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SPATIAL CONCEPTS FOR UNDERGROUND PUBLIC SPACES IN THE SURROUNDING AREAS OF METRO STATIONS IN HANOI'S HISTORICAL INNER CITY

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Abstract

Underground public spaces have developed significantly in cities, such as in Japan, Singapore and Europe. These spaces effectively connect urban railway stations with commercial, cultural and recreational facilities, as a response to the pressure of urbanization and land shortage. In Vietnam, particularly within the historic center of Hanoi, the increasing population, high building density and limited public spaces also emphasize the necessity for developing underground public spaces. These could supplement existing amenities, alleviate the burden on infrastructure and preserve urban heritage. This paper aims to propose solutions for designing underground public spaces connected to urban railway stations. The key research methodology combines case study, mapping and questionnaire survey. Case studies are chosen in three areas: Hang Dau station, Kim Lien station and the station at the intersection of Lieu Giai – Nguyen Chi Thanh – Dao Tan – Kim Ma streets with different development characteristics in Hanoi's inner city. The paper proposes a spatial concept for multifunctional and flexible underground public spaces. The results will contribute to urban planning and urban management practices, and particularly to the enhancement of the quality of life in Hanoi.

Keywords: underground public space; urban railway station; Hanoi; historical inner city.

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1. Introduction

"Underground public spaces" (UPS) refer to spaces constructed below ground for public purposes such as circulation, community activities, and recreation [1, 2]. In the past, humans primarily utilized underground spaces as temporary shelters for worship or seclusion, for protection against external factors and climatic conditions, and as storage for goods and food, among other uses [3]. The exploitation and utilization of underground space is an essential requirement for urban development, especially as living environments become increasingly insufficient, traffic conditions may be from time to time chaotic, and development costs put new burdens on cities. The construction of urban rail transit systems has improved commuting conditions, shortened the distance between people's workplaces and homes in daily life, as well as commercial activities, and effectively organized three-dimensional traffic circulation within underground spaces. Urban rail transit and underground space have become two elements that are both independent and inseparable in urban development [4].

Globally, countries are increasingly exploring the development and utilization of subways and underground spaces. In London, for instance, historic underground stations have been repurposed as museums and art galleries. Since the 1990s, Montreal (Canada) has constructed a 36 km^2 underground city, significantly expanding its capacity for public activities. This subterranean network is primarily

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connected to transport hubs, using stations as central nodes from which the city develops outward based on the radiation concept [5]. In Shanghai, the Jing'an Temple Metro Station links subterrain plazas, urban complexes, and shopping centers through an integrated underground network, with plans underway to develop the surrounding area into a regionally cohesive system [6].

UPS offer considerable potential to meet essential human needs, foster environments conducive to social interaction and service-based economies, and contribute to sustainable urban development. Furthermore, these spaces can provide vast pedestrian networks linking urban centers, be reinforced as low-vulnerability zones in crises, and offer users flexible, multi-purpose environments—all of which underscore their strategic importance [7]. The planning of UPS must comply with fundamental principles, including property rights, urban integration, accessibility, safety, archaeological preservation, and construction feasibility [8]. When developed with careful consideration of legal, economic, social, safety, technical and environmental factors, and also guided by comprehensive usage plans, UPS can serve as an effective component of urban development [9].

The versatility of UPS also presents benefits that ensure greater attention in urban planning. These spaces are able to enhance public safety, ensure long-term environmental protection by avoiding negative impacts on surface ecosystems and agricultural land, accommodate shared utility tunnels and facilitate the creation of underground pedestrian zones [10]. By satisfying criteria across multiple domains—such as "optimal land use, improved regional legibility, and safety" (physical); "traffic flow and interconnection" (transportation); "social justice and participation" (social); and "environmental protection and climate comfort" (environmental), while also ensuring economic efficiency—it is entirely feasible to effectively restructure and integrate UPS into urban life.

Until recently in Hanoi, the concept of underground space was limited to technical infrastructure, such as utility pipelines and parking garages. However, driven by greater urban development pressure and land-use constraints, the development of underground space gained momentum around 2010. In this period, integrated UPS with commercial and service functions began to emerge within large-scale complexes like the Royal City and Times City shopping centers. While these projects are notable examples of underground organization, they remain disconnected from their surroundings, resulting in isolated "pockets" of activity. Their primary aim has been to expand commercial real estate for investors rather than contributing to the city's broader dynamism [11].

Hanoi's urban railway (UR) projects are expected to be a major catalyst for the formation and use of UPS. The Master Plan for Underground Space Development in the Central Urban Area to 2030 designates 39 stations for multifunctional underground development, 17 of which are located within the historic inner-city area (HICA), as shown in Fig. 1 [11].

However, the organization, construction and utilization of UPS can be considered a relatively new concept in Vietnam, and its legal framework remains underdeveloped. Current regulations focus predominantly on technical infrastructure and have not yet adequately addressed UPS designed for public use. The Law on Construction (first promulgated in 2003, amended in 2014 and 2020) serves as the primary legal foundation, defining the rights and responsibilities for underground projects. While the Law on Urban Planning (2009) provides a general direction, it lacks detailed guidance for organizing UPS. Similarly, other laws—including those on Investment (2020), Public Investment (2019) and Public Assets (2017)—indirectly govern aspects of UPS. At the sub-law level, various decrees regulate construction and infrastructure but do not specifically target the complexities of UPS. Moreover, a well-developed spatial model for UPS connected to railway stations, one commensurate with the unique context of the HICA, has yet to take shape.

