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INTEGRATED UNDERGROUND SPACES PLANNING IN BELGRADE: A SMART CITY PERSPECTIVE

Milena Grbić[1], Olivera Stanković[2], Ksenija Lalović[3]

Abstract: The aim of this paper is to explore the opportunities and challenges of applying underground architecture within the *smart city* concept in Belgrade. The study analyzes the current state of underground space planning, highlighting the prevailing focus on the metro system and the lack of a comprehensive approach. By applying the smart city concept and the *Deep City* model, the research investigates potentials for integrated planning that incorporates technological tools, sustainability, and multidisciplinary collaboration. By comparing domestic practices with international experiences from Helsinki and Singapore, the paper proposes specific guidelines for improving the planning of underground spaces in Belgrade, with the goal of achieving more efficient and sustainable management of this important urban resource. The contribution of this study, supported by strong argumentation, emphasizes the need for a multidisciplinary approach to the planning and design of underground typologies, in order to establish a balance between technological innovation, economic investment, and social benefits. The paper also provides directions for further research on the integration of underground elements in smart cities, with the aim of enhancing the quality of urban life.

Keywords: comprehensive analysis, holistic planning, deep city, sustainable development, the indivisibility of urbanism

1. INTRODUCTION

Underground spaces have always been a special engineering fascination and a reflection of human ingenuity – from Persian canals (an early example of sustainable engineering) and Roman catacombs (addressing burial constraints as well as urban crowd management and public health), to infrastructure pipes, basement floors of buildings and garages, civil protection facilities, and metro systems that have almost organically evolved over decades in many modern cities, functionally responding to contemporary urban challenges.

Today, as even more efficient ways to expand limited urban space are needed to meet the demands of a growing population, modern underground spaces go beyond traditional models or functions. While earlier underground structures were mostly developed horizontally, there is an increasing number of underground typologies that require spatial development in the vertical dimension. To avoid the "first come, first served" approach seen in many urban areas – including Belgrade – this work highlights the challenge contemporary planners face: how to organize the use of underground space in a way that enables complementary rather than competitive exploitation of resources?

Achieving this requires first understanding and appreciating that underground space encompasses everything between the surface and the Earth's core, whether biotic or abiotic in origin. In this context, this study treats underground space through the Deep City approach [1], where underground space includes resources classified as physical space, spatial continuity, geoecological characteristics, subterranean flora/fauna, excavated materials, cultural heritage, and renewable resources (including groundwater and geothermal energy) [2].

[1] PhD, Grbić Milena, Dipl. Ing. Arch., Associate Professor, University of Novi Sad, Faculty of Civil engineering Subotica, Kozaračka 2a, Subotica, Serbia, mdelevic@gmail.com , https://orcid.org/0000-0001-6485-1478

[2]MSc, Stanković Olivera, Dipl. Ing. Arch., PhD candidate, University of Belgrade, Faculty of Architecture, Bulevar Kralja Aleksandra 73/II, Belgrade, Serbia, olivera.arh.urb@gmail.com

[3] PhD, Lalović Ksenija, Dipl. Ing. Arch., Associate Professor, University of Belgrade, Faculty of Architecture, Bulevar Kralja Aleksandra 73/II, Belgrade, Serbia, ksenija.lalovic@arh.bg.ac.rs , https://orcid.org/0000-0001-7261-7921

Effective exploitation of underground spatial resources thus requires a multidimensional approach that simultaneously considers functional, transportation, socio-cultural, and landscape-ambient parameters, which in turn indicate the level of complexity and the need for further interdisciplinary concretization ensuring spatial and functional coherence.

