A STUDY ON THE URBAN STRUCTURAL CHARACTERISTICS OF CENTRAL LIVING STREET FOR POPULATION DENSITY MANAGEMENT: THROUGH COMPARATIVE ANALYSIS OF NATURAL ORIGIN AND PLANNING CENTER (1101)

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Abstract. The city road plays an important role in urban space as a space where daily life and various activities take place. However, in this space, population density management is important in terms of infectious disease management and urban revitalization at the same time as areas where a large population is active. By comparing actual urban user data (POI), urban structural spatial characteristics, and floating population data, we intend to derive the characteristics of urban space in which actual users are active. The above study is of important significance in urban risk management by studying the relationship between the morphological structure of urban streets and the urban center.

POI-intensive areas were selected for the entire Seoul Metropolitan Government to compare the urban structural differences between naturally occurring cities and planned centers through POI. Among the POI concentrated areas, Eulji-ro was the naturally occurring city, and Seolleung was selected as the planning center. POI data was visualized through GIS based on 2022 data, using a public data portal provided by the governmentThis study is basically based on multiple regression analysis. By setting the indicators of spatial syntax as major independent variables and POI-related variables as dependent variables, we would like to find out the impact of the physical structure of the city on people's behavior patterns.

As a result, many POIs were located in areas with high integration and connection, and the back street was found to be a POI-intensive area. The degree of integration of the naturally occurring area (Eulji-ro) was correlated with integration only in 800M units, and for the central street with high integration and connection, the back street with low integration and high connection compared to the central street was POI dense. Through this study, it provides an analysis framework for urban planning and location preferences in compact urban centers. In addition, the planning effect was proved through an empirical analysis between the urban center and the pedestrian-centered urban plan. This can suggest a planning direction when creating a walking environment through the development or redevelopment of a new city in the future.

Keywords: Urban Structure, Center, Population Density, POI, Space Syntax.

1. Background and purpose of the study

1.1. Background

The city road plays an important role in urban space as a space where daily life and various activities take place. By comparing actual urban user data (POI), urban structural spatial characteristics, and floating population data, we intend to derive the characteristics of urban space in which actual users are active. This spatial information will be useful basic data for infectious diseases and density management.

1.2. Purpose of the study

Quantitative characterization of urban morphological structures based on space Syntax distance analysis data is meaningful in analyzing urban forms. In addition, the purpose of the study is to analyze the correlation with urban activity center data (POI) so that urban space management can be performed through data between urban form and actual users.

2. Theoretical and Prior Research Analysis

2.1. POI

Compared to existing building usage data, POI big data can identify various functions of the center (housing, commerce, work, leisure, etc.) and has the advantage of analyzing urban spatial structure and identifying the function of the center because there are no spatial restrictions on boundaries with microscopic data.

2.2. Space Syntax

Space syntax is a spatial analysis method developed by researchers at the University of London, and is a research methodology that quantitatively presents accessibility from each space to another space by analyzing the structure of each space.

In the space syntax, there are accessibility areas that analyze the shipper's road and visibility areas that analyze the space that is the area. Among the two factors, the analysis will be conducted focusing on accessibility. As such, space syntax analyzes the mutual organic combination of space based on the interrelationship between all spaces from a macro perspective and reflects the path through which people move, so the analysis is conducted focusing on the behavior of people using space.

2.3. Analysis of previous studies

When analyzing existing previous studies, it is largely divided into a study that analyzed the correlation between side streets and pedestrian volume, and a study that analyzed the correlation between road pedestrian volume using space syntax.

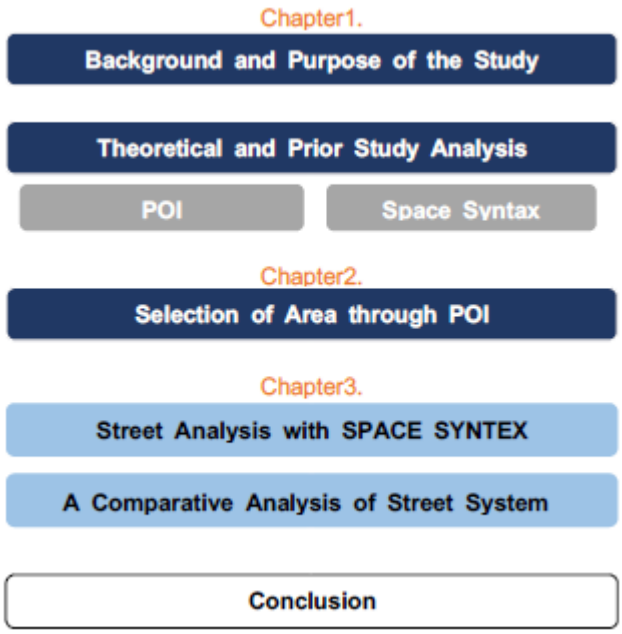
In the case of back streets and pedestrian traffic, data on empirical users were used using POI data, and road connectivity, integration, and morphological analysis were mainly conducted.

