Common Space Spatial Layout Transition in Japanese Nursing Home
- By Space Syntax point of view

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Abstract

This article analyzes changes of common space spatial characteristics in Japanese nursing homes in the past 35 years, aims to provide a reference for future common space design. The analysis is done by using Space Syntax theory. Totally 62 nursing homes from Japanese architecture publications are selected and analyzed. The analysis shows that compared with classical large-scale care nursing homes, the spatial integration of community space in modern unit care nursing homes is increased by 15%, but service station and dining room are reduced about 10% and 13%, which indicates the spatial importance of community space in modern nursing homes.

Keywords: DepthMapX, Common Space, Nursing Home, Convex Map, Space Syntax.

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1.0 Introduction

Along with the development of modern Japanese economy, Japanese nursing home has also been evolved. In 1963 when the 1st welfare law for the elderly was issued, Japan was experiencing high economic growth and remodeling of household function, which making it difficult for elderly to take care of themselves, and leading to high market needs of the senior facility. Consequently, lots of large-scale care nursing home with big shared room for more than ten residents were built up. This alleviated the shortage of senior facility but brought the difficulty to residents in getting care service in such a big collective living. Later, to realize the home alike living style and to have individual care service, nursing home with private living room and unit care living space appeared in 1996, this is so-called modern unit care nursing home, and now is the main senior facility in Japan (Murakami, 2003).

By the transition of the nursing home from large-scale nursing care to unit care, the living space structure has also been changed, as shown in Fig. 1. In the large-scale care nursing home, the common space is mainly concentrated in one location, where eating, recreation, and rehabilitation are taken place. On the other hand, in unit care style the dining room and day activity are separated, living space is designed and shared by several private rooms, and further, it connects to place with higher publicity.

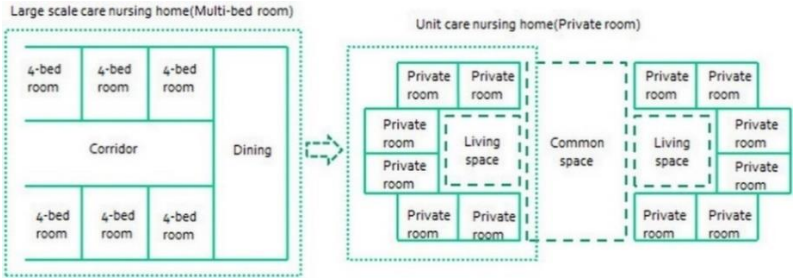

Figure 1: Space syntax axial map
(Source: From MHLW, 2015)

Withthis transition, except living space what has been changed in spatial characteristics in other common facilities, like community space, physical training room, service station, and dining room?Further, Japan is facing rapid aging, and super-aging society, the quality of life of residents in the nursing home has already aroused people's high attention. On the other hand, because space syntax theory has demonstrated the close relationship of spatial characteristics and human social activity(Hillier B, 1996), a common space with high space syntax spatial metricscan be expected to promote resident social life in the nursing home. Therefore,in this paper 62 nursing homes built in the year from 1978 to 2014 are selected from Japanese architecture publications, with which the spatial characteristics of common facilities are analyzed to develop an understanding of how common space layout has been transformed, and to provide a recommendation ofcommon space layout designin future nursing homes from the perspective of space syntax spatial characteristics.

2. 0 Literature Review

Common space design is a study of concern in Japanese nursing home. There is much research reported so far to verify the utilization and importance of common space to resident social life by the observation of resident environmental behavior or interview on resident daily activities. The researches done by Inoue(1990), Kato(2007),Mori S.(2004), Kozuma (2015), Toyoma (2002), Murakami(2011), and Mori K.(2014) are typical examples.

By analyzing the actual utilization status, Inoue put forward the topic of the necessity of having common facilities in the nursing home(Inoue, 1990), and based on environmental behavior observation for over 50 residents in 3 nursing homes, Kato conducted a research on factors to improve residents living quality(Kato, 2007).Further, by the observation of actual care activities and people's movement in common space, Mori pointed out the problem in current nursing home common space designing that some of the care functions which should originally be performed in common space were actually packed into private room(Mori S., 2004), and Kozuma proposed a living space layout rearrangement to improve residents stay and routines of movement (Kozuma, 2015). Moreover, Kan.S conducted space syntax analysis on four Japanese nursing homes by using space syntax theory, concluded to widen facility and front room hall to secure communication within residents (Kan.S, 2012).

