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ANALYZING SPATIAL DISPARITIES IN THE DISTRIBUTION OF PUBLIC FACILITIES AND SERVICES: A GIS–MCA ASSESSMENT IN TISSEMSILT PROVINCE, ALGERIA

Abstract: This study assesses spatial disparities in the distribution of public facilities across the 22 municipalities of Tissemsilt, an interior province in western Algeria, for the period 2008–2020. Despite national planning efforts, interior regions continue to exhibit pronounced territorial imbalances. The study employs a robust methodological framework coupling Geographic Information Systems (GIS) and Multi-Criteria Analysis (MCA) to evaluate 20 indicators across six essential sectors: education, health, trade, culture, sports, and tourism. A composite Global Index (IG) was constructed to synthesize sectoral performance, and a Spearman Rank Correlation test was applied to statistically validate the systemic nature of these disparities. The results reveal a persistent core–periphery dichotomy, where administrative centers concentrate the majority of services while peripheral and mountainous municipalities remain structurally marginalized. Although 17 out of 22 municipalities showed a relative improvement in their ranking by 2020, the strong correlation ($p<0.01$) between deficits in health and education confirms that inequalities are deeply structural. Beyond this case study, the proposed GIS–MCA approach offers a replicable diagnostic framework for monitoring Sustainable Development Goals (SDGs) at a micro-regional scale. These findings provide critical insights for policymakers in the Global South to transition from administrative-based allocation toward evidence-based territorial equity.

Keywords: spatial disparities, GIS–MCA, territorial equity, public facilities, Spearman correlation, Tissemsilt

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Introduction

In the contemporary global landscape, achieving territorial equity remains a major challenge for developing countries, including Algeria. Despite the strategic objectives outlined in the National Spatial Planning Scheme (SNAT, 2010), which aims to promote social justice and regional balance through localized development frameworks, spatial inequalities continue to intensify (Aibeche et al., 2023). These disparities are not merely geographic incidents; rather, they constitute a structural constraint to economic development and citizen well-being (Chenini & Zenasni, 2021). In many cases, such imbalances stem from deep-rooted historical trajectories and unequal distribution of resources during national development transitions (Andreas, 2024).

The province of Tissemsilt, located in Algeria's western interior, illustrates these territorial challenges with particular clarity. Identified by the National Agency for Spatial Planning (ANAT, 2006) as one of the country's most vulnerable regions, it continues to face persistent underdevelopment and marked spatial divides between municipalities. Based on 18 socio-economic indicators related to education, health, and income, nearly 40.9% of its municipalities fall below minimum service thresholds compared to national averages (Abdelhadi, 2011). This structural deprivation has contributed to substantial internal migration flows toward urban plains, generating unsustainable demographic pressures on existing public facilities (PNUD & ANAT, 2011). As a result, urban centers now accommodate approximately 66.71% of the province's 362,229 inhabitants (DPSB, 2020).

This study seeks to evaluate spatial disparities among the municipalities of Tissemsilt by quantifying their levels of public service provision through a multifactorial model based on synthetic indicators (Ouahiba et al., 2022; Hamadène & Bouder, 2024). The methodological framework integrates a GIS–MCA coupling and incorporates statistical validation using Spearman rank correlation matrices (Azzini & Munda, 2025; Francesca et al., 2024), ensuring the robustness of the analysis. Considering that monetary-based approaches to local disparities are often constrained by data limitations, this research adopts a non-monetary perspective aligned with Algeria's national poverty mapping methodology (Ministry of National Solidarity, 2006). This framework enables a realistic diagnosis of territorial imbalances and provides relevant insights for sustainable spatial planning.

The study is grounded in a diverse body of national and international literature addressing the multifaceted nature of spatial disparities. This includes work on the contribution of transportation networks to regional development (Hamza et al., 2023; Pritchard et al., 2019; Lee et al., 2024), the spatial equity of educational services as a factor of social advancement (Juan Manuel et al., 2023; Mohammed et al., 2020), and the quantitative assessment of infrastructure quality (Asma & Ahcene, 2022; Li et al., 2024; Josan et al., 2024). Methodologically, the research draws on multi-criteria assessment frameworks previously applied in urban flood management and spatial–environmental analyses (Noredine & Marzouk, 2022; Souad, 2021). By focusing on Tissemsilt—a marginalized "shadow zone" (*zones d'ombre*) that has received limited scholarly attention—this study extends beyond a local case analysis. It offers a replicable diagnostic tool for territorial planners in the Global South to identify "statistical laggards" and optimize resource allocation. Ultimately, this work contributes to the broader scientific debate on how multidimensional indicators can facilitate the transition toward balanced and resilient territorial development beyond specific local contexts.