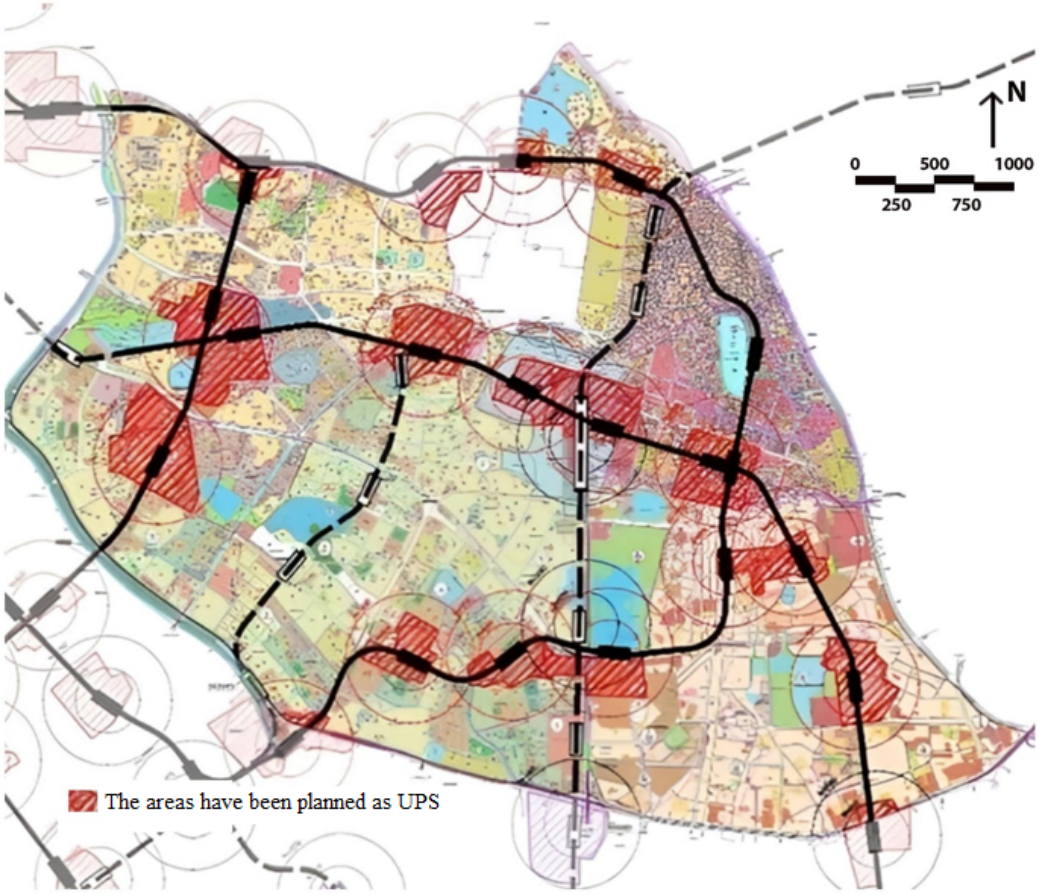

Figure 1. Locations of UPS connected to UR stations in the HICA

2. Theoretical background

2.1. Underground space zoning

Zaini, Suratman & Che Kassim in "The Vertical Land Use Zoning for Underground Space Development in Malaysia" (2021) clearly presented vertical zoning based on the principle of utilizing underground space for different purposes. The spatial development of underground space is commonly structured on a basis of a vertical zoning system, which allows functional uses with depth levels to optimize land use efficiency and minimize surface disruption. This approach organizes underground development into three principal strata, each associated with distinct infrastructural or public functions.

- Underneath Layer (B1, 0–5 meters below ground level): This uppermost stratum primarily supports the installation of essential urban technical infrastructure, including water supply and drainage systems, electrical networks, and telecommunications lines. Its proximity to the surface facilitates provides access for maintenance and integration with existing surface-level utilities.

- Middle Layer (B2, 5–15 meters): Occupying the central zone of underground development, this layer is typically the most functionally diverse and intensively utilized. It accommodates a wide range of public and commercial activities, such as pedestrian corridors, retail spaces, restaurants, and underground parking facilities. This stratum plays a critical role in activating underground space for everyday urban life.

- Deep Layer (B3, 15–30 meters and beyond): The deepest tier is generally reserved for large-scale infrastructure systems, including subway lines, technical service tunnels, and other specialized facilities. Due to its significant depth, this layer is well-suited for uses that require spatial isolation or minimal interference with surface activities, such as underground water reservoirs or energy storage systems.

This vertical stratification reflects a multifunctional, depth-sensitive model for underground urbanism, offering a rational framework for maximizing spatial efficiency while ensuring compatibility with surface-level urban function [12].

2.2. Typologies of UPS structures

Wu Shin in "Research on Design Methods of Urban Underground Public Space" defines the components of UPS integrated with metro stations which are generally categorized into four types in terms of morphology. First, centralized (node) form is concentrated and inward-facing space, typically including stand-alone underground centers. Second, linear form develops along an axis, common examples include underground pedestrian passages. Third, radial core is characterized by a large central void that serves as the core for surrounding linear spaces, forming a radial spatial network. This model typically centered around metro stations, creating a relatively complete system. Last but not least, net (network) is the urban metro system which serves as the backbone, connecting all civil underground spaces across the city into a comprehensive UPS network [13].

2.3. Classification of UPS integrated with metro station by Spatial Function

Cheng Peng, Chenxiao Ma, and Yunhao Dong in the paper "Unravelling the Formation Mechanism of Sustainable Underground Pedestrian Systems: Two Case Studies in Shanghai" (2023) describe two key modes of underground pedestrian network integration, including:

- Connecting UPS: Centered around UR stations, these spaces form pedestrian networks that link underground public spaces together, creating continuous chains of underground–underground and aboveground–underground connections.

- Integrated UPS: These spaces take advantage of urban redevelopment land and the underground portions of existing buildings to increase land-use efficiency by integrating UPS closely with aboveground structures. This creates synchronized complexes that help alleviate the pressure on overloaded existing public service [14].

2.4. Classification of UPS by Service Type

Zhao et al. in "Study on Development Pattern and Comprehensive Evaluation of Integration of Urban Underground Space and Rail Transit in China" (2023) classified UPS into three service types:

Public Service Spaces: These are functional spaces primarily intended to provide daily life services for residents and station visitors, such as food courts, restaurants, product exhibition areas, and entertainment zones. Additionally, to reduce pressure on ground-level public spaces, auxiliary service types like cultural facilities, healthcare and administrative services may also be organized.

Specialized Spaces: These are areas designed with specific functions to support heritage conservation, cultural activities, recreation, etc. They maximize the connection to redevelopment land and underground portions of buildings to form urban-scale public complexes.

Transportation Spaces: In order to enhance the connectivity within the underground space, metro station areas are also organized as transportation hub for visitors, including underground parking lots, reception lobbies, access routes to the surface [15].

