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A Comparative Analysis of Museum Accessibility in High-Density Asian Cities: Case Studies from Seoul and Tokyo

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Abstract: We investigated the relationship between urban accessibility of museums in the urban spaces of Tokyo and Seoul within limited travel distances. Similarities and differences were identified in the museum accessibility between the two cities. The urban accessibility of museums was set as the dependent variable, calculated via space syntax. For the spatial accessibility of museums, five walking ranges (1000–2000 m) were set as independent variables, with a distance of 250 m as the basic unit. Data normality and independence of the derived data were checked, and polynomial curve fitting was performed to interpret the accessibility of museums in each city. A comparative analysis was conducted on museum accessibility. The results show areas with a high concentration of museums in Tokyo and Seoul partially deviated from the center of the urban hierarchy. The urban and spatial accessibilities of museums in both cities quantitatively correlated with limited travel distances. Museum visitors in Tokyo were more likely to have relatively free-flowing routes in the city. The museums in Seoul had a lower overall accessibility than those in Tokyo, and travel patterns and routes to these museums were likely to be restricted when located in urban areas and consequently resembled a forced movement pattern.

Keywords: high-density cities; museum; accessibility; Seoul; Tokyo; space syntax

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1. Introduction

1.1. Background and Purpose

With rapid urbanization in the past few decades, more than half of the global population now lives in cities [1]. As this trend continues, approximately 5 billion people are expected to be city dwellers by 2030 [2]. However, many developed countries are currently experiencing a decline in population in regional cities due to aging and declining birth rates. Both these factors contribute to severe social problems, including lack of employment, decline in economic strength, and loss of urban competitiveness [3–5]. Consequently, young people are leaving regional cities and moving to large metropolitan areas and major cities [6–8]. This “out-migration” has been considered the main cause of the high population density in cities [9–11], and some high-density cities have transitioned from industrial to cultural cities [12–15] by developing strategies to enhance their city brand via cultural tourism, generating economic profits, promoting culture externally, and upgrading their image [16–18]. The transformation process from an industrial to a cultural city entails the regeneration of industrial heritage sites and the construction of new cultural facilities. These factors indirectly play a positive role in promoting projects involving the construction of urban museums [18–21]. The newly constructed museums satisfy the requirements of tourists who visit the city to explore the regional culture [22,23], thereby strengthening the city brand and actively promoting it to become a cultural city [17,19,23]. These characteristics have been reflected in the special wards of Tokyo (hereinafter referred to as Tokyo) and Seoul, the two cities compared in this study. Moreover, each city has maintained its respective cultural promotion strategies to become leading urban tourism destinations in East Asia.

According to The United Nations World Tourism Organization, urban/city tourism is a form of tourism in which people travel to cities or places with a high population density [24]. This is distinguished from other types of tourism by attracting diverse travelers in a relatively limited range, with a focus on concentrated cultural offerings [25–27]. If the number of travelers is considered as visitors for tourism without limiting them to specific attributes, such as their gender or age or whether they are national or international visitors [28,29], the density of cultural offerings can be interpreted as a prevalence of cultural facilities, including museums in the city [30,31]. That is, the development of urban tourism can explain the direct correlation between urban accessibility and the distribution density of cultural facilities. Moreover, such characteristics are more pronounced when applied to high-density cities compared with those associated with general urban tourism. When considering the growth of cultural cities, accounting for museum accessibility during the design and construction process can have a qualitative impact on their future use [32,33]. Therefore, the accessibility of urban museums can be a significant factor in promoting urban tourism in addition to the density of museums in high-density cities.

Therefore, this study investigated the distribution of museums in Seoul and Tokyo, examined their spatial accessibility, and compared and analyzed their similarities and differences. The study is expected to provide a basis for selecting the location of museums in high-density cities in the future. The comparative analysis was limited to Seoul and Tokyo, as despite Asia being home to over 50% of the global population, most live in developing countries [34,35]. Considering urban development, the probability of these cities transforming from industrial to cultural cities is also relatively higher than that of cities in other regions. South Korea and Japan are developed countries [36], and Seoul and Tokyo are high-density cities playing crucial roles in the economic, cultural, and political development of their respective countries [37,38]. Furthermore, the two cities are similar in area and population density [39]. Seoul and Tokyo deindustrialized and developed into cultural cities earlier than other Asian cities [40,41]. Both cities are ranked among the top cities internationally according to the Global Power City Index [42]. Before the COVID-19 pandemic, they were popular destinations in East Asia [43–45] and attracted a wide range of travelers considering the high proportion of foreign tourists visiting for urban tourism and cultural experiences [46–48].

1.2. Research Needs, Gap, and Scope

Between 2020 and 2022, studies on museums identified trends toward digitization and open exhibits, such as online exhibits and virtual tours [49–51]. Many similar studies have sought to improve the accessibility of exhibition contents [52–54]. Methods have been actively sought to facilitate information accessibility for users [55–57]. In addition, the social crisis caused by COVID-19 between 2020 and 2022 led to restrictions on museum visits and forced museum authorities to develop alternative operating measures [58–60] and is the main reason for the recent promotion of the digitalization of museums. Positive added values, such as cultural publicity, economic profits, and strengthening of city brand created by diverse travelers visiting museums, in the urban tourism of cultural cities have been observed [17,19,21,23]. With COVID-19 no longer being a global health emergency, as declared by the World Health Organization in May 2023 [61], the urban tourism business, which has been subdued for the past three years, is expected to revive as air traffic gradually returns to pre-COVID-19 levels. Accordingly, the implementation of prior research on the spatial accessibility of museums based on urban tourism is currently ongoing.

Recent studies highlighted the significance of datasets on urban accessibility. These studies were conducted on various areas by considering the correlation between urban form characteristics and accessibility and factors, such as time, distance, average speed, and transportation services, associated with traveling to destinations within a city [62–67].