Currently, the underground space of Belgrade can be classified into several functional categories: pedestrian underpasses (e.g., beneath Terazije), traffic tunnels (e.g., the Terazije Tunnel), and railway stations (e.g., Vukov Spomenik). At the same time, the underground area holds significant potential related to layers of historical, cultural, and archaeological heritage, as well as to thermal water sources. The development of underground infrastructure is defined by the General Regulation Plan for Rail Systems in Belgrade, which includes elements of detailed elaboration. A key emphasis is placed on the phased implementation of the metro system, which has led to the establishment of the public utility company *Beogradski metro i voz*. Through the official website of this company, information on project status is available. The projects are conceived in phases and encompass the construction of four BG Voz lines and three metro lines.

Belgrade's problem, reflected in the existing planning documentation which practically only considers underground space from the perspective of the metro system, reveals its incoherent approach. The absence of key concepts almost always means their absence in all subsequent elaborations. Planning of underground urban spaces (UUS) in Belgrade still relies on expert and personal experience, cognitive biases, and analog reflections on previous cases, while quantitative research methodologies are minimally used. This means planners mostly depended on subjective knowledge and experience regarding the laws of underground space use, which inevitably leads to sporadic resource exploitation and inconsistencies that sabotage the maximization of efficiency.

In present conditions, as a way to comprehensively utilize resources, this study explores the potentials, challenges, and possibilities of applying integrated underground space planning in Belgrade from a *smart city* perspective. The smart city concept implies holistic management of urban resources through digital technologies, sustainable solutions, and efficient infrastructure, aimed at improving quality of life. The development of new technologies has the potential to revolutionize underground space management. Tools such as Building Information Modeling (BIM) enable precise design and risk assessment, while AI systems optimize traffic flow, climate control, and energy efficiency. Above all, data-driven approaches assist comprehensive planning. By connecting technology, sustainability, and citizen participation, smart cities strive to become more resilient, functional, and better adapted to the real needs of their users, enabling more rational resource use and a higher level of urban comfort. In this context, the primary goal of this work is to identify research trends and key focal points regarding underground space planning currently leading the field, in order to concretely improve Belgrade's planning processes and integrate underground and aboveground planning.

More broadly, the study unequivocally points out the need for greater collaboration among planners, architects, engineers, and decision-makers to fully understand the potentials of this spatial, social, and resource dimension. Integrated planning is essential, requiring coordination and involvement of state and private stakeholders, as well as the entire public. With the help of ICT – Information and Communication Technologies – we can unlock the potential of underground space and make better use of it.

2. MATERIAL AND METHODS

From a methodological perspective, this study investigates the potentials, challenges, and possibilities of applying integrated underground space planning in Belgrade from the viewpoint of contemporary smart city concepts. The aim is to improve planning processes by linking underground and aboveground planning into a unified methodological framework.

In a dedicated section, the study analyzes specific problems and the treatment of underground space in Belgrade. Through a general analysis of bibliographic data—primarily General Urban Plans and legislation—a chronological analysis of planning practice was conducted, systematizing the main characteristics, evolutionary trends, and developmental trajectories in planning practice, with particular attention to underground space. Thematic categorization highlights key challenges in the treatment of underground space as an identification of research focal points. A SWOT analysis, employed as a brainstorming tool, was carried out to present Belgrade's underground space as a complex and multilayered segment of the urban fabric that requires thoughtful institutional management and long-term strategic planning.

Simultaneously, by analyzing publicly available planning documents on experiences from leading cities seriously engaged in underground planning, key planning approaches currently shaping this field were identified. Through a comparative analysis of reference international cases (Helsinki and Singapore) – cities and projects leading in the implementation of sustainable and integrated underground infrastructure planning – and by analyzing existing underground urbanism plans, available technologies, and public policies, key factors were illuminated that have the potential to contribute to sustainable and successful future implementation, thus outlining guidelines for a possible (adequate) planning approach for Belgrade.

Based on all collected data, after identifying key shortcomings in the field (Belgrade) and analyzing successful international examples, the final section proposes appropriate guidelines and recommendations customized for the Belgrade context. These correspond to contemporary planning requirements and have the potential to contribute to more efficient shaping or expansion of the theoretical planning system by adapting it to new developmental approaches.

