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A Study on the Spatial Hierarchy of Low-Rise Spaces in Large Geriatric Hospitals

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Abstract

With the aging of society, facilities for the elderly are becoming larger and more subdivided functionally due to increased demand, but the quality of such facilities remains low. In particular, in geriatric hospitals, there has been difficulty in spatial planning due to the combination of a special target, i.e. the elderly, and a special facility, i.e. a hospital. This study builds basic data for the design of a large geriatric hospital by analyzing the spatial structure of low-rise spaces of a large geriatric hospital. To achieve this objective, this study utilized space syntax, a kind of spatial hierarchy analysis method, to analyze the accessibility and cognition of a unit space. The conclusions are as follows. 1) The J-Graph of an Outpatient department in the hospital selected in this study has a tree type, which indicates that its space is designed to be suitable for outpatients. 2) Looking at the subdivisions of the Outpatient department in detail, the deviation between the highest and lowest value of connectivity tends to be larger. 3) The reception desks and information desks in a large geriatric hospital need to have a high restriction, but some hospitals showed low values. 4) The spatial structure intelligibility derived in this study sometimes shows a value of 0.6 or less due to the increase in a convex unit space, which is the result of the enlargement and subdivision of a geriatric hospital. However, it is considered that the simple enlargement of a hospital does not cause this problem; the low spatial structure intelligibility is caused by the arrangement and hierarchy of convex unit spaces. As such, when designing a large geriatric hospital, it is necessary to consider the spatial hierarchy and cognition of a space to design a moving line hierarchy that is suitable for the elderly

Keywords: Geriatric hospital, low-rise space, outpatient department, central treatment department, justified graph, spatial syntax

1. Introduction

1.1. Background and purpose of study

The number of elderly people is growing rapidly as average life expectancies increase worldwide due to continuous economic growth, medical technology development, and improvements in living standards. According to data from Statistics Korea and Korea Population, Health and Welfare Association in 2019, the elderly represented 14.9% of the population in Korea in 2019, a 5-fold increase from 1970. However, this has led to a number of serious problems, one of which is a rapid rise in medical costs. In particular, the rate of increase of medical expenses in Korea is three times the average of OECD member countries. According to the “2017 Korea Medical Quality Report” by Korea Institute for Health and Social Affairs, the annual average increase in medical expense from 2005 to 2015 was 6.8%, the highest among OECD member countries. The growth of the elderly population means there is an increased number of elderly patients suffering from various chronic diseases, which in turn greatly increases the demand for geriatric hospitals. According to the general data on welfare facilities for the elderly released by Ministry of Health and Welfare in 2020, the demand for elderly medical welfare facilities increased from 3,852 in 2010 to 5,287 in 2018. This means that the scale of the hospital industry continues to grow due to the recent increase in medical demand and the enlargement of hospitals. On the other hand, the existing geriatric hospitals do not reflect the various characteristics of the elderly in their spatial plans. Geriatric hospitals were excluded

from elderly welfare facilities when the Elderly Welfare Act was revised in June 2011 and instead were classified as nursing hospitals under the Medical Act, despite being facilities that mainly provide medical care for the elderly. [1-6] Recently, due to the rapid increase in the elderly population, geriatric hospitals are gradually becoming larger and more subdivided. As their main users are the elderly, geriatric hospitals should reflect their patients' physical and psychological characteristics. [7-10] Nevertheless, there has been little research on quality improvement of facilities for the elderly, so there is an ongoing need for various studies in this area. [11-14]

This study builds basic data related to the planning and design of large-sized geriatric hospitals by performing a hierarchical analysis of the space for geriatric hospitals in operation.