Study area

The Province of Tissemsilt is situated in the central-northwestern region of Algeria, between 30° and 32° north latitude and 0° and 3° east longitude. The geographical location and administrative boundaries of the study area are illustrated in Figure 1. It occupies a strategic position within the Western High Plateaus, serving as a natural transition zone between the Cirso Plateau and the Chlef Valley. The region is topographically diverse, bordered to the north by the Ouancheries forests and to the south by Mount Nador. Covering a total area of 3,151.37 km², the province shares administrative borders with the provinces of Chlef and Ain Defla to the north, Tiaret and Djelfa to the south, Medea to the east, and Relizane to the west (Directorate of Tourism and Traditional Industry, 2021).

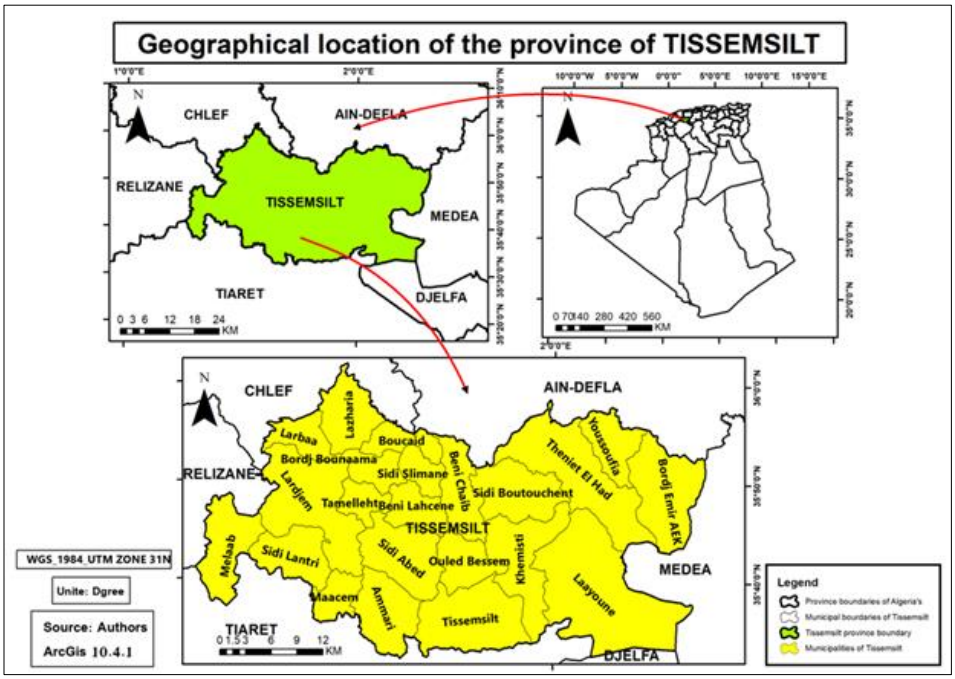

Fig. 1. Study area of Tissemsilt Province

Demographically, Tissemsilt has undergone significant growth. The population increased from 294,476 inhabitants in 2008 (ONS, 2008) to approximately 362,229 in 2020 (State Statistical Guide, 2020), representing an average annual growth rate of 1.74%. However, as shown in the administrative mapping (Figure 1), this demographic expansion exhibits a profound spatial imbalance. Population density is heavily concentrated in only six major urban centers, which together account for over 69% of the total provincial population. Conversely, the remaining 18 municipalities support only 31% of the population. This asymmetric distribution reflects a strong trend toward urban polarization, as residents gravitate toward administrative centers and district headquarters equipped with superior infrastructure and higher-quality services, while distancing themselves from marginalized "shadow zones" (zones d'ombre).

Materials and Methods

Methodological Framework: GIS–MCA Integration

Measuring socio-spatial disparities in Algeria remains a complex challenge due to the scarcity, fragmentation, and heterogeneity of available territorial data. These constraints, as highlighted by Oudina et al. (2022), can significantly reduce the reliability and robustness of conventional statistical approaches. In response, this study adopts an integrated Geographic Information Systems (GIS) and Multi-Criteria Analysis (MCA) framework. This coupling is widely recognized in regional planning research for its capacity to integrate diverse datasets, address multidimensional phenomena, and produce spatially explicit decision-support outputs (Malczewski., 2006).