Most of the studies conducted quantitative analysis by setting indicators as variables through space syntax.

This study differs from previous studies in that it used POI data for domestic target sites to study the correlation between users' empirical data and road networks.

3. Scope and method of research

3.1. Flow of research



3.2. Selection of Area through POI

The POI data for the selection of the target site used the public data portal in Seoul, and all POI data showing actual population activity were used.

POI refers to restaurants, tourist attractions, leisure, and cultural facilities that many people visit, centering on commercial districts.

The temporal range of the analysis data was calculated based on the data in 2021 provided by the public data portal.

In addition, data analysis was conducted to examine areas that are activated on the street, such as car-free streets, green transportation, and commercial districts.

Through data analysis earlier, two locations around Seolleung Station and Eulji-ro, which has a high POI density throughout Seoul, were selected.

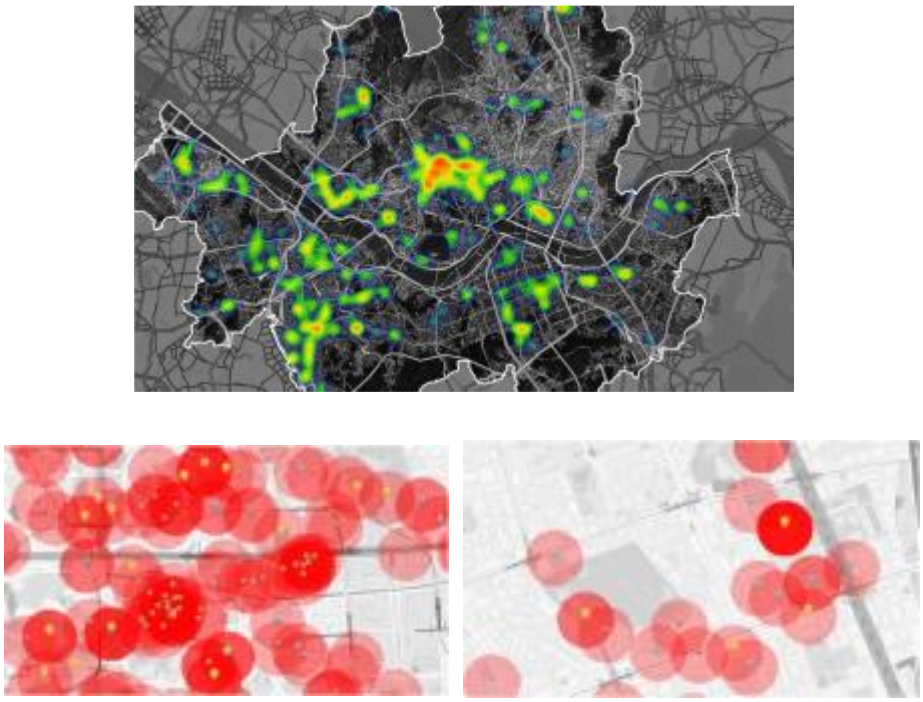


Figure 1. Seoul POI Data Density

3.3. T-test analysis and variable setting

This study is basically conducted based on multiple regression analysis. By setting the indicators of spatial syntax as major independent variables and POI-related variables as dependent variables, the impact of the city's physical structure on people's behavior was investigated.

Therefore, as independent variables, space integration, control, and connection were used, which can be collected on a road-by-road basis in space. As dependent variables, POIrelated variables such as density, absolute number, and industry of POI can be produced and used. At this time, variables related to spatial syntax are expressed by road unit, and POI is expressed by point vector in space, which is applied by road unit.

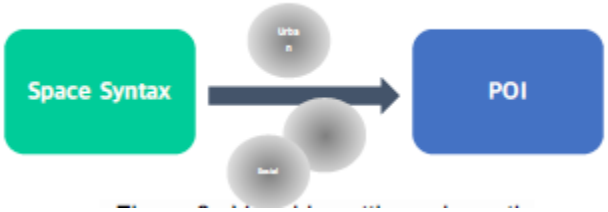


Figure 2. Variable setting schematic

4. Analysis of Living Street in the Center

4.1. Area characteristics

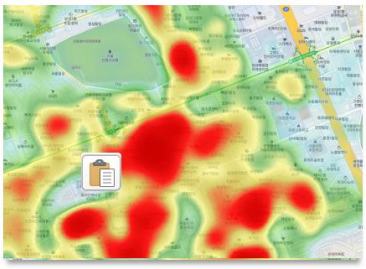
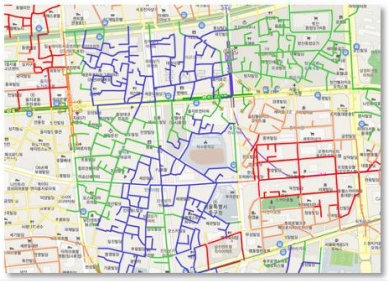
Euljiro has a high population density and floating population on both weekdays and weekends around the POI target site.

