An Analysis of the Urban Spatial Structure Change in Seoul, Korea using Space Syntax[1]

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Abstract

Spatial structures of large cities are typically complex and dynamic due to constant changes of their physical and socioeconomic characteristics. Studying both spatial and temporal forms is important for understanding their structures and forecast possible future changes in city growth patterns. In this study, we analyze structural changes of Seoul, the capital city of Korea using physical and socioeconomic factors such as street structure, land use and population. We used 25 administrative sub-regions composing Seoul City for 30 years from the 1960's to the 1990's every ten years. We used space syntax theory for the analysis of the changing structure of its street pattern in smaller resolution than existing methods that have focused on issues of accessibility based on zone levels. First, we analyze the attribute values of space syntax, population density and land uses changed in each administrative area of Seoul in each time period. Next, we examine the relationship between street networks and spatial pattern and evaluate whether development patterns are positive or not. Finally, we present the differences of spatial structures between planned areas and naturally grown areas.

1. Introduction

In urban planning, regional conditions and features need to be considered in order to improve the quality of living for residents and to create a sustainable urban environment. Spatial planning constitutes a basic and essential part of urban planning. The spatial structure of a city consists of physical elements and social elements and represents a dynamic system that continually transforms and evolves. Analysis of urban spatial structure is important in establishing urban planning.

In this dynamic system, land use planning is, usually, established first, followed by an infrastructure of the street structure. This leads to industrial development and becomes a main attraction for migration. When industries begin to decline, people

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move out, creating a cycle. In spatial planning, hierarchy of space depends on the street structure; it is closely connected to land use and affects population structure. A community should be formed in such a way that does not create conflict between traffic flows and land use. The objective of this research is to analyze the relationship between the street structure and urban spatial structure through the space syntax and a time-series analysis of spatial features, population density, and land use. This study will then demonstrate the quality of the development and differences between naturally grown areas and planned areas in terms of spatial structure for each administrative area in Seoul.

Yu Han and Tsou Jin-yeu (2009) have conducted a quantitative, time-series analysis of changes in the road network in Foshan, China, up to the 2000s, using global and local integration of space syntax as an index. A pattern of changing spatial function was marked on the map by population shift, but the data was not used for analysis. Erinsel Onder (2010) used global and local integration, selected an Istanbul region with five mosques, and examined their accessibility. This was a new approach in that it used space syntax to examine the location of specific spots in the area; however, the methodology was not sufficiently specific considering the small scope of the research.

Noting this, we carried out quantitative analysis of urban spatial structure, using space syntax, and examined changes in spatial structure, and the street structure by each administrative area, using population and land use data that present patterns of spatial functions. We evaluated the spatial scopes of 25 administrative sub-regions in Seoul for over a 30-year period, from 1960 to 1990, in 10-year increments. For analysis of changes in the street structure, we adopted space syntax to examine spatial structure from various angles, instead of employing the previous method that only examined a number of nodes and subsequent accessibility. We divided the area into five sections and examined each section's global integration, intelligibility, land use development, and population density. In order to evaluate the relationship between the street structure and urban spatial pattern, we analyzed visualized data on population density and global integration, in terms of planning aspects, and urbanization ratio and intelligibility in terms of the spatial aspect. Lastly, we compared the naturally-formed areas in the "Center" section, including Jung-gu area, with the planned "Southeast" section, including Gangnam-gu area.

2. Research Subjects

2.1 Space Syntax Theory

Space syntax theory was developed in the 1970s by the research team of Bill Hillier and Hanson Julienne at the University of London. It indicates a series of methodologies and theory used to objectively describe and analyze spatial configuration. Space syntax theory offered a new concept of determining accessibility of a place based on visibility; it assesses the social context and function of spatial structure in a quantitative manner. According to this theory, a space is measured, not in terms of physical distance but with regard to the concept of 'depth,' indicated by a minimum number of axial lines that are intersected when moving from one place to another. Adjacent spaces have a depth of 1; mean depth indicates the extent of difficulty in accessing a certain space from all other areas. An axial line is drawn by connecting all spaces with a minimum number of the longest straight lines.