These studies investigated the importance of common space and its layout in affecting resident living quality, but the results did not provide systematic spatial characteristics of common space. Although Kan.S(2012) applied space syntax theory to analyze spatial characteristics in the nursing home, the study was limited on the hall visible scope, and the research method, Isovist, is based on the panoptical view a person has from a given point. This method is useful for orientation or wayfinding in the urban fabric but is ineffective in evaluating spatial characteristics in relatively small space like inside nursing home building (Ne, 2011).

3.0 Methodology and Metrics

Space syntax (SS) theory is applied in this study. The theory quantifies and analyzes the properties of architectural and space by a set of spatial attributes: connectivity, depth, and integration (Hillier, 1996). More detail can be found in this literature.

The integration value of a space expresses the relative depth of that space from the others, is one of the fundamental indicators of spatial structure centrality, and is used to predict the pedestrian use of the space: the higher integration of the space, the greater centrality of this space, and the more utilization of the space is expected (Dettlaff, 2014). This is the main metric to describe the spatial characteristics in this article.

UCL DepthMapX tool provides different approaches to calculate space characteristics (Varoudis, 2013). One of the approaches is the convex map which utilizes vertical boundaries to convert 3D space to some "fattest" or largest 2D convex polygon and establishes the connection based on the availability of direct access (Peponis, 2002; Klarqvist, 1993). Due to this "fat" nature of the convex shape, this method is said to be best suited for defining spaces such as building interiors(Daniel, 2013), and this approach is applied in this article for common space spatial metrics calculation.

Floor plan of each selected nursing home is scanned and converted to AutoCAD file, then imported to DepthMapX tool to create convex maps. Based on space functionality, each space unit is presented by one or multiple convex maps but to use the least possible number of the convex map to cover all the spaces. The wall, any partition which separates spaces is taken as a boundary while doors and openings are considered as connection points. For multi-story buildings, the elevators and staircases are regarded as connection points.

However, it should be aware that this method abstracts space to 2D graph, and the analysis is performed on the morphological structure of the graphs, which neglects the precise space location (Dawes, 2013).

4.0 Results and Discussions

4.1 Large-scale Care Nursing Home

1. Spatial layout characteristics

Fig. 2 is a typicalfloor plan of large-scale care nursing home where along corridor is built up. The spatial integration result is presented tothe rightwith colors based on its value, the high value of spatial integration to low is represented in red, yellow, to green, and dark blue.

It can be seenfrom Fig. 2 that the long corridor is the place with highest spatial integration in this typical large-scale care nursing home.

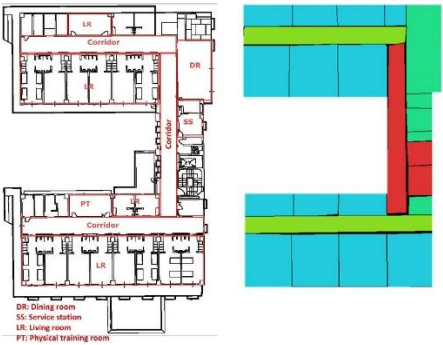

Figure 2: Typical large-scale care nursing home floor plan(left) and integration result(right)
(Source: Created by the author)

For all large-scale care nursing homes investigated, the result of highest and lowestspatial integration place is listed in Table 1 and Table 2.

Table 1 tells that for more than half of the large-scale care nursing homes investigated, the place ofthe highest spatial integration is the long corridor, which accounts for 22 in 40 in ourinvestigation.

On the other hand, Table 2 makes it clear that the place of the least spatial integration in large-scale care nursing homeis the living room, warehouse, and staff rooms.