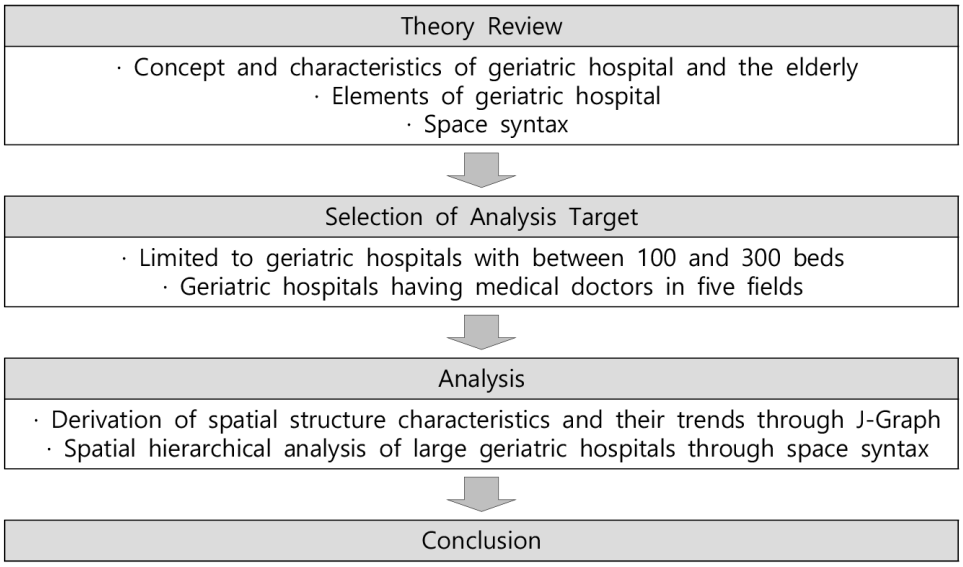
1.2. Background and purpose of study

The purpose of this study is to build basic data for spatial planning of a large geriatric hospital. As shown in Fig. 1, it proceeded through three steps.

First, as a step for theoretical review, the concept and characteristics of both a geriatric hospital and the elderly and the elements of a geriatric hospital were examined. In addition, this study investigated the indicators and analysis methods of the space syntax used as a quantitative analysis method for spatial hierarchical analysis. Second, a large geriatric hospital was selected for analysis. It is difficult to classify geriatric hospitals into large, medium, and small, as there are no specific classification criteria related to size. However, as a large general hospital is defined as a hospital with between 100 and 300 beds and also with medical doctors in seven treatment areas, this study limited the scope of targets to geriatric hospitals with between 100 and 300 beds. The reason why treatment areas were not considered for selection criteria is that there are treatment areas which are not necessary due to the characteristics of the elderly, such as pediatrics department, etc. Third, this study analyzed a spatial hierarchy for a geriatric hospital and used space syntax as an analysis method. Space syntax is an analysis method that can quantitatively derive the accessibility and cognition, etc. of an indoor unit space, and is suitable for this study. [15-19]

However, the scope of this study includes only the low-rise spaces, including Outpatient department and central treatment department, which are expected to be congested and require high cognition. In addition, of the various space syntax analysis methods this study applied a method using convex space diagram, and used S3 Axial developed by the Urban Architecture Space Analysis Laboratory at Seoul National University to apply the methodology. [20-24]

Fig. 1 Flowchart of Study



2. Review of Geriatric Hospital and Spatial Hierarchy Analysis Methodology

2.1. Concept and characteristics of the elderly and geriatric hospitals

An elderly person is defined by the International Association of Gerontology and Geriatrics as a person in a complex process where there is a mutual interaction among physiological, psychological, environmental, and behavioral changes due to the aging process. This includes loss in the physical, psychological, and social aspects. As such, the typical characteristics that appear with the elderly can be classified into three characteristics, i.e. physical, psychological, and cognitive. A detailed explanation of these is provided as follows.

First, the physical characteristics are typical aging characteristics, such as decreased mobility, decreased hearing ability, and decreased visual ability. [25-27] Second, the psychological characteristics include low memory power, low problem solving ability, and low thinking ability. Regarding low memory power, the latest information received rapidly declines to some extent compared to the past. Accordingly, when using a new space, the elderly show a passive attitude to the large amount of information required in a three-dimensional space. [28, 29] Third, regarding cognitive characteristics, the elderly have poor cognitive ability compared to the general population. [30. 31] Regarding cognition, which is a process of judging and responding by collecting and processing a large amount of information from the surrounding environment, the amount of information collected and the range of cognition is significantly decreased considering the physical and psychological characteristics of the elderly. Based on these three characteristics of the elderly, the cognition and access of a space should be planned in order for it to be convenient for the elderly.

Facilities for the elderly are classified into residential welfare facilities, medical welfare facilities, leisure welfare facilities, and elderly home care facilities. Of these, geriatric hospitals are operated as a type of nursing hospital that provide medical care for the elderly. In Korea, geriatric hospitals are established and operated in three types. First, there are geriatric hospitals established using a loan fund for paid elderly welfare facilities. Second, there are municipal or provincial geriatric hospitals. Third, there are general hospitals that are converted to or operate as geriatric hospitals.