The GIS–MCA integration enhances analytical rigor by coupling quantitative ranking procedures with spatial interpretation. MCA is particularly well-suited for evaluating complex socio-economic systems where decision-making relies on multiple, often non-commensurable criteria (Munda; 2004). In the Algerian context, this approach facilitates a structured diagnosis of territorial imbalances while ensuring consistency with national planning instruments, notably the National Spatial Planning Scheme (SNAT) and the Regional Spatial Planning Schemes (SRAT). This methodological transition allows the study to move beyond purely descriptive mapping toward a rigorous, evidence-based tool for territorial evaluation.

The overall sequence of the analytical steps, from data collection and preprocessing to multi-criteria aggregation and spatial visualization, is summarized in the conceptual framework presented in Figure 2.

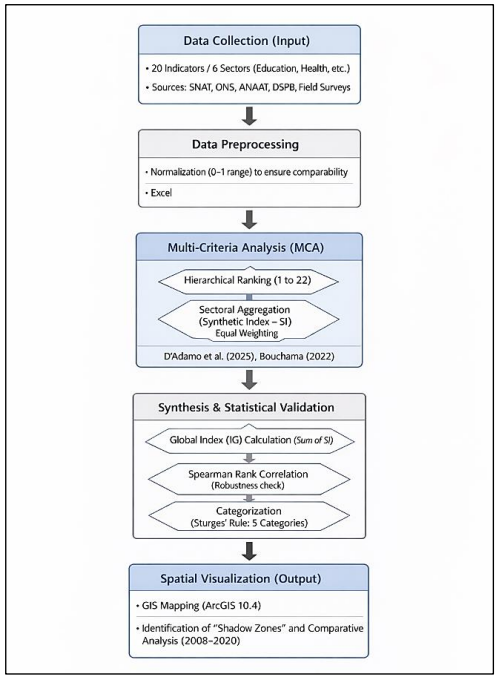

Fig. 2. Conceptual framework of the integrated GIS–MCA methodology

Indicator Selection and Data Sources

Twenty indicators across six sectors (Education, Health, Trade, Culture, Sports, Tourism) were selected following the UNESCO (2009) framework (Table 1). Emphasis was placed on Education (9 indicators) and Health (5 indicators), key drivers of socio-economic development (Mohammed et al., 2020; OECD, 2010). Data were triangulated from official sources: SNAT (2010–2030), Provincial Plan (ANAT, 2012), RGPH census (2008), and the Tissemsilt Statistical Guide (DPSB, 2020), complemented by field surveys with local authorities.

Table 1. Criteria and indicators used to analyze the spatial disparities in the municipalities of Tissemsilt governorate

Nature of the standards	Index number	Indicator name
Educational	01	Schooling rate (primary and middle school) Number of students in both levels / School-age population (6-15 years old)
	02	Schooling rate (secondary) Number of students in secondary school/number of school-age population (15-19 years)
	03	Staffing ratio (primary) Number of pupils/number of teachers
	04	Classroom occupancy rate (primary) Number of students/number of classrooms
	05	Framing rate (middle school) Number of students/number of teachers
	06	Classroom occupancy rate (middle school) Number of students in middle school/number of classrooms
	07	Framing rate (secondary level) Number of students in the secondary level / Number of teachers
	08	Classroom occupancy rate (secondary level) Number of students in the intermediate level/number of classrooms
	09	Illiteracy rate for adults 10 years and older
Health	10	Number of General Doctors / 1000 inhabitants
	11	Number of Specialized Doctors / 1000 inhabitants
	12	Number of pharmacists / 1000 inhabitants
	13	Number of Dental surgeons / 1000 inhabitants
	14	Number of hospital beds / 1000 inhabitants
Commercial	15	Shops per capita (number of shops/1000 inhabitants)
Sportif	16	Multisports halls / 1000 inhabitants
	17	Neighborhood playgrounds / 1000 inhabitants
Touristic	18	Hotel beds / 1000 inhabitants
Cultural	19	Library / 1000 inhabitants
	20	Cultural center /1000 inhabitants

Weighting and Hierarchical Ranking Procedure

Weight assignment is a critical step in multi-criteria evaluation. To ensure transparency and avoid subjective bias, this study adopts an equal weighting approach, consistent with recent Algerian research (Ouahiba, B et al., 2022; Hamza, B et al., 2023), This is a view supported by previous literature (OECD., 2008). and recommended by D'Adamo et al. (2025a, 2025b) when official priorities are unavailable. This approach ensures territorial neutrality and reproducibility.

