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Deep subterranean railway system: Acceptability assessment of the public discourse in the Seoul Metropolitan Area of South Korea

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ABSTRACT

The objective of this study is to analyze the public acceptability of deep subterranean railway systems, which will be constructed in the space 40 m below ground level and will be operated at twice the speed of the existing subway system. Although such railway systems have been feasible in terms of construction technologies and economics, public acceptability must be considered for the successful introduction of such a new public infrastructure. Therefore, to perform the analysis of public acceptability, a telephone-based survey was conducted for residents in the vicinity of the planned the deep subterranean railway systems. As a result, about 70% of the respondents answered that they took a neutral or opposing attitude to introducing the deep subterranean railway systems. Awareness of the deep subterranean railway systems has a positive impact on its acceptability. In addition, the acceptability is found to show a negative relationship with environment and inconvenience factors. Based on the analysis results, an affective approach through soft measures such as awareness campaigns and advertisements is recommended to effectively address and mitigate the concerns and issues raised by the public.

1. Introduction

The construction of a new rail transportation system in an existing metropolitan area has to overcome various restrictions, which include land compensation issues, urban landscape issues, environmental issues such as noise and vibration, and conflict with road transportation systems. The subsurface use of public land such as urban roadways has been partly satisfied with such limitations. Based on this background, the Seoul Metropolitan Government has also constructed a subway transportation network along with the urban roadway network, and its length amounts to about 500 km. In addition, the daily and annual ridership of the subway transportation system in the Seoul Metropolitan Area is the third highest in the world, after that in the Tokyo Metropolitan Area, Japan and the Moscow Metropolitan area, Russia (Derrible and Kennedy, 2009).

Despite the high ridership of the subway transportation system in the Seoul Metropolitan Area, the Korean Government is planning to extend the subway transportation systems to mitigate road traffic congestion as well as to cope with the global warming issue. That is, the current policy priority for the high and increasing ridership lies in constructing a high-speed

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railway system to complement the service of the existing urban subway systems. However, underground space in the Seoul Metropolitan Area is already crowded with various types of facilities such as electricity cables and ducts, sewerage and water supplies, gas pipes, underground parking lots, and subways. Additionally, since a specific level of horizontal curve is required for the operation of the high-speed railway, the subway system construction along with the urban roadway network can restricts the speed of high-speed subway train.

As a result, the Korean Government has been increasingly interested in the utilization of other spaces other than the subsurface of the urban roadways. One such space is 'deep subterranean space' defined as that space under 40 m of depth in which there is no need to compensate landowners of the surface space for the use of the underground space. However, the use of deep subterranean space could lead to the emotional uneasiness of system users due to safety and security worries, such as seismic activity,[2] the fear of deep subterranean, and other disasters. In addition, it may be perceived as inconvenient to access and transfer to deep stations, and as environmentally annoying in terms of noise and vibration. The purpose of this study is therefore to analyze the public acceptability of the deep subterranean railway systems, prior to the planning project of its construction.

2. Literature review

2.1. Deep subterranean railway systems in urban areas

After the introduction of the concept of the subterranean street by Webster (1914), significant advancements in construction technologies during the 20th century resulted in a boom in underground space development. These technologies include reinforced concrete, tunneling in soft ground and the creation of open underground excavations with minimum subsidence of adjacent ground (facilitated by sheet piling, bored piles, and diaphragm walls). The late 20th century especially benefitted from advancements in underground construction and geotechnical soil improvement technologies. These technological advancements not only led to the operation of deep subterranean railway systems to connect locations via underwater tunnels such as Seikan Tunnel in Japan in 1988 and Channel Tunnel between the United Kingdom and France in 1994 (Chow et al., 2002; Koyama, 1997), but also enabled progressive urban underground space development in densely populated city areas, including excavation of large caverns in the shallow subsurface. As a result, the use of urban underground space has been more intensive with such technological advancements as well as with increasing urban underground space congestion and land prices and other environmental issues.

Urban underground space is functionally used for utilities and communications (e.g., water, sewerage, gas, electric cables), transportation (e.g., railways, roadways, pedestrian tunnels), storage (e.g., food, water, hazardous goods), industry (e.g., power plants), public use (e.g., shopping centers, hospitals, civil defense structures), and private and personal use (e.g., parking lots). According to research by Bobylev (2008), utilities and transportation are the most common functions of urban underground space. This study was based on three cities, Paris, Tokyo, and Stockholm, and the result showed that the cities used more than 32% of urban underground space for transportation. Specifically, the city of Tokyo showed 55% of underground space being for rail transportation at 43%. Thus, the depth in Tokyo metro lines has progressed from shallow ground layers to deeper layers, and recently, it has reached 50 m in depth (Bobylev, 2009; Goto, 2001; Takasaki et al., 2000).

Recently, Li et al. (2013a) proposed a new paradigm of economic development: underground urbanism defined as an innovative concept for urban restructuring and a transformational construction practice. In this study, they introduced its concept, process, and application in the city of Geneva, Switzerland. Also, to formulate 3D zoning, they demonstrated a comprehensive evaluation methodology for underground resources beneath the municipality of Suzhou in China (Li et al., 2013b). In these two studies, they introduced the holistic management concept of the underground resources including underground space, groundwater, geomaterials and geothermal energy.

In terms of its transportation environment, such as traffic congestion and public transportation services, the Seoul Metropolitan Area is very similar to that of Tokyo. Thus, the Korean Government is considering constructing a deep subterranean railway systems, which is to be twice as fast as the existing subway in the Seoul Metropolitan Area and is to be constructed in the space under 40 m from the ground level (Lee et al., 2010; Park et al., 2010). The status of this system is currently at the feasibility study.

2.2. Public acceptability

Procedurally, public acceptability has to be studied prior to adapting a new policy or an innovative technology. In the literature in the transportation field, road pricing policies have frequently been found to be a new congestion relief tools (Pridmore and Miola, 2011). Jaensirisak et al. (2005) reviewed a large number of public acceptability studies of road pricing in the UK in view of two aspects: factors influencing acceptability of road pricing and predictive models of acceptability. In the study, they explained variations in public acceptability of road pricing between car users and non-car users based on a

[2] Although underground structures perform well during seismic events due to the lower amplitudes of vibration experienced by buried facilities and the robustness of structure design and construction (Hashash et al., 2001), the public generally feel that they are unsafe during seismic activities. Thus, underground structures in the study are expressed as unsafe ones.