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A Study on the Analysis of Case by Forms According to Location of Multi-Dimensional Urban Planning

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Abstract: As urbanization continues to grow and densify and the demand for land increases, various problems have surfaced with limited means to accommodate more urban infrastructure. Urban regeneration has recently become a new trend and efforts are being made to solve the many problems caused by the rapid industrialization of the city. Among them, 'multi-dimensional planning of the urban' is the development method which can utilize the land resources efficiently by observing the urban space by introducing the three-dimensional stereoscopic viewpoint in the existing plan. Through the analysis of the preceding articles and references,'multi-dimensional planning of the uban' was classified into three-dimensional city planning, multi-dimensional urban planning, multi-dimensional road planning, multi-dimensional landscape planning and multi-dimensional underground planning.

Key words: Urban regeneration, multi-dimensional urban planning, multi-dimensional road planning, urbanization, development, grow

INTRODUCTION

The concentration of people and industries in cities is increasing the size and density of cities and the demand for land is increasing in accordance with such activities. Existing methods of two-dimensional plane-based planning applied to the limited land resources of cities have resulted in problems such as increased traffic congestion, disorganized building arrangements and increased risks to pedestrians. In addition such methods are limited in the ability to accommodate the need for more urban infrastructure facilities. Greater benefits and city services are especially in demand in modern cities which has led to the exploration of methods to diversify and increase the efficiencies of urban spaces. Through urban regeneration, modern cities are making greater efforts to resolve the problems of existing planning methods. Moreover, multi-dimensional/mixed development methods have often been applied as a means of the multi-dimensional planning of cities (Yoon and Yim, 2008).

Unlike existing two-dimensional plane-based planning methods, multi-dimensional planning of cities introduces a three dimensional perspective of urban spaces. Because of this, such methods can be used to efficiently develop land resources. Methods of the multi-dimensional planning of cities are also separately referred to as multi-dimensional urban planning, multi-dimensional road planning, multi-dimension applied urban planning or mixed-use development. In some cases, multi-dimensional planning and development methods planned for underground or mid-air spaces are also known as midair suspended streets, aboveground open spaces, aboveground bridges, underground multi-dimensional cities or underground multi-dimensional architecture (Bae, 2001; Shinyoung, 2006; Kyung, 2009; Lee *et al*., 2017; Jang, 2010; Sun and Yi, 2010; Kang, 2003; Lee and Sou, 2006).

The application of three dimensions, rather than two dimensions, to urban designing is part of an effort to resolve various problems associated with the increasing densities of cities and to maximize the efficiencies of city infrastructure facilities. However, the period and background by which its terms have been created vary slightly. Several studies and media outlets often mix or interchangeably use the terms to describe different examples, resulting in misinterpretation. Incidentally, due to the fact that multi-dimensional urban planning in of itself involves development carried out by accommodating a complex mix of social demands, there are cases in which its forms or concepts cannot be further classified.

Purpose of research: The development of a new type of classification regarding multi-dimensional urban development as a clear concept for future cities will not only enable the efficient and practical use of land resources but will also, as shown in several overseas cases, contribute to urban developments that produce various benefits.

Amidst active initiatives associated with the multi-dimensional development of cities, the purpose of

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multi-dimensional urban development is not simply reduced to its role of designating mixed uses of land. In reality, land use designations are not limited only to underground spaces or aboveground spaces. Due to the use of land resources being planned in three dimensions rather than two dimensions, it is expected that studies limited in scope to aboveground or underground development are difficult to apply to actual urban planning cases.

Under these circumstances, this study surveyed several different cases of mixed-use forms of development that were presented in various studies. Different terms were used and attempts were made to establish and employ a classification method that would estimate the multi-dimensional planning of cities in the future. It is expected that this study will contribute to appropriate urban planning in the future by serving as a practical theoretical reference for urban planning.