Referring to the United Nation's SDGs [68], several studies have begun including walking accessibility by focusing on travel modes that yield the lowest carbon emissions; these studies have also addressed limiting the travel range in terms of the duration and distance while examining the diversity of travel patterns within this range [33,69–71]. In addition, most previous studies conducted on Tokyo and Seoul focused on analyzing urban accessibility in terms of the urban form, urban development sustainability, and urban services [33,72–77]. Only a few have considered the spatial accessibility of cultural facilities in cities, and studies on museums are rare. For example, the urban hierarchy of Seoul was analyzed from the perspective of a cultural city, after reaching specific areas considering vehicle traffic, and the accessibility of museums was reviewed considering walking angle and travel distance (the basic unit was 250 m and could reach up to 2 km) [33]. Thus, museums in Seoul seem to be isolated from primary spaces where people typically travel and move around. In particular, the correlation with urban accessibility was higher when the travel radius approached 2 km. Therefore, this study analyzed museum accessibility in Tokyo and Seoul on the basis of urban accessibility and spatial accessibility with a limited travel distance (set in the range of 1–2 km, using the above 250 m unit) (Figure 1). Research was limited to walkable areas on the ground when examining the walking accessibility of the museums in the two cities. Consequently, this study established a limited travel distance for analysis purposes.

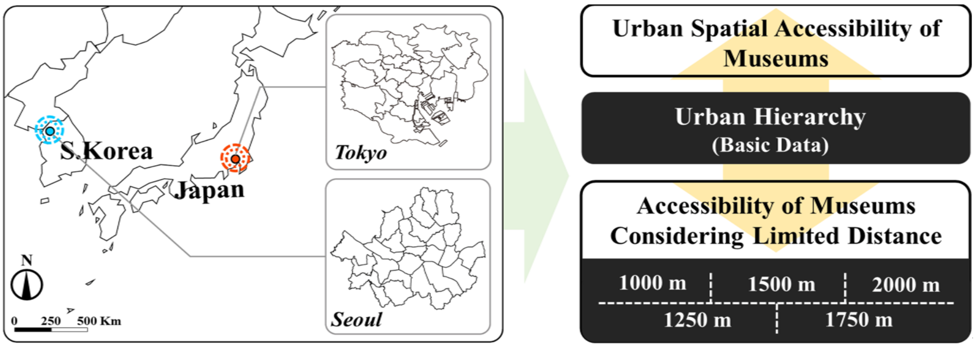

Figure 1. Scope of research.

2. Materials and Methods

2.1. Space Syntax

Professor Bill Hillier at the Bartlett School of Architecture, University of London, conceived the concept of space syntax [78] in 1976. In 1984, he coauthored a comprehensive review paper on space syntax in "The Social Logic of Space" [79] that has since been developed into a spatial analysis technique applied to architecture and cities [80–83]. In the first analytical form of the space syntax (convex space, axial map), spatial depth is defined as the step taken when moving from one space to another, regardless of the size or distance of the space; the evaluation index of the space is calculated from the connected topological structure of each space [79]. In 2001, Turner presented the possibility of an angular analysis by considering the passing angle in axial maps commonly used in urban space [84]. The author later proposed a topological representation called a segmented axial map that considers street attributes and angle weighting [85]. Among these representations, the axial map corresponds to an urban hierarchy graph that is based on the physical structure of urban space, while the segmented axial map is a graph that reflects the travel habits of people passing through roads based on urban hierarchy. Figure 2 shows the difference between these axial and segmented axial maps. Indicators calculated using this method are related to the social, cultural, and economic phenomena of cities [86–89]. A study examining the walking accessibility of museums in Seoul is highly relevant to our study. In particular, Zhao and Moon proved that there is a difference between the hierarchical relationship of a pure physical space and the hierarchical relationship that reflects travel habits when a specific facility is a destination in urban space [33]. In addition, the part that explains the correlation uses polynomial curve fitting. In this approach, museum accessibility is derived as an independent variable. It is calculated based on the physical space and is set as the dependent variable. After reaching a specific area by vehicle and then walking, this approach provided a theoretical basis for this study and ensured the possibility of conducting research using space syntax.

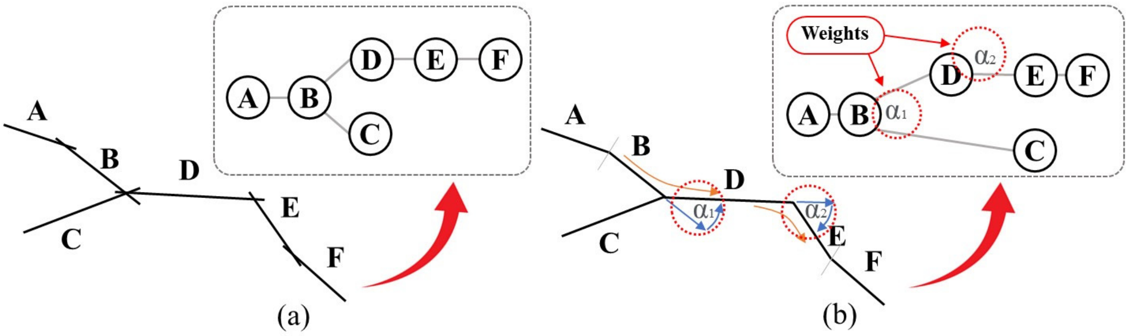

Figure 2. Differences between axial and segmented axial maps: (**a**) axial map; (**b**) segmented axial map.

In spatial syntax, integration is a primary indicator of spatial accessibility. In addition, inhabitants (residents) understand and perceive urban structure based on their choice values, while strangers (tourists) rely more on integration indicators [90]. That is, the integration index calculated in this study is a measure to predict the spatial cognition and travel patterns of foreign or outside visitors who visit cities for urban tourism and museum culture tours. Hillier's book, *Space is the Machine*, provides more information on the formula for calculating the integration [91]. Hillier also evaluated spatial accessibility by dividing this into global integration (GI) and local integration (LI) to create an axial map of urban space. GI is calculated by considering all the spatial depths from a specific space to the entire space according to the formula for space syntax integration. LI is calculated by limiting the spatial depth when moving from a specific space to other spaces (typically, the spatial depth is 3), and intelligibility (R^2) is the correlation between GI and LI. However, in the concept of integration in segmented axial maps, which differs from the concept of integration in axial maps and includes the angular weight, the integration of space is calculated by setting a limit radius. That is, while the indicators shown when the limit radius is set to n are similar to the concept of GI with a specified limit distance, the calculated integration corresponds to the accessibility shown in the limit distance range.

Accordingly, this study investigated the accessibility of museums in Tokyo and Seoul with limited travel distances using space syntax and derived index values using segmented axial maps. However, the standard of GI shown in axial maps was applied for the urban accessibility of museums in urban space. This approach was adopted owing to the findings of Zhao and Moon [33], who reported that GI has a relatively higher explanatory power than LI for the accessibility of museums in Seoul within a travel distance of 1–2 km. The LI data of cities calculated in this study were specifically applied to interpret the urban hierarchy in Tokyo and Seoul and facilitate comparative explanations of intelligibility.