In space syntax theory, spatial features are measured in terms of depth, connectivity, global integration, local integration, control value, and intelligibility. For the purpose of this research, global integration and intelligibility were used. Integration can be divided into global and local levels. The former indicates the level of integration for the entire space being examined, while the latter considers up to three spaces, centered on the space being examined. A higher level of global integration means that the designated space is close to the center of the overall spatial structure; it also means it is easy to access other areas. Intelligibility indicates the extent of perceiving overall space from a certain spot. This means the interrelationship is based on a coefficient, derived from local integration and the regression analysis of connectivity or global integration. Greater intelligibility indicates higher spatial perception of the entire region; it also means that the spatial use pattern is more systematic and predictable.

2.2 Urban Growth in Seoul and the Change of Spatial Structure

The boundary of Seoul has expanded since it became the capital of Chosun Dynasty in 1394. Even though the city was massively destroyed in the Korean War (1950-1953), its main street structure remained, more or less, intact. After the war, Korea went through rapid economic development and the wave of industrialization and urbanization led to a dramatic increase in population. In 1394, Seoul accommodated some 100,000 residents; the number rose to 900,000 by the time of emancipation from the Japanese colonization, and to 10 million by the 1990s. The administrative area of Seoul expanded from 288.35 ㎢ to 613.04 ㎢, in 1963, and to 627.06 ㎢ in 1973.

With regard to population distribution, since the 1980s, the "Center" section of Seoul, including Jung-gu area, lost more than half of its population due to the hollowing-out of downtown. Meanwhile, other areas saw their population growing more than 10 times. These phenomena have closely been reflected in policies. As the population rapidly grew, planning was adopted to diffuse urban functions and to even out population density. As part of such endeavors, in 1966, "basic urban planning" shifted Seoul from a single-core structure to a multiple-core structure. Development projects, which used to be heavy in the northern area, moved to the southern area for more balanced growth and the "land readjustment project" was implemented to provide residential units in the southern area of Seoul. This research analyzes the dramatic changes in Seoul's spatial structure in terms of its street

structure, population density, and land use, according to the policies that have been in place since the1960s.

3. Analysis of Urban Spatial Structure in Seoul

3.1 Data Analysis

To analyze data from Seoul, the city was divided into five sections, based on the administrative boundaries that were in place in 1990. These sections take development features and locations into consideration (Figure 1).

Figure 1. Five sections in Seoul

Table 1 shows time-series data for Seoul and its five sections. The population density for the “Center” section has dropped considerably since the 1980s; the nearby “Northern” area showed a slight fluctuation. Meanwhile, the “Southern” area saw a rapid increase in the 1970s in the “Southwest” section; this later shifted, in the 1980s, to the “Southeast” section. The urbanization ratio for all sections of Seoul continued to increase; this ratio rose sharply during the 1970s and 1980s. In the 1960s, the urbanization ratio for the “Center” section rose over 50%, and after 1980s, this ratio slightly decreased, due to the expansion of the green zone. During the 1970s, the “Northeast” section was actively developed and its urbanization ratio increased more than five times. In the 1980s, the two “South” sections went through active urbanization. By the 1990s, all sections showed an urbanization ratio over 50%.

In terms of global integration, the street structure stretches out from the center of the city; as a result, in all periods, the value for the “Center” section was the greatest, and the extent of rise was greatest for the “Southeast” section. As accessibility improved with the expanding street structure, the value rose to over 1 by the 1990s. Until the 1980s, intelligibility steadily increased as the street structure expanded and

then decreased because the newly-formed regions were not homogenous with the existing regions.

