,336	0,267	0,333	1,554

Source: elaborated by the authors using JASP software.

The validity of this ranking is confirmed by the convergence of the metrics employed, each providing a specific perspective:

- Gower Distance – indicates a balanced distribution of performance. The low values for Otaci (0.149) and Drochia (0.157) suggest mature infrastructural systems;
- Euclidean and Manhattan Distances – highlight the magnitude of the gaps. In the case of Lipcani, the Manhattan value of 2.514 signals an accumulation of critical structural handicaps;
- Mahalanobis Distance – confirms the consistency of the municipal system. The values for Briceni (0.789) and Drochia (0.732) attest to a systemic evolution of the indicators;
- Chord Distance – reflects differing investment priorities. For instance, Biruința (0.347) and Ocnița (0.328) present similar scores but possess distinct infrastructure supply structures.

Based on these data, the formation of three homogeneous groups is observed, which maintain their hierarchical positions regardless of the metric applied:

- ✓ High-Performance Group (Otaci, Drochia, Ocnița, Biruința, and Briceni): These form the core of statistical stability, exhibiting the highest degree of similarity to the benchmark model.
- ✓ Medium-Performance Group (Dondușeni, Rîșcani, Soroca, and Sîngerei): This group reflects a consolidation stage, albeit with asymmetries that require targeted investments.
- ✓ Structural Disparity Group (Lipcani, Mărculești, Glodeni, and Costești): This cluster stands out due to maximum distance values, indicating chronic deficiencies across most of the analyzed indicators.

For an in-depth interpretation of proximity relationships, the distance matrix was graphically transposed into a hierarchical tree based on the Neighbor-Joining algorithm (Figure 1).

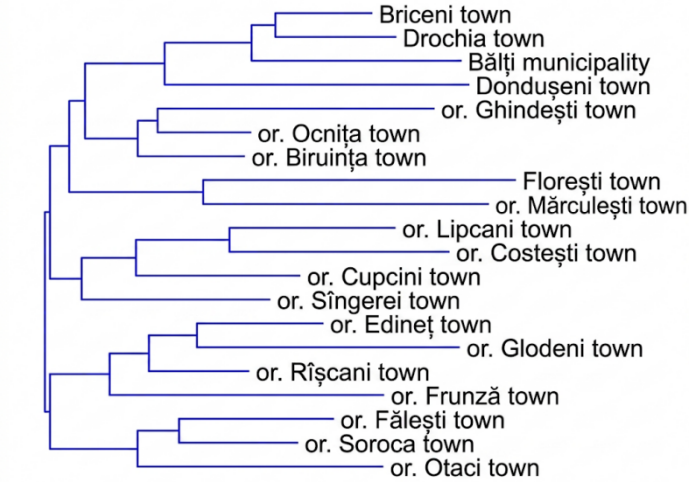

Figure 1. Hierarchical Tree of Infrastructural Proximity (Neighbor-Joining Algorithm based on Mahalanobis Distance).

Source: Elaborated by the authors using JASP software.

The use of Mahalanobis distance in this model is essential, as it eliminates informational redundancy by weighting the correlations between indicators, thus providing a faithful representation of structural similarity. The visual analysis of the hierarchical configuration reveals the following fundamental aspects:

- Validation of the Benchmark Core: A primary, extremely short branching is observed between the municipality of Bălți and the towns of Briceni and Drochia, confirming their convergence toward the maximum performance model.
- Structure of the Resilience Group: Cities such as Ocnița, Biruința, and Dondușeni are clustered on adjacent branches, demonstrating a synchronized trajectory of infrastructural development.
- Highlighting Territorial Anomalies: Localities positioned on the longest and most isolated branches (e.g., Lipcani, Costești) reflect not only a quantitative deficit but also a public service architecture that is profoundly divergent from regional standards.

Conclusions

1. Polarized Competitive Advantage: Competitive advantage in technical-municipal infrastructure within the Northern Development Region is highly polarized, with only a narrow core of cities (Otaci, Drochia, Briceni) significantly approaching the benchmark model represented by the municipality of Bălți.
2. Structural Convergence vs. Statistical Proximity: Statistical proximity to a reference center does not guarantee actual structural convergence; cities with similar distances may exhibit completely different infrastructure profiles, reflecting distinct investment trajectories.
3. Systemic Reinforcement of Deficits: Infrastructural deficits do not manifest in isolation but are systemically self-reinforcing—a city with poor sewerage connectivity typically exhibits reduced access to gas networks or green spaces, creating structural development traps.
4. Resilience and Quantitative Disparities: Quantitative differences in municipal provisions translate into qualitative differences in territorial resilience; cities with chronic disparities (Lipcani, Mărculești, Costești) are more vulnerable to demographic and economic shocks.
5. Strategic Diagnostic through Triangulation: The triangulation of statistical metrics (Euclidean, Manhattan, Gower, Chord, and Mahalanobis) transforms descriptive ranking into a strategic

diagnostic, allowing for the precise identification of gap types and providing the foundation for regional cohesion policies tailored to each city category.

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