2.2. Research Methods

The current state of museums in Tokyo and Seoul was identified by referring to the Overview of National Cultural Infrastructure published by the Ministry of Culture, Sports and Tourism in 2022 [92], along with the information registered by the Japan Association of Museums [93]. The research scope was limited to general, folk, art, history, nature, and science museums by referring to the museum types specified in the relevant laws in Korea and Japan [94,95]. For the urban spatial analysis of Tokyo and Seoul, axial maps were created using geographic information system (GIS) data released by the Japanese Ministry of Land, Infrastructure, Transport and Tourism and the Ministry of Land, Infrastructure and Transport. The data were of 1:1000 scale and taken from the year 2022 [96,97]. The scope of this study was limited to walking distances (range). Therefore, publicly available road centerline GIS data were introduced into the QGIS program. All the codes and lines corresponding to overpasses, underground roads, and track traffic were deleted by referring to Japanese and Korean GIS data codes [98,99]. Accordingly, an axis map was created by adjusting the actual distance and the distance in the drawing to a 1:1 ratio, referring only to walkable roads. As this study focused on comparing and analyzing the accessibility of museums in Tokyo and Seoul, comparing the derived data on the same scale could relatively improve the objectivity and persuasiveness of the research. Therefore, this study arranged the integration of axis lines derived using the depth map developed from the space syntax in descending order. The relative interval value (A_r) of the indicator (N_x) corresponding to the museum was then applied to the entire space. The derived relative interval (Equation (1)) [100] takes a value between 0 and 1 (up to 3 decimal places). The lower the relative interval value, the higher the integration index corresponding to the museum in the total space.

$$A_r = 1 - \frac{N_x - N_{min}}{N_{max} - N_{min}} \tag{1}$$

Since the correlation analysis and ANOVA in this study assumed normally distributed data, it was necessary to first test for the normality of the data using a Q–Q plot. After checking for the normality, the study aimed to verify the relative independence of the variables using the Friedman test. The independence test checked if the data derived from this study had a relatively independent distribution under the premise of a normal distribution. In particular, despite confirming a normal distribution using the Q–Q plot, a nonparametric Friedman test was performed. The aim was to check the independence of the data, because the variables employed in this study were composed of three or more factors. As the relative intervals derived from Equation (1) were organized in descending order, they may have contained some of the attributes of sequential data.

After ensuring normality and independence through the above process, the spatial accessibility of the museums in the two cities was set as the dependent variable by referring to [33]. The integration of the museums in Tokyo and Seoul was the independent variable for limit distances of 1000, 1250, 1500, 1750, and 2000 m. Next, after examining the correlation between the independent and dependent variables, a comparative analysis of the museum accessibility was performed using polynomial curve fitting. When the correlation between the dependent and independent variables failed to show significance, the corresponding analysis term was rejected. Only the analysis term showing a correlation between the dependent and independent variables that met the significance level of at least $p < 0.05$ was adopted for the polynomial curve fitting. This was done to control the probability of random events at a significant level and minimize the deviation in the results. Additionally, the interpretation of the curve fitting variance results of the independent and dependent variables correlated in statistically significant results is more convincing. IBM SPSS Statistics 25 was used for the normality, independence, and correlation analyses, and Origin 2021 was used for the polynomial curve fitting. Figure 3 shows a flowchart of the comprehensive research process.

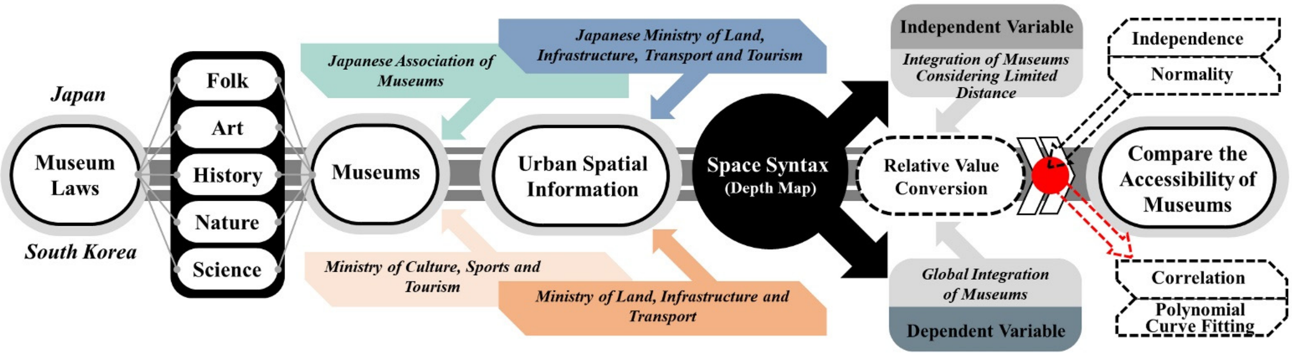

Figure 3. Research process of the study.

3. Results

3.1. Distribution and Topological Status of Museums in Tokyo and Seoul

Table 1 shows the basic characteristics of Tokyo and Seoul. As of 2022, the population densities of Tokyo and Seoul were 15,146 and 15,551 per km^2, respectively. In terms of area, Seoul is 22.3 km^2 smaller than Tokyo. Tokyo and Seoul have 183,602 and 167,295 axial lines (axial lines constituting an urban road network were edited according to the guidelines for creating axial maps in space syntax), respectively. The area ratio of Tokyo is approximately 3.6% higher than that of Seoul. However, the number of axial lines differs by 8.9%. This indirectly shows that Tokyo has a higher land use density than Seoul, both being high-density cities with similar attributes.

Table 1. Basic characteristic of Tokyo and Seoul.

Characteristic	Tokyo	Seoul
Population density (people/km^2)	15,146	15,551
Area	627.53 km^2	605.23 km^2
Axial lines	183,602	167,295

Overall, we identified 127 museums in Tokyo and 180 in Seoul using data from the Overview of National Cultural Infrastructure and the total number of general, folk, art, history, nature, and science museums registered with the Japan Association of Museums. In Tokyo, the top three areas with the highest number of museums were Shinjuku, Minato, and Chiyoda, with 15, 14, and 12 museums, respectively. The numbers of museums in Seoul, Jongno-gu, Jung-gu, Gangnam, and Yongsan-gu were 55, 20, 12, and 12, respectively. In addition, areas with the highest concentration of museums in Tokyo and Seoul were adjacent to each other (Figure 4). These results show a trend in which a wide distribution of museums is built in specific areas in both cities.