Literature review

Classifications and concepts of multi-dimensional urban planning and development

Concepts of multi-dimensional urban planning: Multi-dimensional urban planning largely refers to the designation of space above or under a certain point of a land plot for a variety of uses to promote the practical use of land. Such forms of planning can be applied to all forms of mixed developments. A more narrow definition refers to the combined multi-dimensional decision-making of urban elements and non-urban elements of planned urban facilities. That is the description is not limited to the practical and efficient use of land associated with mixed-use designated single land plots. Rather, it also, encompasses a form of planning to be undertaken for efficient and practical land use. This expanded concept facilitates the resolution and prevention of various problems associated with modern cities. It also, addresses the need to conserve funds used for urban infrastructure by linking urban infrastructure facilities such as roads to privately owned buildings. As shown in Fig. 1, the basic concept of multi-dimensional development of cities regards the creation of new space upon mutually linking spaces. This linkage is both associated with the buildings themselves that are situated on the ground surfaces of a city as well as the aboveground, mid-air and underground spaces associated with the space occupied by buildings (Kyung, 2009).

"Multi-dimensional planning of cities" includes both the general and specific roles of multi-dimensional urban planning as previously mentioned. The term is also used to define the underground spatial planning and mid-air spatial planning practices that are currently being implemented as urban regeneration methods.

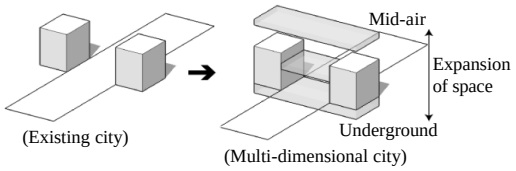


Fig. 1: Concept of the multi-dimensional planning of the urban

Multi-dimensional urban planning enables the practical use of land with respect to surface spaces, enables the reciprocal mix of spatial use during the multi-dimensional planning of underground space and minimizes the environmental damage associated with land use when undertaking the multi-dimensional planning of mid-air spaces. As part of the redevelopment projects of city centers, the multi-dimensional development of cities enables improvements to city functions. This is achieved by upgrading aging city centers to modern standards and supporting continuous city growth. The undertaking of urban regeneration through multi-dimensional planning makes it possible to secure open spaces for use as plazas, small parks, roads and parking lots. Such an initiative also improves land use, enabling the recovery of existing city functions.

MATERIALS AND METHODS

Scope of research: With urban regeneration recently gaining recognition as a new trend, several efforts have been made to resolve the many problems associated with the rapid industrialization of cities. Of these efforts, this study focuses on the multi-dimensional planning and development of cities from the perspective of urban regeneration.

The concept of urban regeneration first began as a means of revitalizing city centers. In South Korea, urban regeneration projects have largely entailed the redevelopment of aging urban residential complexes through a number of means. These have included individual urban redevelopment projects or the physical removal of unwanted buildings and the redevelopment to improve urban environments. The use of multi-dimensional and mixed-use methods of development and modification to develop land within cities in a multi-dimensional manner is considered to increase city efficiencies and competitiveness. Lee *et al.* (2017) The implementation of multi-dimensional urban planning and development during the initial phases of planning entail the advantage of the effective use of land resources. Conversely, multi-dimensional development in existing cities is considered to be even more valuable from the standpoint of urban regeneration or as a method to resolve the city-related problems.

In light of this, this study limited the review of case studies to those of multi-dimensional planning. Such cases included that of cities that were developed from the perspective of urban regeneration, those associated primarily with mid-air and underground developments with respect to multi-dimensional planning and the cases of city development aboveground buildings.

Method of research: Through the cases of multi-dimensional development undertaken as part of an urban regeneration initiative, this study aimed to establish a new type of classification for multi-dimensional urban development including aboveground, underground and mid-air spaces. The method of research of this study progressed as shown.

First, through a review of previous studies, the terms regarding the multi-dimensional development of cities were classified according to their concepts. Second, based on the classifications, the analysis items were developed and the cases were classified according to the categories as revealed through the case studies. Third, based on the classification types, the cases were organized and the characteristics and developmental backgrounds by type were analyzed.

Classification of types of multi-dimensional urban planning: There are several previous studies regarding the multi-dimensional planning of cities. Of these studies, those related to multi-dimensional urban planning and the classification of types were identified as follow (Table 1). The list of previous studies regarding the multi-dimensional planning of cities can be analyzed and organized as follows.