2.2. Elements of a geriatric hospital

The elements of a geriatric hospital may differ depending on the researcher's perspective, but can be categorized into ward, outpatient, central treatment, management, service, and auxiliary facilities, as shown in Table 1. [32, 33] With the rapidly increased number of elderly people in a geriatric hospital, the area ratio of each element is different from that of a general hospital, and the ward area is increasing. [34, 35] Meanwhile, the outpatient department and the central treatment department occupy a smaller percentage of space than in a general hospital. This is due to the tendency of elderly patients to have longer hospital stays than general patients. This study analyzes the movement of patients, guardians, and staff in a hospital using the outpatient and central treatment departments to improve the accessibility and cognition of the elderly to a space, thus removing any difficulties in their life.

As mentioned earlier, of the elements constituting a large geriatric hospital, the focus of this study was limited to the outpatient department, central treatment department, and auxiliary facilities where outpatients visit and receive treatment.

Table I. Configuration and elements of geriatric hospitals

Department	**Elements**
Ward	Hospitalization room, intensive care unit, assistive personnel room, etc.
Outpatient	Outpatient examination room, treatment room, health examination center, emergency treatment room, etc.
Central Treatment	Nursing department, clinical pathology room, rehabilitation treatment room, radiation room, etc.
Management	Administrative office, volunteer office, conference room, etc.
Service	Medicine room, kitchen and restaurant, medical record room, etc.
Auxiliary Facility	Elderly goods store, convenience facility, CVS, etc.

2.3. Review of space syntax

This study presented a space syntax as a methodology to analyze the accessibility and cognition of low-rise spaces including the outpatient department and the central treatment department in a geriatric hospital. Of the analysis methods of space syntax, this study used convex, which is usually used for quantitative analysis of an inner space. Convex means a unit space of an open space that can recognize all points in a space as a point of view. It is possible to analyze the connectivity between unit spaces by dividing an indoor space to be analyzed into a convex space [36]. In addition, this study adopted space syntax as an analysis method because it is a technology that can quantitatively analyze the relationship and characteristics of each space. It can analyze the accessibility, passage and cognition based on the connection relationship between unit spaces.

The evaluation index and details derived from space syntax are as follows [37, 38]. Connectivity refers to the number of connections from a specific convex space to surrounding convex spaces. Therefore, a convex space with a high connectivity is expected to be congested due to its high frequency of access. It can be said that a convex space with a high connectivity is at an important location in a moving line. The restriction is a quantified numerical value indicating an influence by a specific convex space on adjacent convex spaces. A convex space has high restriction when a passage to a neighboring convex space is high. In addition, the information desk, reception desk, and nurse's office in a hospital should have high restriction, because high restriction means the surrounding convex spaces are under a high level of control. Integration

refers to the number of convex spaces to cross when moving from a specific convex space to a surrounding convex space. If integration is high, access to other spaces is easy. Integration quantifies the relationship between a specific convex space and the convex space of the entire space. Local integration is a numerical representation of the accessibility to a specific unit convex space, and it is based on the fact that humans generally perceive a convex space having a spatial depth of 3 when following a moving line. In other words, if the accessibility to a specific unit convex space compared to the convex space of the entire space is an integration, the accessibility to a specific unit space in consideration of human cognitive ability is a local integration. Finally, spatial structural intelligibility refers to the correlation between integration and local integration. Cognition of a space tends to be higher as the correlation between the two indicators increases. [39-46]

3. Analysis Method and Result

3.1. Analysis method

This study is a spatial hierarchical analysis of the low-rise spaces in a large geriatric hospital, including the outpatient department and central treatment department. As shown in Fig. 2, it proceeded through the following method.

First, this study grouped spaces based on the low-rise spaces in a large geriatric hospital including outpatient department, central treatment department, and other common spaces. If the outpatient department and central treatment department exist on the same floor, only that floor was analyzed. However, if they are located on two different floors, both floors were analyzed. Second, in this study, a convex space was divided into unit spaces based on the floor plan of a large geriatric hospital. If multiple spaces are homogeneous (excluding corridors), they are regarded as a single convex space although there is a visual blocking. Third, J-Graph and its type were derived based on the divided convex space. J-Graph visualizes the relationship between unit spaces, and it can be classified into four types as shown in Fig. 3.