Table1:Number of N.H.(Nursing Home) bythe highest spatial integration place

Place	Long corridor	Connect corridor	Lobby	EV hall	Community space	Service station	Others	Total
Number of N.H.	22	3	8	4	1	0	2	40
Ave. Integration	1.7219	2.1805	1.5198	1.2993	1.3329		1.1546	

Table 2: Number of N.H.by the lowest spatial integration place

Place	Living room	Warehouse	Staff room	Bathroom	Stairs	Dining	Others	Total
Number of N.H.	8	6	5	3	2	1	15	40
Ave. Integration	0.5956	0.6502	0.5697	0.4847	0.5415	0.4297	0.6460	

2. Common facilities

The spatial integration of the four common facilities and nursing home all space unit average, as well as the order from high to low, are summarized in Table 3.

(1) Service station

As shown in Fig. 2,the service station is typically positioned in the middle of living area to provide care service to all residents in large-scale care nursing home, whichalso resulted inhigh integration. In Table 3, its integration is higher than other common facilitiesin 29 of 40 surveyed nursing homes.

Table 3: Common facility integration result of large-scale care nursing homes

No.	Build year	Nursing Home Ave.	Community space	Physical training room	Service station	Dining room	Order*
1	1978	0.8100		0.9169	1.0195	0.8537	SS>PT>DR>**NH**
2	1979	1.0772	0.7806		1.0103	1.1366	DR>**NH**>SS>CS
3	1979	1.0186		0.8265	1.2700	1.1038	SS>DR>**NH**>PT
4	1980	1.3511		1.5526	1.6018	1.2615	SS>PT>**NH**>DR
5	1981	1.0607		1.1035	1.2086	1.1280	SS>>DR>PT>**NH**
6	1982	0.9419	0.8070	0.8646	1.0772	0.8411	SS>**NH**>PT>DR>CS
7	1982	0.9775		0.8295	1.0318	0.9341	SS>**NH**>DR>PT
8	1982	0.9731	0.8700		1.1322	0.8522	SS>**NH**>CS>DR
9	1982	1.3352		1.2774	1.9041	1.3278	SS>**NH**>DR>PT
10	1983	1.0014			1.3593	1.2113	SS>DR>**NH**
11	1984	0.8658	0.8497	0.6290	1.3838	1.0305	SS>DR>**NH**>CS>PT
12	1985	0.9100	0.7841	0.7655	1.1260	0.6967	SS>**NH**>CS>PT>DR
13	1987	1.0073		0.8815	1.6049	1.5062	SS>DR>**NH**>PT
14	1987	0.9370	0.9983	1.0193	1.0193	1.0035	SS=PT>DR>CS>**NH**
15	1987	1.1985		0.8488	1.3092	0.9087	SS>**NH**>DR>PT
16	1987	0.8996		0.8758	1.1700	0.9388	SS>DR>**NH**>PT
17	1988	0.9309		0.7810	0.9953	0.8460	SS>**NH**>DR>PT
18	1989	1.1146	1.1255	0.9413	1.3992	0.9413	SS>CS>**NH**>PT=DR
19	1990	0.9913	0.9521	1.0266		1.1032	DR>PT>**NH**>CS
20	1990	0.7862		0.9084	0.7561	0.7886	PT>DR>**NH**>SS

21	1990	0.7577	0.9920	0.8479	0.7348	0.8479	CS>PT=DR>**NH**>SS
22	1991	0.9841		0.4297	1.4932	1.5895	DR>SS>**NH**>PT
23	1992	0.9852		1.2601	0.8995	1.2312	PT>DR>**NH**>SS
24	1993	1.1548		1.0204	1.5597	1.3399	SS>DR>**NH**>PT
25	1994	0.7351		0.5661	0.7746	0.6766	SS>**NH**>DR>PT
26	1994	0.8809		0.9431	1.3970	1.4636	DR>SS>PT>**NH**
27	1994	0.7210	0.8370	0.7650	0.6578	0.7335	CS>PT>DR>**NH**>SS
28	1995	1.0933	0.9838	1.2756	1.3498	0.9922	SS>PT>**NH**>DR>CS
29	1995	0.9021			1.3475	1.0017	SS>DR>**NH**
30	1995	1.0329		1.0631	1.0631	0.9813	SS=PT>**NH**>DR
31	1996	0.9383	0.9838	0.9058	0.9492	1.0196	DR>CS>SS>**NH**>PT
32	1997	0.7098	0.7938	0.7908	0.9249	0.8827	SS>DR>CS=PT>**NH**
33	1997	0.8417	1.0553	0.7904	0.9059	0.7811	CS>SS>**NH**>PT>DR
34	1998	0.7737	0.9062		0.6354	0.7274	CS>**NH**>DR>SS
35	1998	1.4389		1.4690	1.7488	1.8834	DR>SS>PT>**NH**
36	1999	0.8449	1.3329	1.2012	2.7778	1.2012	SS>CS>PT=DR>**NH**
37	1999	1.2856	1.1967		1.4286	1.2887	SS>DR>**NH**>CS
38	2001	1.0590			1.2726	0.9442	SS>**NH**>DR
39	2001	0.9642			1.2346	0.6838	SS>**NH**>DR
40	2001	0.6983		0.7199	0.9598	0.7491	SS>DR>PT>**NH**
Ave.		0.9747	0.9558	0.9405	1.2178	1.0358	SS>DR>**NH**>CS>PT