In terms of the current state of urban hierarchy in Tokyo and Seoul, the maximum and minimum GI values for Tokyo were 0.657 and 0.290, and the maximum and minimum GI values for Seoul were 0.569 and 0.090, respectively (Figure 5). The minimum LI in Tokyo and Seoul was 0.333, and the maximum values were 5.185 and 6.001, respectively. The R^2 values of the intelligibility calculated by the correlation between GI and LI were 0.165 and 0.278 in Tokyo and Seoul, respectively. The R^2 value for Tokyo and Seoul was <0.6, indicating a low overall recognition in both urban spaces. Considering that Tokyo has a higher land use density and lower intelligibility than Seoul, the land use density concentrated in a high-density city can act as a factor affecting the recognition of urban space. In addition, when referring to the GI, the areas with high index values in Tokyo were partially distributed in Itabashi, Kita, and Nerima; and in Seoul, these areas were Gangnam, Gwangjin, and Dongdaemun. This distribution of high index values and the distribution of museums (Figure 4) demonstrate that neighborhoods with a high concentration of museums are partially away from the spatial hierarchical centers of these cities.

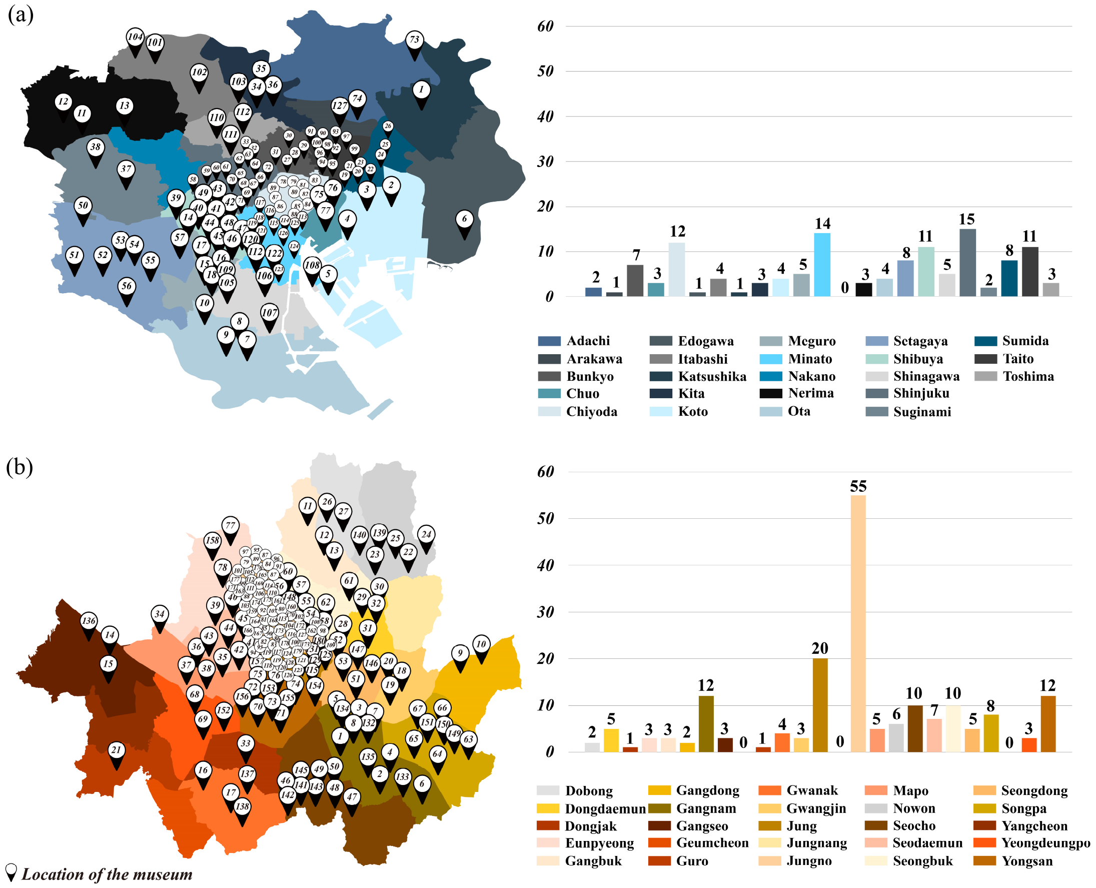

Figure 4. Distribution of museums in (**a**) Tokyo and (**b**) Seoul.

