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# MEASURING SPATIAL SEGREGATION OF ROMA NEIGHBORHOODS IN URBAN SETTLEMENTS: CASE STUDY OF RUSE, BULGARIA

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**Abstract:** Post-socialist European cities face many challenges, such as growing socioeconomic inequality, spatial polarization, and a lack of sustainability. The rise of Roma ghettoized quarters in the cities imperatively imposes comprehensive research on the origin, evolution, and significance of these areas in the urban fabric. These ghettoized neighborhoods deepen the social, economic, and spatial divisions between citizens and significantly influence urban development and policy. Adapting the model developed by Divyani Kohli and coauthors in 2012, this study proposes a modified conceptual framework and index for assessing the spatial segregation of Roma neighborhoods in Bulgaria, using the four Roma settlements in the city of Ruse as a case. It aims to facilitate the elaboration of effective policies for integrated and sustainable urban development. The research utilizes quantitative and qualitative methods, including participant observation, in-depth interviews, and the analysis of normative documents, remote sensing, and geographic information systems (GIS), to collect detailed spatiotemporal data on Roma neighborhoods and calculate an index reflecting their urban design. Applying the index to the case of Ruse, the Selemetya neighborhood emerges as the most distinct and segregated Roma neighborhood, while the other three neighborhoods exhibit features of partial segregation. Despite the fact that the level of spatial segregation of Roma neighborhoods can be measured based on various approaches and criteria, the suggested index, despite its shortcomings, can be considered appropriate, although not universal, and therefore, the local specifics of deprived areas should be taken into consideration.

**Keywords:** ghettoization; segregation assessment; Roma population; urban development; Bulgaria

## 1. Introduction

Rapid urbanization confronts contemporary European cities with many challenges and opportunities, resulting in controversial changes in urban space. The most evident trends are the increasing social polarization and economic inequalities, resulting in growing spatial

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segregation (Musterd, 2005; Nieuwenhuis et al., 2020). The latter is not limited only to Western European cities; recently, it has become one of the main features of post-socialist cities (Marcińczak et al., 2014; van Ham et al., 2016). Węclawowicz (2002) states that the new social and spatial segregation patterns are mainly rooted in economic power manifested by post-socialist countries' old and new elites and income differentiations. Although there are significant differences between the former socialist countries and substantial changes in the intra-urban fabric, it can be argued that those cities are characterized by a lower housing segregation than in other European countries. This can be explained by the policies of the socialist period, which were mainly based on apparent social equality and weak income disparity. However, many authors, such as Marcińczak (2007), Sýkora (2009), Szelényi (1983), and Toušek (2011), point out that the above statements are not valid for all groups of residents, especially those who identify as Roma, and demonstrate the increase in their level of spatial and other forms of segregation in recent decades.

Segregated Roma neighborhoods are typical for post-socialist cities in many Eastern European countries: Bulgaria, Romania, Hungary, Slovakia, the Czech Republic, etc. (European Commission, n.d.). Various aspects of segregated Roma communities have been studied by numerous authors across Central and Eastern Europe and the Balkans. These studies address topics such as living conditions and the legalization of Roma housing in Serbia (Davinić, 2016; OHCHR-UN & SIPRU, 2020; Vuksanović-Macura & Macura, 2007). They also include case studies of selected informal Roma settlements in Serbia (Vuksanović-Macura, 2020), as well as marginalization, segregation, and ghettoization of the Roma in Romania (Berescu, 2011; Creţan & Turnock, 2008; Pop & Vincze, 2016; Vincze, 2019).

Studies have also explored the influence of environmental factors, social relations, and place attachment in Roma communities in Hungary (Málovics et al., 2019a, 2019b). A comparison of spatial marginalization of Roma communities in Bulgaria and Hungary has been conducted (Virág, 2018), as well as the research on access to transport infrastructure and services (Horňák et al., 2023). Finally, the impact of spatial segregation on social exclusion, poverty, and housing conditions in Slovakia has also been analyzed (Rochovská & Rusnáková, 2018). While all of the above-mentioned studies share some general Roma-related topics on ghettoization and exclusion, the current research stands out as being focused on the level of spatial segregation of Roma neighborhoods, and most importantly—can it be measured and how?