2.5. Connectivity in Integrated Underground Urbanism

As Monique Labbe argued in "Architecture of underground spaces: From isolated innovations to connected urbanism" (2016), connectivity is not merely a matter of spatial linkage but a foundational principle that enables multifunctionality, continuity and urban coherence. This theoretical approach views underground spaces—particularly those surrounding metro stations—as extensions of the public realm rather than isolated transit infrastructure. Connectivity in this context is regarded as multi-dimensional, including:

Physical connectivity, which ensures seamless movement across underground, surface, and elevated urban layers through an integrated network of pedestrian pathways, vertical circulation systems and multimodal transfers.

Functional connectivity, where diverse urban programs such as retail, administrative services, cultural venues, and civic functions are co-located and co-designed to complement the transportation core, transforming metro stations into multi-use urban hubs.

Social and cultural connectivity, enabling underground spaces to host performances, exhibitions, and community events. This reinforces the station's role as a platform for public life and not just movement.

Perceptual connectivity, which enhances wayfinding, safety, and comfort through thoughtful architectural design, lighting, and signage, making underground environments legible and inviting [16].

Thus, research on underground space zoning has made significant progress internationally, with various models and classification systems proposed to pave the way for the spatial organization of urban underground areas. In contrast, research in Vietnam remains relatively limited and fragmented. While there is growing awareness of the potential for underground space development, most existing studies focus intentionally and merely on technical aspects or individual transport nodes, lacking comprehensive frameworks for zoning, integration, and multifunctional use. Therefore, it is imperative to develop a systematic zoning framework adapted to local urban morphology, planning regulations, and socio-economic conditions; to explore the integration of underground spaces with existing and future metro infrastructure. Such long-awaited investigations would contribute to a more strategic and sustainable use of subterranean space in rapidly urbanizing Vietnamese cities, particularly in the context of increasing pressure on surface-level infrastructure and public space.

3. Research Objectives and Methods

3.1. Research objectives

The research focuses on the spatial organization within metro stations and their connections to surrounding underground structures, with the aim of enhancing the functional use and also the social diversity of public spaces in Hanoi's inner-city area.

3.2. Research methods

This study adopted a multi-step empirical approach to evaluate the potential for developing UPS in integration with metro stations in the HICA of Hanoi. The methodology consists of three main components: case study selection, mapping and spatial analysis, and questionnaire surveys. Each step was designed to address the core research objective of understanding the spatial and social feasibility of UPS development in different urban contexts.

- Step 1: Case Study Selection. Three metro station areas—Station 1, Station 2, and Station 3—were selected as case studies based on three criteria: (1) their representation of different historical phases of urban development, (2) contrasting urban typologies (residential, mixed-use, commercial), and (3) distinct functional characteristics of surrounding land use. Station 1 is situated in a traditional

inner-city residential neighborhood with an aging population. Station 2 is located near university campuses and office zones, accommodating a mixed population of students, white-collar workers, and residents. Station 3 is embedded within a dense commercial and business district characterized by high-rise complexes and dynamic daily influx of commuters. The comparative diversity of these sites enables a contextualized evaluation of UPS integration scenarios across varied socio-spatial settings.

- Step 2: Mapping and Spatial Analysis. Field surveys were conducted in each case study area to collect data on land use, public facilities, transportation infrastructure, green spaces, and cultural-historical elements. These data were used to create thematic maps at a 1:500 scale, using background maps provided by the Hanoi Urban Planning Institute. The purpose of this step was to document the existing spatial conditions, identify potential constraints and opportunities for underground development, and provide a spatial framework for interpreting survey responses.

- Step 3: Questionnaire Survey. A structured questionnaire consisting of 10 key indicators related to public space usage and perception of UPS potential was administered to 30 local respondents in each case study area (totaling 90 participants). The sample included residents, students, workers and daily commuters selected through purposive sampling to reflect local diversity. This step was essential in capturing user behavior, preferences, and spatial demands, which are critical for assessing the social viability and responsiveness of potential UPS interventions. By structuring the research into these clearly defined steps—site selection based on urban diversity, spatial documentation through mapping, and social feedback via surveys—the study ensures that both the physical and human dimensions are integrated into the analysis of UPS development around metro stations in Hanoi's historic inner city.3.3. Reseacrh scope: The scope of the study is limited to the Hanoi inner-city area (HICA), which is currently experiencing increasing pressures from population growth and building density, simultaneously facing a shortage of public spaces. In the HICA, three typical stations were selected for in-depth study including: Hang Dau Station (Station 1), Kim Lien – Pham Ngoc Thach Station (Station 2), Lieu Giai – Nguyen Chi Thanh – Dao Tan – Kim Ma Station (Station 3).

Station 1 is located in Hanoi's Old Quarter, which has significant cultural, historical and architectural values. Public land area for parks or squares is almost scarce, as most land plots are used up for residential purposes, commerce (shops, traditional markets) or administrative offices (e.g., Ward People's Committees, police stations). Existing public spaces such as gardens, playgrounds or open spaces are usually small in size, scattered throughout residential areas or near public buildings, and are not well connected in order to form a coherent network. This fragmentation does not obviously enable accessibility or effective use, especially in the context of high traffic volume and population density.

Station 2 is situated in Kim Lien collective housing area, which was built over 50 years ago. The apartment buildings are largely deteriorated and the population density is high in consideration of limited land area. The system of green parks in the settlement is relatively underdeveloped and often shared with the courtyards of collective housing blocks. There is a lack of large public spaces for events and recreational activities for residents.

Station 3 is constructed in a mixed development zone that includes recently built towers (typically office complexes, commercial-service centers, or mixed-use apartment towers), urbanized village areas and collective housing blocks.

4. Theoretical concept

The diagram (Fig. 2) illustrates a theoretical hypothesis regarding the functional composition of underground public space, categorized into three distinct typologies based on urban context: conser-

vation areas, redevelopment spaces, and development-restricted zones. This hypothesis proposes that the proportion and hierarchy of underground functions vary according to the historical, social, and developmental characteristics of each area. In Type 1, typically associated with conservation zones such as old quarters or historic towns, underground space prioritizes cultural heritage functions, followed by essential public services (including tourism infrastructure), and finally, community activities at the base level. Type 2, corresponding to redevelopment areas (e.g., collective housing zones), maintains a functional balance where relic-based cultural elements are preserved to a lesser extent, while essential public services dominate, and community activities continue to play a foundational role. In contrast, Type 3—reflecting development-restricted or newly constructed areas—omits cultural functions altogether, emphasizing non-essential public services (such as commercial or recreational uses) and community activities. This theoretical framework suggests that the functional layering of underground space should be responsive to both the surface-level and underground urban fabric, supporting both cultural continuity and community needs while adapting to the specific developmental constraints of each area.