Fig. 2 Analytical Method

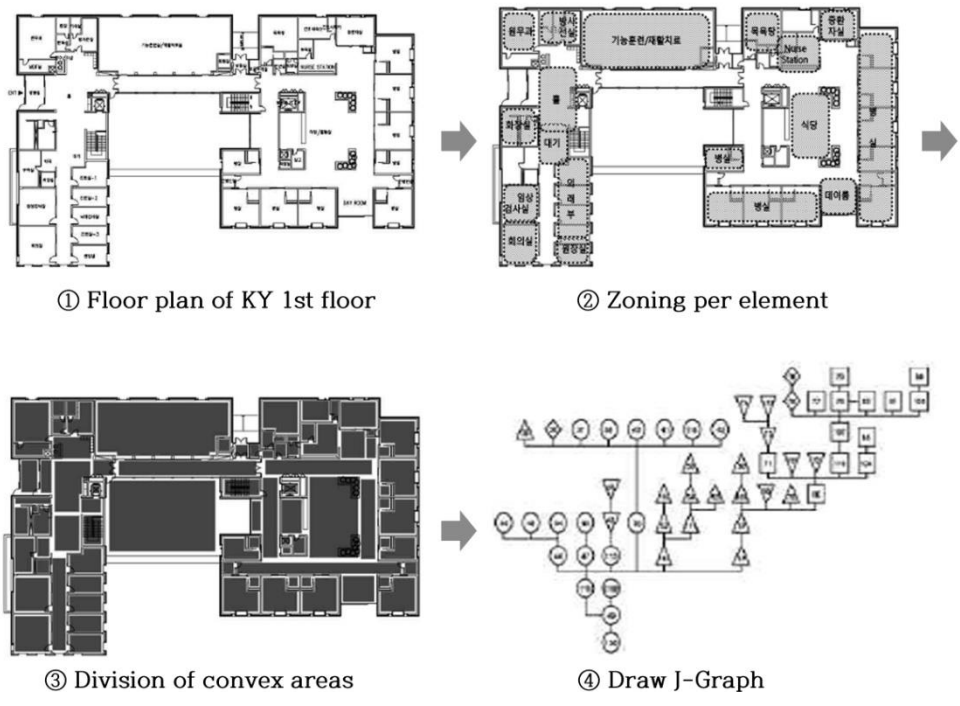
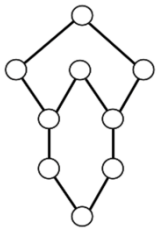
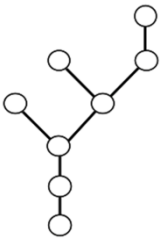
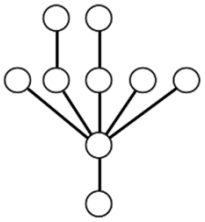
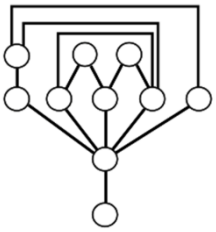


Table 2. J-Graph classification and characteristics

Type	**Tree Type**		**Ring Type**	
	Small Scrub Tree	**Tall Tree**	**Tall Tree**	**Shallow Ring**
Image				
Features	Sequential and continuous moving line in a space. Has high cognition and visibility between spaces.		Moving line with high sociality. Space with high autonomy and restriction by giving an option when using spaces.	

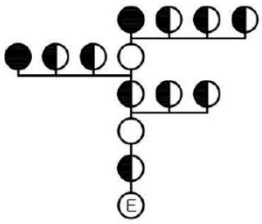
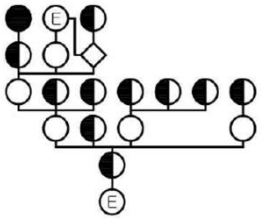
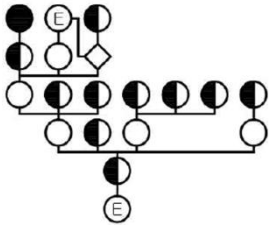
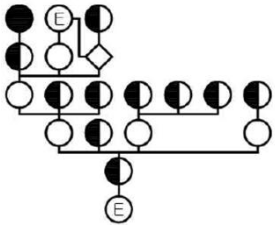
3.2. Selection of analysis target

The large geriatric hospitals selected in this study are listed in Table 3, and the selection criteria are as follows. First, as mentioned above, there is no classification or standard for size when classifying geriatric hospitals. Therefore, this study derives the criteria of a large geriatric hospital based on the criteria of a general hospital. A large general hospital is defined as a hospital with between 100 and 300 beds, and also with seven treatment areas. Therefore, when selecting a geriatric hospital for analysis in this study, the criterion was a hospital with between 100 and 300 beds. However, the number of available treatment areas was not considered when selecting the geriatric hospitals, because some treatment areas are unnecessary due to the characteristics of the elderly, and the hospitals were specialized for the elderly. As shown in Table 3, the large geriatric hospitals selected in this study have the capability of providing treatment equivalent to that of a general hospital.