According to Francini (2013), the process of segregation is multi-layered, highly dependent on the researchers' standpoints, and jeopardizes the city's integrity, causing spatial, economic, and social inequalities. The Roma neighborhoods are often interpreted as a spatial and functional challenge in the urban space. They need support from the municipal budget to improve their living conditions, and in many cases, they reveal the inability of the authorities to deal with the accumulated problems. Virág (2018) summarizes that the challenges the segregated Roma neighborhoods confront are unsecured property tenure, limited or no access to social infrastructure, spatial segregation, a lack of safety and proper housing, and restricted accessibility. The low quality of housing available for the Roma and the gradual segregation of Roma housing estates are perceived as one of the main policy challenges for their integration (Slaev, 2007). When comparing the different conceptual frameworks for exploring, evaluating, and mapping the poor and exclusive neighborhoods, the following queries can be raised: "Where?" aims to determine the quarter's location within the urban

space (Kohli et al., 2012; Kuffer et al., 2016); "When?" explores their temporal evolution (Liu et al., 2019), and "What?" primarily deals with population issues and the development of infrastructure and services (European Commission, 2020; Horňák et al., 2023; Ilieva, 2022).

The Roma ethnic group, comprising 4.4% (266,720) of the Bulgarian population as of 2021, is the third largest ethnic group in the country after Bulgarians and Turks (National Statistical Institute of the Republic of Bulgaria [NSIRB], 2021a). However, due to various factors, including political, social, and psychological influences, many Roma individuals either adopt a different ethnic identity or avoid declaring their ethnicity during censuses. This phenomenon of "preferred ethnic identity" complicates the accurate determination of the Roma population and their spatial distribution (Marushiakova & Popov, 1997).

Over the past three decades, Roma neighborhoods in Bulgaria have expanded significantly, with the population concentrated in specific regions covering over 20% of the national territory (Ilieva, 2013). Today, more than 51% of the Roma population resides in urban areas, making the study and mapping of Roma neighborhoods crucial for their integration and societal inclusion. This issue is particularly pressing given Bulgaria's demographic decline and the increasing prominence of such structures in urban areas (Ilieva & Bardarov, 2020; Ilieva & Kazakov, 2019; Petkova, 2023a, 2023b). Two main challenges hinder research on Roma neighborhoods in Bulgaria: the lack of a clear, normatively established definition for the term and the scarcity of comprehensive, comparable data about these areas (Ilieva, 2019; Tomova & Stoytchev, 2021).

The study introduces a new dimension to international ghettoization research through a spatially oriented analysis that provides quantitative data on the degree of spatial isolation of Roma communities. While many previous studies have focused on the social and economic aspects of spatial marginalization, the present study demonstrates how the spatial distribution of these communities also contributes to their isolation. Incorporating physical space as a significant factor in the ghettoization process and applying the complex approach to the set of indicators allows us to advance previous research and existing indices and deepen the understanding of the peculiarities of Roma neighborhoods.

Therefore, the study aims to propose:

- modified conceptual framework based on the model of Kohli et al. (2012) with a set of indicators subordinated in 3 hierarchical levels for spatial segregation evaluation; and
- index for the assessment of the spatial segregation of Roma neighborhoods in Bulgarian cities (case study: Ruse) facilitating the elaboration of effective policies for integrated and sustainable urban development.

## 2. Case study

The city of Ruse ranks fifth in terms of population (124,787 people) after Sofia, Plovdiv, Varna, and Burgas, according to the last census (NSIRB, 2021b). Ruse is the administrative center of the Ruse district (NUTS 3) and the North Central region (NUTS 2) of Bulgaria and is the largest city located on the banks of the Danube River in the country. It is among the most important economic, cultural, educational, and transport hubs in Bulgaria, responsible for managing cross-border connections and interaction with Romania.

Ruse has a heterogenous ethnic structure. Bulgarians constitute 89.5% of the population, and there are more than 8% of Turks. Although the Roma population is only 1.1% of the city's population, it is concentrated in several different areas of the city (NSIRB, 2021a). Based

on the recommendations of local authorities and representatives of the Roma community, four quarters have been selected as the most typical: Selemetya, Druzhba 2, Traktsia, and Trite Galaba (Figure 1). The total area of the selected neighborhoods constitutes 6.3% of the urbanized residential area of the city, and unofficially 9.6% of the city's population that is an estimation made by experts, local authorities, and Roma leaders. As a rule, the Roma neighborhoods' attributes vary considerably regarding their location in the urban spatial structure. In addition, their location in the urban fabric determines the degree of physical and social segregation from the rest of the city. Specific features distinguish each of the selected Roma neighborhoods and reveal, to a different extent, the spatial patterns of the Roma neighborhoods in Bulgaria.