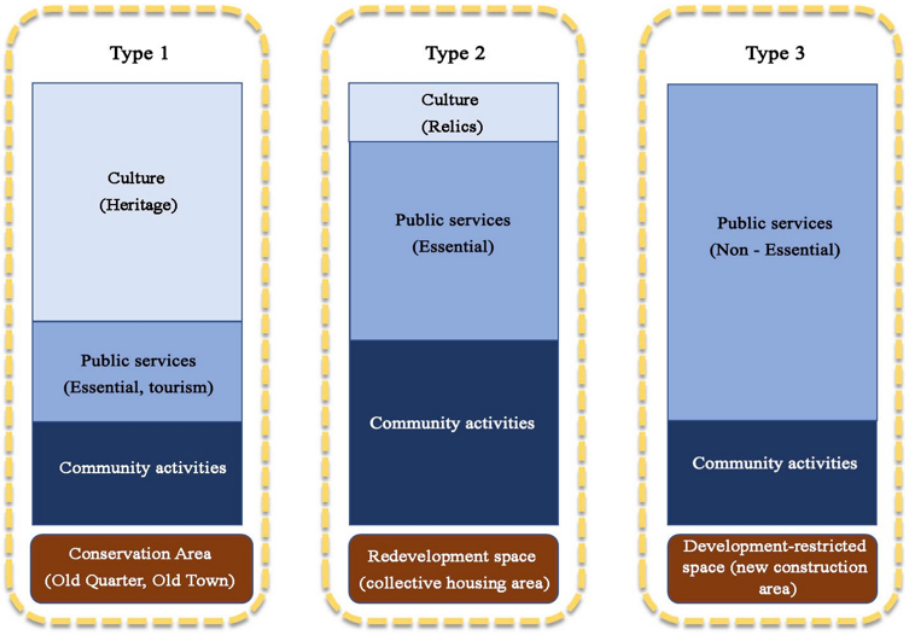

Figure 2. Proportion of UPS functional components adapted to specific conditions of zones in HICA

5. Survey Results

5.1. Connectivity with Heritages

Stations 1 and 2 are both located in zones characterized with high levels of historical and cultural value. However, in terms of potential to integrate heritages with UPS, only Station 1 demonstrates such potential (see Fig. 3).

Specifically, Hang Dau Water Tower—which has been recognized as a heritage building—can be integrated with underground public space systems to create a complex for art exhibitions, historical experiences and cultural displays. This approach complies with urban development goals that also emphasize heritage conservation and honoring existing urban legacies. According to the survey results, up to 70% of respondents found heritage sites to be highly attractive. However, among them,

around 60% reported difficulties in accessing these sites, indicating the existence of certain barriers to enhancing the connection between heritage and the public.

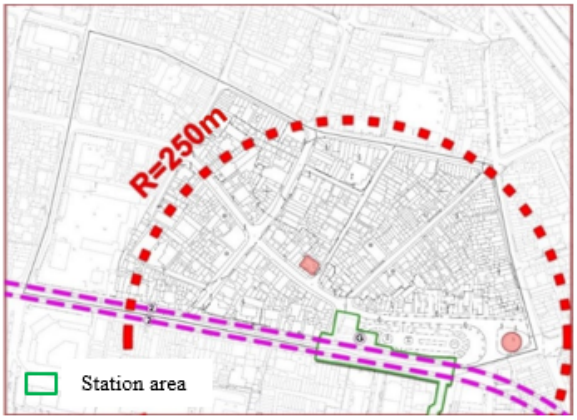

Figure 3. Location of cultural spaces surrounding Station 1

5.2. Connectivity with Commercial and Public Facilities

With regard to Station 3, the surrounding area is featured as a high concentration of commercial-service buildings. The architectural form is primarily composed of high-rise blocks with high floor area ratios, including commercial centers, hotels, and office buildings (such as Lotte Center, Vincom Metropolis, Daiwoo Hotel, etc.) (see Fig. 4). The commercial functions of these buildings are typically arranged on the podium levels (from floors 5 or 6 downward). Furthermore, these existing buildings often include underground spaces functioning as supermarkets, parking garages, restaurants, cinemas, and retail stores. This presents strong potential for future design integration with UPS linked to the transit stations.

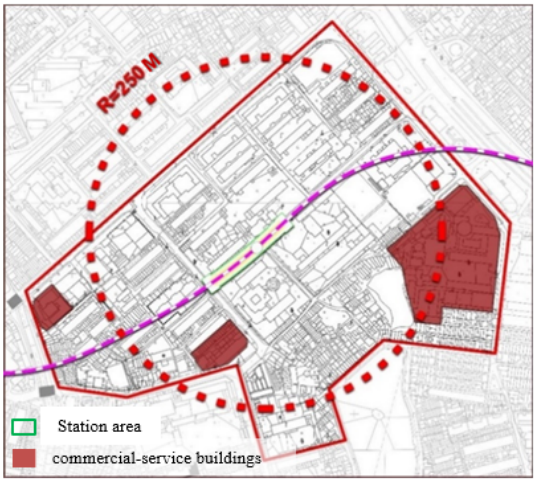

Figure 4. Locations of commercial-service buildings around Station 2

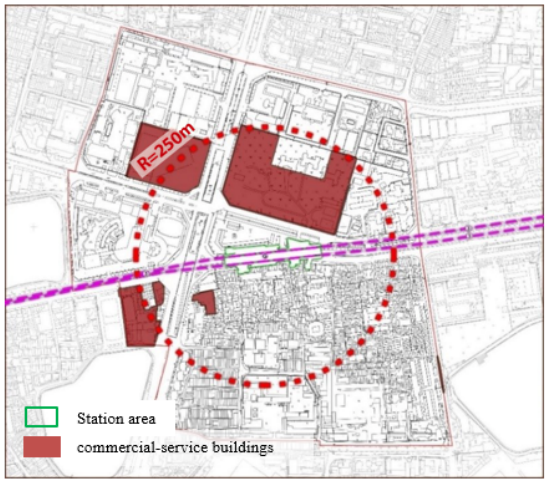

Figure 5. Locations of commercial-service buildings around Station 3

In consideration of the area surrounding Station 1 and 2, the existing uses are primarily small retail shops, traditional markets, etc. with mostly low-rise architecture, making it difficult to establish connections with UPS. In the area surrounding Station 2, although there are a few high-rise buildings such as Long Vi Wedding Center, Vietnam Maritime Corporation building, T&T Capella, Kim Lien

Hotel, etc. (see Fig. 5), the locations of these buildings are relatively far from the central station, making direct integration with the station and future UPS unlikely.