Table 3. Outline of analysis target

Name		**City**	**Number of Beds**	**Treatment Departments**	**Year Constructed**	**Image**
Hyoja Geriatric Hospital	HH	Yongin, Gyeonggi-do	292	Neurology, Internal Medicine, Rehabilitation Medicine, Psychiatry, Family Medicine	1997	
Bukbu Geriatric Hospital	BH	Seoul	200	Neurology, Internal Medicine, Rehabilitation Medicine, Family Medicine	2006	
Bobath Memorial Hospital	MH	Sungnam, Gyeonggi-do	524	Rehabilitation Medicine, Internal Medicine, Neurology, Radiology, Obstetrics and Gynecology, Surgery	2006	
Tongyeon Geriatric Hospital	TH	Tongyeong, Gyeongnam	280	Neurology, Internal Medicine, Surgery, Oriental Medicine	2007	

Table 4. Extraction of J-Graph type in outpatient department

Hyoja Geriatric Hospital	**Bukbu Geriatric Hospital**
	
Small Scrub Tree	Tall Tree
Bobath Memorial Hospital	**Tongyeong Geriatric Hospital**
	
Small Scrub Tree	Small Scrub Tree

Second, the results of a connectivity analysis for the low-rise spaces of a geriatric hospital are as follows. As mentioned above, congestion may be expected for a convex with high connectivity. In particular, it can be a more serious problem for the elderly due to their reduced physical ability. When deriving a connectivity for the low-rise spaces of a geriatric hospital, the corridors and waiting areas adjacent to the treatment department showed higher values, and it is expected that the deviation between the maximum and minimum values of connectivity increases, which can be an issue, as the treatment area becomes more subdivided and larger. In addition, it seems that the overlapping of moving lines connected to the central treatment department and other convenient facilities contributes to the increase in connectivity. To solve this problem, it is necessary to properly plan a guide sign for the elderly to prevent congestion in a space with high connectivity. In addition, it is necessary to minimize congestion for a moving line for which congestion is expected by thoroughly separating it from that used by staff.

Table 5. Connectivity analysis

Hospital Name	**Connectivity**			
	Minimum	**Maximum**	**Average**	**Five convex spaces with higher values**
Hyoja Geriatric Hospital	1	13	2.25	Lower left corridor of treatment department, lower right corridor of treatment department, central hall, upper left of the ward, central hall

Bukbu Geriatric Hospital	1	18	2.12	Upper corridor of clinical laboratory, upper corridor of nursing room, lower corridor of right hospital room, left examination waiting room, central corridor of treatment room
Bobath Memorial Hospital	1	28	2.16	Upper corridor of warehouse, outpatient hall and corridor, left corridor of filming room, right corridor of examination center, physical therapy room
Tongyeong Geriatric Hospital	1	10	2	Lower corridor of physical therapy room, central waiting hall, upper corridor of hospital office, E.V. hall, lower corridor of pharmacy

Third, in the low-rise spaces of a geriatric hospital, the convex spaces that should have a high restriction are the reception desk and information desk, and the appropriateness of the spatial hierarchy was evaluated by deriving their restriction values. The restriction of the reception desks and information desks of Hyoja Geriatric Hospital, Bukbu Geriatric Hospital, Bobath Memorial Hospital, and Tongyeong Geriatric Hospital were 0.45/2.83, 2.14/No information desk, 5.47/No information desk, and 0.125/No information desk, respectively. The reception desks and information desks should have a high restriction, but the reception desks of Hyoja Geriatric Hospital and Tongyeong Geriatric Hospital have low values. This means that they are not located at important moving lines because the connectivity to adjacent convex spaces is low. This should be considered when designing a large geriatric hospital in the future. Fourth, the convex space of an outpatient department should have a high local integration because the main users of a large geriatric hospital are elderly patients. When analyzing local integration, the treatment and waiting spaces tend to show higher values than adjacent convex spaces. The treatment, waiting, and elevator halls are particularly advantageous in terms of space cognition. However, this is a local integration by considering three convex spaces when using a moving line, so an analysis should consider more diverse aspects.

Table 6. Analysis of local integration

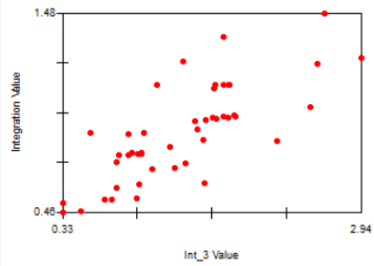
Hospital Name	**Local Integration**			
	Minimum	**Maximum**	**Average**	**Five convex spaces with higher values**
Hyoja Geriatric Hospital	0.33	2.93	1.34	Lower left corridor of treatment department, central hall, lower right corridor of treatment department, upper central corridor of the ward, upper left corridor of the ward
Bukbu Geriatric Hospital	0.33	3.54	1.39	Upper corridor of clinical laboratory, upper corridor of nursing room, left examination waiting room, lower left hall, upper corridor of exercise treatment room
Bobath Memorial Hospital	0.42	4.83	1.45	Physical therapy room, outpatient hall and corridor, corridor in front of sleeping room, entrance hall of underground parking lot, warehouse

				corridor and hall
Tongyeong Geriatric Hospital	0.33	3.38	1.31	Central waiting hall, lower corridor of physical therapy room, upper corridor of central hospital office, E.V. hall, lower corridor of pharmacy