3. RESULTS

3.1. Overview of Underground Planning in Belgrade

The underground infrastructure framework was first mentioned as a concept in the General Urban Plan of Belgrade 1950–70 (1950) [3]. The first comprehensive study on the development of the metro system in Belgrade was conducted in 1968 by the Design Institute of the Yugoslav Railways Community. This study, based on the General Plan, proposed three metro lines; however, only the underground passage at Terazije was implemented, and that on a limited scale compared to the original design, which foresaw its extension toward the railway infrastructure in the deeper layers of the city. The plan also included the introduction of an underground tram system to facilitate passenger movement to other parts of the city center [4].

In the early 1970s, before the preparation of the General Plan of Belgrade 1972–2000 (1972), a Rapid Urban Transport Study was carried out. This study analyzed two metro systems: deep metro and shallow metro (cut and cover), intending to determine the most suitable system for Belgrade [5]. In practice, from 1966, several pedestrian underpasses were built: in New Belgrade at locations identified as favorable for future underground system development, while those at Terazije and Zeleni Venac emerged as necessary solutions due to conflict points and pedestrian safety concerns. These implementations were considered within the concept of underground urbanism, a new planning and design discipline in urban practice at the time [6].

The 1972 General Plan of Belgrade planned two metro lines, and in 1976 a study on the technical and economic feasibility of rapid public urban transport in Belgrade was initiated. The study proposed a transport system supported by a city distribution metro and a regional metro. The intersection of rail systems at three points in the central urban core created opportunities for pedestrian zones, while park-and-ride terminals were planned at city metro termini on the outskirts to reduce pressure from private vehicles on the inner central city zone [4]. In amendments and supplements to this plan until 2000, it was noted that many goals related to transportation set since 1972 had not been realized. Due to the city's different spatial development, it was necessary to reassess and align the planned metro system with the physical changes that had occurred. The BETRAS Study, which accompanied the General Plan 1985–2000 (1985), introduced the term *premetro* in 1989, with the idea that other transport systems would operate on routes planned for the metro until conditions allowed for metro activation [7].

The Strategy for Public Transport Development in Belgrade (1993), part of a broader plan titled Transport Systems of Belgrade – Part II, proposed that the capacity rail system in public transport be principally addressed through the construction of a light metro integrated into other public transport subsystems [8]. The General Plan of Belgrade 2021 (2003) suggested revitalization and rehabilitation of existing public transport forms and gradual introduction of a modern urban rail system such as Light Rail Transit, alongside planned city (and suburban) railways and trams [9]. After adopting the General Plan 2021, numerous activities were undertaken to evaluate necessary transport parameters and to develop detailed planning and project documentation for the light rail system. Simultaneously, experts from other European cities were consulted to form an expert opinion on the metro concept suitable for Belgrade. In mid-2010, the City Assembly adopted the document Belgrade Metro – Basis for Solution Selection. The French consulting company EGIS was commissioned to develop a General Concept and define the metro system in Belgrade, which would serve as a basis for network development.

The most recent overarching planning document, the General Plan of Belgrade until 2041 (currently in early public review since June 2022), is the first plan developed with digital tools. Although its methodology is based on integrated urban development, coordinating spatial, economic, social, and ecological dimensions, the plan's text does not explicitly address underground urbanism. However, it does mention ICT, the Smart City concept, digital twins, and other modern terminology. [10]

The fact that a term is not explicitly defined in the Planning and Construction Act glossary does not mean it cannot be addressed within urban planning documents. When a term is included in the legal glossary, it gains an official, legally binding definition that ensures consistent interpretation across planning stages. However, even in the current 2023 Planning and Construction Act glossary, metro is mentioned as one of the linear infrastructure objects under underground urbanism [11]. More detailed provisions in the Metro and Urban Railway Act (2021) specify concepts linking aboveground and underground segments, such as protective zones of 25m on each side of the track, 5m below the route, and vertically from the structure to the land surface; infrastructure zones of 5m beside aboveground and 4m from underground metro parts; and that stairs, escalators, halls, platforms, and underpasses represent rare points of integration between aboveground and underground spaces [12].

