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STUDY OF COMMON SPACE LAYOUT DESIGN IN JAPANESE NURSING HOME

FROM THE PERSPECTIVE OF SPATIAL CHARACTERISTICS AND SPACE UTILIZATION

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ABSTRACT

The common space in nursing home is an important place to enhance residents' social exchange, and to promote residents healthy and life satisfaction. However, investigation shows the utilization of common space in Japanese nursing home is low.

This paper explores the association between space utilization and space spatial configuration, aims to contribute to spatial design for better resident's social exchange. The factors of spatial configuration in this paper includes space geometric metrics like area size per residents, shape, distance to living space, and the spatial metrics which is measured by Space syntax theory.

Firstly, the common space area sizes and factors of spatial configuration form Space Syntax theory are analyzed and compared through the past 35 years nursing home samples for clarifying the spatial characteristics.

Secondly, actual spatial utilization by residents are observed through the field survey in 12 nursing homes, and the tendency of utilization in each common space are clarified. Thirdly, the spatial characteristics are combined with spatial utilization in the multiple regression analysis, then spatial integration, area size per resident, and spatial connectivity are extracted as significant factors. That is

$$UTI(\%) = f(INT, CNN, ARE)$$

$$= 3.752 * INT + 3.301 * ARE + 0.506 * CNN - 4.206$$

where UTI is space utilization, INT is spatial integration, CNN is spatial connectivity, ARE is common space area size per resident, which tells that generally the space utilization(utilization rate) can be increased by 3.75% per unit of spatial integration, and can be increased by 3.30% per m2 per resident area size, and can be raised by 0.51% per unit of spatial connectivity.

As a conclusion, allocate common facility to place with higher spatial integration, more spatial connectivity with surroundings, and increase the average space area size per resident are valid way to raise the space utilization of common space in Japanese nursing homes.

KEYWORDS

Space Syntax, Space utilization, Spatial characteristics, Common facility, Nursing home

1. INTRODUCTION

Investigation shows majority of the elderly people evaluate their QoL(quality of life) positively on the basis of social tie and material circumstances(Gopalakrishnan 2008). This also applies to residents of nursing home: the resident-resident relationships influence their life satisfaction(Park 2009), subjective well-being(Street and Burge 2012), and quality of life(Ball 2004; Candace L. 2012).

Moreover, the architecture structure influences the resident's social life(Penn 1999; Sailer and Penn 2009). The physical environment, specially the common space, can promote peoples' social integration(Byoung-Suk 1998). The formation of social ties is substantially depended on the informal social contact which occurs in the common space(Frances E 1998).

However, the utilization of common space in Japanese nursing homes is low, especially in the public and semi-public space. Investigation shows residents spent about more than 90% of time a day within the care unit where they're living, the time staying in hall, lobby, community space, physical training room etc. common space was only about 4% to less than 10%(Kanki 2005a; Tachibana 2002; Ishibashi 2015).

The longer staying time of residents in the care unit and lower utilization of common space in Japanese nursing home brings the risk that the residents close themselves in the small unit, and affects their social life. In order to enhance residents social life, it is important to promote the use of common space outside of the unit(Kanki 2005b). Therefore, there is the needs to find a means to promote common space utilization from the viewpoint of common space design.

On the other hand, there has been growing interests in applying Space Syntax(SS) theory to analyse the relationship between people's activity and the spatial structure in urban design and public buildings(Takano 2012), especially from the year of 2000, there are many successful examples in applying SS theory to commercial building facilities, libraries, and museums.

However, the elderly's movement and involvement in space in nursing homes are different from general people's space recognition and behaviour in public facilities because of the slow space recognition of elderly and defined care service in the nursing home. The methodology and application of SS theory for general peoples' recognition and involvement in space may not be always applicable to elderly residents in nursing home.

For this reason, in this article we verify the feasibility of applying SS theory to express elderly's space involvement, to find the association between residents' space utilization and spatial configuration, and to explore a way in effective design of common space from the perspective of having higher utilization in Japanese nursing homes.

2. DATASETS AND METHODS

2.1 Common space in Japanese nursing home

There are mainly 3 types of nursing home for elderly in Japan, they are intensive care nursing home, private residential home, and elderly housing with supportive service. Among them, the intensive care nursing home is funded by Japanese government, and is the main elderly facility, it is selected as research objective in this article, hereinafter referred to as nursing home for abbreviation.