Table 1. Time-series Data Value for Seoul

Spatial	Administrative Area	Year	Population Density (person/㎢)	Urbanization Ratio(%)	Global Integration	Intelligibility (R^2)
Seoul		1960	10,139	17.5	0.574	0.243
		1970	15,116	36.4	0.835	0.505
		1980	17,362	51.8	0.998	0.527
		1990	17,669	61.1	1.122	0.520
Center	Jongno, Jung, Yongsan	1960	18,808	54.4	0.777	0.659
		1970	22,663	70.6	0.987	0.656
		1980	16,348	68.1	1.174	0.640
		1990	10,853	61.0	1.333	0.602
North east	Nowon, Dobong, Gangbuk,Seongbuk, Seongdong, Gwangjin, Dongdaemun,Jungnang	1960	11,600	8.6	0.486	0.104
		1970	17,889	40.6	0.870	0.464
		1980	19,479	54.2	1.000	0.576
		1990	19,604	61.5	1.119	0.556
North west	Eunpyeong, Seodaemun, Mapo	1960	13,165	28.9	0.653	0.330
		1970	10,416	49.6	0.810	0.445
		1980	18,226	58.2	1.029	0.359
		1990	16,237	55.9	1.103	0.368
South west	Yangcheon, Gangseo, Guro, Geumcheon, Yeongdeungpo, Dongjak, Gwanak	1960	6,104	15.0	0.628	0.260
		1970	14,717	26.8	0.749	0.449
		1980	18,015	52.9	0.888	0.425
		1990	20,614	63.2	1.043	0.453
South east	Seocho, Gangnam, Songpa, Gangdong	1960	5,509	3.4	0.440	0.113
		1970	8,133	9.0	0.818	0.615
		1980	12,098	27.7	1.031	0.653
		1990	14,829	52.1	1.125	0.615

Figure 2 illustrates changes in the street structure and the urbanization ratio for Seoul, between 1960 and 1990. Urbanized areas are marked in yellow. As can be seen, urbanization was focused in the “Center” section in the 1960s, in the “Northern” section in the 1970s, in the “Southwest” section in the 1980s, and in the “Southeast” section in the 1990s. As for the street structure, higher global integration was marked in thicker lines. As shown in Figure 2, that expanding street structure affected the urbanization ratio. Accessibility improved from an old-fashioned street structure in the “Center” section to a grid system in the “Southeast” section.