First as indicated in many of the studies on the multi-dimensional planning of cities, most studies regard the methods related to urban regeneration. Second, the phrase "multi-dimensional urban planning" is mainly used. The phrases specific to the overlapping designation of use, the planning of multi-dimensional roads and the overlapping designation of use were used separately during the research conducted to perform legal reviews. Third, the multi-dimensional planning of mid-air spaces collectively regarded mid-air open spaces, mid-air suspended streets and mid-air bridges. The multi-dimensional planning of underground spaces regarded underground living spaces, underground avenues and underground multi-dimensional cities.

In light of this, this study largely classified the types of the multi-dimensional planning of cities into multi-dimensional urban planning, multi-dimensional road planning, mid-air multi-dimensional planning and underground multi-dimensional planning. The concept, background and purpose of each classification were organized as shown in Table 2.

Table 1: Previous research and references

Researchers	Name	Purpose of research
Bae (2001)	Multi-dimensional land use Use of mid-air space Use of underground space	Classification of type
Shinyoung (2006)	Multi-dimensional urban planning Multi-dimensional road planning	System improvement
Kyung (2009)	Multi-dimensional urban planning Mixed-use development	
Lee *et al.* (2017)	Multi-dimensional urban planning Designation of multi-dimensional road zones	
Jang (2010)	Multi-dimensional urban planning Mixed-use planning	
Lee and Sou (2011)	Mid-air open space Mid-air suspended streets Mid-air bridge	Feasibility studies
Kang (2003)	Mid-air suspended streets	
Lee and Sou (2006)	Underground living space Underground avenues Underground shops	Analysis of case studies
Sun and Yi (2010)	Underground multi-dimensional city Indoor city	

Table 2: Characteristics of the classification types of multi-dimensional development of cities

Variables	Details
Multi-dimensional urban planning (mixed-use development)	
Concept	The enabling of designation for other use by planning urban spaces in three dimensions, utilizing both underground and mid-air spaces in addition to aboveground spaces (multi-dimensional land use planning)
Background	With the legal decision to overlap urban planning facilities, it is possible to install mixed-use buildings on top of a single plot of land. In addition, infrastructure facilities and private facilities can be planned to be multi-dimensionally linked together
Purpose	Aims to effectively install roads and infrastructure in a practical and efficient manner of using the land
Multi-dimensional road planning (multi-dimensional/mixed road)	
Concept	Multi-dimensional installation of two or more facilities such as roads or buildings aboveground, underground and mid-air spaces of the same plot of land in which the roads are integrated
Background	This concept was born as a result of further specifying multi-dimensional urban planning and was created as an expansion of urban regeneration projects such as balanced development projects and urban regeneration promotion projects
Purpose	The problem of urban traffic congestion and environmental pollution were to be mitigated and also had the aim of vitalizing communities and undertaking urban regeneration through mixed-use development
Mid-air multi-dimensional planning (mid-air suspended streets, multi-dimensional streets, mid-air bridges)	
Concept	The problem of urban traffic congestion and environmental pollution were to be mitigated and also had the aim of vitalizing communities and undertaking urban regeneration through mixed-use development
Background	The problem of urban traffic congestion and environmental pollution were to be mitigated and also had the aim of vitalizing communities and undertaking urban regeneration through mixed-use development

Table 2: Continue

Variables	Detail
Underground multi-dimensional planning (Underground multi-dimensional city, underground space development, indoor city)	
Concept	This concept regarded the use of urban resources and spatial resources that were created artificially to some degree or were naturally formed under the ground-level surface within the scope of its appropriate use
Background	The concept regarded the development of subways expanding the usage of subway stations which led to the development of underground spaces Resulted in further developments as it became possible to install facilities that were safe and comfortable
Purpose	This concept promotes pedestrian comfort levels by separating vehicle roads and pedestrian walkways and creating a new space to increase commercialization. It also, raises public accessibility by enabling connections with buildings and establishing aboveground, underground and in midair connections