Fifth, the spatial structure intelligibility derived in this study is shown in Table 7. If the value for spatial structure intelligibility is less than 0.6, it may be difficult to use a space. The Bukbu Geriatric Hospital and Bobath Memorial Hospital showed values less than 0.6. This may be because the number of convex unit spaces is increased due to the enlargement and subdivision of a geriatric hospital. However, it is also considered that it is not only the simple enlargement of a hospital that causes this problem, but also the arrangement and hierarchy of a convex unit space, as shown in the J-Graph of Table 4 derived earlier. Therefore, it is necessary to consider the spatial hierarchy and cognition of a space to design a moving line hierarchy that is suitable for the elderly when designing a large geriatric hospital.

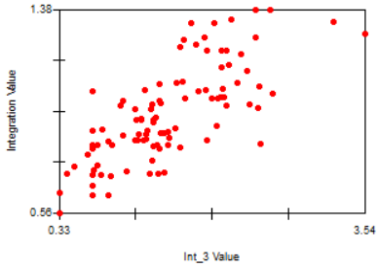
Table 7. Spatial structure clearness diagram

Hyoja Geriatric Hospital



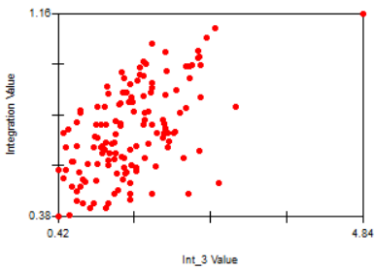
0.621

Bukbu Geriatric Hospital



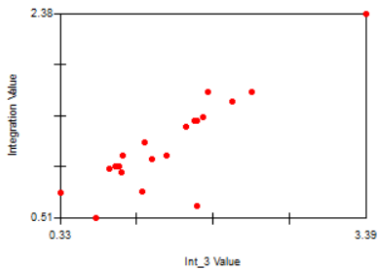
0.555

Bobath Memorial Hospital



0.405

Tongyeong Geriatric Hospital



0.750

4. Conclusion

This study relates to the planning of low-rise spaces of a large geriatric hospital, which include the outpatient department, central treatment department, and common space. The conclusions are as follows.

First, the J-Graph of an outpatient department of the hospital selected in this study, which seems to be designed to be suitable for use by outpatients, is a tree type. In a large geriatric hospital, the number of

convex spaces are increased because of its enlargement and subdivision, so it may be not suitable for use by the elderly. However, the hospital has a tree-type structure which seems to be designed to improve spatial cognition and visibility.

When deriving the connectivity for the low-rise spaces of a geriatric hospital, the corridors and waiting areas adjacent to the treatment department showed higher values, and it is expected that the deviation between the maximum and minimum values of connectivity increases, which can be an issue, as the treatment area becomes larger and more subdivided. In addition, it seems that the overlapping of moving lines connected to the central treatment department and other convenient facilities contributes to the increase in connectivity. To solve this problem, it is necessary to properly plan a guide sign for the elderly to prevent congestion in a space with high connectivity.

Third, the reception desk and information desk of a large geriatric hospital should have a high restriction, but the reception desks of some geriatric hospitals have low values. This means that they are not located at important moving lines because the connectivity to adjacent convex spaces is low. This should be considered when designing large geriatric hospitals in the future.

Fourth, regarding the spatial structure intelligibility derived in this study, some geriatric hospitals showed values less than 0.6. This may be because the number of convex unit spaces is increased due to the enlargement and subdivision of a geriatric hospital. However, it is also considered that not only the simple enlargement of a hospital causes this problem but also the arrangement and hierarchy of a convex unit space. Therefore, when designing a large geriatric hospital it is necessary to consider the spatial hierarchy and cognition of a space in order to design a moving line hierarchy that is suitable for the elderly.

This study is about the spatial planning of geriatric hospitals, which are becoming larger and further subdivided, and is a valid concern in this era in which we are becoming a super-aging society. However, this study has limitations because it used only space syntax for analysis, which does not consider physical distance and size. Future studies in this area should consider more diverse aspects.