The hierarchical ranking follows three steps:

1. Individual Ranking: Each municipality (C) is ranked from 1 (best equipped) to 22 (least equipped) for each indicator *Ii*.
2. Sectoral Aggregation: A Synthetic Index (SI) is calculated for each sector.

$$SI_{(sector)} = \sum_{i=1}^{n} Rank(I_i) \quad (1)$$

3. Global Index (IG): The overall variance index sums ranks across all six sectors.

$$IG = \sum_{i=1}^{6} \mathrm{SI}_{\mathrm{Cti}} \quad (2)$$

Categorization of Municipalities

Municipalities were grouped into homogeneous categories using the Sturges equation to determine the number of classes (*K*):

$$K = 1 + (3.322 \times \log_{10}(20)) \approx 5 \text{ classes} \quad (3)$$

The class width (*W*) as calculated as:

$$W = \frac{\text{Maximum value} - \text{Minimum value}}{\mathrm{K}} = \frac{255 - 158}{5} \approx 19 \quad (4)$$

Five levels were defined: (I) Best-equipped, (II) Acceptably-equipped, (III) Moderately-equipped, (IV) Below-average, and (V) Weakest-equipped.

This classification provides an objective spatial diagnosis consistent with Algerian standards and SNAT guidelines.

Statistical Validation and GIS Visualization

To ensure the robustness of the ranking, a Spearman Rank Correlation analysis was performed. As emphasized by Azzini and Munda (2025), correlation analysis between model inputs is essential for ensuring methodological consistency. Finally, results were spatialized using ArcGIS 10.4 to generate comparative maps for 2008 - 2020, facilitating interpretation of territorial gaps.

Results

Synoptic Ranking and Global Inequality Index (IG)

The application of the Multi-Criteria Analysis (MCA) resulted in the Global Inequality Index (IG) for the year 2020, providing a comprehensive ranking of the 22 municipalities of Tissemsilt (Table 2). According to the model's logic, municipalities with lower cumulative scores represent the most developed and well-equipped territories. Youssoufia ranks first

(IG = 158), followed by Theniet El Had (161) and Melaab (165). These municipalities consistently display low ranks across education, health, and commercial indicators, reflecting a relatively balanced provision of essential services. In contrast, Tamellahet (255), Beni Lahcene (234), and Sidi Abed (223) occupy the lowest positions, indicating severe deficits in service availability and accessibility.

Table 2. Ranking of municipalities according to public facilities and service indicators in the state of Tissemsilt in 2020

A: Education indicators; B: Health indicators; C: Commercial indicators; D: Sports indicators; F: Tourism indicators; E: Cultural indicators; T: total points; R: synthetic rank.

Synoptic table

Municipalities	A									B					C	D		F	E		T IG	R
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20		
Youssoufia	3	13	5	16	8	6	13	13	13	13	4	1	4	1	18	10	11	2	2	2	158	1
Theniet el had	21	8	6	14	4	3	7	4	17	1	4	4	2	1	2	9	15	2	20	17	161	2
Melaab	6	13	13	11	9	16	13	13	11	3	4	6	7	3	15	10	3	2	4	3	165	3
Boucaid	4	2	16	10	17	8	2	12	1	16	4	10	21	3	4	10	4	2	13	11	170	4
Ammari	14	11	12	9	16	10	3	3	7	5	4	8	9	2	7	2	19	2	11	17	171	5
Larbaa	7	13	22	1	21	9	13	13	6	12	4	17	3	3	14	10	2	2	1	1	174	6
S.Boutouchent	2	13	18	4	10	2	13	13	20	10	4	11	11	1	17	10	6	2	6	5	178	7
Sidi slimane	17	1	11	12	22	1	5	10	12	9	4	9	20	3	10	3	7	2	12	10	180	8
Lazharia	20	5	10	8	13	7	1	5	10	14	4	3	19	3	9	10	18	2	10	9	180	9
Beni chaib	5	13	17	7	1	22	13	13	3	15	4	17	6	3	11	10	1	2	3	17	183	10
Khemisti	15	7	4	19	5	19	8	1	2	11	4	12	17	2	6	6	14	2	19	15	188	11
Lardjem	18	3	9	18	7	15	9	8	4	6	4	13	8	3	3	7	21	2	17	13	188	12
Laayoune	13	6	7	13	2	21	6	6	5	8	4	7	16	11	5	10	16	2	15	17	190	13
Tissemsilt	19	9	2	21	6	17	12	07	19	4	2	5	5	2	1	8	13	1	21	16	190	14
Bordj emir AEK	16	10	1	20	19	5	11	2	8	7	4	16	14	1	12	4	12	2	14	12	190	15
Bordj bounaama	22	12	8	15	11	18	4	11	22	2	3	2	1	3	2	5	20	2	18	14	195	16
Maacem	1	13	15	6	14	12	13	13	15	20	4	17	13	2	13	10	9	2	8	7	207	17
Sidi lantri	10	13	19	2	18	4	13	13	14	21	4	17	15	3	13	10	8	2	9	8	216	18
Ouled bessem	9	4	3	17	12	13	10	9	16	17	4	14	22	2	8	10	17	2	16	17	222	19
Sidi abed	8	13	20	3	3	20	13	13	21	19	4	17	12	2	20	10	10	2	7	6	223	20
Beni lahcene	12	13	21	22	20	14	13	13	18	18	4	17	10	3	19	1	5	2	5	4	234	21
Tamellahet	11	13	14	5	15	11	13	13	9	22	4	15	18	3	16	10	22	2	22	17	255	22

