doi.org/10.62683/SINARG2025.173

Research paper

THE TRANSFORMATIVE ROLE OF MOBILITY FOR SUBURBAN CENTRE – CASE STUDY OF SREMSKA KAMENICA, SERBIA

Marina Carević Tomić[1], Ranka Medenica Todorović[2]

Abstract

The paper explores the transformative role of mobility in suburban center of Sremska Kamenica, within the urban area of Novi Sad, Serbia, where a transit road passes through the heart of the settlement center. Throughout history central functions of the settlement were developed along the main road and thanks to its busyness. However, population growth together with the rise of the motorization rate and the share of motor traffic in modal split caused the traffic congestions and threatened the pedestrian and social activities recently. The imminent construction of a new bridge, as part of a ring road around Novi Sad, stands as a pivotal intervention that promises to divert traffic flows away from the overloaded center, ushering in a new era of pedestrian-friendly public spaces. Finalization of this bridge would divert traffic flows – presumably, the traditional center, now overloaded with transit traffic, would be less busy, and at the same time, as shown in Space Syntax analysis, accessibility at the local level wouldn't fall. The key objective is to understand the development of the centrality in Sremska Kamenica through time and to predict how changes in mobility patterns will affect further public space usage and livability. The research approach is based on the combination of Space Syntax tool, site surveys, contextual analysis and planning documents reading. The paper shows how the traffic diversion facilitated by the new bridge gives the opportunity for urban planners to reimagine public spaces, prioritizing vibrant, walkable spaces that promote social interaction and improve overall urban experience.

Key words: *Suburban center, mobility patterns, Space Syntax*

[1] PhD, assistant professor, University of Novi Sad, Faculty of Technical Sciences, Serbia, marinac@uns.ac.rs, ORCID 0000-0003-0209-5747

[2] PhD candidate, teaching assistant, University of Novi Sad, Faculty of Technical Sciences, Serbia, ranka.medenica@uns.ac.rs, ORCID 0000-0003-1734-6772

1. INTRODUCTION

Various authors [1, 2, 3, 4] define the urban center in different ways, lacking a unified analytical framework. Nevertheless, the center of a settlement is generally taken for granted, typically referring to a focal point characterized by a concentration and mix of land uses and activities in a prominent location. Since the precise delineation of urban centers exceeds the scope of this work, the aim here is to understand the development of centrality in Sremska Kamenica through Bill Hillier's concept of centrality as a spatio-functional process, rather than to describe it as a static condition [5].

Suburban centers are specific per se, for their dependance on the main city center on one side and the expectation to be sustainable economically and environmentally and to provide local economic activities in order to minimize travel and to support cohesive and vibrant communities [6]. Vibrancy[3] is one of the key qualities of cities, most prominently expressed in their central areas. However, the specific scope and dynamics of central urban functions are shaped by the broader settlement network and the local socio-economic context.

In the case of Sremska Kamenica (Figure 1a), earlier studies [9] have shown that both historical and contemporary factors have played a decisive role in the distribution of land uses. The old core of the settlement (Figure 1b) functions as the traditional center of identity and urban life, accommodating trade, administration, culture, education, hospitality, and more. The role of this center has evolved and strengthened over time, adapting to changing conditions. Another important aspect is accessibility, as areas with higher accessibility tend to support a greater mix of uses. For a long time, the socio-economic situation in Sremska Kamenica has remained stable, as have the patterns of primary uses, building types, and residential densities, with no indication of imminent change. However, mobility patterns are expected to shift due to the construction of two new bridges, and the aim of this paper is to explore how such changes in mobility may affect public space usage and overall livability.

Figure 1. (a) Sremska Kamenica within the urban area of Novi Sad. Red line indicates the location of the planned fourth bridge, while yellow line marks the position of the fifth bridge. (b) Central area of Sremska Kamenica, according to the detailed regulation plan [10] (author: M. Carević Tomić, source of a map: Google Earth).

[3] Jane Jacobs explains urban vibrancy as an active street life comprised of the presence of pedestrians at all hours of the day, that way encouraging activities and interactions [7], while for Jan Gehl [8] urban vibrancy does not only refers to the number of people and inhabitants, but to the feeling that the place is inhabited and being used.