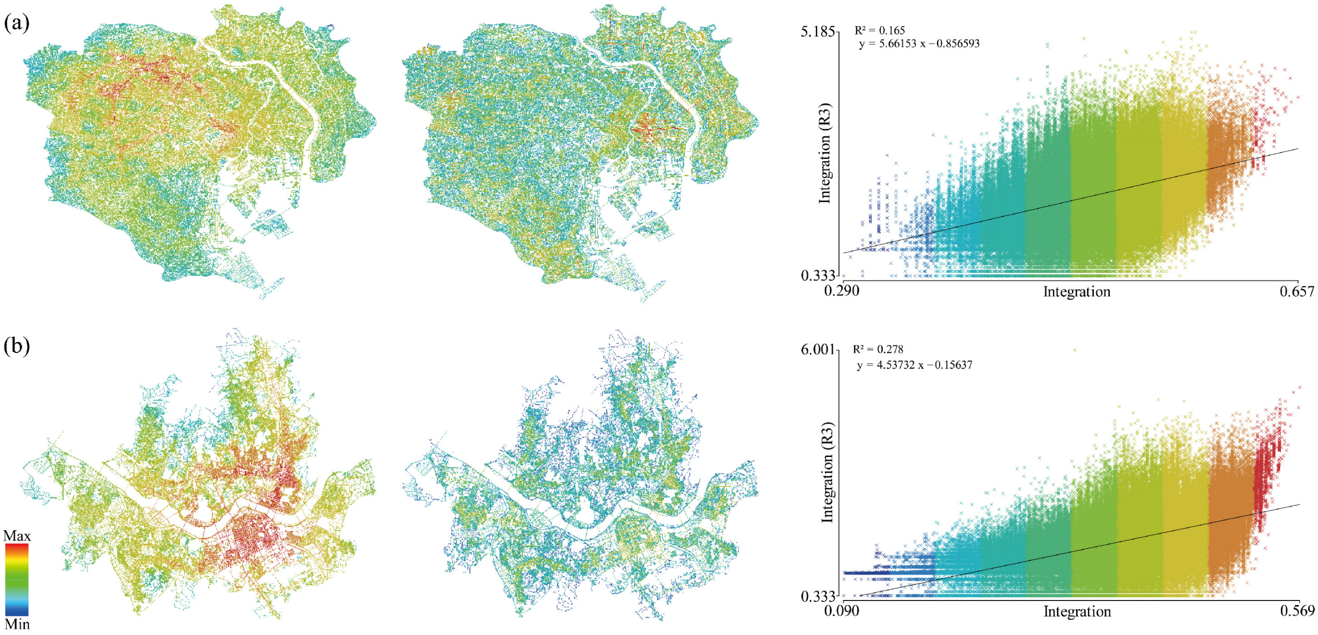

Figure 5. GI, LI, and intelligibility graphs for (**a**) Tokyo and (**b**) Seoul.

3.2. Normality of Data, Independence Tests, and Correlation Analysis

The Q–Q plot was used to examine the normality of the data. The analysis facilitated a comparison of the GI of museum locations in Tokyo and Seoul, as well as the relative integration values of the museums with limited distances. The residuals of all the variables were distributed both above and below the Y = 0 baseline (Figure 6) and were generally within ±0.4; all the data were distributed close to the diagonal of the normal Q–Q plot. Thus, all the variables in this study followed a normal distribution. After checking for the normality, a Friedman test was conducted on the corresponding variables to verify the relative independence of each variable between the cities. The mean rank of the GI of the museums in Tokyo was 2.24, and the mean rank values of the integration with limit distances (1000, 1250, 1500, 1750, and 2000 m) were 4.54, 4.57, 3.80, 3.48, and 2.86, respectively (Tables 2 and 3). The chi-square of the entire data was 126.949, whereas the chi-square of the entire data of the museums in Seoul was 169.299. The mean rank of the GI of the museums in Seoul was 4.81, and the mean rank values of the integration with limit distances (1000, 1250, 1500, 1750, and 2000 m) were 2.54, 2.86, 3.24, 3.69, and 3.86 respectively. Furthermore, the independence of the variables in the Tokyo and Seoul data groups were all at $p < 0.001$. This indicates that each variable can account for the distinct differences in the distribution and that the collected data were relatively independent. In particular, the chi-square value of the data from Seoul was higher than that of those from Tokyo. This allows us to indirectly predict that there was a wider gap in the distribution of the museum data group in Seoul than in Tokyo.

Table 2. Descriptive statistics of museum data for Tokyo.

Type	N	Mean	Std. Deviation	Min	Max	Percentiles			Mean Rank	Chi-Square
						25th	50th	75th		
GI ***	127	0.355	0.278	0.006	0.959	0.119	0.299	0.551	20.24	126.949
R 1000 m ***		0.591	0.274	0.024	0.989	0.388	0.618	0.823	40.54	
R 1250 m ***		0.568	0.277	0.019	0.981	0.344	0.615	0.798	40.07	
R 1500 m ***		0.557	0.282	0.018	0.989	0.327	0.585	0.795	30.80	
R 1750 m ***		0.536	0.282	0.019	0.991	0.283	0.563	0.758	30.48	
R 2000 m ***		0.526	0.277	0.013	0.991	0.301	0.552	0.747	20.86	

*** $p < 0.001$.

Table 3. Descriptive statistics of museum data for Seoul.

Type	N	Mean	Std. Deviation	Min	Max	Percentiles			Mean Rank	Chi-Square
						25th	50th	75th		
GI ***	180	0.684	0.297	0.002	0.999	0.521	0.791	0.915	40.81	169.299
R 1000 m ***		0.435	0.277	0.005	0.992	0.193	0.400	0.677	20.54	
R 1250 m ***		0.457	0.285	0.003	0.997	0.209	0.434	0.726	20.86	
R 1500 m ***		0.474	0.292	0.003	0.999	0.224	0.454	0.746	30.24	
R 1750 m ***		0.492	0.299	0.003	0.999	0.246	0.489	0.759	30.69	
R 2000 m ***		0.502	0.298	0.003	0.999	0.273	0.522	0.761	30.86	

*** $p < 0.001$.

After confirming the normal distribution and relative independence of the variables, the correlations between the variable groups in Tokyo and Seoul were examined (Tables 4 and 5). For Tokyo, the Pearson's correlation coefficients for the GI of museums and the integration with limit distances (1000, 1250, 1500, 1750, and 2000 m) were 0.499, 0.491, 0.509, 0.480, and 0.510, respectively. The Pearson's correlation coefficients for the dependent and independent variables in Seoul were 0.393, 0.448, 0.492, 0.526, and 0.531, respectively, all of which corresponded to a significance level of $p < 0.01$. Therefore, the dependent variable (GI of museums) correlated with all the integration indicators of museums with limit distances. An overall positive correlation was present between the dependent and independent variables, as confirmed by the Pearson's correlation coefficient. That is, the accessibility of museums could indirectly reflect the urban spatial accessibility of museums when limiting the travel distance of visitors in the two cities. However, in the case of Tokyo, the Pearson's correlation coefficient did not change significantly with the increase in the limit distance. In contrast, in Seoul, the correlation became more positive after extending it. Considering this, it can be predicted that the museums in Tokyo are associated with more stable and organized spatial structures for walking access than those in Seoul.