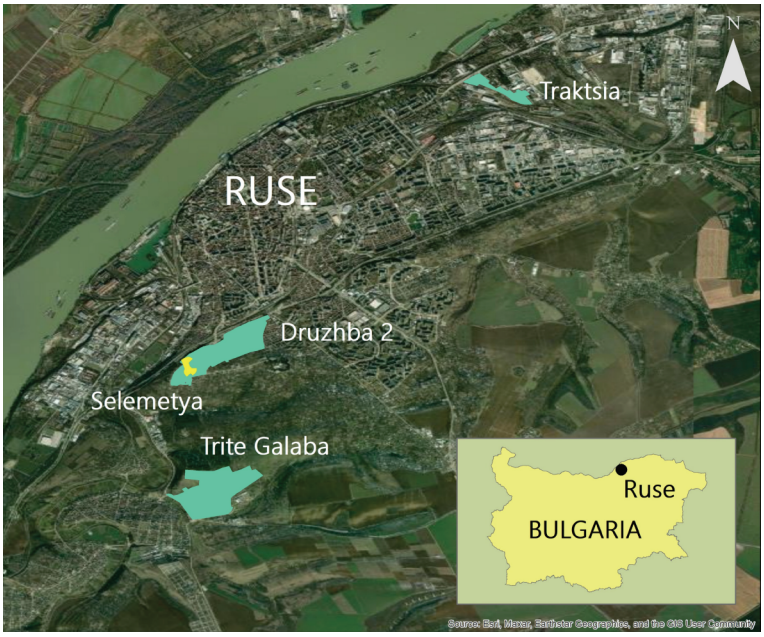


**Figure 1**. Location of selected Roma neighborhoods in the city of Ruse.

*Note.* Map source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, 2024.

## 3. Data and methods

The analysis and taxonomy of the four selected Roma neighborhoods have been done according to the generic slum ontology suggested by Kohli et al. (2012), and the conceptual framework identifies three hierarchically subordinated tiers that describe the urban structure: environs, settlement, and object. The ontology requires local adaptation as not all indicators are relevant for particular slum identification (Kuffer et al., 2016). In the study, the ontological framework by Kohli et al. (2012) has been modified, and the three main levels have been preserved, but with different labels—location, neighborhood, and dwellings. In addition, some supplementary indicators (considered to be typical descriptive features of Roma neighborhoods in Bulgaria) have been introduced to the model (Table 1).

**Table 1.** Primary and secondary indicators with values for four studied Roma neighborhoods in Ruse

| Level | | Indicator/ Neighborhood | Selemetya | Druzhba 2 | Trite Galaba | Traktsia |
|---|---|---|---|---|---|---|
| Primary indicators | Level 1 | Location in the urban space[1] | 2 | 2 | 3 | 2 |
| | | Access to school | 3 | 2 | 3 | 3 |
| | | School segregation[2] | 1 | 1 | 1 | 1 |
| | | Access to kindergarten | 3 | 2 | 3 | 1 |
| | | Access to public transport | 2 | 2 | 2 | 1 |
| | | Proximity to anthropogenic hazards and potential pollution sources | 2 | 2 | 2 | 3 |
| | Level 2 | Access to tap water | 2 | 2 | 2 | 2 |
| | | Population density | 3 | 3 | 1 | 3 |
| | Level 3 | Residential area per inhabitant | 3 | 1 | 2 | 1 |
| | | Share of buildings with no ownership documents | 3 | 3 | 1 | 2 |
| Secondary indicators | Level 1 | Access to emergency medical care | 3 | 3 | 3 | 3 |
| | | Access to outpatient care | 3 | 3 | 3 | 3 |
| | | Access to public parks | 3 | 3 | 3 | 2 |
| | | Natural hazard risk | 1 | 1 | 1 | 1 |
| | Level 2 | Road surface type | 2 | 1 | 1 | 1 |
| | | Proximity to major transport axes | 2 | 2 | 3 | 1 |
| | | Sewerage | 2 | 1 | 1 | 1 |
| | | Waste collection | 3 | 3 | 3 | 3 |
| | | Green areas for public use | 3 | 3 | 1 | 3 |
| | | Children's playground | 3 | 3 | 3 | 1 |
| | | Built-up area dynamics[3] | 3 | 2 | 1 | 1 |
| | | Spatial expansion[4] | 3 | 2 | 1 | 1 |
| | | Morphology of the urban space[5] | 3 | 2 | 1 | 2 |
| | | Open space for public use | 3 | 3 | 3 | 3 |
| | | Population dynamics | 1 | 1 | 1 | 1 |
| | | Housing and sectoral policies | 3 | 3 | 3 | 3 |
| | Level 3 | Built-up area density[6] | 3 | 3 | 1 | 3 |