*Note: NH – Nursing home, CS – Community space, PT – Physical training room, SS – Service station, DR – Dining room.

(2) Community space

Community space has low spatial integration in large-scale care nursing home. The overall average in Table 3 tells it is lower than service station, dining room, and nursing home all space unit average, and there are five nursing homes where the integration of community space is the lowestamong fourcommon facilities.

(3) Physical training room

The overall average in Table 3 shows physical training room is the place with lowerspatial integration compared with other common facilities.

(4) Dining room

Table 3 discloses a dynamic changein dining roomspatial integration. It is the common facility with the lowestintegration in 8 nursing homes and highest in 6.

4.2 Unit Care Nursing Home

1. Spatial layout characteristics

Fig.3 is a typicalfloor plan of unit care nursing home, where multiple care units are connected by connection corridor and a common living space is designedfor each care unit.The calculation shows the connection corridor is the place with highestspatial integrationas shown on the right of Fig. 3.

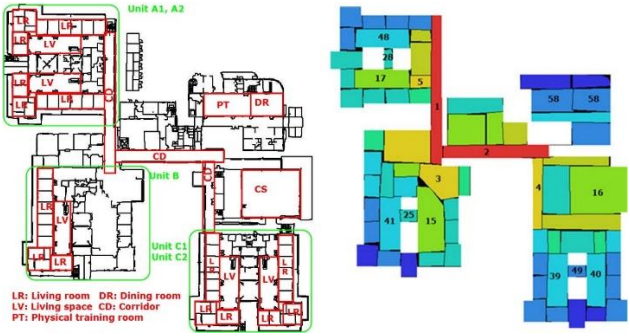

Figure 3: Typical unit care nursing home floor plan(left) and integration result(right)
(Source: Created by the author)

For all unit care nursing homes surveyed, the result of highest and lowest spatial integration place is listed in Table 4 and Table 5.

In Table 4, there are ninenursing homes where the connection corridor is the place withthe highest integration, which accounts for 40% in our investigation.

Table 4: Number of N.H. by the highest spatial integration place

Place	Connect corridor	Lobby	EV hall	Community space	Service station	Physical training room	Total
Number of N.H.	9	4	4	2	2	1	22
Ave. Integration	1.7285	1.6709	1.6948	1.4314	1.4291	1.3030	

Table 5: Number of N.H. by the lowest spatial integration place

Place	Living room	Warehouse	Staff room	Bathroom	Stairs	Dining	Others	Total
Number of N.H.	11	1	1	4	1	2	2	22
Ave. Integration	0.5141	0.7700	0.5011	0.6358	0.5690	0.5671	0.5960	

2. Common facilities in unit care nursing home

The result is in Table 6. In the table, the number of nursing homes where the integration of service station,community space, physical training room, and dining room is the highest among the four common facilities is 10, 7, 2, and 1respectively,and, the overall average shows community space is the place with high spatial integration. Both results reveal that compared with large-scale care nursing homes, community space has been taken as a place with higher spatial integrationin modern Japanese unit care nursing homes.