A community survey conducted at Stations 2 and 3 shows that 65% of visitors are between the ages of 20 and 30, while approximately 30% are in the 40 to 50 age group. The majority of respondents (85%) reported that they usually visit these areas on weekends. Although the locations are considered to have convenient parking, traffic congestion frequently occurs during peak hours from 5:00 PM to 7:00 PM. This indicates a clear need to improve transportation infrastructure and the organization of public spaces.

In all three cases, it is demonstrated the well connectivity of public buildings such as administrative offices, schools, health stations, and cultural houses which generally meet the basic needs of the local population. However, these still lack surrounding functional spaces that support the public facilities (see Fig. 6). Therefore, the development of UPS in the future will essentially create new functional spaces to supplement the public services currently offered by these aboveground facilities.

(a) Area surrounding station 1 (b) Area surrounding station 2 (c) Area surrounding station 3

Figure 6. Locations of public buildings around the stations

5.3. Connectivity with Public Open Spaces

In the area surrounding Station 1, as shown in Fig. 7, the park lies adjacent to the station. This area is currently the Hang Dau Garden Park, which frequently hosts community activities, entertainment, sports, and recreational uses for local residents. It is also a popular tourist site tied to historical landmarks. This area has strong potential to become a cultural hub directly linked to both the UPS system and the station square.

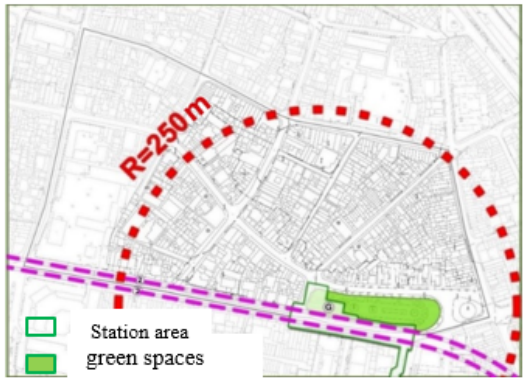

Figure 7. Current status of green spaces around Station 1

For Stations 2 and 3, existing green park spaces are mostly small-scale gardens, playgrounds, and sports courts interspersed within residential complexes, with limited area and scope.

Survey results show that 100% of respondents expressed a strong appreciation for this green space, particularly children under 12 and seniors over 65. They visit the area regularly on a daily basis, primarily between 5:00 PM and 7:00 PM. Notably, around 20% of visitors come from other places to experience the green space associated with the heritage site.

5.4. Land Use

Surrounding area of Station 1 (Fig. 8(a)): This area has the highest proportion of residential land. Other land uses mainly include public land serving residential units such as schools, green parks, and plots designated for administrative offices such as the ward People's Committee and the ward police station.

Surrounding area of Station 2 (Fig. 8(b)): This area has a diverse range of land uses, interweaving residential with public land such as schools, markets, and green parks serving both urban and residential needs. It also features urban-level commercial and service centers.

Surrounding area of Station 3 (Fig. 8(c)): This area has a low proportion of residential land. Most of the land is used for public and commercial purpose such as schools, research and training institutions, hotels, and commercial-service complexes.

(a) Land use around station 1 (b) Land use around station 2 (c) Land use around station 3

Figure 8. Land use in the case studies

5.5. Redevelopment Project

The area in the surrounding area of Station No. 2 is associated with Kim Lien apartment complex, a location that reflects the distinct features of Hanoi's transitional period in particular, and Vietnam's reform in general. Currently, apartments built in the 1970s are showing many disadvantages in terms of construction quality and deteriorating infrastructure, along with overcrowding due to the population burden. As a result, the city government plan to redevelop these areas to improve residents' quality of life and make efficient use of urban land resources . (see Fig. 9).

In the surrounding area of Station 3, residential areas in this location are quite diverse, including townhouse and old apartment buildings. The Ngoc Khanh apartment complex presents an opportunity for urban redevelopment projects (see Fig. 10).

Community surveys at Station 2 and Station 3 indicate strong support for local redevelopment projects. Notably, 60% of respondents expressed a desire to be resettled on-site in order to maintain community life and their connection to familiar surroundings. This highlights the importance of social factors in the urban planning and development process.

5.6. Transportation and Public Parking

In the area surrounding area of Station 1, as shown in Fig. 11, this area lacks designated parking lots. Instead, several informal parking spots have emerged near the Hang Dau garden, mainly serving visitors and users of nearby services and amenities. This is a temporary solution adopted by local authorities and residents to address the shortage of available land for parking.

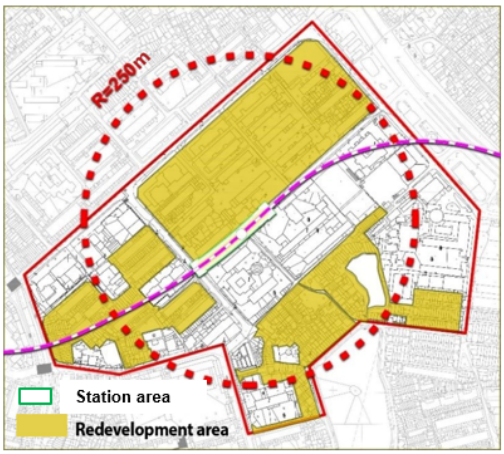

Figure 9. Redevelopment area around Station 2

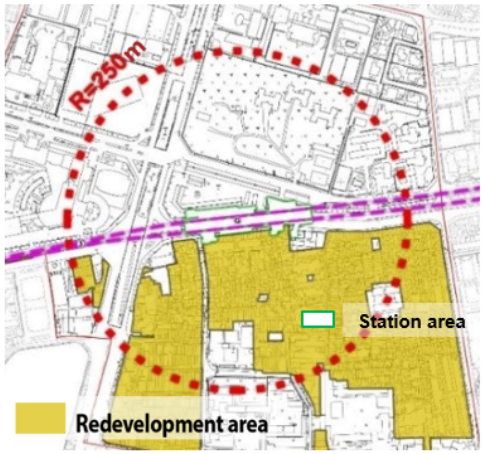

Figure 10. Redevelopment areas around Station 3

In term of bus stops, two bus stops located along Quan Thanh and Phan Dinh Phung streets are relatively well-positioned for easy access to the metro station and public spaces (such as Hang Dau flower garden).