Historically, the intensive care nursing home has been transited from large-scale care type to unit care type by the introduction of regulation on unit care nursing home by Ministry of Health, Labour and Welfare in 2002 [Note 1)], which is also the main nursing home in Japan.

The space in unit care nursing home is divided to shared space and personal space. The shared space is further divided into public space which is used for social community service, and the semi-public space used by residents from different living units. The personal space is divided into semi-private space such as living space, dining room, and the private space(private room) as shown in Fig. 1.

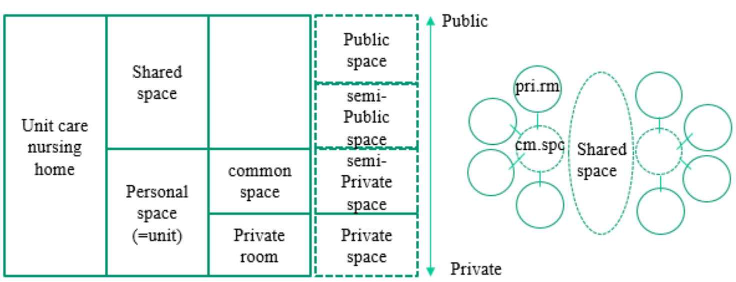

Fig. 1 Common space in Japanese classical large-scale care nursing home(left), unit-care nursing home(right)(Source: MHLW 2015(left), Mori 2003(right), translated by author)

The common space in this research covers the public and semi-public space which includes the community space, physical training room, club house, care and service station, restaurant, and dining room, as shown in Table 1.

Table 1 Common space in Japanese nursing home

Symbol	Space category	Example
ENH	Public space	Entrance hall, lobby
DRM	Semi-public space	Restaurant, dining room
PTR	Semi-public space	Rehabilitee centre, club room, club house, physical training room
MTR	Semi-public space	Multiple purpose room, hobby room, game room etc
SST	Semi-public space, semi-private space	Care station, service station
CMS	Public space	Community centre, community space
DSR	Public space, semi-public space	Daily service room
LVS	Semi-private space	Living space, common room

2.2 Factors affect common space utilization

There are a number factors which may affect the utilization of common space. These factors can be human administrative, external changeable factors and the space internal inherent characteristics.

The human administrative factors include the planned, and organized group activities like festival events, welcome party etc.

Besides, the external factors like the equipment deployed on-purpose, air conditioner, the equipped sofa/chair, table, and decorations can also affect residents' common space utilization. These factors are easily changeable after common space is designed and created.

In this research we focus on the space inherent spatial characteristics, includes spatial metrics like the accessibility, connectivity with surroundings. And, because Space syntax theory only analyse the space spatial relationship based on space topological geometry, the space area size, shape, physical distance etc geometric metrics is ignored, here to make the analysis more realistic, the space geometric metrics are also included. These spatial characteristics can't be changed as long as the space is designed and created. The administrative factors such as special event will be carefully excluded through the onsite observation, and the external factor such as temperature will be checked so as to have similar temperature condition.

For the space accessibility and connectivity with surroundings, the spatial metrics measured by Space syntax theory is selected because researches confirmed SS theory is a valid tool to quantitatively evaluate the spatial configuration(Hillier and Hanson 1984, Hiller 1990).

In summary, the factors of spatial configuration considered in this research includes:

- The spatial geometric metrics:
  - Space area size
  - Space shape: circle, square, rectangle, triangle, etc
  - The proximity(distance between each other)
- The Space syntax syntactic spatial metrics:
  - Spatial connectivity
  - Spatial depth
  - Spatial integration

2.3 Common space utilization

The space utilization in this research means the proportion of time that a common space is occupied during certain period a day.

The on-site survey and interview of nursing home care staff of resident's utilization of common space is performed. Here the utilization of a common space is defined as the percentage of time averagely one resident spent at a common space to the total observation duration(8:00am ~ 18:00pm). The number of residents stay in common space is recorded in each 30 mins time interval, which leads the utilization as:

$$\text{UTI} = \frac{\sum(NUM * TIM)}{Total\ observed\ residents * DUR\ (mins)} \qquad (1)$$

where the NUM is the number of residents staying in common facility observed; TIM is the observation time interval, 30 mins; DUR is observation period, 600 mins from 8:00am to 18:00pm.