As this overview has shown, the general characteristics and development of Belgrade's planning documentation have been oriented towards solving current problems while neglecting the city's potential and possible development. Each higher-level planning document had to integrate errors from the city's past development. Specific planning of underground urban spaces is most often associated with transport infrastructure, metro or pedestrian traffic, and sometimes managing stationary traffic beneath larger public areas. In some document sections, planning documentation tends to be closer to analog than digital processing, often lacking topographic bases. According to the Rulebook on Content, Methods, and Procedures for Preparing Spatial and Urban Planning Documents (2019), topography is obtained as needed, although it is a primary element for setting the city's vertical regulation [13].

Overall, Belgrade has evolved from a city with pronounced development potential after the first serious planning document in 1950 – a time when urbanization had not reached a critical threshold – into an urban environment significantly compromised by inconsistent and reactive urban planning approaches. Despite initial ideas and studies, underground Belgrade remains an unexplored urban dimension, with underground transport as a technical challenge and strategic component of sustainable urban mobility that has not achieved functional integration into the broader urban system. This situation points to complex institutional, economic, technical, and spatial barriers and a lack of long-term strategic planning incorporating smart city principles.

Under actual planning conditions, it is almost impossible to fully foresee all potential challenges related to underground space planning. Considering that underground space is a non-renewable resource whose structure cannot be easily altered after construction, it is necessary to highlight Belgrade's potential through objective mapping of its underground space. Additionally, to identify possible management and planning approaches based on good international practices, particular attention will be given to integrated planning emphasizing coordination between underground and aboveground urbanism, as well as an ICT model that could enhance planning processes and urban functionality.

3.2. Objective Evaluation of Belgrade’s Development Potential

To demonstrate that Belgrade’s underground space represents a complex and multilayered segment of the urban fabric requiring thoughtful institutional management and long-term strategic planning, we chose to apply a SWOT analysis as a brainstorming method. We consider SWOT analysis particularly effective in the early stages of strategic reflection, research, and planning, as it enables a systematic examination of internal strengths and weaknesses, as well as external opportunities and threats relevant to the integrated management of underground space.

Table 1. *Strengths*

Strengths	**Explanation / Example**
Historical and cultural potential	The use of historical underground structures (Roman Well, catacombs, lagums) enables the preservation of Belgrade’s cultural identity and the development of unique tourist offers, increasing its international visibility and economic utilization of the space.
Geological suitability	Favorable geological soil structure allows stable construction of underground infrastructure with lower construction costs.
Academic and research support	Laboratories at the Faculty of Mining and Geology and Faculty of Civil engineering, as well as 3D GIS research, support the development and testing of solutions, strengthening the scientific foundation.
Infrastructure potential – transport	Metro, underground garages, tunnels, and pedestrian corridors contribute to reducing traffic congestion, lowering harmful gas emissions, and freeing public spaces for recreation.
Infrastructure potential – energy and logistics	Underground heating plants, storage facilities, and delivery tunnels enable energy efficiency and improve the functionality of the city’s network.

Table 2. *Weaknesses*

Weaknesses	**Explanation / Example**
Regulatory gap	The current Law on Planning and Construction does not recognize the concept of subsurface zoning; the legal status of underground volumes is not clearly defined.
Loss of ecological function of green areas	Installation of underground concrete structures beneath grassy zones reduces soil permeability and degrades the ecosystem of green spaces [14].
Neglected underground structures	Unmaintained and abandoned underground facilities pose safety, sanitary, and aesthetic issues.
High investment costs	Construction of underground infrastructure is on average 3 to 5 times more expensive than above-ground construction [15]
Lack of three-dimensional spatial data	Absence of integrated 3D GIS causes conflicts between existing installations and leads to inefficient planning.

