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A study on the hierarchy in spatial configuration of outpatient department in general hospital through spatial distinction theory: Focusing on general hospitals located in Korea

Sangwon Oh[1], Heangwoo Lee[2], Yongseong Kim[3*]

[1]Graduate School of Techno Design Kookmin University, 77 Jeongneung-ro, Seongbuk-gu, Seoul, Korea
E-mail: speed-yooh@hanmail. net
[2]Graduate School of Techno Design Kookmin University, 77 Jeongneung-ro, Seongbuk-gu, Seoul, Korea
E-mail: moonup2001@nate. com
[3]Graduate School of Techno Design Kookmin University, 77 Jeongneung-ro, Seongbuk-gu, Seoul, Korea*
E-mail: yongkim@kookmin. ac. kr

Abstract
Hospital architecture is a process to change a social substructure called medical treatment system into a physical environment called architecture. Therefore, when planning hospital architecture in consideration of moving line of patients according to patients' symptoms and characteristics, pleasant living space should be established. The purpose of this study is to provide preliminary data for planning the space configuration of hospital through spatial hierarchy analysis, and this study is carried out in theoretical consideration and process of concluding space syntax. The analysis target of this study was a large university hospital with over 600 sickbeds, and the result of this study is as follows. First, the lobby and hall to access the outpatient department have high connectivity of convex so that congestion is expected, and especially, the connectivity of convex for emergency treatment is high so that congestion is expected in case of using the space, so it should be considered during the design process. Second, the lobby core showed high integration, indicating the favorable spatial cognition moving line for moving between floors of outpatient department and the analysis result showed that the hall and specific corridor showed high integration. Therefore, in order to improve cognition, a study to improve plan and cognize spatial composition in connection with hall and corridor with high integration is necessary. Therefore, there is a limitation in this study that only spatial hierarchy of outpatient department was evaluated, and it is necessary to carry out a study to analyze the spatial hierarchy of department on each floor in future.

Keywords: General hospital, Hierarchy of space, Convex, Space syntax

Introduction

Hospital architecture is classified into one of special architecture which is distinct from other normal architecture, and high efficient composition and rationality are reflected in this special architecture as a set of complex and collective functions. The moving line should be classified into the moving line of patients and caregivers, that of visitors, medical staff, and supply for hospital planning, and the systematic analysis according to the space composition and moving line is required.

The outpatient department is a typical part of hospital where various user activities are carried out, and it is located near the main entrance and established at lower level to allow patients to use conveniently. And, the entrance and moving line between users and employees should be separated and the entrance for inpatients, outpatients and visitors should be also separated if possible when carrying out hospital planning. Users can be classified into patients and medical staff, and the business of patients occurs based on the treatment room and and the task of medical staff occurs based on the station, so the relationship between patients and medical staff becomes a major issue in ward planning. Fundamentally, the ward is considered as the living place of patients, so a problem to create pleasant ward environments is emphasized in ward planning and the work efficiency of nurses is considered incidental, so that patient-oriented cognition is predominant. In order to accommodate these elements, an efficient planning of corridor space which connects between the living space of patients and nursing service space is necessary. Also, the corridor space has a great effect on the whole area of outpatient department, so careful consideration in the aspect of economic feasibility is also required.

Therefore, the purpose of this study is to provide preliminary data for hierarchy of plane structure in outpatient department for efficient planning of outpatient department by investigating, analyzing the area distribution of outpatient department and determining the correlation between architectural planning and design elements.

Methods and Procedures of the study

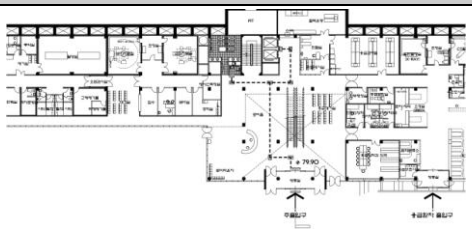
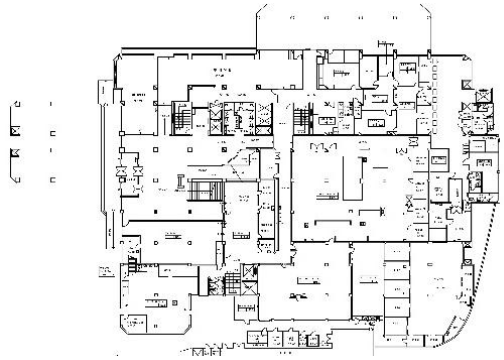
This study was carried out in the following procedures to analyze understanding on the plane structure and hierarchy of space through theoretical consideration; to draw and analyze the quantitative plane hierarchy of outpatient department in general hospital through the space syntax.