*Note*. [1]Urban center; semi-periphery; periphery—location of the neighborhood; [2]Share of Roma students (100%; over 50%; less than 50%); [3]Measures the share of the built-up area of the total area of the neighborhood in the beginning and at the end of the selected period (2003–2023); [4]Measures the newly (from 2003 on) built-up area outside the limits of the neighborhood; [5]Measures the share of rectangular/chaotic street network in the neighborhood; [6]Measures the share of built-up area out of the total area of the neighborhood (%)

Population numbers and dynamics have been calculated based on 2009 and 2023 election data for the city of Ruse (Oblastna administratsia Ruse, n.d.; Rayonna izbiratelna komisia Ruse, n.d.; Tsentralna Izbiratelna Komisia, n.d.; Tsentralna Izbiratelna Komisia-rezultati ot izborite, n.d.), as well as the 2021 Census data for the share of population aged 0–17 by ethnicity (NSIRB, 2021b). Population density has been calculated based on the population number as of 2023 and the area of the neighborhood calculated in a GIS environment. Built-up areas and their dynamics have been calculated in a GIS environment, based on Google Earth Pro satellite

imagery for 2004 and 2024. All indicators referring to proximity (to the city center and social infrastructure, hazardous or potentially hazardous areas, etc.) have been calculated using the ORS tool in QGIS (isochrones from point/line). For the calculation of the residential area per inhabitant and share of buildings with no ownership stated, data from the Geodesy, Cartography, and Cadastre Agency (n.d.) are used. Supplementary data and information are gathered by content analysis of various strategic and planning documents (Integriran plan za gradsko vuzstanoviavane i razvitie na grad Ruse 2014–2020, 2013; Municipality of Ruse, 2021; 2022; Obsht gradoustroistven plan na grad Ruse, 2021; Obsht ustroistven plan na obshtina Ruse, 2020) and using qualitative research methods (participant observation, in-depth interviews with local authorities representatives, neighborhood residents, educational and health mediators).

The search for a measure to assess the level of spatial segregation of the Roma neighborhoods in the city of Ruse led to the introduction of the so-called index for spatial segregation assessment, ranging from 0.33 to 1; the higher the value of the index, the higher the level of spatial segregation observed. The index is calculated based on different components and using quantitative and qualitative methods (Table 1).

To develop the index for spatial segregation assessment, a total of 27 indicators have been used in the study, describing all the three of the suggested levels to a different extent. The largest numbers of indicators describe the neighborhood level—a total of 14 selected indicators, followed by location indicators (10) and dwelling indicators (3). However, the calculation of the level of segregation is not based on the above-mentioned three levels, but on the division of all the indicators into two categories: primary indicators (a total of 10) and secondary indicators (17)**.** Primary indicators are considered those that best describe typical features of segregated/deprived areas, while secondary indicators have been deemed to have less significance for assessing the segregation level of urban structures (city neighborhoods). The suggested formula below regards all primary indicators as equally important, regardless of their level (location, neighborhood, dwellings). The same applies to the secondary indicators. In other words, the difference in significance is only between primary and secondary indicators, and not between the individual indicators within the category itself. All the indicators initially receive a score between 1 and 3, depending on their actual values, where a score of 1 stands for the best values, 2 for average values, and 3 for the worst values. The calculation of the scores depends on the nature of the indicators; for example, the "access to kindergarten, school, public parks, etc." indicator receives a score of 1 in case the whole area of the given neighborhood is within the walking distance set by the legal regulations; score 2 in case the area of the neighborhood is only partially within the required distance to the kindergarten, school, etc.; and score 3 in case the entire area of the neighborhood is beyond the required distance set by the legal regulations (Table 1).

Each score value (1, 2, 3) represents a variable ($x$). Calculations aim to convert qualitative indicators into quantitative ones, and since the algorithm should be equally applicable to other neighborhoods/settlements, the grouping variables need to be done not by value but by type. The ratio between the number of primary and secondary indicators is approximately 40:60. Since the primary indicators ($lp$) must form a major part of the overall score, their weight ($Lp$) needs to be 75 out of 100, whereas secondary indicators ($ls$) are given a much smaller weight ($Ls$)—25 out of 100, thus balancing the ratio between the two categories of indicators. A modification of each indicator is further done by multiplying the weighting factor by the value of the variable ($x$) and by adding the value of the variable ($x$) to the resulting score.

The formula below aims to derive a segregation level (*Sl*) by dividing the sum obtained from all (∀) modified indicators ($S_{sum}$) and their maximum possible score ($S_{max}$):

$$S_{sum} = \sum lp\forall + \sum ls\forall \rightarrow Sl = \frac{S_{sum}}{S_{max}} \quad (1)$$

where $\sum lp = [lp\forall(x) \cdot Lp]$ is the sum of the scores of all the primary indicators; $\sum ls = [ls\forall(x) \cdot Ls]$ is the sum of the scores of all the secondary indicators; *Sl*—the spatial segregation level; $S_{sum}$—the final sum of the indicators scores; $S_{max}$—the maximum possible sum of the indicators' scores; *lp*—primary indicators; *ls*—secondary indicators; *Lp*—primary indicator's weight with a constant value of 2; *Ls*—secondary indicator's weight with a constant value of 0.5.