Table 3. *Opportunities*

Opportunities	**Explanation / Example**
Application of digital twins and 3D GIS technology	Creating integrated three-dimensional underground models allows precise planning, minimizes errors, and enables efficient infrastructure management.
Revitalization of existing underground shelters	Repurposing unused underground spaces into cultural or IT centers can contribute to urban regeneration and content diversification [16]
Utilization of EU funds for sustainable energy	Significant opportunities exist for financing through EU funds, especially for green technologies such as geothermal pumps, energy efficiency, and innovative infrastructure.
Complementarity of underground functions	Data centers, residential spaces, and energy infrastructure can operate synergistically—for example, waste heat from data centers can be used for district heating, sharing installations and optimizing costs.
Application of digital twins and 3D GIS technology	Creating integrated three-dimensional underground models allows precise planning, minimizes errors, and enables efficient infrastructure management.

Table 4. *Threats*

Threats	**Explanation / Example**
Seismic and hydrogeological risks	High groundwater levels, porous soil, and seismic activity require complex and costly waterproofing and soil stabilization measures.
Uncontrolled construction and urbanization	Unplanned settlements that are later legalized by remediation plans complicate urban planning and slow down the implementation of new planning documentation.
Risk of destruction of cultural-historical layers	Soil vibrations, inadequate archaeological protection, and unregistered sites threaten the preservation of archaeological and historical heritage during underground works.

Negative impacts on end users of space	Factors such as noise, presence of microparticles, increased humidity, and feelings of claustrophobia can negatively affect acceptance and use of underground spaces.
Economic and political instability	Extended timelines, changes in public budget priorities, and unpredictable costs can jeopardize the realization of capital investments in underground infrastructure.

3.3. International Practices: Lessons from Helsinki and Singapore

Cities like Helsinki and Singapore were purposefully selected as reference examples in this study because they differ in institutional and planning approaches, each offering valuable insights for defining development directions in the context of Belgrade.

3.3.1. Helsinki

The city of Helsinki represents one of the most advanced examples of macro-level underground space planning in contemporary urbanism. As early as 1986, Helsinki developed the first plan for the allocation of underground space at the city-wide level, which included spatial mapping of underground layers and vertical usage zones [17]. The first General Plan for underground space was adopted in 2010, and since 2017 a revision has been underway, which was adopted in 2021 [18]. This plan holds the legal status of a planning document, making it binding for implementation [19]. Underground spaces are not considered in isolation but are mandatorily integrated into the General Urban Plan and detailed plans. In this regard, vertical integration of aboveground and underground spaces is legally required. The plan specifies reserved areas and coordination relations for key underground transport and utility infrastructure, as well as proposed zones for constructing underground public service facilities and pedestrian systems. Numerous positive effects of urban underground space usage were taken into account, such as contributing to an ecologically sustainable and aesthetically acceptable landscape, expected longevity of constructions, and preservation of potential for urban development for future generations. This attests to the application of sustainable and human-centered development concepts [20]. Among the planning tools for underground space management in Helsinki are:

- **Categorization of underground zones by depth and purpose**. Helsinki plans the underground space in three dimensions, separating functions by vertical layers. Shallower layers are intended for metro and pedestrian zones; middle layers for garages, storage, commercial facilities, while deeper layers are reserved for energy and technical infrastructure.
- **3D Digital Models**. Advanced 3D Geographic Information System (GIS) is used for mapping, linking existing and planned objects, geological conditions, infrastructure, ownership, and usage rights. These models enable simulation of functional conflicts and better strategic decision-making. For example, around 400 functional underground objects are recorded in the plan, while more than 600 locations are designated for future development [21] – from public pools and sports-recreational facilities to data centers. At the same time, the energy aspect is considered: stable underground temperatures enable more efficient cooling of server equipment, while surplus heat will be used for heating residential buildings [16].
- **Centralized Underground Database** integrates data on existing tunnels and underground facilities, permits, usage rights, infrastructure networks, and hazard zones (e.g., groundwater). It is available to investors and designers, speeding up permits and reducing spatial conflicts.
- **Participatory planning and transparency.** Helsinki employs open platforms and digital tools (such as Map Service and Helsinki 3D+) to provide citizens, experts, and decision-makers insight into projects, opportunities for commenting, and better understanding of spatial consequences of underground interventions.