Table 2. Population density on weekdays and weekends around Euljiro Station

	Population density	The living population
Weekly population		
Weekend Population		

Around the POI target site around Seolleung Station, the population density and floating population are both higher than on weekends.

Table 3. Population density during weekdays/weekends around Seolleung Station

	Population density	The living population
Weekly population		
Weekend Population		

4.2. Analysis of Street System in Urban Space

4.2.1. Segment Analysis

For each of the two target sites, the range of radius 800m and 1000m, including the target site, was investigated, respectively. Segment analysis is used to analyze all roads as separate elements based on intersections, not axial analysis, which sees the following roads as an axis.

Table 4. Segment elements

Segment analysis investigates 8 factors

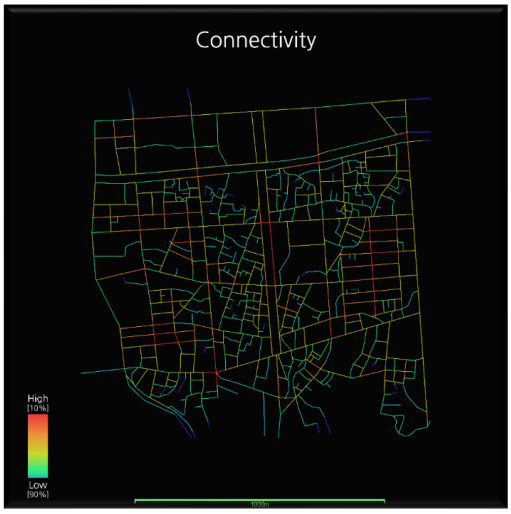
Segment	Contents
Connectivity	The number of connected roads indicates connectivity to the surrounding area
Angular Connectivity	The sum of the angles entering the road from the connected road, It also indicates the convenience of connecting to the road
Choice	When traffic occurs within the scope of the investigation, the relevant road shall be used An indicator of the likelihood of selection, indicating the activity of the road
Control	In the event of traffic on the connected road, the relevant road shall be used It is an indicator of possibility, and it is a local indicator of choice
Global Integration	We're going to make sure that all roads within the scope of the investigation are connected Indicators indicating the accessibility of the road
Local Integration [200m, 400m, 800m]	within the distance specified by local integration Measure integration for nearby roads

4.2.2. t-test

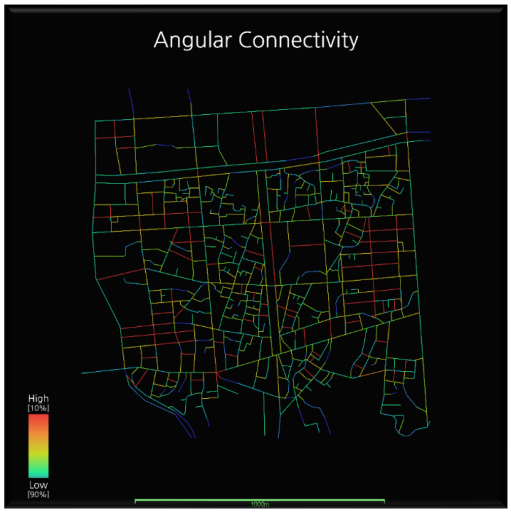
Categorize roads where POI is located and roads that are not Verify by t-test that there are significant differences in characteristics between the two groups.