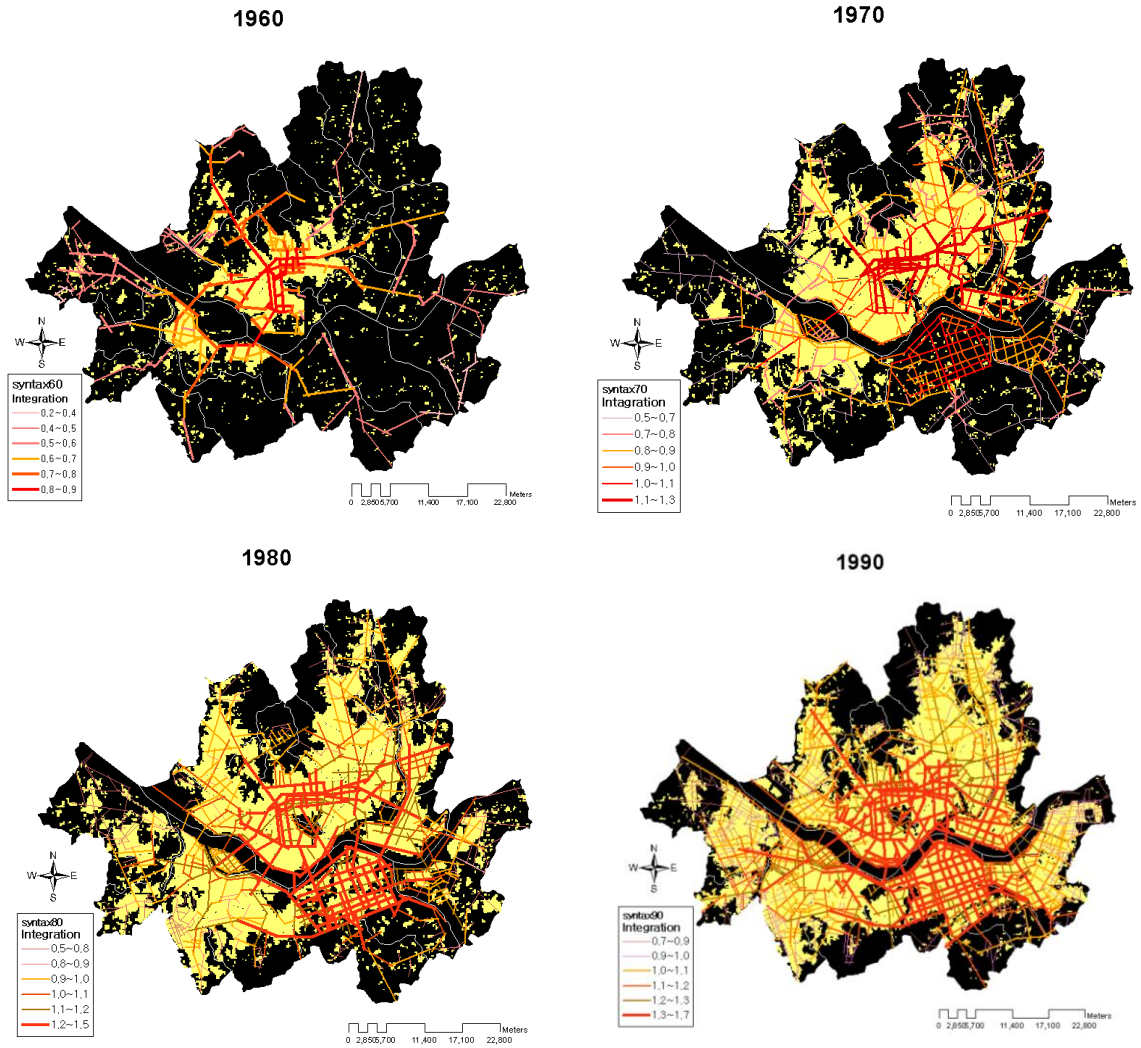

Figure 2. Changes in the street structure and the urbanization ratio in Seoul

3.2 Relationship between the Street structure and Urban Spatial Structure

The average value for the time-series data of 25 areas in Seoul was calculated to demonstrate the relationship between the street structure and urban spatial structure. To analyze the planning aspect and accessibility, population density and global integration were used (Figure 3). To examine spatial aspect, the urbanization ratio and intelligibility were used (Figure 4).

In Figure 3, sections with high population density and global integration indicate that the development properly addressed the issue of rising population and accessibility. Sections with low population density and global integration indicate underdeveloped areas. High population density with low global integration, or vice versa, indicates that population growth was considered either before the planning began, or after the planning was completed. In the 1960s, the city was mostly undeveloped with a few exceptions in the “Center” and the “Northwest” sections. As the population rose in 1970s, most areas in the “Southwest” section implemented urban planning after an increase in population. Most areas were developed properly throughout the 1980s; the “Southeast” section shows high accessibility, indicating

that population increase was considered in the urban planning. In the 1990s, population trends varied from area to area and accessibility partially changed within administrative areas. Planning is needed in order to improve the accessibility of the "Southwest" section.