2. METHODOLOGY

Previous research on central areas has highlighted the diversity of issues and the complexity of relationships among various urban phenomena across different types of settlements. In the center of Sremska Kamenica, the current arrangement of land uses and activities is likewise shaped by multiple factors, with accessibility standing out as one of the most significant [9]. Accordingly, this research combines Space Syntax analysis, site surveys, contextual analysis, and reviews of planning documents to explore the complex interplay between mobility flows and spatial organization in the urban center.

As both a theory and method, Space Syntax offers a rational and qualitative approach to investigating urban spatial networks. It has been widely applied in urban studies over the past several decades [11]. In this study, it is used to gain insight into spatial configuration and future mobility patterns, particularly accessibility, under the assumption that it can simulate changes to the urban network resulting from the construction of two new bridges. The analyses cover the entire urban area of Novi Sad, comparing the current state with a projected state that includes the new bridges. Both axial and segment analyses were employed. Axial analysis was used to measure changes in the importance of the main street within the system and the movement flows along it (via the choice measure), while segment analysis assessed how the construction of the new bridges could influence centrality processes in Sremska Kamenica. Global analysis was used to simulate vehicular traffic, while a 400-meter radius was applied for examining pedestrian accessibility.

3. HISTORICAL AND SPATIAL DEVELOPMENT OF SREMSKA KAMENICA CENTRE

Sremska Kamenica developed on the northern slopes of the Fruška Gora mountain, extending to the right bank of the Danube. In its oldest parts (Figure 2)—formed on a lower plateau and later along Karađorđeva Street—the indigenous urban matrix and traditional plot organization have been largely preserved. These areas differ from the newer parts in their morphological characteristics, the positioning of houses along the regulation line, and the prevalence of narrow, winding streets, which are typical of settlements on Fruška Gora. The area is also characterized by low housing density, with around 40 inhabitants per hectare [9], a figure not expected to change significantly in the future.

Figure 2. Historical photos of Sremska Kamenica, area of Kralja Petra I Square (unknown author) [12]

The functional structure of the original center (today Kralja Petra I Square and its surroundings (Figure 2)) in the past consisted of public uses—such as a church, old school, local community office, library, post office, and café—some of which remain today. The expansion and displacement of the center from an oldest historical core took place gradually towards the upper plateau and Trg Zmaj Jove, along the main route that connected Sremska Kamenica with Petrovaradin and Novi Sad. After World War II, the settlement became part of the Novi Sad and Petrovaradin municipality, leading to increased dependence on Novi Sad. The spatial connection was further strengthened by the construction of the Most Slobode bridge over the Danube in 1981, which encouraged further development.

In the decades following World War II, urban planning envisioned the development of a conurbation consisting of Novi Sad on one side of the Danube and Petrovaradin and Sremska Kamenica on the other. One of the main goals was to concentrate public facilities, residential areas, and workplaces on the right bank, creating a new development pole. However, this vision was never fully realized due to specific social, political, and economic circumstances, especially after the 1990s. Nevertheless, certain unique functions—such as the institutes for oncology, pulmonary and cardiovascular diseases, the Basic Police Training Centre, and SOS Children's Village—make Sremska Kamenica a distinct sub-center within the Novi Sad area [13]. Apart from these unique functions, most non-residential uses serving the essential needs of the population are concentrated in the traditional center, encompassing central services, education, childcare, health, culture, and religion. The range of activities in the center of Sremska Kamenica is broader than in other parts of the settlement but remains limited, as the rest of the area is predominantly residential. Previous research in the central area[4] recorded 86% housing, 7% primary non-residential, and 7% secondary non-residential uses[5]. A significant increase in non-residential uses occurred in the 2000s, during the post-transition period, when the population of Sremska Kamenica grew[6] notably due to suburban sprawl.

On the other hand, according to the Study of Housing [17] from 1995 to 2009 the share of commercial space in the total built area decreased—presumably a result of large-scale residential construction in peripheral zones. This period also coincided with the stabilization of the country's economic and political situation following the turbulent 1990s, likely contributing to a more favorable environment for business and service development. The growth of entrepreneurship during this time also led to an increase in retail outlets, with portions of houses facing the street being converted into business premises in the center and adjacent streets. Despite these developments, daily commutes to the center of Novi Sad remain intensive.