In addition, in 2023, Hanoi introduced two public bicycle stations in the area, helping to enhance connectivity and laying the foundation for a future Transit-Oriented Development (TOD) model.

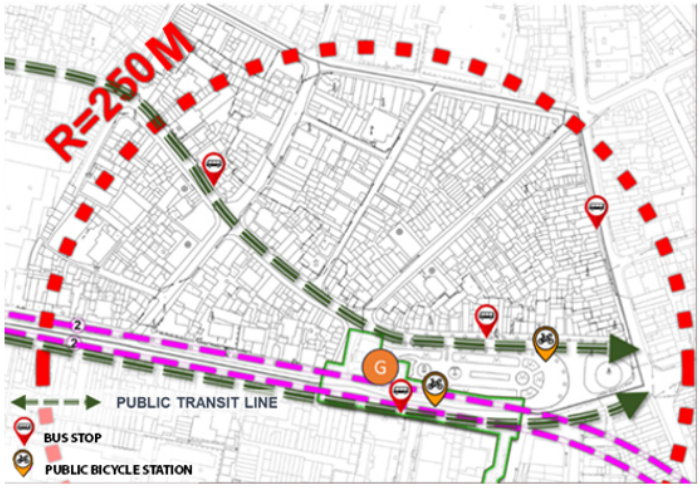

Figure 11. Bus stops and parking facilities around Station 1

The area in the neighbouring area of Station 2 also faces the lack of public parking lots. Residents are forced to utilize sidewalks and shared courtyards within apartment complexes as parking areas. The bus stop system in this area is placed along the two main roads of Pham Ngoc Thach and Dong Tac (Fig. 12). However, the distance to the current metro station is not appropriate (usually far from home for walking), resulting in poor connectivity with public transit.

According to the urban zone Station 3, a number of parking areas ranging from 500 to 2,500 m^2 have been proposed within the Kim Lien apartment complex, integrated with the community's shared living spaces.

In the neighboring area of Station 3, it only provides few underground parking areas within commercial-service buildings (Fig. 13). With reference to the plan, a new parking lot will be integrated on the site of the former Ngoc Khanh parking area and hereby connected to the metro station

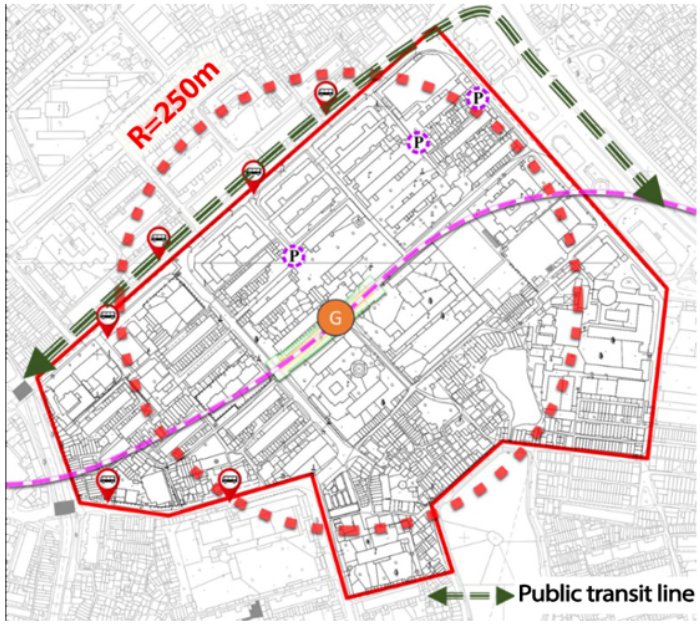

Figure 12. Bus stops and parking around Station 2

entrance.

The bus system here is similar to that of Station 2, with bus routes operating on two main corridors: Kim Ma – Dao Tan and Lieu Giai – Nguyen Chi Thanh. However, the stops are quite far from the metro station connection points, leading to a poor transit integration.

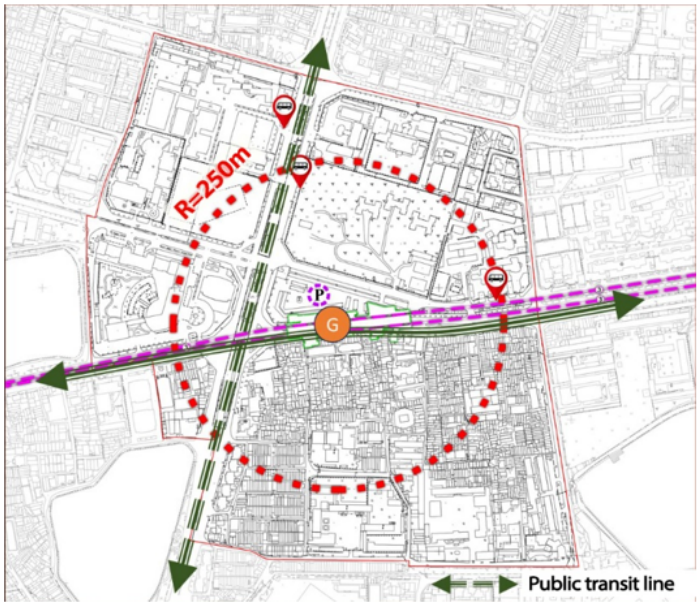

Figure 13. Public transport stops and public parking around Station 3

The survey conducted at the three stations reveals significant differences in accessibility. Station 1 is considered convenient due to its good connections to bus stops and public bicycle stations. At Station 2, 80% of respondents under the age of 40 found the walking distance from the bus stop acceptable, whereas those over 60 reported difficulty and expressed that the station was not accessible

to them. For Station 3, 100% of respondents stated that the distance is too far and unreasonable, indicating the need for additional measures to improve accessibility in the area.