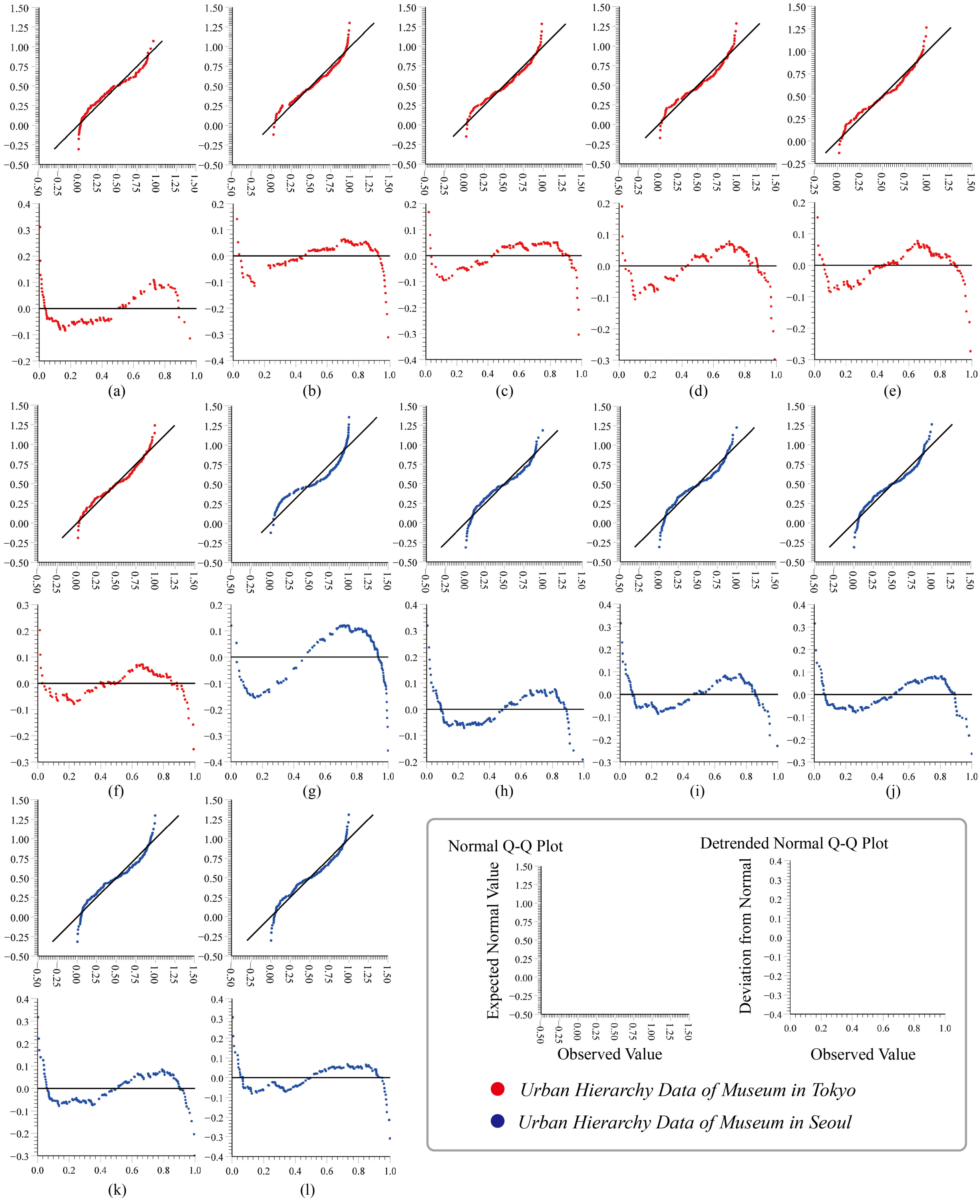

Figure 6. Normal and detrended normal Q–Q plot analysis: (**a**) GI (Tokyo), (**b**) R 1000 m integration (Tokyo), (**c**) R 1250 m integration (Tokyo), (**d**) R 1500 m integration (Tokyo), (**e**) R 1750 m integration (Tokyo), (**f**) R 2000 m integration (Tokyo), (**g**) GI (Seoul), (**h**) R 1000 m integration (Seoul), (**i**) R 1250 m integration (Seoul), (**j**) R 1500 m integration (Seoul), (**k**) R 1750 m integration (Seoul), and (**l**) R 2000 m integration (Seoul).

Table 4. Correlations of museum data for Tokyo.

Type		GI	R 1000 m	R 1250 m	R 1500 m	R 1750 m	R 2000 m
Pearson's correlation	GI	1					
	R 1000 m	0.449 **	1				
	R 1250 m	0.491 **	0.969 **	1			
	R 1500 m	0.509 **	0.943 **	0.976 **	1		
	R 1750 m	0.480 **	0.887 **	0.931 **	0.967 **	1	
	R 2000 m	0.510 **	0.871 **	0.919 **	0.964 **	0.950 **	1

** $p < 0.01$.

Table 5. Correlations of museum data for Seoul.

Type		GI	R 1000 m	R 1250 m	R 1500 m	R 1750 m	R 2000 m
Pearson's correlation	GI	1					
	R 1000 m	0.393 **	1				
	R 1250 m	0.448 **	0.980 **	1			
	R 1500 m	0.492 **	0.947 **	0.986 **	1		
	R 1750 m	0.526 **	0.902 **	0.953 **	0.983 **	1	
	R 2000 m	0.531 **	0.875 **	0.928 **	0.964 **	0.977 **	1

** $p < 0.01$.

3.3. ANOVA and Polynomial Curve Fitting

After confirming the quantitative correlation between the dependent and independent variables of the two groups, the possibility of applying polynomial curve fitting to the collected data was checked with ANOVA. Tables 6 and 7 present the results of the dependent and independent variables of the museums in Tokyo. The F-values at 1000, 1250, 1500, 1750, and 2000 m were 17.922 ($p < 0.001$), 23.325 ($p < 0.001$), 25.765, ($p < 0.001$), 23.305, ($p < 0.001$), and 24.411 ($p < 0.001$), respectively. The F-values of the variance according to the index of the museums in Seoul were 17.661, 23.390, 29.271, 34.944, and 36.314, respectively; these values had a significance level of $p < 0.001$. Therefore, all the independent variables set for each group in this study can be explained by regressions on the corresponding dependent variable. Tables 8 and 9 show the polynomial curve fitting results of the dependent and independent variables for the museums in Tokyo and Seoul. Figure 7 shows the GI and limit distance range: fitted curve plots. Among these, the residual sum of squares (RSS) values according to the dependent and independent variables for the museums in Tokyo were 7.363, 7.052, 7.089, 7.282, and 6.951, and the adjusted R^2 values were 0.212, 0.262, 0.282, 0.261, and 0.271, respectively. The results for museums in Seoul for GI and R at 1000, 1250, 1500, 1750, and 2000 m were 11.488 (0.157), GI and R 1250 m (11.486, 0.200), GI and R 1500 m (11.435, 0.240), GI and R 1750 m (11.446, 0.283), and GI and R 2000 m (11.294, 0.291). The adjusted R^2 values for both groups were all <0.4. This indicates that the independent variables have a degree of deviation in their ability to explain the dependent variable. The adjusted R^2 for museums in Tokyo showed the highest value (0.282) at 1500 m. However, for the museums in Seoul, the adjusted R^2 gradually increased with the increase in the range of the limit distance. Combining these results with the aforementioned correlation analysis results proves that museums in Tokyo are more suitable for walking within the limited distance range. On the other hand, museums in Seoul are more likely to have higher adjusted R^2 values of the independent and dependent variables when increasing the distance to over 2000 m. That is, it is possible to present a more valid hypothesis to examine the accessibility of museums in Seoul within the range of vehicle travel than walking, which can be mutually verified with the results presented in [33].