First, elements which are reflected when carrying out space planning based on spatial aspects are drawn as the stage of literature review to draw the analysis method.

Second, the space composition and characteristics of outpatient department are drawn through the space syntax analysis result of selected target.
Third, the analysis on the accessibility and cognition of space through indicators is carried out.

General hospitals with more than 600 sickbeds located in Korea were selected as the analysis target of this study.

Table 1: Overview of analysis subject

Hallym University Medical Center: H. C		
	Establishment year	2004
	Number of bed	600
	Number of floors (above ground/underground)	8/1
	 	
Ajou University Hospital: A. H		
	Establishment year	2005
	Number of bed	959
	Number of floors (above ground/underground)	14/3
	 	
Chosun University Hospital: C. H		
	Establishment year	2007
	Number of bed	715
	Number of floors (above ground/underground)	4/4
	 	
Inje University busan Paik Hospital: I. H		
	Establishment year	2011
	Number of bed	898
	Number of floors (above ground/underground)	11/2
	 	

Concept and composition of the outpatient department

The outpatient department is named and classified in order to classify the function of hospital, and it can be defined as the department which is in charge of patients' treatment which is the main purpose of hospital, and this department has the following functions:

First, function to treatment patients who can visit hospital regularly (outpatients)

Second, function to examine a patient who wishes or needs to be hospitalized, determine his/her disease and decide whether or not to hospitalize the patient.

Third, function to provide continuous treatments to a discharged patient from the hospital.

Fourth, function to prevent, discover a disease in early stage or promote health improvement through a medical examination.

Fifth, function to restore the paralysis of function, maintain remaining function, develop and study supplement functions.

Lastly, function as the educational place for resident doctors [1].

Therefore, the outpatient department consists of each outpatient department and drugstore (internal medicine, surgery, pediatrics, obstetrics and gynecology, dermatology, otolaryngology, ophthalmology, dentistry, etc) emergency room, treatment room, small examination room, outpatient waiting hall, drugstore, injection room, outpatient consultation room and funeral hall.

Concept and index of space syntax

The space syntax is a method to consider convex as a unit space and analyze the arrangement and connection between unit spaces quantitatively, and a convex space is a part which is projected convexly, and it means space which visual permeability is available from all directions.

First, the simplest composition called the moving line of people occurs in the space.

Second, a space where people form a group with other people or people access visually (visual permeability) from all directions occurs. Such space can occur in the lobby or reception room even if this is not official space. The requirement of this space is visual permeability. Two people inside this space should be able to observe each other wherever they are. Hillier expresses such space as 'Convex'.

Third, convex can be expanded externally and when a person inside the convex look all around, the range of visually accessible space is determined in form of cross. In other words, the person can look without disconnection or being blocked. A person in the middle convex can look and visually access a person in any space.

The following is the relevant conceptual process of space syntax used in this study including main indicators such as connectivity, integration, intelligibility and local integration.

Table 2: Key indexes of space syntax

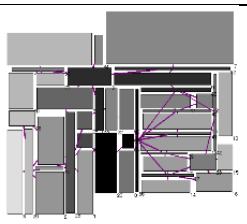
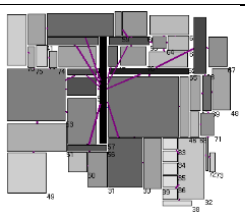
Connectivity	Connectivity indicates the number of axes with which the space is connected to the surrounding unit space. A space with high connectivity has a high frequency of use.
Integration	This index expresses relative depth to approach surrounding unit space from a specific space, and access is easier as this index is higher.
Local Integration	While the integration shows the relation of whole spatial arrangement, the local integration is the integration within a fixed adjacent range considering several spatial depths. On average, human being generally considers up to 3 depths for recognizing space, but it may be different according to the characteristics of study object or circumstances. The higher the local integration is, the higher the spatial cognition is.
Intelligibility	Defined as correlation between the overall attributes of spatial structure and attributes of local space. Spatial cognition as a whole is high in areas with high spatial structure intelligibility, and the spatial structure and spatial use patterns are systematic.