Source: Authors

Categorization of Development Levels

Based on the Sturges formula, the IG values were classified into five distinct categories to delineate homogeneous territorial profiles (Table 3). The distribution is structured as follows:

- **Category I –** Best Equipped: 6 municipalities (27% of the total), largely corresponding to major administrative and semi-urban centers.
- **Category II –** Acceptably Equipped**:** 10 municipalities (45%), forming the largest cluster and representing intermediate, relatively stable localities.
- **Categories III–V –** Average to Poorly Equipped: 6 municipalities (28%), characterized by structural marginalization and a lack of service diversification.

This classification highlights a significant asymmetric distribution of public services, where a limited number of central municipalities concentrate the majority of the province's infrastructure, while the peripheral zones remain underserved.

Table 3. Classification of municipalities based on the level of public facilities and services (2020)

Categories	Category limits in numbers	Level of Service Provision	Frequency (N)	Municipalities
I	158-177	Best Equipped	6	Youssoufia - Theniet El Had – Melaab –Boucaid-Ammari-Larbaa
II	177-196	Acceptably Equipped	10	Sidi Boutouchent - Sidi Slimane - Lazharia - Beni Chaib - Khemisti - Lardjem -Laayoune Tissemsilt – Bordj Emir Abedelkader-Bordj Bounaama
III	196-216	Average Level	2	Maacem-Sidi Lantri
IV	216-235	Below Average	3	Ouled Bessem - Sidi Abed - Beni Lahcene
V	235-255	Poor Level	1	Tamellahet

Source: Authors' elaborations

Statistical Validation: Spearman Rank Correlation Analysis

To ensure the methodological robustness of the GIS–MCA approach and validate the internal consistency of the results (Azzini & Munda, 2025), a Spearman Rank Correlation matrix (r_s) was calculated to examine the associations between the six primary sectors and their contribution to the Global Inequality Index (IG). The results, detailed in Table 4, demonstrate that the IG is strongly and significantly correlated with the two fundamental pillars of the study: Health (r_s=0.619, p=0.002) and Education (r_s=0.541, p=0.009). These correlations, significant at the 0.01 level, confirm that these two sectors act as the primary explanatory variables and pivotal drivers of territorial disparities within the province of Tissemsilt. Interestingly, the correlation between the Education and Health sectors themselves is statistically negligible (r_s=0.027, p=0.905). From a methodological perspective, this lack of internal redundancy is a critical finding; it proves that these two dimensions capture distinct and independent facets of territorial equipment, thereby justifying the use of a multi-criteria model to encompass the complexity of the phenomenon. Furthermore, this dimensional independence reinforces the decision to adopt an equal weighting approach, as it prevents the model from over-representing a single developmental trend and ensures a balanced representation of non-commensurable services.

Concomitantly, the matrix reveals a very strong positive correlation between the Commercial and Cultural sectors (r_s=0.722, p<0.001) and between the Cultural and Sports sectors (r_s=0.607, p<0.01). This "infrastructure clustering" indicates a clear polarization of leisure and economic facilities within specific urban hubs, notably those classified in Cate-

gories I and II. It suggests that in municipalities where commercial dynamism is established, cultural and sports facilities are systematically co-located, further intensifying the "administrative centrality" effect. Conversely, the analysis identifies moderate negative correlations, such as between Education and Commercial sectors (r_s=−0.411, p=0.057). Although these values do not reach the strict 0.05 significance threshold, they reflect a localized spatial mismatch or functional specialization; while educational facilities are distributed according to demographic and residential logic, commercial and tourism infrastructures follow specific economic or natural potentials.