Table 6. Global integration and limit distance range: ANOVA (Tokyo).

Type	**GI**														
	R 1000 m ***			**R 1250 m *****			**R 1500 m *****			**R 1750 m *****			**R 2000 m *****		
DF	M	E	T	M	E	T	M	E	T	M	E	T	M	E	T
	2	124	126	2	124	126	2	124	126	2	124	126	2	124	126
Sum of squares	2.128	7.363	9.492	2.653	7.052	9.705	2.946	7.089	10.035	2.737	7.282	10.020	2.737	6.951	9.688
Mean square	1.064	0.059		1.327	0.057		1.473	0.057		1.369	0.059		1.368	0.056	
F		17.922			23.325			25.765			23.305			24.411	

*** $p < 0.001$.

Table 7. Global integration and limit distance range: ANOVA (Seoul).

Type	**GI**														
	R 1000 m ***			**R 1250 m *****			**R 1500 m *****			**R 1750 m *****			**R 2000 m *****		
DF	M	E	T	M	E	T	M	E	T	M	E	T	M	E	T
	2	177	179	2	177	179	2	177	179	2	177	179	2	177	179
Sum of squares	2.293	11.488	13.780	3.036	11.488	14.522	3.782	11.435	15.218	4.519	11.446	15.966	4.634	11.294	15.928
Mean square	1.146	0.065		1.518	0.065		1.891	0.065		2.260	0.065		2.317	0.064	
F		17.661			23.390			29.271			34.944			36.314	

*** $p < 0.001$.

Table 8. Global integration and limit distance range: polynomial curve fitting analysis (Tokyo).

Type	**GI**				
Equation	$y = \text{Intercept} + B1 \times x^1 + B2 \times x^2$				
Type	R 1000 m	R 1250 m	R 1500 m	R 1750 m	R 2000 m
Intercept	0.373 ± 0.048	0.320 ± 0.047	0.296 ± 0.047	0.276 ± 0.047	0.284 ± 0.046
B1	0.957 ± 0.281	1.107 ± 0.275	1.170 ± 0.276	1.215 ± 0.280	1.030 ± 0.273
B2	−0.598 ± 0.314	−0.718 ± 0.308	−0.761 ± 0.308	−0.849 ± 0.313	−0.607 ± 0.305
RSS	7.363	7.052	7.089	7.282	6.951
R-Square	0.224	0.273	0.294	0.273	0.283
Adj. R-Square	0.212	0.262	0.282	0.261	0.271

Table 9. Global integration and limit distance range: polynomial curve fitting analysis (Seoul).

Type	**GI**				
Equation	$y = \text{Intercept} + B1 \times x^1 + B2 \times x^2$				
Type	R 1000 m	R 1250 m	R 1500 m	R 1750 m	R 2000 m
Intercept	0.103 ± 0.070	0.092 ± 0.070	0.081 ± 0.070	0.066 ± 0.070	0.062 ± 0.070
B1	0.826 ± 0.297	0.833 ± 0.297	0.844 ± 0.297	0.894 ± 0.297	0.963± 0.295
B2	−0.418 ± 0.265	−0.369 ± 0.265	−0.330 ± 0.265	−0.333 ± 0.265	−0.392 ± 0.263
RSS	11.488	11.486	11.435	11.446	11.294
R-Square	0.166	0.209	0.249	0.283	0.291
Adj. R-Square	0.157	0.200	0.240	0.275	0.283