Selection of analysis target

General hospitals with more than 600 sickbeds located in Korea were selected as the analysis target of this study. The connectivity and integration which were indicators of space syntax were drawn for the evaluation on the hierarchy of plane structure in general hospitals. The analysis result on the spatial hierarchy of outpatient department is as follows and Table 3 is the result regarding the connectivity of outpatient department in selected general hospitals, presenting 5 convex with high connectivity.

The connectivity in Hallym University Medical Center was shown higher in order of mortuary hall, lower corridor of nurse station, upper corridor of cast room, indicating that it is located in the middle of moving line in outpatient department, and the connectivity in Ajou University Hospital is shown higher in order of entrance corridor of radiology, lobby, right lateral corridor of stair hall inside the radiology, corridor of left stair hall of outpatient waiting room, and reception desk of radiology. Also, the connectivity in Chosun University Hospital was shown higher in order of lobby, lower corridor of control room, entrance corridor of emergency patients, and the connectivity in Inje University busan Paik Hospital was shown higher in order of left longitudinal corridor of nutrition department's kitchen, funeral hall, lobby, lower corridor of bank and left longitudinal corridor of supply room. When analyzing the result above, the lobby and hall to access the outpatient department have high connectivity of convex so that congestion is expected, and especially, the connectivity of convex for emergency treatment is high so that congestion is expected in case of using the space, so it should be considered during the design process.

Table 3: Average and deviation of connectivity of convex space by component

Name of building	Connectivity (5 values in descending order)	
H. C	① Hall of the mortuary department (14) ② corridor of the lower nurse room (8) ③ corridor of the upper cast room (7) ④ corridor of the upper main doctor's office (7) ⑤ corridor near the entrance for emergency patients (6) *Whole Average: 2. 033	
A. H	① Entrance corridor of radiology (8) ② Lobby (7) ③ Right lateral corridor of stair hall inside the radiology (5) ④ Corridor of left stair hall of outpatient waiting room (5) ⑤ Reception desk of radiology (5) *Whole Average: 2. 605	
C. H	① Lobby (7) ② corridor of the lower control room (7) ③ corridor near the entrance for emergency patients (7) ④ corridor of the lower x-ray room (7) ⑤ treatment area for emergency patients (6) *Whole Average: 2. 060	
I. H	① Left longitudinal corridor of nutrition department's kitchen (9) ② Funeral hall (7) ③ Lobby (6) ④ Lower corridor of bank (5) ⑤ Left longitudinal corridor of supply room (4) *Whole Average: 2. 125	

As shown in Table 4, the integration is the indicator which affects the cognition on the outpatient department, and the integration in Hallym University Medical Center was higher in order of mortuary hall, lower corridor of nurse station and upper corridor of main treatment room. Also, the integration in Ajou University Hospital was higher in order of entrance corridor of radiology, lobby, integrated examination room, right corridor of hospital administration, lower corridor of emergency room, and the integration in Chosun University Hospital was higher in order of lower corridor of control room, lower corridor of roentgenography room and left waiting room of roentgenography room. The integration in Inje University busan Paik Hospital was higher in order of left longitudinal corridor of nutrition department's kitchen, upper corridor of nutrition department's kitchen, right longitudinal corridor of C. T room, upper corridor of coffee shop, coffee shop and storage. The analysis result of these contents shows that the hall and specific corridors show high integration. Therefore, a plan to link with the corridor or hall is necessary to improve cognition.