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REFERENCES

Song, H. J. Choi, S. H. "A Study on the Evaluation of Treatment Conditions of the Nursing Homes based on the Characteristics of the Elderly - Focusing on the Municipal Nursing Homes in Seoul." Korea Institute of Healthcare Architecture 15.3 (2009): 31-39.

Kwon, S. J. "A Study on the Conceptualization and Architectural Planning Strategy of Elderly Hospitals - Focused on Nursing Hospitals." Korea Institute of Healthcare Architecture 15.1 (2009): 5-12.

Lee, Y. W. Choi, H. G. "A Study on the Recreational Program for Senior's Specialized Hospital and Customer Satisfaction." Business Management Review 2.1 (2011): 43-65.

Gvion, L. "Organised leisure as promoting nostalgia: Israeli senior citizens singing in Yiddish. " Leisure Studies 28.1 (2009): 51-65.

Estrada-González, A. E. "Social tourism, senior citizens, and education." World Leisure Journal 59.1 (2017): 22-29.

Gau, W. B. "Communities of practice for senior volunteers: A mutual engagement perspective." Educational Gerontology 37.11(2011): 1009-1026.

Kwon, Y. H. Lee, H. Y. Hwang, S. S. "A Study on the Knowledge, Attitude and Nursing practice of the nurses-towards the Elderly in Geriatric Hospitals." Korean Society of Science and Technology 14.11 (2013): 5785-5791.

Lee, M. S. Jeon, H. W. "A Study on the Characteristics of Rehabilitation for Space Configuration in the Special Clinic for the Elderly." Journal of the Korean Society of Interior Design 17.1 (2008): 120-129.

Newman, D. M. "A community nursing center for the health promotion of senior citizens based on the Neuman systems model. " Nursing Education Perspectives 26.4 (2005): 221-223

Jiaxin, Z. "Research on the Influence of Taijiquan on Senior Citizens' Mental Health." Journal of Hubei Sports Science 26.3(2007): 355.

Yang, J. H. Park, A. S. "Impact of Emotional Labor on the Turnover Intention of Medical Technology Workers in General Hospital." International Journal of Advanced Nursing Education and Research 4.2 (2019): 13-18.

Park, S. J. Hwang, Y. H. "Death Awarenes and Death Preparation Experiences In Hospitalized Elderly People in a LongzTerm Care Facility." International Journal of Elderly Welfare Promotion and Management 1.1 (2017): 21-28

Adhikari, S. "Health, nutrition and care for senior citizens of Nepal in twenty first century. " Journal of Health and Allied Sciences 3.1(2013): 73-75.

Skinner, J. "Social dancing for successful ageing: Models for health, happiness and social inclusion amongst senior citizens. " Anthropology & Aging 34.1(2013): 18-29.

Lee, M. S. Jeon, H. W. "A Study on the Characteristics of Rehabilitation for Space Configuration in the Special Clinic for the Elderly." Journal of the Korean Society of Interior Design 1.1 (2008): 120-129.

Kim, H. Y. Jun, C. M. Kwon, J. H. "Syntax-based Accessibility for 3D Indoor Spaces." Space Information Society of Korea 15.3 (2007): 11-18.

Dawson, P. C. "Space syntax analysis of Central Inuit snow houses." Journal of Anthropological Archaeology, 21.4 (2002): 464-480.

Hillier, B. "Studying cities to learn about minds: some possible implications of space syntax for spatial cognition. " Environment and Planning B: Planning and Design 39.1 (2012): 12-32.

Tao, Y. "Digital city and space syntax: A digital planning approach." Planners 28.4 (2012): 24-29.

Rashid, M. "On space syntax as a configurational theory of architecture from a situated observer's viewpoint. " Environment and Planning B: Planning and Design, 39.4 (2012): 732-754.

Ratti, C. "The lineage of the line: space syntax parameters from the analysis of urban DEMs. " Environment and Planning B: Planning and Design, 32.4 (2005): 547-566.

Legeby, A. "From housing segregation to integration in public space: A space syntax approach applied on the city of Södertälje. " The Journal of Space Syntax, 1.1(2010): 92-107.

Hwang, Y. W. "A study on the space analysis of residential house plans in rural new-town development area using the space syntax." Korean Institute of Interior Design Journal 22.5 (2013): 241-249.

D'Acci, L. "Orientational versus esthetical urban street morphology parameterization in Space Syntax." Spatial Cognition & Computation 19.3 (2019): 172-189.