3.3.2. Singapore

Unlike Helsinki, Singapore does not have a separate underground space planning system; instead, it integrates underground planning within its existing two-tier urban planning framework – the legally binding Concept Plan and the non-binding Special and Detailed Control Plans, which serve as guidelines. These plans set long-term strategic directions for the use and development of the entire underground space. Key planning tools for underground space management in Singapore include:

- **Zoning of Underground Areas**. Specific zones for underground development are not explicitly defined. However, an analysis of Singapore's Master Plan reveals that areas such as Marina Bay, Punggol Digital District, and Jurong Innovation District undergo detailed three-dimensional underground space planning [22,23], which emphasizes the interdependence of layers and functions.
- **Geotechnical 3D Models**. Singapore's 3D planning primarily focuses on geotechnical aspects and stratification, producing a 3D geological model based on extensive borehole data, enabling efficient planning of urban underground functions.
- **Participatory Planning and Transparency**. Participation efforts in Singapore are more investor-focused. For example, the Urban Redevelopment Authority (URA) developed a Pedestrian Network Strategy aimed at reducing surface congestion. The strategy proposes a 29 km network of underground pedestrian corridors to improve access to central urban zones. Private investors can compete for URA grants to construct underground passages at 20 designated locations. These spaces are exempt from the standard gross floor area limits, incentivizing their implementation. [24].

4. DISCUSSION

Both examples demonstrate a stable legal framework governing the relevant issues: in Singapore, this is the Planning Act [25], while in Finland it is the Maankäyttö- ja rakennuslaki [26]. These laws provide a legal basis that is long-term aligned with the needs of urban development and planning policies. In 2015, Singapore adapted two laws to the requirements of underground urbanism: the State Lands Act, which specifies the depth to which land parcel owners hold property rights – below which the underground space belongs to the state [27] – and the Land Acquisition Act, which enables expropriation of specific underground layers [28].

Serbia, on the other hand, during the same period, underwent multiple amendments to its legal framework, completely changing approaches, terminology, and by-laws. The latest Law on Planning and Construction (2009) has undergone 15 amendments so far, indicating instability and inconsistency in the legal status of spatial and urban planning, or even legislative adjustments influenced by individual interests [29]. A stable and clearly defined legal framework, like those in Singapore and Finland, highlights the importance of the legal system keeping pace with development needs and ensuring predictability and consistency in implementation – an absolute prerequisite for successful urban planning and project execution.

Table 1. *Comparative Overview of Underground Space Governance in Helsinki and Singapore*

Element	Helsinki (Finland)	Singapore
Legal Framework	Land Use and Building Act (1999)	Planning Act (1998); Land Acquisition Act (2015); State Lands Act (2015)
Underground Planning	Underground Master Plan adopted in 2010	Underground development integrated within the overall Master Plan (2019), with concept projections up to 2025
Planning Governance	Collaborative approach involving local and national authorities	Centralized governance under the URA, which oversees planning and implementation
Digital Technology Use	Utilizes 3D modeling and Building Information Modeling (BIM), though not fully integrated into a digital twin	Employs a comprehensive digital twin platform known as Virtual Singapore
Underground Space Usage	Primarily allocated for public infrastructure and community functions	Emphasizes maximizing spatial utilization for a variety of functions
Geological Conditions	Predominantly hard granite bedrock conducive to tunnel construction	Complex mixed soil conditions necessitating advanced geotechnical solutions
Public Participation	Extensive citizen involvement through public consultations, participatory platforms, and urban models	Limited public participation; primarily administrative-led planning with public feedback during master plan development