It is assumed that the opportunity of communication would increase when people stay in common space longer. Compared to the specific behaviour like chatting, playing, reading, meditating the stay time is more fundamental and is considered in this research.

2.4 Spatial metrics by Space syntax theory

SS theory provides a number of spatial synthetic metrics to depict spatial configuration(Hillier 1996). Among them, the depth measures the topological steps(turns) from one space to another(Klarqvist 1993); the connectivity specifies the number of units directly connected to a space; the integration expresses the relative depth of a space from the others, it is fundamental indicator of spatial centrality: the higher integration of a space, the higher centrality of this space within the space system(Dettlaff 2014). This is the main metric to describe the spatial configuration in this research.

In this research, these spatial metrics are used to describe the common space spatial configuration.

SS theory uses different approaches to calculate spatial metrics(Varoudis 2013). One of the approaches is convex map analysis method which utilizes vertical boundaries to convert 3-D space to a number of 2-D convex polygon(Peponis 2002), and establishes connection based on the availability of direct access(Klarqvist 1993). Due to this “fat” nature of the convex shape, it is said that this method is best suited for defining spaces such as building interiors(Daniel 2013; Peiman 2014). This approach deployed in DepthMapX computer tool(Varoudis T. 2012) is applied in this research for calculating the spatial metrics of nursing home.

For nursing home architecture, based on space functionality each space unit is presented by one or multiple convex spaces and to use least possible number of convex spaces to cover all the architecture spaces. The wall, any kind of partition which separates space is taken as boundary while doors and openings are considered as connection points. For multi-story buildings, according to the allocation of common facilities, elevators and staircases are regarded as connection points.

2.5 Regression analysis of common space utilization and spatial configuration

The multiple linear regression analysis between space utilization and spatial characteristics is performed to find the significant spatial factors. The multiple linear regression model is selected is because it attempts to model the relationship between two or more independent variables and a dependent variable by fitting a linear equation to observed data, and fits the need to find the significance of each independent variables(spatial configuration in this research) to dependent variable.

This is done by using IBM SPSS data analysis tool(IBM Corp. 2016).

3. RESULTS

3.1 Common space utilization survey

12 nursing homes within Tokyo area were selected for onsite survey. The staying time of residents in common space in these nursing homes from 8:00 ~ 18:00 were recorded in each 30 minutes interval, then the total staying time of all observed residents are summarized and is used to calculate the average utilization of common space of residents in nursing home. Within the 12 nursing homes surveyed, totally 1070 nursing home residents were involved. The surveyed nursing home is listed in Table 2.

Table 1 The list of nursing homes surveyed

No.	NHID	Year of build	Capacity	No. of observed residents	Observed floors	Site area, m^2	Total floor area, m^2

No.	NHID	Year of build	Capacity	No. of observed residents	Observed floors	Site area, m^2	Total floor area, m^2
1	7	1981	100	66	1F	21,205	3,225
2	12	1983	100	87	1F		
3	13	1984	150	100	1F, 2F	16,606	6,150
4	14	1985	120	72	1F	11,790	4,989
5	16	1987	180	63	1F, 2F	6,693	3,904
6	23	1990	66	60	1F,2~3F	2,200	3,288
7	27	1993	110	52	1F, 2F	4,603	6,636
8	30	1994	180	50	1F	9,441	8,145
9	45	1999	88	80	1F, 3F	3,895	5,517
10	48	2001	60	54	1F, 2F	5,991	3,531
11	50	2001	111	96	1F, 2F	2,670	4,036
12	74	2012	140	140	1F, 2F, 5F	4,006	7,989

The overall investigation result from 12 nursing homes is listed in Table 3 and Fig. 2, where the blank in the table means no such common facility or no utilization data is available.

Table 3 Nursing home common space utilization investigation result, %

No.	NH ID	ENH	DRM	PTR	MPR	SST	CMS	DSR	LVS
1	7	9.70	22.73*1	0.45			1.21		0.11
2	12	1.49	6.90			0.23	0.86		
3	13	3.15	9.20	1.40			1.00	1.60	
4	14	2.08	18.06*2	1.39	2.78		6.25		
5	16	1.27	15.87	0.63			1.27		
6	23	5.50	7.50	0.33	0.50	0.50	0.50	0.83	
7	27	8.37	7.69	0.38	0.38		1.54	0.96	
8	30	6.00	0.60			0.60	2.00	4.00	
9	45	0.88	13.44	1.25	0.75	0.50	0.19	0.50	
10	48	3.52	5.56		0.37	0.56	0.37	4.44	0.56
11	50	3.75	14.06	0.73		0.73	0.94		
12	74	1.36	0.57	0.36		0.07	2.14		0.21
Ave		3.92	9.70	0.77	0.89	0.46	1.52	2.06	0.29

*1,2 These two utilization data is extremely higher than others, the reason is there was a special event hold. This data from extreme case is removed for following analysis.