The value of the proposed index for spatial segregation assessment can only vary between 0.33 and 1. The following intervals of the whole range of the index represent the respective levels of spatial segregation, as follows:

- 0.33–0.55: Some to no segregation features are exhibited (lack to low level of spatial segregation);
- 0.56–0.77: Certain segregation features are exhibited (moderate level of spatial segregation);
- 0.78–1.00: Definitive features of segregation are exhibited (high level of spatial segregation).

## 4. Results

### *4.1. Analysis of four Roma neighborhoods according to the indicator scores*

This section provides a detailed comparative analysis of four Roma neighborhoods in the city of Ruse (Selemetya, Druzhba 2, Traktsia, and Trite Galaba), and is based on the selected indicators used for the computation of the spatial segregation index (Table 1). Each neighborhood's analysis follows a consistent framework, assigning scores to specific indicators structured into three levels: Location (Level 1), Neighborhood (Level 2), and Dwellings (Level 3).

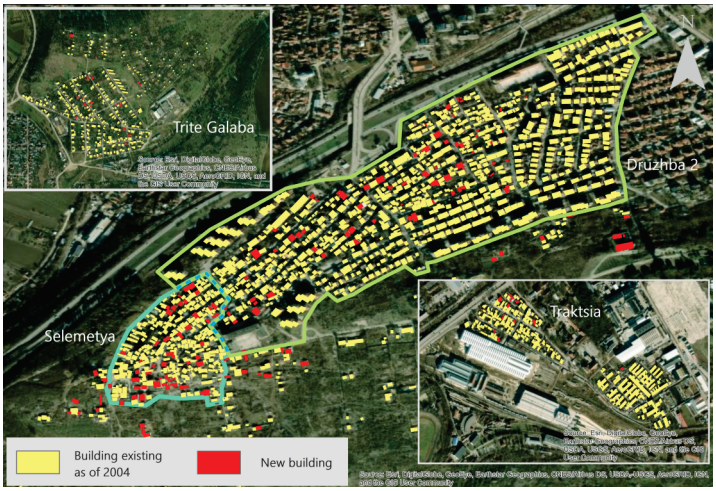


**Figure 2.** New construction in the selected Roma neighborhoods in Ruse for the period 2004–2024.
*Note.* Map source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, 2024.

The primary features that distinguish the four Roma neighborhoods are highlighted to provide an in-depth understanding of each neighborhood's unique context. And finally, the four neighborhoods under study in Ruse show different levels of spatial segregation according to the index values (Figure 3).

### *4.1.1. Selemetya*

Selemetya is the smallest among the studied neighborhoods (6.3 ha, or 0.4% of the urbanized residential area of the city) and is the most typical Roma neighborhood in Ruse, bordering Druzhba 2 to the west. Its population is around 4,000.

*Level 1 (Location) indicators.* Selemetya is located at the southern periphery (zone 3) of Ruse, and therefore it receives a score of 2 in terms of location. It receives an average score in terms of its proximity to the city center (2), but in terms of the access to social infrastructure such as kindergartens and schools, it has the worst score (3). Access to public transport has been accessed as average (score 2), while the segregated school indicator is scored as 1 since the existing school in Selemetya is not segregated according to the city authorities. Selemetya receives a score of 2 in terms of proximity to hazards and geomorphology of terrain since there are no industrial zones near the neighborhood, except for "Bulgaria" Boulevard, which represents a major road of regional/national level; the "equivalent noise level" indicator is above the limit values of the noise levels according to the adopted regulations. The secondary indicators describing access to social infrastructure, however (access to medical emergency centers, hospitals, outpatient care, and public green spaces), all receive a score of 3, which is to be expected, given that Selemetya is considered the most segregated and typical Roma neighborhood in Ruse.

*Level 2 (Neighborhood) indicators.* Selemetya is the most densely populated neighborhood among the studied ones—approximately 65,000 people/km$^2$ (score 3). It has access to tap water, but the quality of the water supply network is low; therefore, it receives a score of 2 for that indicator. The majority of secondary Level 2 indicators in the case of Selemetya receive a score of 3 (regularity of garbage collection, built-up density, open public spaces, green areas, children's playgrounds, dynamics of the built-up area, densification of the urban space, morphology of the urban space). Selemetya is the neighborhood with the highest number and share of new buildings among others (Figure 2), a very indicative feature of Roma neighborhoods in Bulgaria.