In summary, the Spearman correlation analysis confirms that territorial inequalities in Tissemsilt follow a systemic and non-random structure. The strong association of the primary pillars with the final ranking, combined with the clear clustering of secondary facilities, provides a robust statistical foundation for the hierarchical classification of municipalities. This validation moves the study beyond a purely descriptive framework toward a rigorous diagnostic tool, confirming the reliability of the Global Index (IG) as a synthetic measure of socio-spatial inequality.

Table 4. Spearman's rank correlation matrix (rs) between sectoral averages and the Global Index (IG).

Sectors	Education	Health	Commercial	Sports	Tourism	Cultural	IG
Education	1.000						
Health	0.027	1.000					
Commercial	-0.411	0.362	1.000				
Sports	-0.266	-0.061	-0.399	1.000			
Tourism	-0.258	-0.293	-0.361	-0.086	1.000		
Cultural	-0.272	0.000	0.722**	0.607**	-0.310	1.000	
IG	0.541**	0.619**	0.176	0.186	-0.086	0.248	1.000

* Significant at p < 0.05; ** Significant at p < 0.01 (2-tailed). N = 22

Spatio-Temporal Evolution and Distribution Analysis (2008–2020)

The proportionate distribution of municipalities is summarized in Figure 3. However, the spatial patterns displayed in Figures 4 and 5 provide a deeper comparative perspective.

These maps show that, despite a general increase in public facilities since 2008, the structural divide between urban administrative centers and peripheral rural municipalities remains persistent. While a general upward shift in ranking is observed, with 17 out of 22 municipalities (77%) improving their relative equipment status, the spatial hierarchy remains remarkably stable. The results illustrate a "spatial inertia" where the core-periphery gap remains statistically significant over the 12-year period, confirming that territorial inequalities follow a systemic pattern.