5.7. Underground Components

According to statistics from the Hanoi Urban Planning Institute, there are 154 buildings with basements (excluding private residential houses) (see Fig. 14). The underground of high-rise buildings in the city are currently used for two main purposes: underground parking and commercial-service centers.

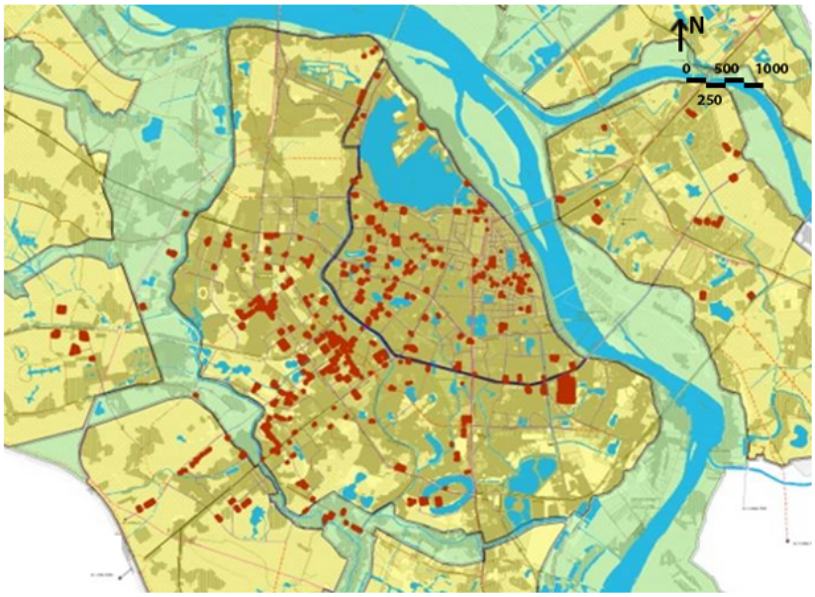

Figure 14. Diagram of the locations of buildings with basements in the HICA [11]

The results of the survey indicate that only the vicinity of Station 3 has currently underground spaces within the high-rise buildings (Lotte Center, Vinhomes, Daewoo Hotel) (Fig. 15). While the Daewoo complex utilizes its 2,500 m^2 underground space primarily for support functions like parking and logistics, the subterranean areas at Lotte Center and Vincom Nguyen Chi Thanh serve a dual commercial role. The scale of these developments is significantly larger: Hanoi Lotte Center features five basement levels totaling around 17,000 m^2, and Vincom Nguyen Chi Thanh provides four levels spanning 11,000-14,000 m^2. It can be regarded as a crucial basis for adding new connections from the underground UR station to help expand commercial and service activities linked to UPS in the area in the future.

Figure 15. Diagram of underground spaces around Station 3

Survey results show that 100% of respondents support the development of underground connections to enhance convenience and minimize pollution caused by surface-level motorized traffic. This highlights the need to integrate underground infrastructure solutions into sustainable urban planning.

5.8. Sociological Survey Results

a. Demographic characteristics

In the vicinity of Station 1, a gradual population shift has occurred, with many long-term residents relocating to adjacent districts such as Long Bien, Tay Ho, and Dong Da. As a result, approximately 70% of the remaining population is now beyond working age. A similar trend is observed around Station 2; however, due to its proximity to university campuses and office buildings, the area has experienced an influx of students and laborers, comprising roughly 30% of the local demographic. Meanwhile, Station 3 is surrounded by numerous high-rise buildings functioning as commercial and office complexes. Approximately 55% of the individuals active in this area are commuters who travel in daily for work and other activities during standard business hours (8:00 AM – 6:00 PM). A sociological survey indicates that the differing demographic compositions surrounding each station result in distinct spatial functions. While Stations 1 and 2 are both situated in predominantly residential neighborhoods, they serve contrasting populations: Station 1 caters mainly to an elderly community, functioning as a local social hub, whereas Station 2 supports a younger, economically active demographic central to the city's labor force. In contrast, Station 3 represents a mixed-use environment, accommodating both permanent residents and a substantial number of daily commuters engaged in professional and commercial activities.

b. Public space demand

Survey data reveal significant variation in public space utilization across the three station areas, reflecting their distinct demographic profiles. In the Station 1 area, there is a high demand for public spaces dedicated to physical exercise and community engagement, with 85% of respondents identifying these as primary needs. Although the transient population around Station 2 uses public spaces less frequently—typically during evenings, weekends, and holidays—this group exhibits a marked preference for facilities that support commercial, recreational, and creative functions, accounting for approximately 45% of total usage. Moreover, given the pendulum migration pattern of this group, about 83% of individuals also utilize public spaces near their workplaces or educational institutions. The area surrounding Station 3 experiences heightened demand during weekends, holidays, and special events, driven by visitors from other regions who frequent large commercial centers such as Lotte and Vincom for shopping, leisure, and entertainment. These divergent patterns of public space use highlight the need for differentiated planning approaches that align with the social and functional profiles of each urban area.

c. Public opinion on scenario development

The results of the community survey on proposed scenario development for three types of areas indicate a relatively high level of consensus while also reflecting specific public expectations. In historical areas, the proposal to allocate a major portion of the space for heritage and cultural activities—alongside 15% for public services and 15% for daily-use services—received agreement from 80% of respondents; the remaining 20% suggested increasing the share for daily amenities. In areas with redevelopment potential, the proposal to allocate 10% of the space for heritage and cultural activities, with the remainder equally divided between public services and daily-use services, was supported by 90% of participants, while 10% felt that integrating cultural functions was unnecessary. For newly developing constrained areas, the proposal to allocate 70% of the area for public services and 30% for daily-use services received support from 80% of respondents, with 20% expressing a desire to increase the share for everyday services. These findings highlight the importance of flexible functional zoning in planning processes, tailored to the characteristics of each area type and the actual needs of the community.

6. Discussions and proposals

6.1. Connectivity and the functional integration of UPS

The comparative analysis of the three case study stations reveals the pivotal role of connectivity in shaping the viability, character, and future development potential of UPS within dense urban environments. The surrounding context at each station—defined by its cultural heritage, commercial fabric, public services, land use, and socio-demographics—presents unique opportunities and limitations in the integration of UPS with existing urban systems.