Role of Underground Space	Focuses on sustainable urban expansion and preservation of public spaces; views underground as a public asset	Addresses urban density challenges and surface space optimization, positioning underground space as a valuable resource
Strategic Orientation	Emphasizes public needs with strong linkages to participatory planning processes	Prioritizes economic development and efficient space use under expert-led centralized management

4.1. Recommendations for Belgrade

The experiences of cities such as Helsinki and Singapore underscore the critical role of institutional coordination, digital infrastructure, comprehensive planning, and legislative frameworks in the development of underground spaces. Belgrade has the opportunity to draw lessons from these examples and create its own model of underground urbanism tailored to local conditions while aligning with global trends. Based on the conducted analyses, the paper recommends several key guidelines for Belgrade:

1. Legal Framework
A new law should be enacted that explicitly defines the legal status of underground space, including usage rights and permits for underground structures, ownership rights in the vertical axis, and the methods for integration into all levels of planning documentation. It is essential to ensure a stable legal and regulatory framework without frequent amendments that destabilize the professional system. Additionally, the establishment of a permanent expert group or institutional system encompassing urban planning, geology, energy, transportation, and communal infrastructure… is recommended to address underground urbanism comprehensively, where the Belgrade metro and rail systems would be one branch within this broader framework.

2. Planning Framework
Belgrade should introduce a strategic framework for underground urbanism, either through a dedicated document following the Helsinki model or via integration into the existing planning system in the manner of Singapore, with mandatory vertical coordination of planning documents. Furthermore, underground space should be explicitly incorporated as a distinct domain within the General Urban Plan of Belgrade 2041, which is currently in draft form. Presently, underground urbanism is not explicitly singled out but is only partially addressed through sections dealing with communal and transport infrastructure.

3. Digitalization and Geographic Information Systems (GIS)
A digital foundation for underground space planning must be established, utilizing a 3D GIS model and a centralized database accessible to all relevant stakeholders. The planning approach should be modernized and aligned with contemporary ICT tools. For example, Helsinki employs a 3D GIS system incorporating data on geology, ownership, and infrastructure, while Singapore utilizes detailed geological models and runs the Digital Underground project, enabling interoperability of data and integration with BIM/GIS standards. Singapore leads in the integration of 3D digital models encompassing all planning layers, including underground space, effectively implementing digital twins.

4. Categorization and Zoning of Underground Space
A zoning system should be developed that combines functional use and depth stratification with predetermined priorities for underground space development.

5. Public Participation and Education
Belgrade requires public digital platforms, educational workshops, and spontaneous information dissemination systems, grounded in the principle that public interest should prevail over individual interests. A combined approach inspired by Helsinki and Singapore could be adopted. Helsinki utilizes digital platforms such as Helsinki 3D+ and Map Service for citizen participation, while Singapore engages the public through consultations during the amendment phases of the Master Plan.

6. Energy Efficiency and Sustainable Use
Planning of underground structures in Belgrade should incorporate options for passive heating and cooling, as well as integration with renewable energy sources, following Helsinki's example of sustainable underground development.

5. CONCLUSION

Beograd is at a stage where it can proactively define a model for managing underground space. The experiences of Helsinki and Singapore highlight the importance of a stable institutional framework, digitized infrastructure data, integrated and multi-layered planning, cooperation among all institutions and sectors, and the application of sustainable technological solutions.

Based on all of the above, Belgrade is closer to the Singapore model, as it enables gradual but firmly institutionalized integration of underground space into the existing planning system. A key advantage of the Singaporean approach lies in the consistent application of a hierarchical planning system, strong legislation, and thorough technical-geological grounding. In this light, Belgrade needs to restore the principle of continuity in planning that existed within the Belgrade General Plan 2021, which ceased to be valid upon the adoption of the General Urban Plan 2021. Restoring this type of planning continuity, together with digitalization, interdisciplinarity, and transparent participation, is a fundamental prerequisite for responsible and sustainable development of underground Belgrade.

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