*Level 3 (Dwellings) indicators.* In terms of residential area per inhabitant, Selemetya exhibits the worst value of the indicator among all the studied neighborhoods—4.7 m$^2$/inhabitant (score 3), as well as regarding another major indicator: the share of buildings with no stated ownership: 80% (score 3), which is very typical for Roma neighborhoods.

### *4.1.2. Druzhba 2*

Druzhba 2 is the largest neighborhood (5,632 people in 2023) by population and the second largest by area (36 ha) among the studied neighborhoods. It constitutes around 2.3% of the residential urbanized space of the city and is located to the east of Selemetya. Druzhba 2 and Selemetya border each other, but are quite different based on ethnic composition characteristics—in contrast to Selemetya, Druzhba 2 is ethnically mixed (residents identify themselves as Roma, ethnic Turks, or ethnic Bulgarians).

*Level 1 (Location) indicators*. Just like Selemetya, Druzhba 2 is located in the southern periphery (zone 3) of Ruse, and therefore it receives a score of 2 in terms of location. It shows average scores in terms of its proximity to the city center and social infrastructure, as the score of all the main indicators in that aspect is 2 (access to kindergartens, schools, and public transport), and a score of 1 for the segregated school indicator since the existing school in the neighborhood is not segregated according to the city authorities. The secondary indicators describing access to social infrastructure, however (access to medical emergency centers, hospitals, outpatient care, and public green spaces), all receive a score of 3, which is typical for segregated communities.

*Level 2 (Neighborhood) indicators*. Druzhba 2 is the second most densely populated neighborhood (after Selemetya) with a population density of around 15,400 people/km$^2$ (score 3). Although Druzhba 2 is supplied with tap water, due to the inadequate state of the water supply network, it has been assessed with score 2 regarding this indicator.

*Level 3 (Dwellings) indicators*. In terms of residential area per inhabitant, however, Druzhba 2 exhibits the best value of the indicator among all the studied neighborhoods: 25.8 m$^2$/inhabitant (score 1). As in all similar neighborhoods, the share of buildings with no stated ownership is high—43% (score 3), which is a very common feature of Roma-segregated areas.

### *4.1.3. Traktsia*

Traktsia is the smallest by population (just 817 people as of 2023) and area (9 ha) among the studied Roma neighborhoods. It represents about 0.58% of the residential urbanized area of the city and is located away from the other three studied neighborhoods. From the point of view of the ethnic composition of the population, it is ethnically mixed (residents identify themselves as Roma and ethnic Turks, professing Christianity and Islam).

*Level 1 (Location) indicators*. Traktsia is located on the eastern periphery (zone 3) of Ruse, which is why it receives a score of 3 in terms of location. It receives an average score in terms of proximity to the city center and access to parks for wide public use, but in terms of access to public services such as kindergartens, public transport (two bus and two trolleybus lines to the center), and the lack of a segregated school, it receives the highest score (1). Traktsia is located next to one of Ruse's industrial zones, which is why its location is the most unfavorable compared to the other three studied neighborhoods, regarding the proximity to anthropogenic hazards and potential pollution sources (score 3).

*Level 2 (Neighborhood) indicators*. Traktsia is the third most densely populated neighborhood (after Selemetya and Druzhba 2), with population density of about 9,100 people/km$^2$ (score 3). Compared to 2009, there has been a population decrease trend (by 31%), which is due to the increased emigration of Roma families abroad (to England, Germany, and Austria mostly) in search of employment and better overall personal realization.

*Level 3 (Dwellings) indicators*. In terms of residential area per inhabitant, Traktsia comes in second best regarding this indicator's value (after Druzhba 2) with 20.83 m$^2$/inhabitant (score 1). Compared to the other neighborhoods, the share of buildings with no ownership documents is extremely low—just 9.7% (score 1), which is not typical for Roma neighborhoods as a whole.

### *4.1.4. Trite Galaba*

*Level 1 (Location) indicators*. Trite Galaba is the second largest neighborhood by area (47 ha) and it is the only one located outside the city limits of Ruse, therefore receiving a score of 3 in terms of location. It represents a peripheral zone of the Sredna Kula suburb of Ruse city

and bears the feature of a village rather than a city neighborhood, which makes it very different from all the other studied neighborhoods.

