A STUDY ON THE CORRELATION BETWEEN PEDESTRIAN NETWORK AND PEDESTRIAN VOLUME ACCORDING TO LAND USE PATTERN

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Abstract

This study aims to clarify the characteristics of pedestrian space use patterns according to land use by analyzing the correlation between pedestrian network and pedestrian volume in downtown Seoul. The study method is as follows: first, the present condition of the land was investigated; second, a pedestrian network was created using space syntax and pedestrian volume examined; and third, the correlation between pedestrian volume and pedestrian network according to land use was analyzed.

The results indicated that the correlation between pedestrian volume and spatial network in residential areas was very low ($R^2=0.07$), while there was a close relationship between pedestrian volume and spatial network in business areas ($R^2=0.872$). With respect to the commercial areas, the pedestrian volume characteristic of the entire commercial area surrounding Namdaemun Market and that of Namdaemun Market itself were different: where the correlation between pedestrian volume and spatial network was high ($R^2=0.694$) in the commercial area excluding Namdaemun Market, but became low when the market was included.

As the results show, there was a very close correlation when it was broken down and analyzed according to the type of land use, which signifies that correlation between pedestrian network and pedestrian volume differ according to land use. The study results also suggest that when planning for pedestrian space, business and commerce areas need a plan that puts more emphasis on spatial network over comfort of pedestrian environment, and in case of residential areas, comfort of pedestrian walkways are more important than spatial network.

Keywords:
Pedestrian network  
Pedestrian volume  
Land use pattern  
Space syntax

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Introduction

Pedestrian traffic as a subject is not being reflected sufficiently in the process of land use planning. Separate planning for land use and pedestrian traffic, and the lack of study results on pedestrian traffic has produced a poor pedestrian environment by limiting pedestrian accessibility and movement. However, the space syntax method has advanced studies of pedestrian traffic behavior in carrying out a quantitative analysis of pedestrian network by setting visibility as a major variable. This study will examine the mutual relationship between land use and the characteristics of pedestrian traffic. More specifically, the correlation between pedestrian network and pedestrian traffic volume according to the type of land use will be analyzed.

The subject is downtown Seoul, a mixed used area that can be used for understanding pedestrian characteristics according to land use. The study first examined the present land use in the case study area focusing specifically the use of 1st floor of buildings, which have a close relation with walking, and within a 1 Km radius around Sungryemun. Secondly, a pedestrian network is constructed using space syntax method to analyze pedestrian accessibility. Third, an observation of pedestrian traffic volume is carried out and fourth, the mutual relationship between pedestrian traffic volume and pedestrian network for each type of land use is analyzed.

Analysis of the Current Situation in the Case Study Area

Current Land Use Pattern

The Namdaemun market is located in the northern part of Hoihyeon-dong area with housing areas distributed in some parts. The main uses of the 1st floors in the northern part of Toegyero with Namdaemun Market in the center are distribution of consumer products and sales facilities, as seen in Figure 2a.
As seen in Figure 2b, large hotels are located in the Bukchang-dong and Sogong-dong areas. Large business buildings such bank headquarters are located there, and restaurants to service them are distributed heavily in the Bukchang-dong region. Restaurants are clustered together in small groups between regular business buildings.

**Characteristics of the pedestrian network**

A total of 58 observation points were selected to analyze the characteristics of pedestrian traffic in the study area. The pedestrian traffic volume was examined every five minutes for each time interval from 11AM to 8PM on Friday, January 24, 2003 (Table 1).

A space syntax model was created to analyze the pedestrian network of the study area. The pedestrian network was modeled by taking into account all parts of sidewalks, underground, and crosswalk sections where pedestrians walk. As for the specifics of creating the space syntax model, a method proposed in previous study (Shin et al, 2004) that used as its subject a nearby area of this region was utilized.
Figure 3 shows the results of Integration (3) analysis that used as its subject an area of 1 Km radius centered on Sungryemun.

Table 1:
The results of observing pedestrian traffic volume in Sungryemun area

Analysis of the Correlation between Pedestrian Volume and Pedestrian Network According to Land Use

Pedestrian characteristics in the Study Area

Table 2a shows the results of the regression analysis between the amount of pedestrian traffic and Integration in the case study area. The coefficient of determination ($R^2$) is 0.515 between the two factors. In this area, various types of commercial facilities exist centered
around Sungryemun, such as Namdaemun Market, and business facilities and housing areas also coexist. Therefore, the predictability of the model is somewhat low when compared with the previous study ($R^2=0.710$) in the neighboring area. In other words, while the area previous study focused on was mainly occupied by business facilities, complex land use is being carried out in the current case study area, and it suggests that pedestrian characteristics may appear differently according to the type of land use.

**Pedestrian Characteristics in Commercial Areas**

Table 2b shows the results of analyzing the correlation between the pedestrian traffic and pedestrian network in all commercial areas within the study subject area. The result of analysis showed that the coefficient of determination ($R^2$) was 0.482, a relatively low value. It is analyzed that this result is produced because the area has a different type of pedestrian characteristic from other general commercial areas due to the influence of the traditional marketplace, Namdaemun market, which has a strong pedestrian absorption force. When the type of land use is further broken down and the correlation of the two variables is analyzed again, the results are as follows.

Table 2c shows the results of regression analysis between pedestrian traffic volume at Namdaemun Market and pedestrian accessibility of Integration (3). The coefficient of determination ($R^2$) is 0.634, showing a higher coefficient than when the entire subject area is analyzed. Hence, it shows that pedestrian traffic volume is more significantly affected by pedestrian network when only the Namdaemun Market is the subject than when the whole commercial area ($R^2=0.482$) is analyzed.