4.3. Attribute Analysis Results

4.3.1. Segment Analysis Results Around Euljiro Station

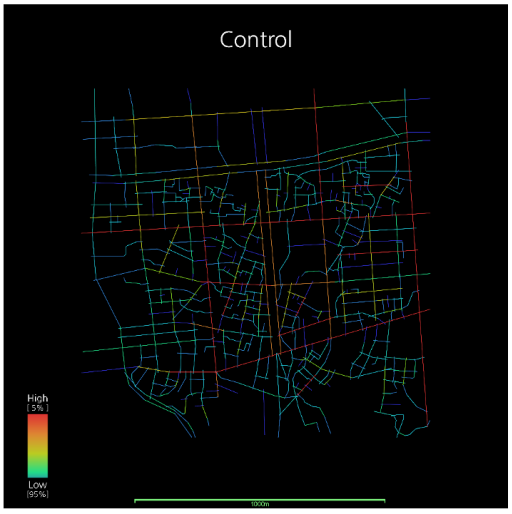


Mean	ST.DEV	MIN	MAX
3.463	1.003	1	6

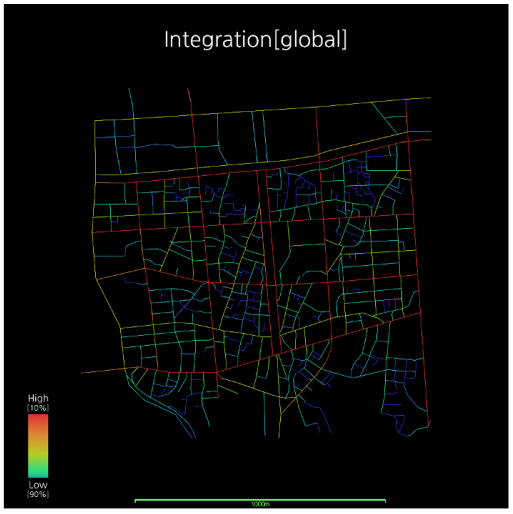


Mean	ST.DEV	MIN	MAX
2.108	.95	.022	4.238

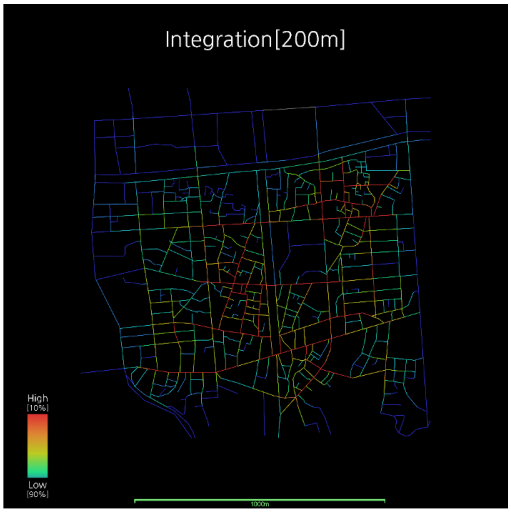
Mean	ST.DEV	MIN	MAX
23,718.612	43,808.833	0	221,237



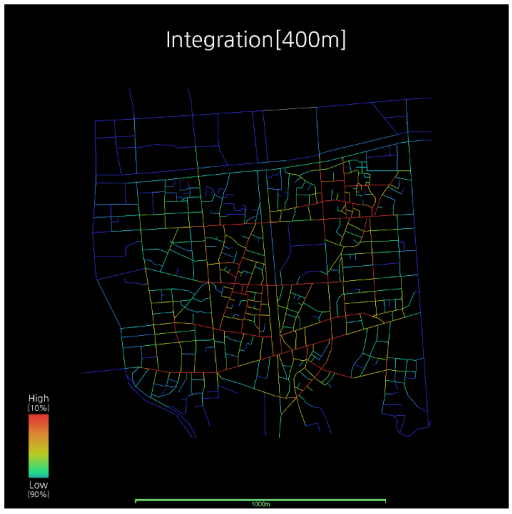
Mean	ST.DEV	MIN	MAX
1	0.782	0.056	10.776



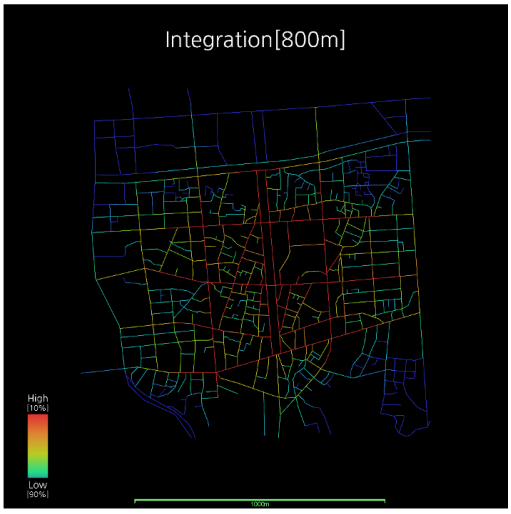
Mean	ST.DEV	MIN	MAX
408.928	87.916	171.332	599.874



Mean	ST.DEV	MIN	MAX
34.123	14.021	-1	77.911



Mean	ST.DEV	MIN	MAX
83.852	34.74	6.036	195.577



Mean	ST.DEV	MIN	MAX
221.216	84.207	32.206	454.987

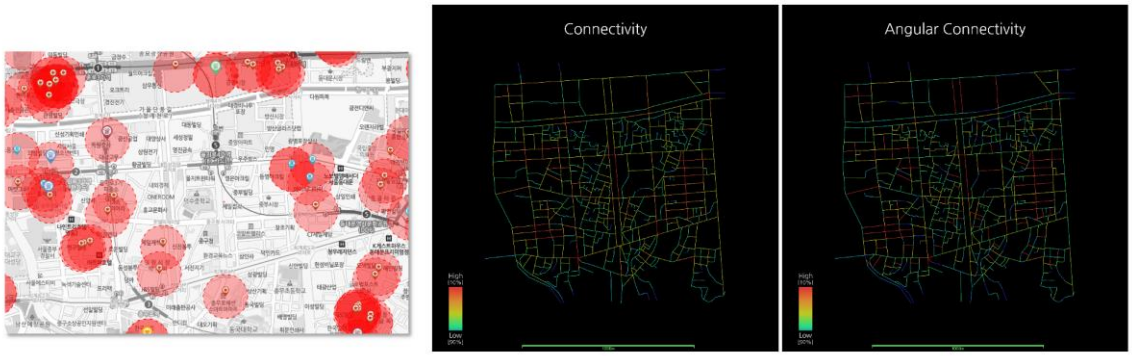
4.3.2. Results of t-test around Euljiro Station