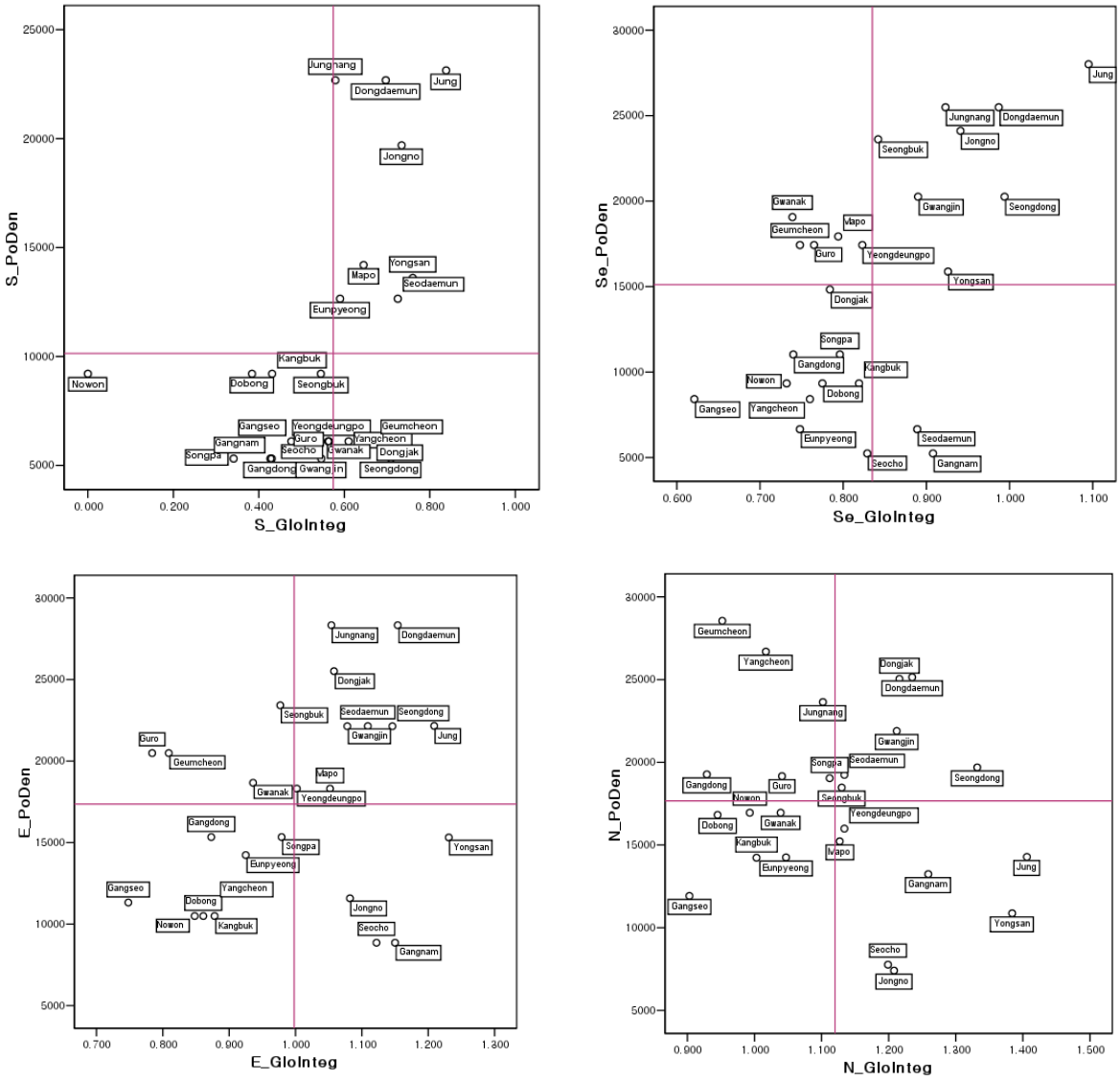

Figure 3. Relationship between population density and global integration

In Figure 4, areas with a high intelligibility and urbanization ratio indicate proper development of both the street structure and land use, while other areas remain in an underdeveloped stage. If one of these two properties is high, this indicates either a well-organized street structure or the need for further improvement. In the 1960s, most land was undeveloped, while the "Center" section showed proper development of land use and a street structure. The surrounding "Center" sections were not developed, but were connected to the "Center" by the road network. In the 1970s, urbanization sprawled from the "Center" section to adjacent areas, calling for further improvements in the street structure. During this time, the street structure was well

organized in the “Southeast” section. In the 1980s, the five sections saw widely varying levels of improvement in the street structure, compared to the urbanization ratio. In the 1990s, the street structure developed separately in each area.