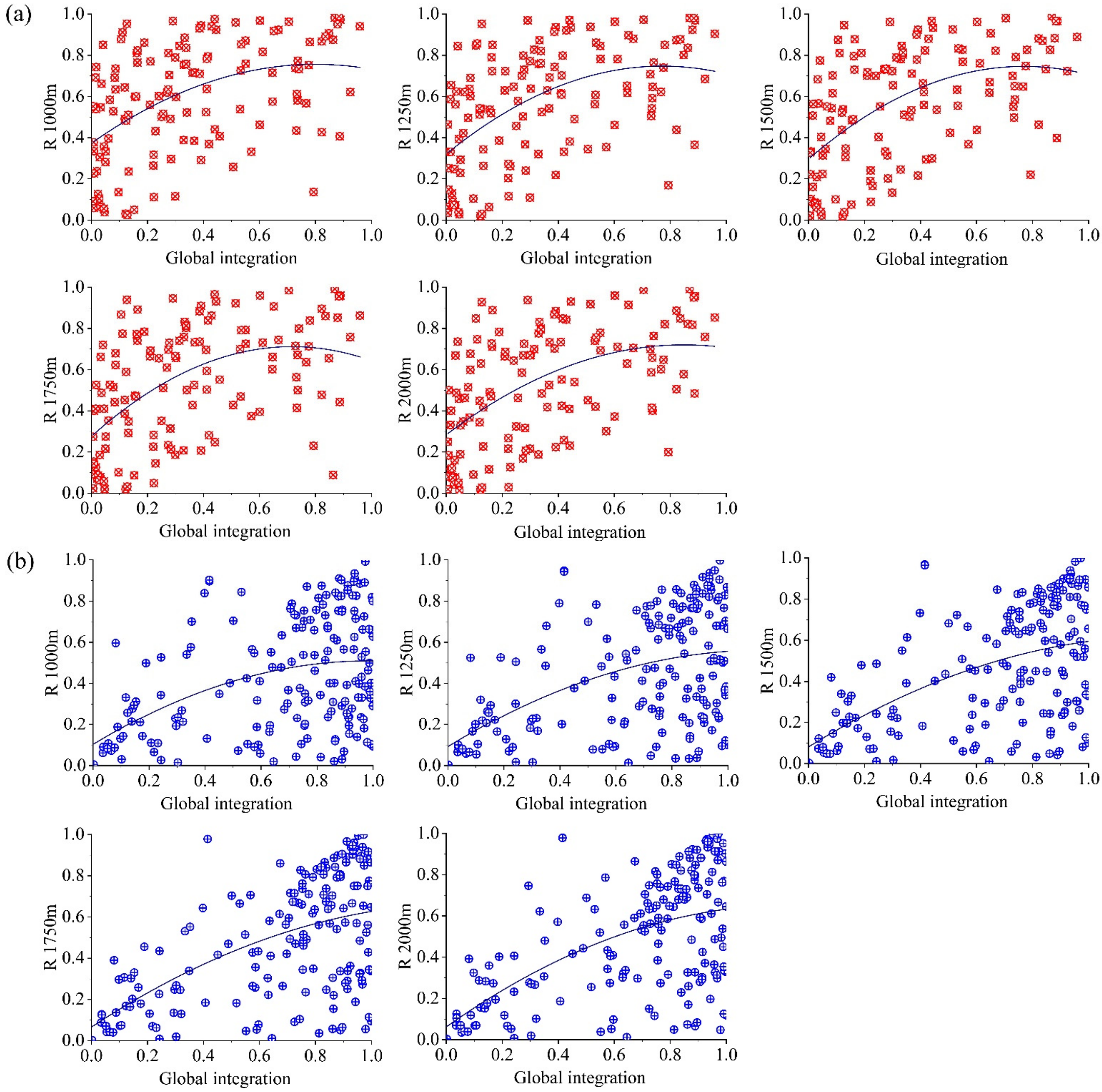

Figure 7. Global integration and limit distance range: fitted curves plot: (**a**) Tokyo; (**b**) Seoul.

4. Discussion

This study compared the urban spaces of Tokyo and Seoul, which are two high-density cities, through an urban hierarchy analysis and showed that their area and population density appear to be similar. However, on reviewing their urban hierarchy status, Tokyo had a relatively higher land use density than Seoul. In addition, the axial map of Tokyo appeared to have a relative balance in the distribution of axial lines compared with that of Seoul (Figure 5). In Seoul, the axial lines were partially concentrated or dispersed depending on the area. However, the intelligibility of the two cities was generally low, and Tokyo, in particular, had a lower intelligibility than Seoul, indicating that Seoul has a more recognizable urban structure than Tokyo. This observation indirectly proves that land cover tends to be relatively balanced in high-density cities. Furthermore, it suggests that an increased land use density increases the probability of lowering recognition in terms of the urban structure.

Based on the analysis of the distribution of museums in Tokyo and Seoul, administrative districts with a high density of museums were found to be interconnected. They relatively deviated from the spatial hierarchy of the city center. These results may be explained in terms of the historical value of the area, the distribution of cultural heritage sites/structures, and/or urban development policies. However, in high-density cities, museums were relatively concentrated in areas away from the urban spatial hierarchical center. We applied statistical techniques to prove that the accessibility of museums with limited distances in Tokyo and Seoul was positively correlated with urban accessibility. However, Figure 7 shows that the dispersion of the data related to museum accessibility was relatively high in the ranges of the X-axis (0.0–0.4 and 0.6–1.0, respectively) and Y-axis (0.4–1.0 and 0.4–1.0, respectively) for both cities. In addition, considering that museums are less accessible as they approach a value of 1, according to the formula for calculating the integration relative interval, museums in Tokyo were generally less accessible on foot when the corresponding limit distance was set. Nevertheless, they were strategically positioned in accessible locations in the overall urban structure. In contrast, museums in Seoul were more difficult to access. In particular, the data in the scatterplots were relatively concentrated in the range of 0.6–1.0 for both the X and Y axes (Figure 7b), indicating a lower museum accessibility.

Therefore, museums in Tokyo are predicted to be in areas with high urban spatial accessibility. This suggests that visitors are more likely to move around relatively freely owing to the ease of spatial access. Consequently, travelers who want to visit museums in Tokyo are more likely to follow free-flowing routes in the city. By contrast, most museums in Seoul are in areas that are challenging to access, and people who wish to visit specific museums are more likely to follow a single path due to the limited options for spatial access. Consequently, these single paths resemble forced movement patterns rather than the free-flowing patterns observed in Tokyo.

This study suggests two methods to select the location of museums in high-density cities. These methods are based on the possibility of free and forced movements of museum visitors, which were derived from analyzing the accessibility of museums in Tokyo and Seoul. In high-density cities where museums are easily accessible on foot, such as in Tokyo, visitors are likely to move in relatively free patterns. Therefore, creating active clusters of museums within walking distances and building museums within this range would be ideal for revitalizing such cultural cities. However, in cities where visitors form forced travel patterns, such as in Seoul, selecting the location of museums according to the lines along which visitors visit museums may be favorable. This approach is beneficial for visitors who want to experience cultural facilities.

5. Conclusions

This study examined the prevalence and distribution of museums in Tokyo and Seoul and reviewed museum accessibility by identifying the correlation between urban accessibility and accessibility within limited distance ranges. The accessibilities of the museums in Tokyo and Seoul were also compared. The main findings are as follows.

First, Tokyo and Seoul have similar population densities. Tokyo has a relatively higher land use density and a more balanced land cover than Seoul. However, for the recognition of urban space, Seoul has a higher intelligibility than Tokyo. Therefore, balanced distributions of the land cover and land development density were considered factors influencing urban spatial recognition in high-density cities.

Second, museums in Tokyo and Seoul were relatively concentrated in specific areas in terms of geographic locations that partially deviated from the hierarchical centers of each city. Thus, forming a relatively concentrated distribution of cultural facilities by establishing cultural tours and externally promoting cultural functions in specific areas is seen as a characteristic of high-density cities in East Asia with cultural attributes.

Third, the walking circulation patterns of visitors in Tokyo and Seoul were estimated on the basis of a correlation analysis between the urban accessibility of museums in these cities and the accessibility of museums with limited travel distances. The results show that visitors to museums in Tokyo were more likely to freely explore the city. The overall museum accessibility in Seoul was lower than that in Tokyo. Thus, the more accessible the museum in urban space, the more likely the routes and circulation patterns are limited, creating forced movement patterns.

This study analyzed the accessibility of museums in Tokyo and Seoul, which are two high-density cities in East Asia. The research scope was limited to walking accessibility, and other transportation means were not considered. In addition, since the mode of transportation affects the time taken to reach a destination, future studies should examine the time taken to access museums when different modes of transportation are used. This study also limited museum accessibility to physical space. Nevertheless, in addition to factors related to spatial access, social and humanistic factors can influence visitor access to museums. Hence, in future studies, the movement of people visiting museums should be tracked by considering factors such as the utilization rate of museums, motivation for using them, and purpose of the visit.

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