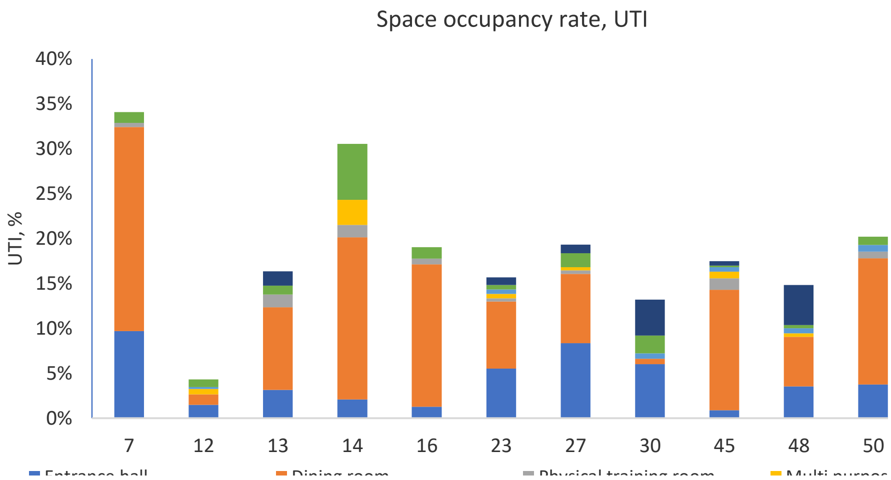

Fig. 1 Utilization investigation result in all common space by each nursing home(Source: created by author)

3.2 Space syntax spatial metrics of common space

The floor plan of each selected nursing home is scanned and converted to AutoCAD dxf file, which is imported to DepthMapX SS analysis tool. Then, the convex space was created for each space unit in nursing home, the spatial integration, spatial connectivity, mean depth, and total depth for each space unit is calculated.

Fig. 3 is an example of spatial metrics calculation result. The floor plan, convex space, connectivity, and the spatial integration results are shown in the left, middle, and right. The integration result is colored based on its value, the high value of well-integrated location to the poor is represented from thick to thin.

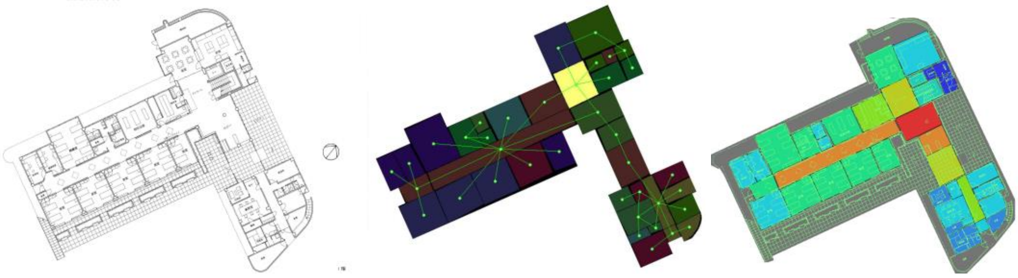

Fig. 3 Floor plans(left), convex space and connection map(middle), and spatial integration(right) result by DepthMapX tool(NHID 1)

For all 12 nursing homes, the result of connectivity, integration, mean depth, and total depth of each common facility is listed in Table 4.

3.3 Common space geometric metrics

The area size of each common space is calculated by AutoCAD area measure tool. Same as the spatial metrics calculation, the loor plan of each selected nursing home is scanned and inputted to AutoCAD, where based on the space functionality, the entrance hall, lobby, lounge, dining room, physical training room, multi-purpose room, care and service station, club house and community space, day service room etc space area size, and average per resident is calculated.

To count in the effect of space shape to space utilization, the ratio of length in vertical direction to length in horizontal direction(VHR) in floor plan is investigated, as shown in Fig. 4.