Table 5. T-test results around Euljiro Station

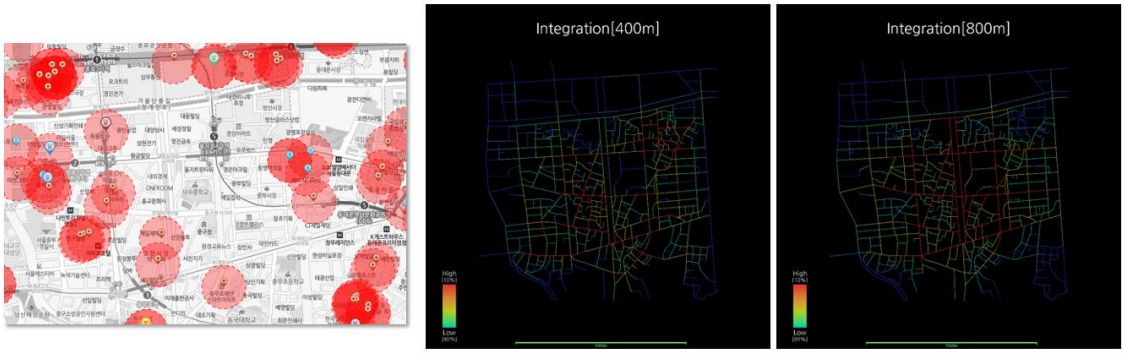
t-test	obs1	obs2	Mean (not POI)	Mean (POI)	dif	St Err	t value	p value
Connectivity	1181	227	3.437	3.599	-.162	.074	-2.2	.03**
Angular Connectivity	1181	227	2.08	2.257	-.177	.067	-2.65	.009***
Choice	1181	227	24,329.127	20,542.322	3,786.805	2938.524	1.3	.199
Control	603	145	.991	1.038	-.049	.07	-.7	.486
Integration [global]	1181	227	409.83	404.235	5.596	6.223	.9	.369
Integration [200m]	1181	227	33.937	35.095	-1.158	.947	-1.2	.222
Integration [400m]	1181	227	82.451	91.144	-8.693	2.466	-3.5	.001***
Integration [800m]	1181	227	216.903	243.653	-26.75	5.607	-4.75	0***

4.3.3. Analysis of results around Euljiro Station

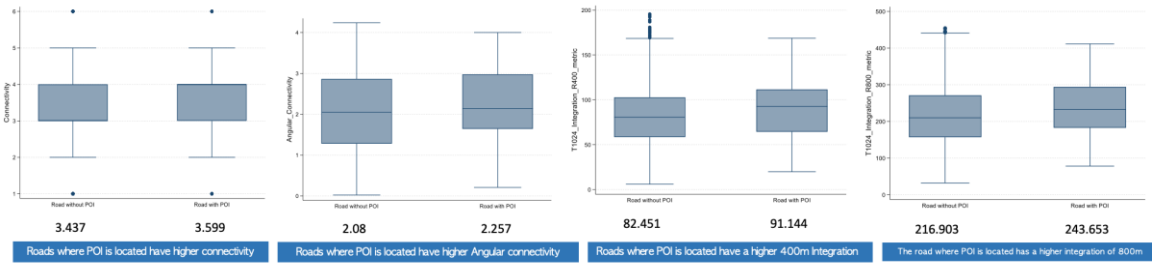
Table 6. A Comparative Analysis of the Street System of Urban Space around Euljiro Station and Actual Users



Both POI points and connectivity around Euljiro Station are highly correlated.

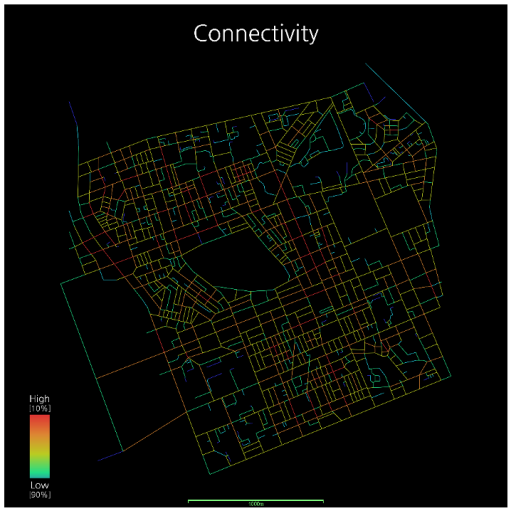


The degree of integration around Euljiro Station has a higher correlation in the 800M range of living area units than 400M.