RESULTS AND DISCUSSION

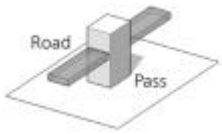
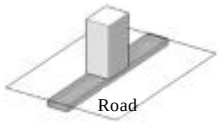
Case analysis: The theories regarding the multi-dimensional planning of cities reviewed in the previous studies were considered to classify multi-dimensional planning of cities into multi-dimensional urban planning, multi-dimensional road planning, mid-air multi-dimensional planning and underground multi-dimensional planning. In addition, the background and purpose of the methods of planning were analyzed. Based on the classification of types in 2, chapter 3 examined case studies to organize a list of cases that presented overlapping planning concepts. The purpose was to contribute to the development of an integrated system of classifications for the multi-dimensional planning of cities. In light of this, the cases used in this study were limited to those already mentioned in previous studies.

Case analysis of multi-dimensional urban planning: The ratio of land use by roads is increasing due to the development of vehicle transportation. Currently, the area covered by roads in urban spaces is approximately 20%. However, many of the problems associated with the increasing city density may be resolved if only 1% of this space can be used in a multi-dimensional manner. In light of this, the multi-dimensional urban planning system primarily identified the positioning of roads as those that pass through or are placed above or under buildings. In Japan where a multi-dimensional road system can be used to the multi-dimensional planning of roads is currently actively underway. There are also, various cases in which buildings have been used to fulfill the multi-dimensional use of roads.

Cases of multi-dimensional urban planning were classified according to the positioning of roads and buildings through mixed-use designations and were organized as shown in Table 3.

Case analysis of mid-air multi-dimensional planning: Mid-air multi-dimensional planning was realized based on various planning concepts. Classification of the types of mid-air multi-dimensional planning can be undertaken according to the planned locations of pedestrian walkways (open spaces).

Table 3: Characteristics of the classification types of multi-dimensional development of cities

Type	Building use
Roads pass through buildings	Office space
	
Case; Gate Tower (Osaka)	
Buildings on top of roads	Commercial, residential
	
Case; Nishidaiwa Residential Complex (Tokyo) Shinbashi Toranomon Region	
Roads on top of buildings	Commercial
	
Semba Center Building (Osaka)	

By separating pedestrian walkways and vehicle roads, mid-air spaces can be perceived as being aboveground. In this configuration, various activities were to be promoted using the open spaces by maintaining underground vehicle roads. Mid-air spaces are used to connect buildings with other buildings to promote greater integration of high-rise cities. Such connections are known as mid-air suspended streets and mid-air bridges. Even in the cases in which buildings are not connected to each other, the spaces can be used as urban gardens or green spaces that can be used as rest areas for city inhabitants. The mid-air multi-dimensional plan classifications according to the location of pedestrian walkways (open spaces) are shown in Table 4.

Case analysis of underground multi-dimensional planning: Due to its enclosed nature, undergrounds spaces in the past created psychological discomfort to people who are more familiar with living aboveground. Despite this, facility and system developments have made it possible to create comfortable spaces. As a means

Table 4: Characteristics of the classification types of multi-dimensional development of cities

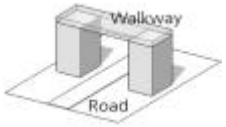
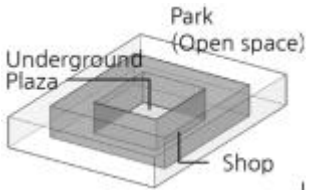
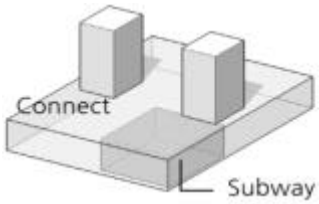
Type	Mass form
Underground (plate type)	Plate type (Landform type)
	
Case; La Defense (Paris)	
Connections between buildings	Horizontal type
	
Case; High Line Park	
Pedestrian walkways on top of buildings	Horizontal type+parks
	
Case Nanba Park Rooftop Garden	

Table 5: Cases of underground urban planning

Type	Purpose
Urban park planning	Public (park, plaza) = commercial use
	
Case	
Ohohtori Park	
Nagoya central Park	
Links to nearby underground spaces	Public+commercial+office
	