Fig. 4 VHR, ratio of vertical to horizontal

The physical distance from resident bed room to common space is also a factor to impact common space utilization. To count in the impact of space physical distance, the proximity, PRX, i.e. the average distance(m) from living zone to common space is also investigated, as shown in Fig. 5.

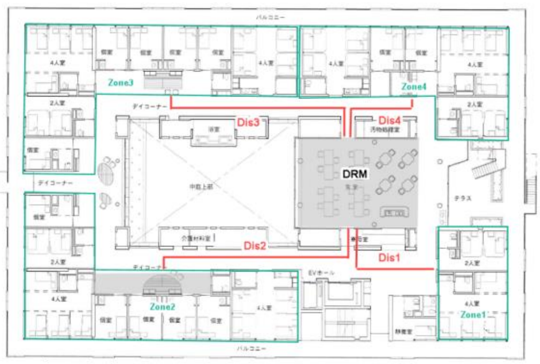

Fig. 5 Proximity to living zone, PRX

The result of each common space geometric metrics in 12 surveyed nursing homes is listed in Table 4.

Table 4 Common facility utilization and spatial configuration data

Common space	NHID	ARE, m^2/p	INT	CNN	DEP	TDP	VHR	PRX	UTI, %
ENH	7	0.70	1.603010	6.0	2.979170	143.00	1.45	42.51	9.70
	12	0.30	0.662910	3.0	6.054545	333.00	0.70	58.43	1.49
	13	0.27	1.5290344	6.0	2.914290	102.00	0.70	6.71	3.15
	14	0.38	1.2029306	5.0	2.8333333	218.00	1.82	44.06	2.08
	16	0.09	1.034520	3.0	3.448280	100.00	0.54	27.00	1.27
	23	0.79	1.017796	6.0	3.976740	43.00	1.15	12.30	5.50
	27	0.58	1.607630	8.0	3.038460	158.00	0.85	24.30	8.37
	30	0.18	1.063750	3.0	4.486110	323.00	0.86	36.77	6.00
	45	0.34	1.631850	3.0	2.800000	112.00	0.67	3.24	0.88
	48	0.95	1.689170	3.0	2.548390	79.00	1.79	21.00	3.52
	50	0.30	1.0885593	2.0	3.1600001	79.00	0.95	26.25	3.75
	74	0.25	0.944118	2.0	4.076920	159.00	0.33	39.69	1.36
DRM	7	0.81	1.128040	4.0	3.812500	183.0	0.55	56.29	
	12	2.40	0.70126456	3.0	5.5999999	280.0	1.00	4.47	1.17
	13	1.00	1.0622765	2.0	3.6388888	131.0	0.61	14.75	9.20
	14	1.48	1.1528085	4.0	3.9473684	225.0	0.78	58.05	
	16	0.61	1.530230	3.0	2.655170	77.0	1.71	10.44	15.87
	23	1.52	1.255640	2.0	2.833333	68.0	0.61	30.65	7.50
	27	0.73	1.085410	1.0	4.019230	209.0	0.97	9.18	7.69
	30	0.23	1.026930	2.0	4.611110	332.0	0.57	34.34	0.60
	45	2.05	1.195890	3.0	3.314290	116.0	0.74	26.19	13.44
	48	1.45	0.95512819	1.0	3.0555556	55.0	1.00	6.13	5.56
	50	1.14	1.474182	3.0	2.7741935	86.0	0.74	17.76	14.06
	74	0.26	0.636484	1.0	5.564100	217.0	1.29	49.95	0.57
PTR	7	0.54	1.103520	1.0	3.875000	186.0	0.75	48.97	0.45
	12								
	13	1.04	0.885230	4.0	4.1666665	149.0	0.55	38.00	1.40
	14	0.56	0.983106	2.0	4.456141	254.0	2.30	40.30	1.39
	16	0.36	1.469020	2.0	2.724140	79.0	0.93	14.40	0.63
	23	1.26	0.789687	1.0	4.837210	59.0	2.71	20.50	0.33
	27	0.84	1.085410	1.0	4.019230	209.0	0.71	36.72	0.38
	30	0.12	0.767246	2.0	5.833330	420.0	0.71	55.29	
	45	0.36	1.030500	3.0	3.685710	129.0	2.00	25.38	1.25
	48								
	50	0.73	1.2246293	2.0	2.9200001	73.0	0.83	10.50	0.73
	74	0.09	0.717967	1.0	5.000000	190.0	0.90	5.40	0.36
MPR	7								