The strengthening of the historical center eventually led to a saturation point, as Trg Zmaj Jove—given existing structures and preservation guidelines—reached its capacity for accommodating new, large-scale programs. This led to the elongation of the traditional

[4] The area of a Detailed Regulation Plan of the Center of Sremska Kamenica [10].
[5] The methodology used for land-use analysis was Mixed-use Index, defined by van den Hoek [14] and here used redefined version where uses are classified on residential, primary non-residential and secondary (non-residential) uses [9], based upon Jane Jacobs's theory. Primary uses are those that bring people to a specific place because they are anchorages (housing, offices, schools etc.). The purpose of the secondary uses is to serve the people drawn by the primary uses – those are the enterprises that grow in response to the presence of primary uses [7].
[6] In 2002 number of inhabitants was 11205, which is for 40% more than in 1991 [15]. According to current data, 12632 inhabitants live in Sremska Kamenica, which is five times more than in 1948, when the first population census was conducted [16].

center, a process accelerated by the construction of new faculties and multifamily housing, which in turn spurred the development of secondary programs in one of the entrance zones to Sremska Kamenica [18] and new linear center has begun to emerge along the busiest streets, especially Vojvode Putnika Street. Notably, most of the premises along this stretch are retail or services dependent on what Hillier and colleagues refer to as "passing trade" [19], in this case primarily car-based, long-distance traffic (e.g., car washes, plant and tool stores). This route continues through the traditional center and connects suburban settlements along the Danube's right bank with Novi Sad.

Recently, the trend of concentrating non-residential uses along this main road has extended toward suburban settlements upstream from Sremska Kamenica, near the projected landing point of the new bridge on the Danube's right bank. The future completion of the fourth bridge may divert traffic away from the current central route, making the future ring road and surrounding areas more accessible, busier, and therefore more attractive for non-residential development [20].

According to the current detailed regulation plan [10], the development concept envisions preserving the ambient character of the center while simultaneously allowing for the integration of missing functions. The goal is to concentrate central activities around Zmaj Jove Square and establish a connection with the terrain along the Danube, thereby creating conditions for direct access to the river. Unfortunately, these objectives have not been realized, and the main square is currently experiencing the degradation of its built heritage due to inappropriate architectural interventions (Figure 3).

Figure 3. Sremska Kamenica today; (a) Kralja Petra I Square, (b, c) Zmaj Jove Square (author: M. Carević Tomić)

4. MOBILITY ANALYSIS

The busiest road passing through the central zone of Sremska Kamenica follows the line of Vojvode Putnika Street, Zmaj Jove Square, and Karađorđeva Street (Figure 1b and Figure 4). This corridor connects Novi Sad not only with Sremska Kamenica itself but also with other settlements upstream on the right bank of the Danube—such as Ledinci, Rakovac, and Beočin—whose residents commute daily to the city. This stretch, along with Železnička Street, is also the most locally accessible area, making it unsurprising that the two main squares were formed here and that the majority of non-residential facilities are located along this route.

However, the high volume of people also brings intense motor traffic, which acts as a limiting factor for developing vibrant public life in the center. The existing urban fabric, shaped in earlier periods, is no longer capable of accommodating current traffic demands[7]. In addition, the heavy traffic contributes to increased levels of noise and air pollution, making

[7] According to the Smart Plan [21] motorization rate and the share of car usage in Novi Sad is in constant raise.

the experience of staying in public spaces less pleasant—even though many key public facilities are located in this area. As a result, the squares generally do not function as gathering places, but are instead used primarily for transient activities, such as shopping, waiting for the bus, or other brief, utilitarian purposes.

5. THE NEW BRIDGE: A GAME-CHANGER

Currently, two parts of the urban area of Novi Sad are connected by three bridges, but for many decades urban plans envision a total of five. Recently, construction of the fourth and fifth bridges has begun. The fourth bridge—most relevant to this paper—is intended to connect the western parts of Novi Sad with the settlement of Sremska Kamenica. It will also form part of a key route linking the city to its broader surroundings via the E75 highway and other national roads. It is expected that the construction of these new bridges will significantly alter the functioning of the city. To assess the potential impact on the center of Sremska Kamenica, Space Syntax analysis was employed. The analyses were conducted for the entire urban area of Novi Sad (Figure 4a, 5a), with a zoomed-in view of the Sremska Kamenica center provided for clarity (Figure 4b, 5b). Due to space limitations, only the axial analyses are presented graphically, while key numerical results are summarized in tables.