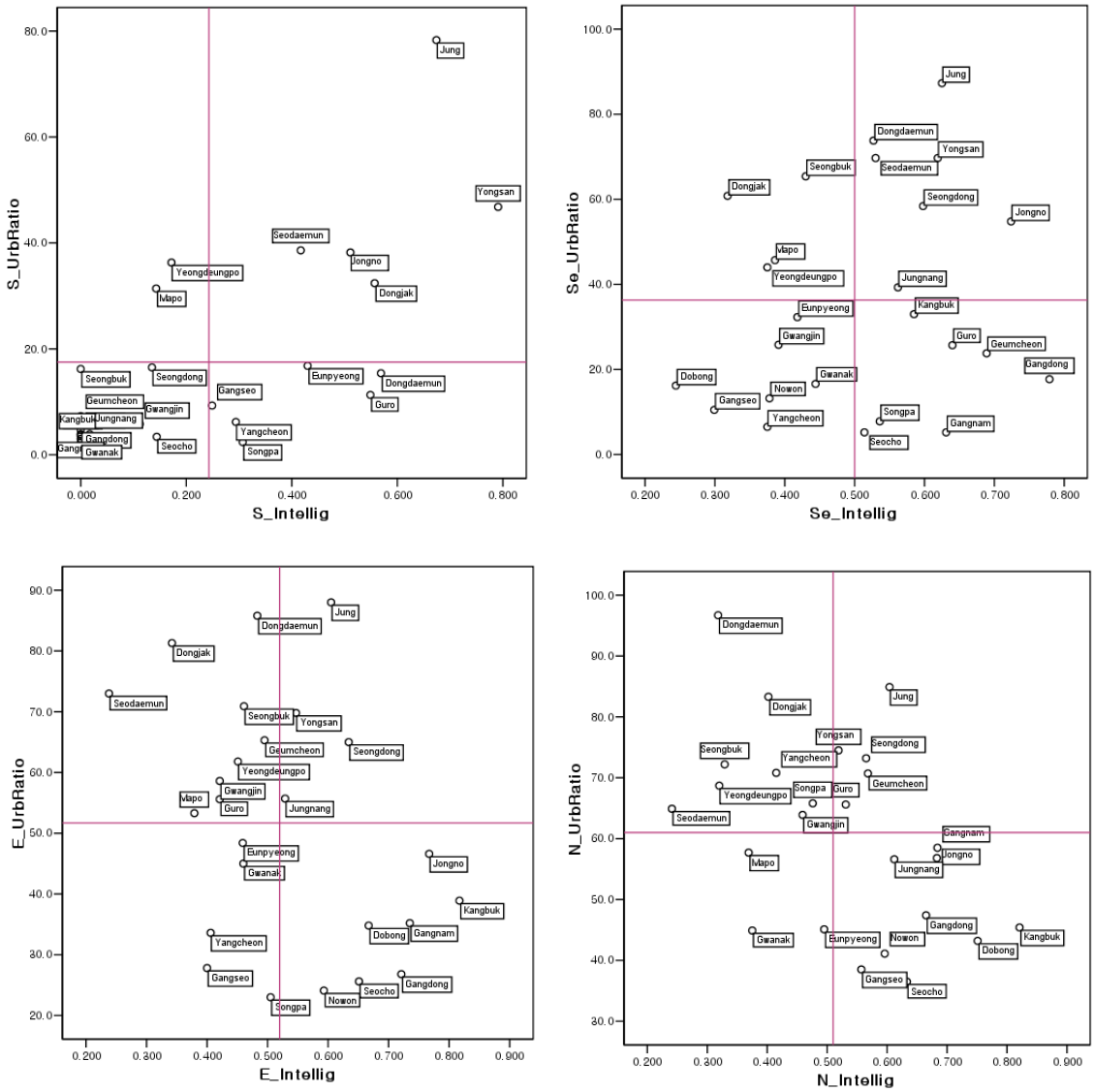

Figure 4. Relationship between the urbanization ratio and intelligibility

3.3 Comparations between the Naturally-formed and the Planned Regions

We compared the naturally-formed “Center” section with the planned “Southeast” section. Since the 1960s, the “Center” section has demonstrated the highest levels for population density, urbanization ratio, global integration, and intelligibility; conversely, “Southeast” section has shown the lowest values. However, the values for the “Center” section gradually decreased, while the values increased for the “Southeast” section. This suggests that the “Center” section reached full capacity in accommodating urban functions, and the “Southeast” section reached better accessibility and spatial intelligibility, due to its well-planned grid street structure, which is an important element in improving urban spatial structure.

4. Concluding Remarks

This research is based upon time-series and spatial data, examined from 10-year intervals, beginning in the 1960s, in order to analyze the urban spatial structure of Seoul. Among the spatial properties used to assess space syntax, global integration and intelligibility were used to analyze the street structure; population density and the urbanization ratio were used to examine patterns of related changes. The overall data indicates that the street structure is closely linked to spatial structure. Furthermore, the street structure, population density and urbanization ratio were used to assess a development project, in terms of planning aspects and spatial quality. Differences between the naturally-formed “Center” section and the planned “Southeast” section were analyzed to underscore the importance of spatial planning.

The spatial structure of Seoul indicates that expansion of the street structure improved accessibility, enabling it to achieve global integration over 1, centered on the “Center” section. This leads to population increase and a higher urbanization ratio. The urban development policies helped to form systematic street structures in the “Southeast” section, shifting the spatial hierarchy of the city. It is expected that linking space syntax with an estimation model for changing land use will help forge more practical and effective spatial planning.

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