	12	0.16	0.921445	1.0	4.636364	255.0	0.89	36.10	0.57
	13	0.45	0.70080745	3.0	5	180.0	0.55	27.71	
	14	0.40	1.1066961	3.0	4.0701756	232.0	1.29	39.95	2.78
	16	0.43	0.966462	1.0	3.620690	105.0	0.71	18.00	
	23	0.52	0.689409	1.0	5.395350	60.0	0.71	26.65	0.50
	27	0.06	1.078540	1.0	4.038460	210.0	1.29	28.62	0.38
	30						0.68	42.04	
	45	0.43	0.863922	1.0	4.375000	176.0	0.79	27.00	0.75
	48	0.75	0.976868	1.0	3.677420	114.0	1.50	46.20	0.37
	50	0.11	0.864444	1.0	3.720000	93.0	0.45	36.05	
	74								
SST	7	0.20	1.208620	3.0	3.625000	174.0	0.73	43.88	
	12	0.08	0.969942	1.0	4.454546	245.0	0.67	13.97	0.23
	13	0.13	1.245880	2.0	3.250000	117.0	0.92	23.69	
	14	0.17	1.489783	2.0	3.280702	187.0	1.08	20.21	
	16	0.06	1.200250	2.0	3.037040	82.0	1.64	12.00	
	23	0.26	0.761979	3.0	4.976740	53.0	1.44	25.27	0.50
	27	0.11	1.704064	2.0	2.877551	50.0	1.09	24.98	
	30	0.22	0.898995	3.0	5.125000	369.0	1.20	57.57	0.60
	45	0.09	1.445772	3.0	2.914286	102.0	1.78	20.25	0.50
	48	0.50	1.3592209	2.0	2.4444444	44.0	0.67	14.00	0.56
	50	0.18	1.228485	3.0	3.1290324	97.0	0.17	22.05	0.73
	74	0.11	0.496585	1.0	6.424240	212.0	1.46	56.97	0.07
CMS	7	0.19	1.103520	2.0	3.875000	186.0	0.58	51.62	1.21
	12	0.36	0.555087	1.0	7.036364	387.0	1.14	57.57	0.86
	13	0.77	0.89306432	2.0	4.1388888	149.0	1.25	38.00	1.00
	14	1.25	1.195505	3.0	3.842105	219.0	0.77	56.75	6.25
	16	0.08	1.360210	1.0	2.862070	83.0	0.83	5.76	1.27
	23	0.12	0.904850	2.0	4.348840	50.0	0.91	24.86	0.50
	27	0.23	1.385440	2.0	3.365380	175.0	0.65	10.80	1.54
	30	0.47	0.839627	3.0	5.416670	390.0	0.63	42.32	2.00
	45	0.34	0.963061	2.0	4.0500002	162.0	0.79	10.80	0.19
	48	0.17	0.976868	1.0	3.677420	114.0	0.48	42.00	0.37
	50	0.19	0.864444	1.0	3.720000	93.0	0.45	32.55	0.94
	74	0.50	0.555364	1.0	6.230770	243.0	1.64	58.59	2.14

Common space	NHID	ARE, m^2/p	INT	CNN	DEP	TDP	VHR	PRX	UTI, %
DSR	7								
	12								
	13	0.21	1.035430	1.0	3.173910	73.0	1.07	26.19	1.60
	14	0.27	0.90925741	1.0	4.7368422	270.0	0.72	23.27	
	16	0.35	0.758781		4.222220	114.0	1.17	32.22	
	23	0.61	1.284840	1.0	2.791667	67.0	0.85	21.83	0.83
	27	0.75	1.085410	1.0	4.019230	209.0	0.84	26.46	0.96
	30	0.50	0.641831	2.0	6.777780	488.0	1.52	51.30	4.00
	45	0.40	0.863922	1.0	4.4000001	176.0	0.79	21.60	0.50
	48	0.87	1.0496821	1.0	3.24	81.0	1.59	16.45	4.44
	50	0.54	0.603339	1.0	6.631580	81.0	0.51	20.30	
	74								

Note; NHID nursing home ID; ENH, entrance hall; DRM, dining room; PTR, physical training room; MPR, multiple purpose room; SST, service station; CMS, community space; DSR, daily service room; LVS, living space.