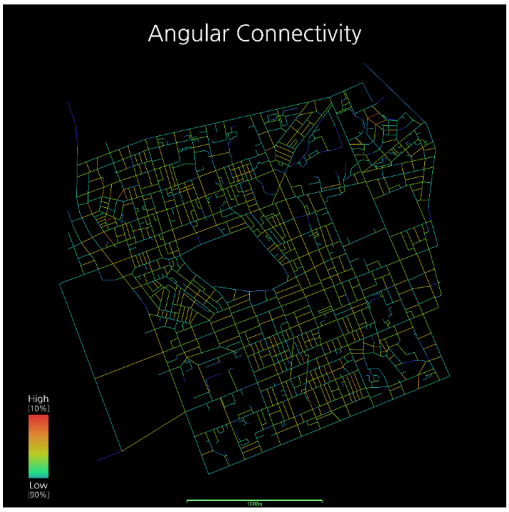


Both POI points and connectivity around Euljiro Station are highly correlated.

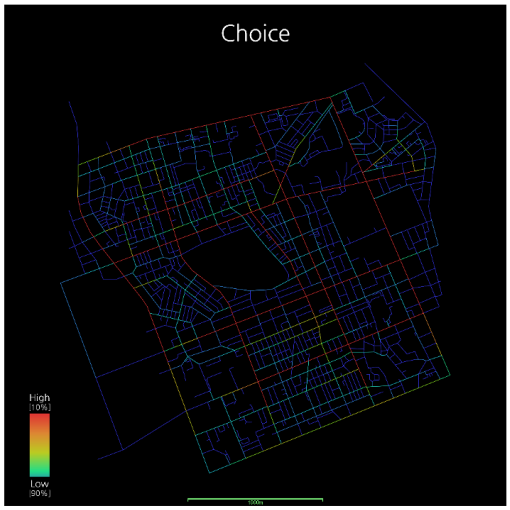
4.3.4. Segment Analysis Results Around Seolleung Station



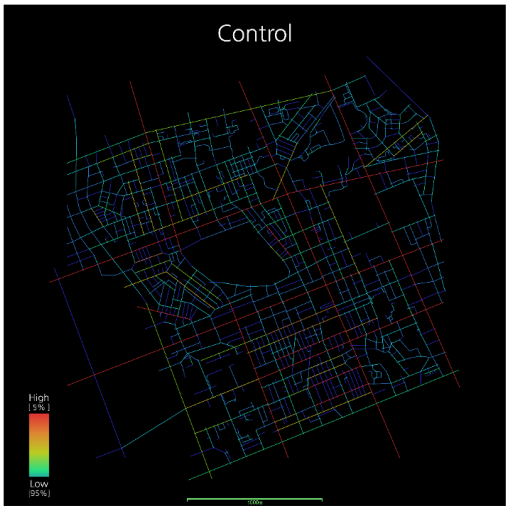
Mean	ST.DEV	MIN	MAX
3.79	1.061	1	6



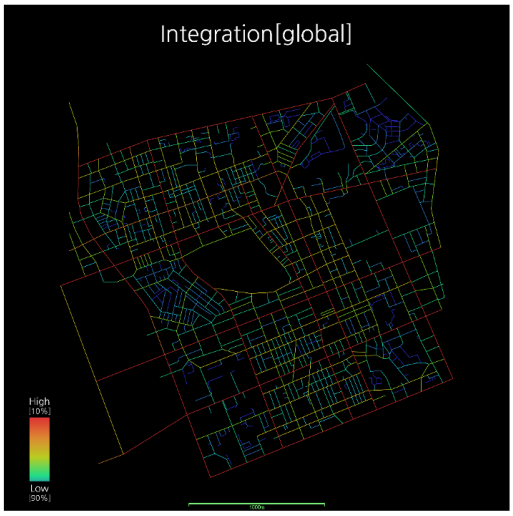
Mean	ST.DEV	MIN	MAX
2.446	.949	.025	5.328



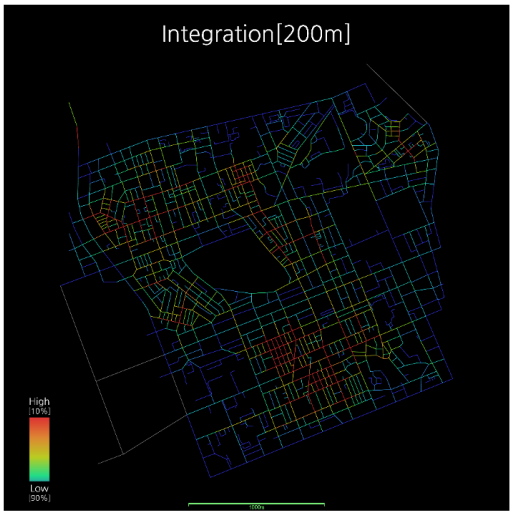
Mean	ST.DEV	MIN	MAX
63,273.822	130,000	0	1,085,614