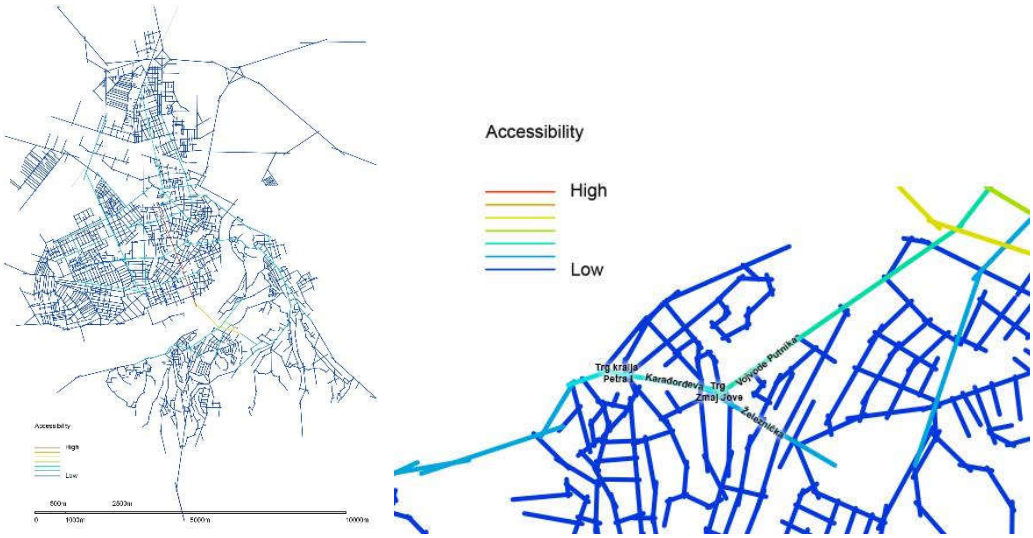

Figure 4. Axial map of Novi Sad – choice analysis (global radius). (a) Full city view; (b) central area of Sremska Kamenica (author: M. Carević Tomić)

Visual inspection and comparison of Figures 4 and 5 suggest that the new connections within the urban matrix positively affect the global choice pattern in the center of Sremska Kamenica. The numerical data (Table 1) support the visual interpretation: the construction of the new bridges is expected to significantly reduce the traffic load on the main transit corridor, particularly on Vojvode Putnika Street. This implies that the route will become less likely to serve as the preferred path for through-movement (i.e., transit traffic) between different street segments in the urban area.

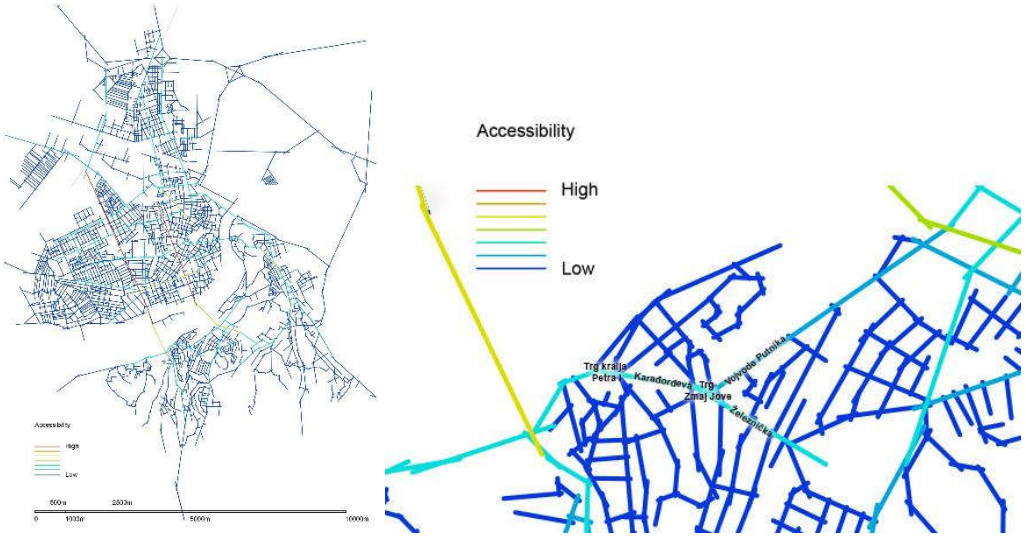

Figure 5. Axial map of Novi Sad after construction of two new bridges – choice analysis (global radius). (a) Full city view; (b) central area of Sremska Kamenica (author: M. Carević Tomić)