3.4 Common space utilization regression model

The space spatial metrics that may affect space utilization investigated in this paper are summarised in Table 5. In regression analysis, these factors are independent variables(IVs), while the space utilization(UTI) is dependent variable(DV).

Dependent variable:

Utilization rate(UTI, 0.0% ~ 100%)

Potential independent variables:

Area size per resident(ARA, m^2/person)
Spatial Integration(INT)
Connectivity(CNN)
Mean depth(DEP)
Total depth(TDP)
Space vertical to horizontal ratio(VHR)
Space proximity(PRX).

Because multiple linear regression analysis attempts to model the relationship between two or more independent variables and a dependent variable by fitting a linear equation to observed data, it fits the need to find the significance of each spatial metric to space utilization, this analysis method is selected in this research.

Table 5 Independent variables considered for space utilization

Factors			Variables	Explanation	Equation definition
Dependent variable, DV	Space utilization, UTI		UTI	Space utilization rate for all staying activity	UTI = (∑(NUM*TIM))/(Total observed residents*600) Where NUM is the number of people who are staying in the common place, and TIM is the time interval of the observation
Independent variables, IVs	Space syntax metrics	Spatial integration	INT	The spatial integration to all space units in nursing home.	INT = 1/RRA RRA is Real Relative Asymmetry
		Spatial connectivity	CNN	The direct connection of a space to its surrounding spaces	CNN = c Where c is the connection routines with surrounding spaces.
		Spatial mean depth	DEP	The mean depth of a space from all other space units.	DEP =(∑(Dk* k))/(n-1) Where D is depth from a space unit, n is total space unit number, k=1~n.
		Spatial total depth	TDP	The total depth from all other space units.	TDP =∑(Dk*k) Where D is depth from a space unit, n is total space unit number, k=1~n.
	Geometrics factors	Area size	ARE	The space area size per resident, m2/a	Evaluated by floor plan

Factors			Variables	Explanation	Equation definition
		Vertical to horizontal ratio	VHR	The ratio of vertical length to horizontal length	VHR = (The length in vertical direction, vln)/(The length in horizontal direction, hln) Evaluated by floor plan
		Proximity	PRX	The average distance(PRX, m) from living space to common space, m.	PRX = (∑(Dis))/(Number of living zones) Where Dis is distance from a living zone to common space.

The different kinds of common facilities in nursing home may have different use purpose, which in turn may affect the utilization rate. However, as the first stage of research, here in this article we don't discriminate the difference in different kinds of common facilities, and take the space in all common facilities as a general common space to analyse the association between utilization rate and space configuration.

The IBM SPSS data statistical analysis tool is used, and multiple linear regression is performed(stepwise method). Among different regression models with different IVs, the result of best regression model is shown in Table 6.

Table 6 Regression result for all common space

Model Summary[a]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
3	.641[b]	0.411	0.381	2.84085

a. Predictors: (Constant), INT, ARE, CNN
b. Dependent Variable: UTI

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
3	Regression	327.274	3	109.091	13.517	.000[b]
	Residual	468.084	58	8.070		
	Total	795.358	61			

a. Dependent Variable: UTI
b. Predictors: (Constant), INT, ARE, CNN

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.(p)	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
3	(Constant)	-4.206	1.441		-2.920	0.005	-7.090	-1.322
	INT	3.752	1.443	0.297	2.601	0.012	0.864	6.640
	ARE	3.301	0.777	0.431	4.249	0.000	1.746	4.855
	CNN	0.506	0.280	0.208	1.809	0.076	-0.054	1.066

a. Dependent Variable: UTI

Table 6, the model summary, tells that spatial integration INT, area size ARE, and spatial connection CNN this three spatial variables are significantly related to space utilization UTI with $F(3,58) = 13.517$, $p=0.000<0.001$. The multiple regression coefficient(R) is .641, indicating approximately(R square) 41.1% of the variance of the space utilization can be predicted by using spatial integration INT, spatial connection CNN, and space size ARE for space utilization analysis.

With the unstandardized coefficients of B in Coefficients table, we get the space utilization UTI regression equation:

$$UTI(\%) = f(INT, CNN, ARE)$$
$$= 3.752 * INT + 3.301 * ARE + 0.506 * CNN - 4.206 \quad (1)$$

3.5 Common space utilization regression model analysis

1. Coefficients of each variables

INT – The coefficient of spatial integration INT in space utilization model is 3.752, indicates every unit increase in spatial integration, the space utilization will be increased by 3.75 percentage in case other spatial variables(CNN, ARE) are constant.