*Level 2 (Neighborhood) indicators*. The population of Trite Galaba is around 1,600 residents, the vast majority of whom are Roma. Given its village-like nature, the lowest population density is no surprise (around 3,400 people/km$^2$). Like the rest of the studied neighborhoods, the population dynamic is stagnant (score 1), which applies to the dynamics of new construction as well; very few new buildings emerged in the period 2004–2023 (Figure 2).

*Level 3 (Dwellings) indicators*. The residential area per inhabitant is the second lowest (after Selemetya): 16 m$^2$/inhabitant (score 2), while the share of buildings with no stated ownership is the lowest among all the studied neighborhoods—just 1%, which is extremely untypical for Roma neighborhoods in Bulgaria.

### *4.2. Spatial segregation index values*

As evident from the index values (Figure 3), the four Roma neighborhoods in Ruse are characterized by different levels of spatial segregation. Selemetya stands out as the most typical Roma neighborhood, with the highest value of the index (0.83). This neighborhood experiences complicated issues of many kinds, with the most negative tendencies in spatial and social exclusion: underdeveloped infrastructure, overcrowding, and the highest rate of housing with a lack of stated ownership, bad access to public transport and public services, social problems, etc. The value of the index for the second-most segregated neighborhood, Druzhba 2, is 0.72, and here as well, the data show relatively high levels of segregation, not only in spatial terms, but also in social ones. The difference in the value of the index between Selemetya and Traktsia, which stands out as the neighborhood with the lowest level of spatial segregation, is considerable, and this significant difference is due to the better scores of some primary indicators in Traktsia neighborhood, such as residential area per inhabitant, share of buildings with no ownership documents, a kindergarten in the neighborhood itself, best access to public transport compared to all the other studied neighborhoods, as well as better scores of some secondary indicators such as access to public parks, children's playgrounds, etc. Traktsia is the only neighborhood where the primary indicators with the best score (1) outnumber the primary indicators with the worst score (3). That ratio for Trite Galaba and Druzhba 2 is 1/1, while at the same time, they are the neighborhoods with the highest proportion of primary indicators with the best score of 1 out of the total number of primary indicators (4 out of 10).

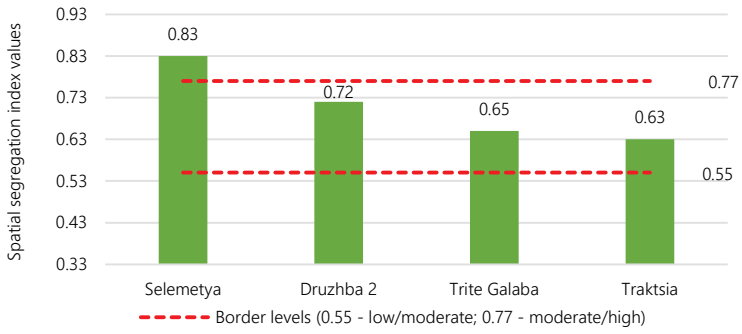


**Figure 3**. Index of spatial segregation in the selected Roma neighborhoods in Ruse.

Another important feature worth mentioning is that the share of secondary indicators with the best score in Druzhba 2 is twice lower than in Traktsia and Trite Galaba, while the ratio between the secondary indicators with the best and worst scores is more than three times higher than that in Traktsia and Trite Galaba (which are the only neighborhoods where that ratio is above 1). In addition, Traktsia is the only neighborhood where both the primary and secondary indicators with the best score (1) exceed those with the worst score (3), while in the case of Trite Galaba, this is observed regarding the secondary indicators only.

## 5. Discussion

As Yao et al. (2019) point out, the measurement of spatial segregation is a challenging task that often suffers from over-simplification and substantial reduction considering territorial dimensions and patterns. The proposed index for spatial segregation of Roma neighborhoods complements the existing studies by offering a quantitative measure of the extent of isolation of Roma communities in urban structures (Ilieva, 2022; Šlezak, 2023) While previous research on Roma ghettoization focuses mainly on the different socio-economic, political, and cultural aspects of marginalization (Méreiné-Berki et al., 2021; Munté-Pascual et al., 2022; OSCE/ODIHR, 2014; Vincze, 2019), this index provides a more specific and objective way to assess physical isolation and its consequences. By incorporating geographic data, the index allows for comparisons between different urban areas and creates a foundation for future studies to track the dynamics of spatial segregation over time. It also enables a deeper understanding of the relationship between spatial distribution and socio-economic inequalities in urban ghettos on the local scale and strengthens the geographical emphasis (Brown & Chung, 2006).