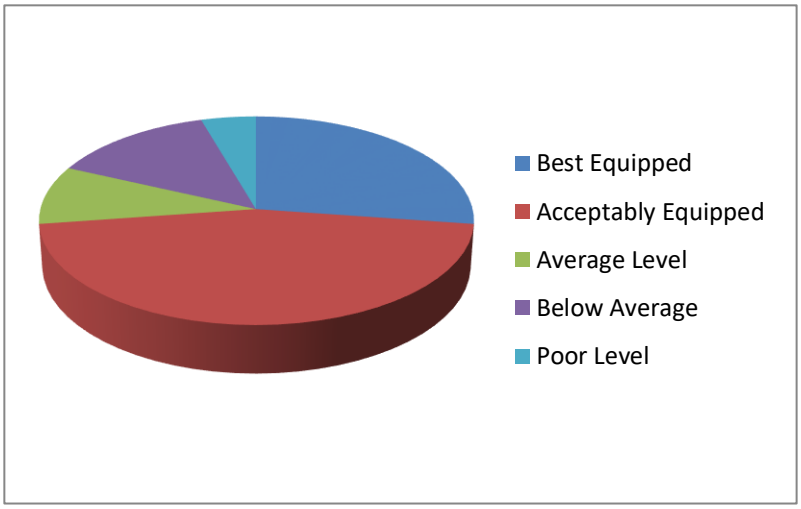

Fig.3. Distribution of Tissemsilt municipalities by development category in 2020

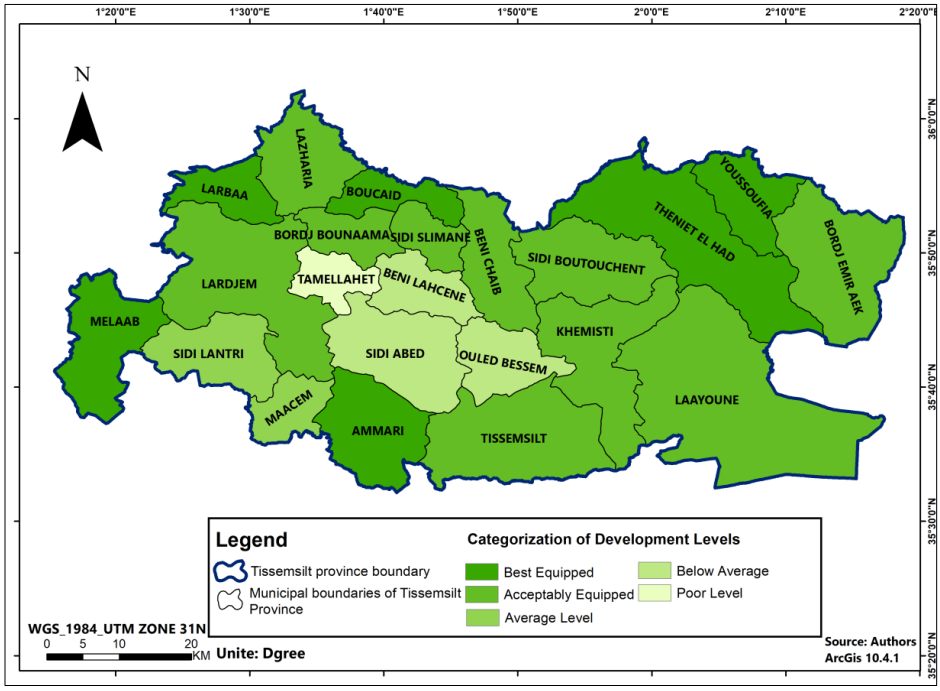

Fig. 4. Spatial distribution of public service equipment levels in 2020 (Categories I to V)

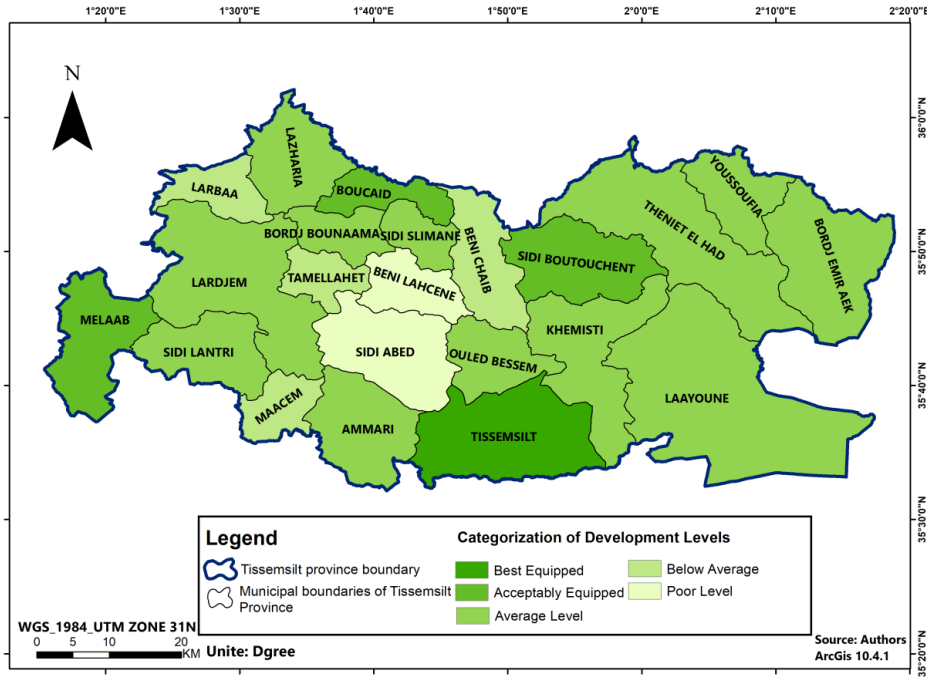

Fig. 5. Spatial distribution of public service equipment levels in 2008 (Baseline)

Discussion

Drivers of Spatial Disparities: Administrative Centrality

The findings clearly demonstrate a pronounced "core–periphery" structure in Tissemsilt. Municipalities ranked in Categories I and II are overwhelmingly administrative headquarters (*chefs-lieux de daïra*)—notably Tissemsilt, Khemisti, and Theniet El Had. Their superior ranking is directly attributed to their institutional role as nodes of public investment and centralized infrastructure. This concentration follows the logic of urban dynamism, where administrative hierarchy acts as a catalyst for service provision, a trend consistent with the findings of Nahal et al. (2022) in Setif and the broader theories of urban concentration.

Structural Marginalization and the Legacy of "Shadow Zones"

The extreme marginalization identified in Categories IV and V reflects a long-term territorial lag. Tissemsilt historically occupies the penultimate rank (47th out of 48) in national poverty indices. This structural underdevelopment, illustrated by the vulnerable conditions in Beni Lahcene and Tamellahet (Figure 6), is shaped by three intertwined factors:

1. Geography and Isolation: The mountainous nature of the North-West and South-East regions increases the technical cost of infrastructure delivery, reinforcing a "spatial mismatch" between population needs and service provision.
2. Historical Insecurity (1989–2000): The period of instability during the 1990s halted development in rural communes, deepening spatial exclusion. Tamellahet (IG = 255) epitomizes this legacy, currently depending on neighboring centers to meet basic needs.