ARE - The coefficient of space area size ARE is 3.301, that is, every square meter per resident increase in space area size, the space utilization will increase 3.30 percentage when other spatial variables remain unchanged.

CNN - The coefficient of spatial connectivity CNN is 0.506, which tells every unit increase in spatial connectivity, the space utilization will be increased 0.51 percentage in case other spatial variables(INT, ARE) are constant.

2. t-statistics of each coefficient

The t-statistics(t column) and associated 2-tailed p-values(Sig. column) in coefficient table of Table 5.5 tells whether a given coefficient is significantly from 0(or no effect) at the 0.05 alpha level(Note 7, Standardized Beta Coefficient). It can be seen that:

INT – The coefficient of INT(3.752) is significantly different from 0 because its p-value is .012 which is smaller than 0.05.

ARE - The coefficient of ARE(3.301) is significantly different from 0 because its p-value is 0.000(0.000079), which is much smaller than 0.05.

CNN - The coefficient for CNN(.056) is nearly significantly different from 0 for the reason that its p-value is 0.076, which is just little bigger than 0.05.

Finally, the intercept is also significantly different from 0 at the 0.05 alpha level.

3. Relation between space utilization and Space syntax metric alone

Based on above common space utilization regression model for nursing home in Japan, except the space spatial metrics INT and CNN measured by Space syntax theory, the space geometric metrics, space area size per resident is confirmed to be significant variable. Which tells, due to the uniqueness of elderly residents' slow movement and space recognition, the methodology and application of SS theory alone for general peoples' recognition and involvement in space is not always applicable to elderly residents in nursing home.

3.6 Effective way of raising space utilization

Because the spatial connectivity, spatial integration, and space area size are significantly related to space utilization for most of common facilities in nursing home, the increase of routines link to common facilities, design the space layout with higher spatial integration, and bigger area size per resident are valid way to improve resident space utilization for most of common facilities in Japanese nursing homes.

4. CONCLUSIONS

This study is to clarify the common space spatial configuration in Japanese intensive care nursing home, and explores the association with space utilization, for contribution to spatial design for better resident's social exchange. The factors of spatial configuration in this paper includes space area size per residents, shape, distance to living space, and the spatial metrics which is measured by Space syntax theory.

Firstly, the common space area sizes and factors of spatial configuration form Space Syntax theory are analysed and compared through the past 35 years nursing home samples for clarifying the spatial characteristic changes.

Secondly, actual spatial utilization by residents are observed through the field survey in 12 nursing homes, and the tendency of utilization in each common space are clarified.

Thirdly, the spatial configuration is combined with spatial utilization to perform the multiple linear regression analysis, then the spatial integration, area size per resident, and spatial connectivity are extracted as significant factors to common space spatial utilization in Japanese nursing home based on the investigated 12 nursing homes in this article, as:

$$UTI(\%) = f(INT, CNN, ARE) = 3.752 * INT + 3.301 * ARE + 0.506 * CNN - 4.206$$

This result reveals that every unit increase in spatial integration, the space occupancy will be increased by 3.75 percentage in case other spatial variables(CNN, ARE) are constant; every square meter per resident increase in space area size, the space occupancy will increase 3.30 percentage when other spatial variables remain unchanged; and, every unit increase in spatial connectivity, the space occupancy will be increased 0.51 percentage in case other spatial variables(INT, ARE) are constant.

The result also confirms that due to the uniqueness of elderly residents' slow movement and space recognition, the methodology and application of SS theory alone for general peoples' recognition and involvement in space is not always applicable to elderly residents in nursing home.

The result above is based on the utilization and common space spatial characteristics in 12 investigated nursing homes. The coefficient and even the linear regression equation may differ if the survey data are changed. However, based on the common space regression model result in this investigation, the increase of routines links to common space, design the space layout with higher spatial integration, and bigger area size per resident are valid way to improve common space utilization in Japanese nursing homes.

NOTE:

1) Ministry of Health, Labor and Welfare(Sep. 28,2009), http://www.mhlw.go.jp/topics/kaigo/kaigi/010928/siryo5-1.html (accessed May 25, 2018).

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