The use of diverse geographic data allows for precise mapping of ghettoized areas, which enables a better understanding of the relationship between physical isolation and socio-economic marginalization. Additionally, the index provides an objective method for comparing different urban structures according to numerous indicators (total number of 27 and distinct as nature) and can be applied to various urban areas to assess the segregation dynamics over time. However, the index also has its limitations. One of them is the reliance on the availability and accuracy of geographic data, which may limit the applicability of the index in contexts where such data are scarce or incomplete. Furthermore, the index does not fully account for the complex social and cultural factors that also influence the marginalization of Roma communities. This tool offers an important insight into the physical aspects of segregation, but a more comprehensive understanding of the issue requires combining it with qualitative data on social relationships and economic conditions.

Further, the study findings also confirm and complement conclusions from previous research by showing how the physical isolation of Roma communities leads to limited access to public resources and services. This aligns with the theoretical framework of spatial injustice discussed in Roma's literature, which emphasizes how urban segregation exacerbates poverty and social isolation. Including new data on the city of Ruse and using a spatial-based approach expands the current understanding of the influence of spatial location, and the interrelation with the other elements of the urban space on the marginalization of Roma communities.

Additionally, the following main recommendations to the local government addressing the segregation of the Roma community can be proposed:

- Encouraging the creation of mixed residential areas outside of Roma neighborhoods. Such areas can improve the position of segregated Roma neighborhoods by promoting social integration, providing access to better services and infrastructure, and creating opportunities for improved living conditions. These areas help break isolation, reduce discrimination, and facilitate the inclusion of Roma into mainstream society.
- Introducing transitional housing programs to support the integration of Roma families into new urban zones.
- Establishing multifunctional centers for joint educational and cultural activities between Roma and other residents.
- Considerably improving infrastructure and access to public services in Roma neighborhoods.

## 6. Conclusion

The outcomes of this study contribute significant added value to the literature on Roma ghettoization by introducing a complex index for spatial segregation measurement based on various quantifiable indicators. While much of the literature focuses on socio-economic, historical, and political aspects, this study delves into the spatial dimensions of segregation by applying a complex set of indicators—27 as a number and divided by their importance and territorial scale. The suggested spatial segregation index is calculated and evaluated in a thorough analysis and corresponds to the results of the authors' earlier fieldwork and observations of Roma neighborhoods of Ruse, Bulgaria (conducted in 2023). By mapping and analyzing the spatial distribution of Roma communities, this research highlights the compounded effects of geographical isolation on access to resources, services, and opportunities. These findings provide a more comprehensive understanding of how spatial factors intensify the socio-economic marginalization of Roma populations, offering a new lens for policymakers and urban planners to address the root causes of inequality in ghettoized urban environments.

The level of spatial segregation of Roma or any other type of ghettoized urban structure can be measured based on various approaches and criteria. Despite its shortcomings, the suggested approach can be considered appropriate, but not universal. Furthermore, the local specifics of deprived areas should be considered before deploying the applied research methodology. The sheer number and nature of indicators can also differ depending on local peculiarities, especially the division of all the selected indicators into primary and secondary. However, some of the suggested indicators can be considered universal; most of the so-called primary indicators in this study are common for all deprived/segregated community types, regardless of their location, size, etc. More variations can be observed regarding the so-called secondary indicators; those can differ depending on the specific socio-economic and ethnocultural environment of the studied areas worldwide.

Apparently, the suggested spatial segregation index could be applied to other, non-ethnic parts of a city. The idea is to apply the index to neighborhoods that are known (in advance) to be Roma-populated. Otherwise, many luxurious gated communities, for example, may also appear "segregated" to a certain level, should the index be applied to them, but the latter, unlike the Roma neighborhoods, are not informal, deprived, etc. communities, and do not represent a social/urban problem. The spatial segregation index, therefore, should be regarded as a tool for measuring one aspect of the overall segregation of ethnic minorities, in this case – the Roma.

In the case of Ruse, Bulgaria, one of the selected neighborhoods stands out as the most typical and the most segregated Roma neighborhood—Selemetya—whereas the other three exhibit features of partial segregation. Those differences result mostly from indicators such as residential area per inhabitant, population density, share of buildings with no ownership documents, and access to public services (including public transport).

Roma neighborhoods in Bulgaria as a whole, including those in the city of Ruse, differ significantly in various aspects, which require differentiated approaches and targeted actions to prevent the continuation of this process. Segregated urban spaces develop and change over time, and not always in a predictable way. It is this fact that justifies the need for the application of tools similar to the ones suggested in this study, in order to manage the processes which take place in such urban structures and often remain hidden from the local government and the local surrounding population. The proposed index thus provides an opportunity to elaborate a long-term analysis of the selected urban structures, resulting in the design of specific measures and policies to be applied in each type of ghettoized urban structure, so as to prevent, if not entirely eliminate, further segregation.

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