Table 1. Axial analyses for Vojvode Putnika Street

	Axial Choice (global radius)
Current accessibility	0,354561
Future accessibility	0,089264

On the other hand, a comparison of integration values indicates that locally (within a 400m radius), the center will maintain its significance. Moreover, at the level of the entire urban area (global radius), it is expected to become even more accessible. This suggests that the central area will remain attractive and retain the high potential to be the destination for movement.

Table 2. Segment analyses for the center (20 segments)

	Integration (global radius)	Integration (r=400m)
Current accessibility	807,734	0,575404
Future accessibility	948,862	0,575404

6. DISCUSSION AND CONCLUSION

The case of Sremska Kamenica highlights the multifaceted and transformative role of mobility in shaping suburban centers. Historically formed along a key transit route, the central area has developed a layered identity as both a functional core and a passageway. However, this dual role has increasingly led to tensions between vehicular mobility and the spatial and social qualities essential for vibrant urban life. The dominance of motorized through-traffic, particularly along Vojvode Putnika Street and Zmaj Jove Square, has compromised the potential of public spaces to serve as places of gathering, interaction, and everyday sociality.

As the Space Syntax analyses reveal, the finalization of the fourth bridge—a critical component of the Novi Sad ring road—will significantly alter existing mobility patterns.

Specifically, the analyses show a notable decrease in global choice values for Vojvode Putnika Street, which confirms the expected redirection of through-traffic away from the traditional center. This shift alleviates the current pressure on the central streets, thereby reducing noise, air pollution, and motor traffic dominance.

Importantly, the research also shows that while the transit function of the central area will diminish, its spatial integration, as one of the indicators of centrality, will remain stable or even improve. This indicates that the traditional center of Sremska Kamenica will maintain its accessibility and potential as a destination, not just as a route. This finding carries important implications for urban planning and design. Reduced transit pressure opens opportunities for reclaiming central public spaces for pedestrian use, social functions, and green infrastructure. In turn, this can elevate the quality of life, improve environmental conditions, and strengthen the spatial identity of the center. Furthermore, the potential redistribution of non-residential functions—especially those relying on high accessibility and visibility—towards the new infrastructure corridor suggests a spatial reorganization that could relieve current land use saturation in the historical center. Yet, the outcomes of such infrastructural shifts are not automatic. Planning responses will be crucial to steer the transformation toward inclusive and sustainable goals. Without proactive urban design and policy support, the freed-up space could risk underutilization or ad-hoc commercialization. On the other hand, a coordinated approach—integrating traffic calming, pedestrian prioritization, and heritage-sensitive design—could revitalize the central area and reinforce its role as a livable, multifunctional hub. Strategies such as a "road diet"—reducing the number or width of traffic lanes—could help repurpose space for pedestrians, greenery, and non-motorized mobility, fostering a more human-centered environment.

The study also identifies a spatial phenomenon of center elongation along the main roads, primarily in the direction of Novi Sad. This linear extension of central functions, increasingly occupied by "passing trade" land uses, reflects the strong functional dependence of suburban settlements on the central city. As this process is shaped by mobility flows, it raises important questions about the long-term viability of these uses in a post-diversion scenario. With a decline in passing traffic, some of these premises may lose their commercial relevance and be replaced by more locally oriented or residential uses. Future research could explore whether this spatial and functional dynamic is a common characteristic of suburban centers and how it might inform broader planning strategies.

ACKNOWLEDGMENTS

This research has been supported through project “The integration of contemporary practices, innovative approaches, and results of scientific research and artistic work in advancing the processes of dissemination and teaching through the application of the digital gallery in architecture, urbanism, and scene design” Faculty of Technical Sciences, University of Novi Sad.