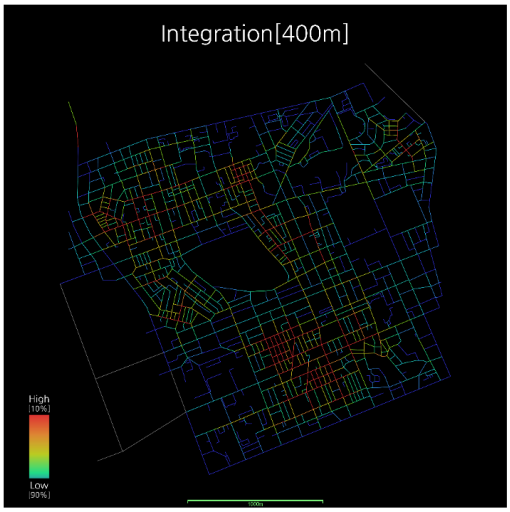
Mean	ST.DEV	MIN	MAX
0.998	0.989	0.026	11.515



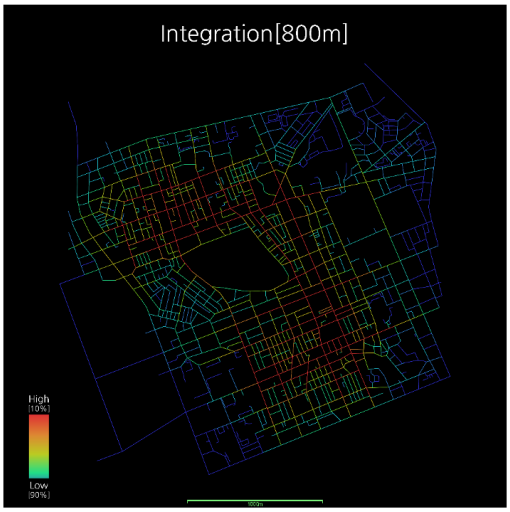
Mean	ST.DEV	MIN	MAX
694.823	147.75	254.028	1043.478



Mean	ST.DEV	MIN	MAX
23.748	10.808	-1	64.43



Mean	ST.DEV	MIN	MAX
57.887	26.658	-1	135.739



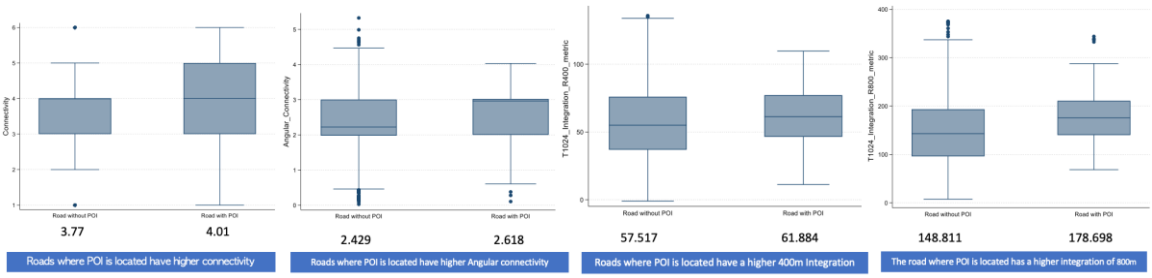
Mean	ST.DEV	MIN	MAX
151.345	66.34	7.557	375.206

4.3.4. Results of t-test around Seolleung Station

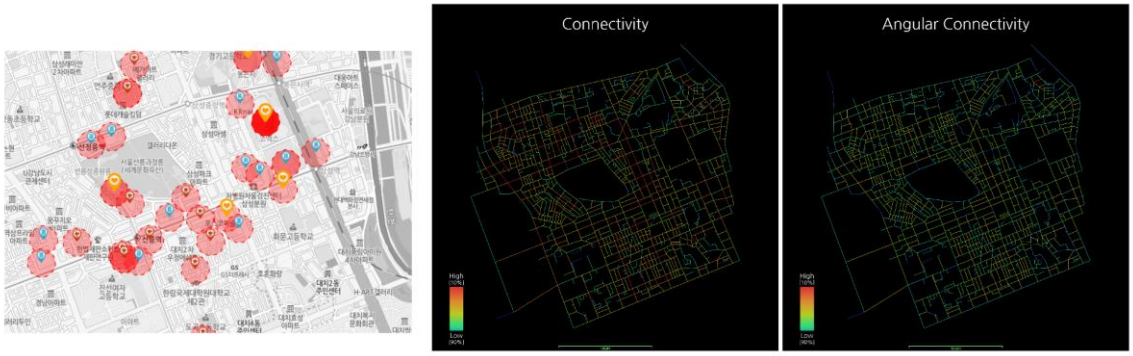
Table 7. T-test results around Seolleung Station