Table 4: Average and deviation of integration of convex space by component

Name of building	Integration (5 values in descending order)	
H. C	① corridor on the right of the left staircase (1. 195) ② corridor near the restroom entrance on the right of the left staircase (1. 162) ③ ELEV. Hall (1. 100) ④ left staircase (1. 094) ⑤ corridor on the right of the left p. s. room (1. 094) *Whole Average: 0. 749	

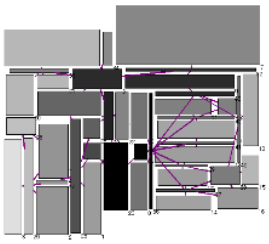
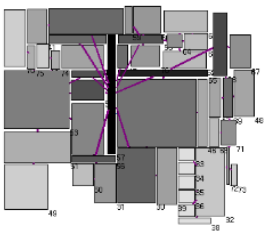
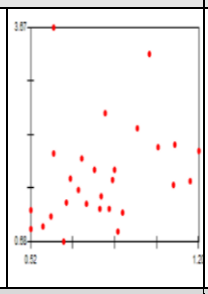
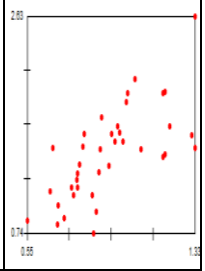
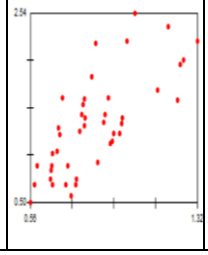
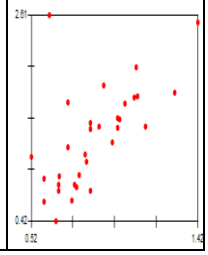
A. H	① Entrance corridor of radiology (1. 326) ② Lobby (1. 326) ③ Integrated examination room (1. 312) ④ Corridor on the right side of hospital administration (1. 211) ⑤ Lower corridor of emergency room (1. 189) *Whole Average: 0. 914	
C. H	① Lobby (1. 324) ② corridor of the upper emergency department office (1. 261) ③ corridor of the lower emergency test room (1. 248) ④ rectangular corridor on the lower-left side (1. 235) ⑤ corridor near the entrance for emergency patients (1. 191) *Whole Average: 0. 819	
I. H	① Left longitudinal corridor of nutrition department's kitchen (1. 421) ② Upper corridor of nutrition department's kitchen (1. 297) ③ Right longitudinal corridor of C. T room (1. 137) ④ Upper corridor of coffee shop (1. 095) ⑤ Coffee shop and storage (1. 095) *Whole Average: 0. 803	

Table 5 shows the result of spatial structure of selected general hospitals, and Hallym University Medical Center, Ajou University Hospital, Chosun University Hospital and Inje University busan Paik Hospital show 0. 195, 0. 505, 0. 552 and 0. 401 respectively, and the spatial structure of these hospitals is unsuitable based on the study [3] indicating that the intelligibility over 0. 6 is suitable for spatial cognition. Especially, Hallym University Medical Center shows low spatial cognition converged on a specific convex, and there is a wide variation in the integration. Therefore, it is necessary to find a measure to improve spatial cognition by preventing the concentration of moving line and designing with low variation in spatial cognition. Therefore, hierarchical and connected spatial structure is appropriate for improving the cognition of outpatient department.

Table 5: Intelligibility of outpatient department

H. C	A. H
0. 195 	0. 505 
C. H	**I. H**
0. 553 	0. 401 

Conclusion

This study was carried out for the purpose of establishing preliminary design data through the quantitative spatial hierarchy analysis of outpatient department in general hospital, and the result of this study is as follows.

First, the lobby and hall to access the outpatient department have high connectivity of convex so that congestion is expected, and especially, the connectivity of convex for emergency treatment is high so that congestion is expected in case of using the space, so it should be considered during the design process.

Second, the lobby core showed high integration, indicating the favorable spatial cognition moving line for moving between floors of outpatient department and the analysis result showed that the hall and specific corridor showed high integration. Therefore, in order to improve cognition, a study to plan spatial composition in connection with hall and corridor with high integration and to improve cognition is necessary.

Therefore, there is a limitation in this study that only spatial hierarchy of outpatient department was evaluated, and it is necessary to carry out a study to analyze the spatial hierarchy of department on each floor in future.

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