Case	
Montreal Indoor City	
Toronto Underground Pedestrian Walkway and Mall System	
Osaka Underground Avenue Development	

of accommodating the demands of urban life while resolving traffic and walkway congestions aboveground, underground spaces have been developed to include underground roads, underground shops and stores and underground entertainment facilities. Cases of using spaces under roads have become popularized through the development of underground walkways and access to subway transportation. This concept creates a network that connects with the neighboring areas while maintaining existing landscapes aboveground. Underground multi-dimensional planning primarily targeted and developed in major subway station hubs and resulted in the development of underground shopping districts by establishing connections between existing buildings. Such practices have also led to further linkages with urban public spaces. The dim nature of underground areas was alleviated by inducing natural light through the use of sunken gardens. The number of successful cases of urban regeneration through the use of underground spaces as a means of connecting urban spaces including aboveground spaces continues to grow. Although, plans for large-scale, multi-dimensional developments of underground urban spaces are being established in South Korea, such cases were not considered cases of urban regeneration and were thus excluded from this study.

Underground urban planning as part of urban regeneration projects present a trend in which development and planning are mostly undertaken using urban resources. Such projects are typically initiated by existing privately-owned buildings that are further connected and developed in the future. Table 5 presents the typological analysis of cases from a planning and development perspective.

The multi-dimensional planning of cities as shown in various cases not only presents a practical means of using land resources but also resolves various urban problems and contributes to the development of comfortable urban environments. In the future, such methods of planning are expected to develop significantly using mixed forms. Further means of promoting the efficiency of urban regeneration must be considered through greater legislative support. Moreover, it is expected that follow-up studies will be required in the future.

CONCLUSION

The aforementioned concerned the reclassification and analysis of cases according to their types of multi-dimensional urban development in single land plots, mid-air spaces and underground spaces. The types of classifications for multi-dimensional urban planning (mixed-use designation) were established based on the relationship that each case had with roads as was the case in previous studies and regarded an initial type of multi-dimensional plan. In the mid-air multi-dimensional planning method, the cases that separate roads from pedestrian walkways were identified and were thus classified according to the location and functions of the pedestrian walkways.

The multi-dimensional development of mid-air spaces entailed developments associated with aboveground, underground and mid-air spaces. These developments

created open spaces and provided pedestrian walkways that resulted in the creation of comfortable urban spaces. In the cases where pedestrian walkways were located above roads, the roads were naturally planned for underground construction. This arrangement is different from the development of underground pedestrian walkways in that pedestrian walkways produce a greater effect of space utilization by serving as an intermediary structure that connects one building to another.

Underground multi-dimensional planning was classified according to the types of planning and development. The cases were further divided into that of developing underground spaces to link with subway stations and that of developing underground spaces for greater open spaces within cities. As previously mentioned, from an urban regeneration standpoint, underground multi-dimensional planning has an advantage over both multi-dimensional urban planning and mid-air multi-dimensional planning in that aboveground landscapes are maintained. However, in addition to the negative perceptions of underground spaces, lack of natural light and difficulties in restoring conditions back to their original state, several factors must be carefully considered when undertaking underground multi-dimensional planning.

Through the case studies of multi-dimensional development found in previous research that was undertaken as part of an urban regeneration initiative, this study aimed to establish a new type of classification for multi-dimensional urban developments including aboveground, underground and mid-air spaces. Through this process, the items of analysis were developed and the cases were appropriately classified and analyzed according to their types. By analyzing the purpose, background and concepts of several different phrases and terms used in previous studies, the multi-dimensional planning of cities was classified into multi-dimensional urban planning, multi-dimensional road planning, mid-air multi-dimensional planning and underground multi-dimensional planning. The phrase that encompasses all of the classifications was considered to be 'multi-dimensional planning of cities.' The cases of multi-dimensional urban planning were classified according to the location of roads. The cases of mid-air multi-dimensional planning were classified according to the location and function of pedestrian walkways (open spaces). The cases of underground multi-dimensional planning were classified according to the types of planning. Upon assigning the categories, the characteristics of each classification were further studied.

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