t-test	obs1	obs2	Mean (not POI)	Mean (POI)	dif	St Err	t value	p value
Connectivity	2321	215	3.77	4.01	-.24	.073	-3.25	.001***
Angular Connectivity	2321	215	2.429	2.618	-.189	.066	-2.85	.005***
Choice	2321	215	63016.644	66050.149	-3033.505	8331.327	-.35	.716
Control	1110	100	.992	1.071	-.079	.117	-.65	.504
Integration [global]	2321	215	691.707	728.467	-36.76	8.795	-4.2	0***
Integration [200m]	2321	215	23.605	25.296	-1.692	.813	-2.1	.038**
Integration [400m]	2321	215	57.517	61.884	-4.367	1.621	-2.7	.007***
Integration [800m]	2321	215	148.811	178.698	-29.887	3.897	-7.65	0***

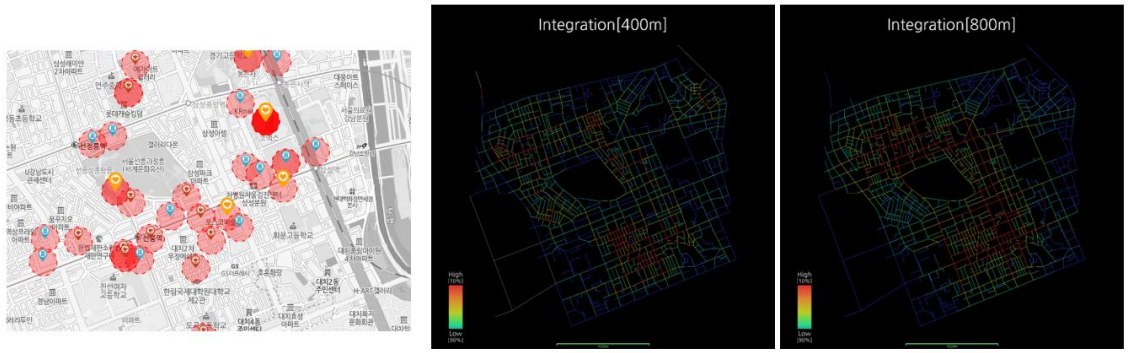
Table 8. Comparative Analysis of Urban Space Street System and Actual Users Around Seolleung Station



4.3.6. Segment Analysis Results Around Seolleung Station



Both POI and connection around Seolleung Station are highly correlated.



Both POI and integration around Seolleung Station are highly correlated.

5. Conclusion

The correlation between actual urban users and urban forms was analyzed by comparing the space syntax variable and POI characteristics, and the following three characteristics were derived.

First, POI was imported a lot in areas with high integration and connectivity.

Second, the naturally occurring area (Eulji-ro) correlates with the degree of integration only in 800M units. Third, the results of Space Syntax showed that the back street was a POI dense area. Fourth, for the central street with high integration and connection, the back street with low integration and high connection compared to the central street was found to be a POI-intensive area.

The above study can provide an analysis framework for urban planning or location selection through road network analysis in the urban center of compact cities.

An empirical analysis between urban centers and pedestrian-centered urban planning proves the effectiveness of the plan, and it can be a standard for the direction of the plan when creating a pedestrian environment through development or redevelopment of a new city.

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References

Mohammad Javad Koohsari, Koichiro Oka, Neville Owen, Takemi Sugiyama, Natural m ovement: A space syntax theory linking urban form and function with walking for transport, Health & Place, Volume 58, 2019

Lei Wang, Xin Han, Jie He, Taeyeol Jung, Measuring residents’ perceptions of city streets to inform better street planning through deep learning and space syntax, ISPRS Journal of Photogrammetry and Remote Sensing, Volume 190, 2022

Chaham Alalouch, Sara Al-Hajri, Abeer Naser, Asma Al Hinai, The impact of space syntax spatial attributes on urban land use in Muscat: Implications for urban sustainability, Sustainable Cities and Society, Volume 46, 2019

Noor Alkamali, Najwa Alhadhrami, Chaham Alalouch, Muscat City Expansion and Accessibility to the Historical Core: Space Syntax Analysis, Energy Procedia, Volume 115, 2017

Magda Mŕria, Núria Salvadó, CONSERVATION OF THE URBAN HERITAGE AND SUSTAINABILITY: Barcelona as a Paradigm, Energy Procedia, Volume 115, 2017, Pages 29-40.