3. Migration-Induced Pressures: Rural-to-urban migration has created a dual burden. While peripheral areas suffer from depopulation, peri-urban centers like Ouled Bessem (IG = 222) face significant demand pressures. Despite its proximity to the capital, Ouled Bessem faces challenging conditions as infrastructure growth cannot keep pace with the massive demographic influx.

Fig. 6. Examples of infrastructure challenges in Category IV and V Municipalities: Beni Lahcene and Tamellahet (Source: Authors)

Interpretation of Progress and Lessons for Algerian Planning

A key finding is the upward mobility of certain municipalities; five localities rose from Category III (2008) to Category II (2020) (Figure 7). This progress is largely explained by their promotion to district headquarters and subsequent access to targeted development funds. This suggests a broader lesson for Algerian planning: infrastructure allocation must transition from a model based solely on population size toward one based on territorial equity. The recent supplementary program (2022) targeting "shadow zones" (*zones d'ombre*) is a positive step. However, planning instruments like the SNAT must integrate micro-regional diagnostics to prevent "administrative status" from being the sole driver of development.

Fig.7. Examples of urban development in Category I and II Municipalities (Source: Authors)

Methodological Robustness and the Rationale for Equal Weighting

The adoption of an equal-weighting scheme for the twenty indicators is statistically justified by the territorial patterns observed in the province. The Spearman rank correlation matrix (Table 4) provides clear empirical support for this choice. The Global Index (IG) shows a high degree of association with the primary pillars of Health and Education, confirming that these sectors act as the fundamental engines of spatial disparity in Tissemsilt.

As emphasized by D'Adamo et al. (2025b), in the absence of national priority coefficients, assigning equal weights remains the most neutral and transparent option, preventing a 'dictator effect' where a single dimension might disproportionately bias the final output. Furthermore, the systemic nature of marginalization whereby deficits in one domain often co-occur with shortages in others underscores the indivisible nature of public services. This multidimensional alignment validates the robustness of our model and ensures that the final ranking provides a realistic representation of structural territorial inequalities.

Critical Appraisal and Study Limitations

First, the temporal scale relies on a comparison between 2008 and 2020, which may not capture very recent fluctuations in local investments. Second, the spatial scale is limited to the communal level; a more granular analysis at the village or hamlet level might reveal deeper intra-municipal inequalities. Furthermore, the Global Index (IG) assumes a linear contribution of indicators, a simplification that might overlook non-linear "synergy effects" between services. Finally, the reliance on non-monetary data, while necessary, excludes household income variables that could further enrich the poverty profile.

Broader Significance and International Relevance

Beyond Tissemsilt, this research offers a replicable methodological framework for other regions in the Global South facing territorial inequality. The integration of GIS with hierarchical MCA aligns with emerging international approaches used to monitor spatial disparities and progress toward the Sustainable Development Goals (SDGs). This approach facilitates a transition from descriptive reporting toward evidence-based spatial planning, allowing policymakers to identify "statistical laggards" and optimize resource distribution.

Conclusion

This study evaluated spatial disparities in public facilities across the province of Tissemsilt between 2008 and 2020. The results confirm a persistent structural imbalance, wherein administrative centers continue to benefit from superior equipment levels compared to isolated mountainous municipalities. While a general improvement in equipment was recorded with 17 out of 22 municipalities rising in rank the entrenched core periphery divide remains a major obstacle to territorial cohesion and social equity.

Beyond the specific case of Tissemsilt, this research carries significant broader implications for regional planning in developing countries. We have demonstrated that the integration of Geographic Information Systems (GIS) with a hierarchical Multi-Criteria Analysis (MCA) scientifically validated through Spearman correlation tests provides a robust and neutral diagnostic tool. By shifting the analysis from descriptive observation toward evidence-based spatial decision-making, this framework enables planners to monitor Sustainable Development Goals (SDGs) at a micro-regional scale and evaluate the spatial coherence of public investments.

The study recommends that public authorities transition from sector-based interventions to integrated territorial strategies, specifically targeting identified "shadow zones" (*zones d'ombre*) to mitigate rural depopulation and reduce urban pressure. Ultimately, the proposed analytical framework is replicable in other interior regions of the Global South. It provides a transparent, needs-based model to ensure that public resources are allocated

according to measurable territorial gaps rather than administrative hierarchy, thereby fostering more balanced, equitable, and resilient territorial systems.

Conflicts of Interest: The authors declare no conflict of interest.

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