Next, the Bukchang-dong and Bongrae-dong commercial areas are analyzed with the exclusion of the Namdaemun Market area. This region shows a land use characteristic in which restaurants serving the business areas are mainly located rather than retail or sales facilities. As shown in Table 2d, the coefficient of determination ($R^2$) is 0.646, higher than when the whole commercial area including the Namdaemun Market is analyzed. Commercial facilities including restaurants and sales and lodging facilities occupy the highest land ratio in the Bukchang-dong area, and regular business facilities are equally distributed in the whole area. The results of a regression analysis between the pedestrian traffic volume in only the commercial areas of this region and Integration show the coefficient of determination ($R^2$) to be very high at 0.621, as shown in Table 2e.

**Pedestrian Characteristics in Housing Areas**

Unlike the Namdaemun Market, the Hoihyeon-dong area at the southern part of Toegyero is mainly residential. It has small business facilities, restaurants, and sales facilities, but the ratio of housing is the highest. The results of regression analysis are as shown in Table 2f. The analysis indicated that there is almost no correlation between pedestrian traffic volume and pedestrian network in housing areas. It means that in housing areas in downtown, pedestrian behavior is influenced by factors other than accessibility arising from pedestrian network. Hence, it is interpreted that pedestrians in housing areas show a pedestrian behavior that arises from such things as trip purpose, spatial experience and learning, rather than one that depends on spatial network.

**Pedestrian Characteristics in Business Areas**

Most business facilities are located in the Seosomun-dong area, as well as some sales facilities including restaurants. The results of regression analysis are shown in Table 2g. The coefficient of
determination ($R^2$) found is very high at 0.872, which means that pedestrian network plays the most decisive role as a factor determining pedestrian traffic volume in the commercial area of Seosomun-dong.

**Pedestrian Characteristics in Areas Where Commercial and Business Facilities Coexist**

Most commercial and business facilities coexist in the Bongrae-dong area. The results of regression analysis show the coefficient of determination ($R^2$) to be very high at 0.779 as shown in Table 2h. As the results indicate, the correlation between pedestrian traffic volume and spatial network is very high in commercial and business areas. The correlation between pedestrian traffic volume within an area that include both business and commercial areas and Integration show that pedestrian traffic volume is highly affected by spatial network in that area, as seen in Table 2i.

### Table 2:

**Analysis of pedestrian network according to land use**

- a. Entire case study area ($Y=2.11+1.918X; R^2=0.515$)
- b. All commercial areas ($Y=1.926+0.306X; R^2=0.482$)
- c. Namdaemun Market area ($Y=2.455+1.918X; R^2=0.634$)
- d. Commercial areas in Bukchang-dong & Bongrae-dong ($Y=1.648+0.351X; R^2=0.646$)
- e. Commercial area in Bukchang-dong ($Y=2.092+0.212X; R^2=0.621$)
- f. Housing area in Homyeon-dong ($Y=2.303+0.095X; R^2=0.07$)
- g. Business area in Seosomun-dong ($Y=2.131+0.245X; R^2=0.872$)
- h. Commercial & business areas in Bongrae-dong ($Y=1.206+0.407X; R^2=0.779$)
- i. All business & commercial areas ($Y=1.921+0.281X; R^2=0.603$)

### Table 3:

The correlation between pedestrian traffic volumes; integration

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<th>Classification</th>
<th>$R$</th>
<th>$R^2$</th>
<th>p-value</th>
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<td>Bongrae-dong area</td>
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<td>All commercial (Excluding Namdaemun Market)</td>
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<td>.646</td>
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<tr>
<td>All</td>
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Conclusion

In this study, the correlation between pedestrian network and pedestrian traffic volume according to the type of land use was analyzed by examining the accessibility of pedestrian spatial networks. Firstly, it was shown that pedestrian characteristics in a housing area have very low correlation with spatial network. It is interpreted that, for the housing areas, pedestrian pattern relies more on learning, experience, or certain specific purpose rather than depending on spatial network. Secondly, it was shown that pedestrian traffic in business areas has a close relationship with spatial network, which was demonstrated with the results of statistical analysis to be the highest correlation among a variety of land uses. Therefore, it can be said that pedestrian traffic volume in business areas is almost determined by spatial network. Thirdly, the correlation between pedestrian traffic volume in commercial areas and spatial network largely show two characteristics. In other words, the pedestrian pattern shows different characteristics for the whole commercial area including the market, and just for the market. For the case of commercial areas, the correlation between pedestrian traffic volume and spatial network is shown to be comparatively high when the market is excluded, but becomes lower when the market is included. The correlation is higher when only the market is analyzed. This is interpreted to mean that pedestrian traffic volume significantly changes according to the changes in the spatial network of a market compared to regular commercial areas.

As seen from the study results, the correlation between the pedestrian network and pedestrian traffic volume in an area where complex land use exists may not seem that high, but when the situation is further broken down and analyzed again; it is shown that there is a close relationship between the two factors according to type of land use. This proves that there are different pedestrian characteristics according to each land use behavior. The relationships between land use, pedestrian network, and pedestrian traffic that were deduced from the results of this study can be utilized as planning elements. Since pedestrian behavior shows a different characteristic according to land use, for business or commercial areas, the planning needs to be centered on spatial network rather than on convenience, comfort or safety in order to revitalize pedestrian activity. However, for housing areas, the planning needs to focus more on convenience, comfort, and improvements in safety that more strongly influence the pedestrian environment than spatial network.

Reference


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