In terms of cultural and historical connectivity, Station 1 demonstrates a strong potential for cultural integration due to its proximity to significant heritage assets. The opportunity to transform this site into a cultural hub through underground connections aligns with broader urban goals of preserving heritage while activating underutilized spaces. In contrast, Stations 2 and 3 lack proximity to historical landmarks, reducing their potential for such an integration.

With regard to commercial and functional connectivity, among the three cases, Station 3 is outstanding as the most promising site in terms of commercial connectivity. The presence of large-scale commercial-service buildings and existing underground facilities offers a strong foundation for future seamless integration with UPS, supporting multifunctional transit-oriented development (TOD). Station 2 is noted for some vertical commercial structures, but their dispersed locations and poor proximity to the station core limit underground connection potential. Station 1 is constrained by a predominance of small-scale, low-rise buildings with limited integration capacity.

For public facility and open space connectivity, although all three areas feature essential public facilities, these often exist in isolation without supporting complementary functions. Here, UPS offers potential to bridge spatial and functional gaps—especially in Stations 1 and 2, where connectivity to cultural and public daily life is more critical. Station 1 also benefits from a large adjacent park, enabling the possible development of green-linked underground civic space, while Stations 2 and 3 are limited to fragmented and/or small-scale public open spaces.

The land use composition varies from place to place. Station 1 is predominantly residential and civic in function, ideal for community-oriented underground spaces. Station 2, though more mixed-in use, includes aging urban housing that is targeted for redevelopment. This offers strategic opportunities for integrating UPS into urban renewal efforts, improving connectivity and service access. Station 3, with a dominant commercial-service land use pattern, is naturally inclined toward high-density UPS integration supporting retail and office functions.

Transit accessibility and multimodal integration are uneven. While Station 1 has relatively well-positioned bus stops and new public bike stations, Stations 2 and 3 suffer from disconnected bus networks and insufficient pedestrian linkages to transit points. This affects the feasibility of UPS as a fully interconnected mobility node. Future development must address last-mile connectivity to maximize the utility of underground infrastructure.

In consideration of infrastructure readiness, only Station 3 currently shows substantial existing underground commercial and parking infrastructure. This existing condition is a significant factor for horizontal and vertical expansion of UPS, supporting retail, transport, and public amenities. The absence of such infrastructure around Stations 1 and 2 implies a need for phased and integrated design strategies if UPS development is to be viable.

The sociological survey underlines the importance of tailoring UPS functions to user needs and daily rhythms. Station 1, with its aging population, requires community-oriented and passive-use spaces. Station 2, which houses a younger and more dynamic community, demands flexible spaces for work, study and recreation. Station 3, with its transient daytime population of professionals and

tourists, is best suited for commercially-driven UPS functions. These insights speak for the necessity of designing user-responsive underground spaces that serve not only mobility but also lifestyle and social engagement.

6.2. Solutions for organizing UPS around UR stations: context-based typologies for UPS integration

This study identifies three primary typologies of UPS development, each corresponding to distinct urban conditions: conservation areas, redevelopment zones, and development-restricted zones. Each typology reflects a unique configuration of spatial functions—culture, public services, and community activities—based on contextual demands and planning constraints.

a. Type 1: Conservation areas (e.g., Old Quarter, Old Town)

In historically sensitive areas, UPS development prioritizes the enhancement of cultural heritage. Cultural functions (account for 60%-70%), such as heritage interpretation, museum spaces, or historical exhibitions, dominate the upper strata of the spatial configuration. These are further solidified by public services (15%-20%)—particularly those oriented toward tourism and essential daily needs—and anchored by community-oriented spaces (15%-20%) at the base. This typology emphasizes cultural continuity and the integration of underground infrastructure as a means of protecting and revitalizing heritage assets without disrupting the aboveground urban fabric.

b. Type 2: Redevelopment zones

In areas undergoing an urban renewal, UPS plays a critical role in delivering essential public services to dense residential populations. While cultural relics may exist, they are less dominant, and thus occupy a smaller share of the underground development program (around 10%). The focus instead shifts to essential public functions (approximately 45%)—such as markets, health clinics, and transit access—while maintaining community activity zones (about 45%) as a foundational element. This typology supports social cohesion and urban regeneration by reactivating underutilized space to address infrastructure deficits.

c. Type 3: Development-restricted zones

In newly developed or strategically restricted areas, UPS integration is less constrained by existing cultural or architectural elements. These spaces allow for a more flexible and multifunctional approach to design. Public services (60%) in this context are often non-essential or leisure-oriented—such as retail shops, fitness centers, or entertainment venues—while community activity zones (40%) provide social infrastructure for emerging populations. This typology prioritizes innovation and adaptability, enabling the underground domain to accommodate a broader range of urban needs.

These typologies underscore the necessity of a context-sensitive approach to UPS planning. Rather than adopting a one-size-fits-all model, UPS functions should be tailored to the heritage, density, service demands, and development stage of each urban area. This allows underground spaces to contribute meaningfully not only to mobility and service delivery, but also to cultural preservation, social equity and urban identity.

7. Conclusions

In the context of population growth and increasing urbanization pressure in Hanoi, the development of UPS integrated to UR stations in the HICA is considered a strategic solution to improve the quality of urban living spaces and promote sustainable urban development. Through practical analyses of three representative areas—Hang Dau Station, Kim Lien Station, and the Lieu Giai – Nguyen

Chi Thanh – Dao Tan – Kim Ma area—this paper has consolidated the theoretical foundations along with the current conditions of the study area, and proposed spatial concept for organizing UPS in response to the cultural, social, and economic characteristics of the city.

The research results indicate that organizing UPS requires integrating multifunctionality to optimize land use efficiency while ensuring the percentage of each function so that it could be appropriate for the local development characteristics. Additionally, the paper emphasizes the importance of preserving and enhancing urban heritage, strengthening surface–underground transportation connectivity, and developing public amenities to meet the demands of both local residents and visitors.

However, the study currently only surveys three typical areas, while Hanoi's urban rail network has a much wider extent, therefore it requires more in-depth research in other areas to ensure a comprehensive approach. Moreover, due to limitations in field data and the slow progress of current urban rail projects, many forecasts in the study remain hypothetical and will need to be updated and verified in future research. With regard to the future city transport development, expanding the survey scope and integrating more quantitative analyses on the social, economic, and environmental impacts of UPS will be essential steps towards refining a sustainable urban underground space development concept for Hanoi and other major cities in Vietnam.

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