REFERENCES

[1] Krehl Angelika, Siedentop Stefan: **Towards a typology of urban centers and subcenters-evidence from German city regions**, *Urban Geography*, 40(1), 58–82, 2019, https://doi.org/10.1080/02723638.2018.1500245

[2] Zhang Weiyang, Derudder Ben: **How sensitive are measures of polycentricity to the choice of 'centres'? A methodological and empirical exploration**, *Urban Studies*, 56(16), 3339–3357, 2019, https://doi.org/10.1177/0042098019843061
[3] Paraskevopoulos Yannis, Photis Yorgos N: **Finding Centrality: Developing GIS-Based Analytical Tools for Active and Human-Oriented Centres.** In Gervasi, O., et al. (Eds.), *Computational Science and Its Applications – ICCSA 2020.* Lecture Notes in Computer Science. (Vol. 12255, pp. 577–592). Springer, Cham. 2020, https://doi.org/10.1007/978-3-030-58820-5_43
[4] Dinić Milena: **Restruktuiranje centara suburbanih naselja - mogućnosti unapređenja modela od funkcionalnog zoniranja ka mešovitim funkcijama**. Univerzitet u Nišu. 2015
[5] Hillier Bill: **Centrality as a Process; Accounting for Attraction Inequalities in Deformed Grids**. *Space Syntax Second International Symposium*, Brasilia, 06.1-06.20, 1999.
[6] https://www.ucl.ac.uk/bartlett/towards-successful-suburban-town-centres *(3.5.2025.)*
[7] Džejkobs Džejn: **Smrt i život velikih američkih gradova**, *Mediterran Publishing*, Novi Sad, 2011.
[8] Gehl Jan: **Cities for People**, *Island Press*, 2010
[9] Carević Marina: **Mešovite namene - ključni parametar planiranja savremenih gradova**. Novi Sad, 2017.
[10] Plan detaljne regulacije centra Sremske Kamenice, Novi Sad, 2016.
[11] Zhu He, Liu Jiaming, Liu Huaxian, Wang Xibo, & Ma Yufei: **Recreational business district boundary identifying and spatial structure influence in historic area development: A case study of Qianmen area, China**. *Habitat International,* 63, 11–20, 2017. https://doi.org/10.1016/j.habitatint.2017.03.003
[12] Kacenberg Silvija: **Uređenje Sremske Kamenice,** DaNS, 25-29, 2000
[13] Kostreš Milica: **Urbano-ruralne veze i odnosi između naselja**, Novi Sad. 2012.
[14] van den Hoek Joost: **The Mixed Use Index (MXI) as Planning Tool for (New) Towns in the 21st Century,** in: *M. Provoost (ed.) New Towns for the 21st Century; the Planned vs, the Unplanned City*, Almere, 2009.
[15] Republički zavod za statistiku: **Uporedni pregled broja stanovnika 1948, 1953,1961, 1971, 1981, 1991, 2002 i 2011. godine**. *Republički zavod za statistiku, Beograd*, 2014.
[16] Kovačević, Miladin, ur.: Starost i pol: podaci po naseljima. **Popis stanovništva, domaćinstava i stanova 2022. godine**, Republički zavod za statistiku, Beograd, 2023.
[17] JP "Urbanizam" Zavod za urbanizam Novi Sad: **Studija stanovanja**, Novi Sad, 2009
[18] Carević Tomić Marina, Kostreš Milica, Reba Darko: **Primary and Secondary Uses in Cities – Principles, Patterns and Interdependence**, *Places and Technologies,* Belgrade, 2018.
[19] Hillier Bill, Penn Alan, Hanson Julienne, Grajewski Tadeusz and Xu Jianming: **Natural movement: or, configuration and attraction in urban pedestrian movement**. *Environment and Planning B: Planning and Design*, 20, 29–66. 1993.
[20] Carević Tomić Marina, Medenica Todorović Ranka: **Land Use Patterns Changes - Case Study Sremska Kamenica, Serbia,** *ICUP 2022*, Niš, 255-261, 2022.
[21] Fakultet tehničkih nauka: **Smart plan – druga faza**, Novi Sad, 2019.