Rose, D. J. "Promoting functional independence among at risk and physically frail older adults through community-based fall-risk-reduction programs." Journal of aging and physical activity 10.2 (2002) 207-225.

Cho. Y. H. "The Space Characteristics of Dementia Units by Using Space Syntax Theory." The Architectural Institute of Korea 26.7 (2010): 27-34.

Yoo. K. M. Choi. Y. S. "Analysis Theme Park Space Configuration Using Space Syntax." The Tourism Sciences Society of Korea 36.4 (2012): 59-80.

Lee. H. J. Park, J. S. "A Study of Vertical Circulation System in General Hospitals by Using Space Syntax." Korea Institute of Healthcare Architecture 19.4 (2013):47-60.

Choi. J. P. Byun. N. H. Kim. M. S. Chronological Analysis of the Accessibility Change of Outdoor Space in Apartment Complexes Using Space Analysis Method. Journal of the Korean housing association 21.4(2010):1-9

Shin, W. W. "The Study on Relationships between Physical and Psychological Health Characteristics and Life Satisfaction of Older Adults: Focused on Moderating Effects of Volunteer Participation." Journal of Welfare for the Aged 54 (2011): 135-163.

Jee, Y. S. Goo, C. M. "The Differences of Abilities to Physical Activity, Social Networks, Depression Degrees of Elderly between residing Rural and Urban." Journal of coaching development 9.2 (2007): 425-439.

Kang, S. A. Kang, S. Y, "Physical activity convergence contents for health care of the elderly." Convergence security journal 15.7 (2015): 63-68.

Choi. J. H. Ham, W. Lee, N. W. "A Study on the Residential Space Organization of the Elderly Care Facilities." Korea Institute of Healthcare Architecture. 10.1 (2004): 47-58.

Cho, C. M. "The Effects of a Cognitive Enhancement Program in Elderly Residents." Journal of the Korean Society for Living and Environment 23.1 (2016): 141-149.

Oh, C. O. "The Relationship Between Interior Style of Residential Space and the Elderly' Cognitive Age. " Journal of the Korean Institute of Interior Design 24.3 (2015): 95-130.

Lee, K. J. Ryu, R. Kim, Y. S. "Analysis on Changes of Accessibility per Period of Outdoor Spaces of Brand-name Apartment Complexes." Asia-pacific Journal of Convergent Research Interchange 5.2 (2019): 11-22.

Jwa, K. W. Kong, S. K. Park, J. H. "A Study on Facility Standards and a Spatial Combination of Geriatric Hosipital and Geriatric Center." Journal of Korean Institute of Spatial design (2016):121-124.

Yu, Y. M. "A Study on the Architectural Planning for Conversion from Acute- Care Hospital to Geriatric Hospital." Journal of the Korea Institute of Healthcare Architecture 14.1 (2018): 49-58.

Kim, M. J. Park, S. J. "Parenting Stress, Spouse's Involvement in Parenting and Turnover Intention of Nurses in Small-Medium Sized Hospitals." International Journal of Advanced Nursing Education and Research 2.1 (2017): 53-60.

Yang, J. H. Yoon, J. A. "A Research on the Profitability of the University Hospitals." International Journal of Business Policy and Strategy Management 3.1 (2016): 53-58.

Kim, M. J. Choi, Y. S. "Effects of Anxiety and Supporting the Act of a Mother Hospitalized Patients Provided Information about the Treatment during Hospitalization with Video." International Journal of IT-based Social Welfare Promotion and Management 3 (2016): 145-150.

Kim, J. Y. Choi, Y. J. Lee, H. W. "A Basic Study on the Planning of Lower Floors According to the Enlargement of Geriatric Hospitals." Journal of The Korea Institute of Healthcare Architecture 4.2 (2020): 1-6.

Cho, Y. H. "The Space Characteristics of Dementia Units by Using Space Syntax Theory." Journal of the architectural institute of korea planning & design 26.7 (2010): 27-34.

Jeong, J. H. "The Relationship between Distribution of Visitors and Spatial Structure in Museum." Journal of the architectural institute of korea planning & design 22.1 (2006): 103-110.

Hwang, S. H. Kim, K. J. Yoo, J. H. "A Study on the Typology of Spatial Organization in Convention by Spatial Syntax." Journal of the Korea Institute of Spatial Design 8.4 (2013): 73-81.

Won, S. K. Choi, A. S. Kim, Y. U. "Examination for Methodology of Design of Emergency Lightings by Using Space Syntax Theory." Journal of the Korean Institute of Illuminating and Electrical Installation Engineers 20.10 (2006): 1-9.