Table 6: Common facility integration result of unit care nursing homes

No.	Build year	Nursing home	Community space	Physical training room	Service station	Dining room	Order*
1	1997	1.0670	1.1008	1.0290	1.1531	0.9314	SS>CS>**NH**>PT>DR

2	2003	0.8406	1.0769	0.9669	0.8425	0.8745	CS>PT>DR>SS>>**NH**
3	2003	0.8796	1.1775		1.2007	0.7443	SS>CS>**NH**>DR
4	2003	0.8530	1.0264	1.2394	1.4236	1.0522	SS>PT>DR>CS>**NH**
5	2004	0.5767	0.9322	0.5299	0.5822	0.5299	CS>SS>**NH**>PT=DR
6	2004	0.8668	1.3462	0.7576	1.4345	0.9115	SS>CS>DR>**NH**>PT
7	2005	1.0172	1.1785		1.3902	1.1325	SS>CS>DR>**NH**
8	2005	0.9310		0.9767	1.1543	0.9862	SS>DR>PT>**NH**
9	2005	1.2381	1.4175	0.9596	1.0942	1.1340	CS>**NH**>DR>SS>PT
10	2005	1.0230	0.9026	0.8910	1.4787	0.7165	SS>**NH**>CS>PT>DR
11	2005	0.9475	1.050	0.8077	0.9633	0.8077	CS>SS>**NH**>PT=DR
12	2005	0.7443	0.9144	0.5842	0.9207	0.5842	SS>CS>**NH**>PT=DR
13	2006	0.7959		1.3029		0.9049	PT>DR>**NH**
14	2010	0.9797	1.0316	1.0869	1.0867	0.8281	PT>SS>CS>**NH**>DR
15	2012	0.9332	0.9324	0.9241	0.8811	0.9001	**NH**>CS>PT>DR>SS
16	2012	0.8924		1.3796	0.9366	0.6695	PT>SS>**NH**>DR
17	2012	0.9185		0.7682	0.7014	1.4745	DR>**NH**>PT>SS
18	2012	0.7455	0.8289	0.6780	0.7469	0.6360	CS>SS>**NH**>PT>DR
19	2012	1.3503	1.4156	0.9957	1.9582	0.9957	SS>CS>**NH**>PT=DR
20	2013	0.7811		0.665434	0.7544	0.6272	**NH**>SS>PT>DR
21	2013	1.0216	1.3374	1.3374	0.90123	1.0237	CS=PT>DR>**NH**>SS
22	2014	1.0327	1.0269	1.3350	1.4751	1.2899	SS>PT>DR>**NH**>CS
Ave.		0.9289	1.0998	0.9608	1.0990	0.8979	CS>SS>PT>**NH**>DR

*Note: NH – Nursing home, CS – Community space, PT – Physical training room, SS – Service station, DR – Dining room.

4.3 Comparison Between Large-scale and Unit Care Nursing Home

The average integration offour common facilities in large-scale care nursing home and unit care nursing home is presented in Fig. 4.

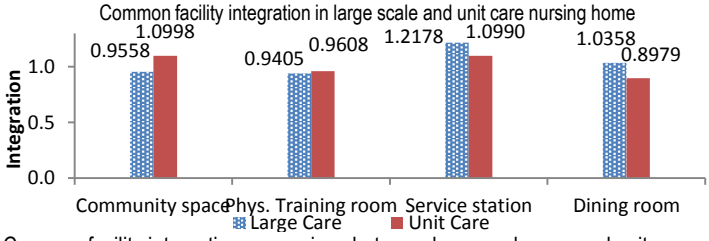

Figure 4: Common facility integration comparison between large-scale care and unit care nursing homes

(Source: Created by the author)

It can be seen from this figure that compared with large-scale care nursing home, integration of community space in unit care nursing home is increased about 15% from 0.9558 to 1.0998, physical training room is increased slightly from 0.9405 to 0.9608, but

service station and dining room are reducedabout 10% and 13% from 1.2178 to 1.0990, and 1.0358 to 0.8979 respectively.

4.4Overall Changes of Common Space in Past 35 Years

The transition and trend line over the past 35 yearsisshown in Fig. 5.Again, the spatial integration of community space shows an uptrend inall period, service station and dining room are in a downtrend.

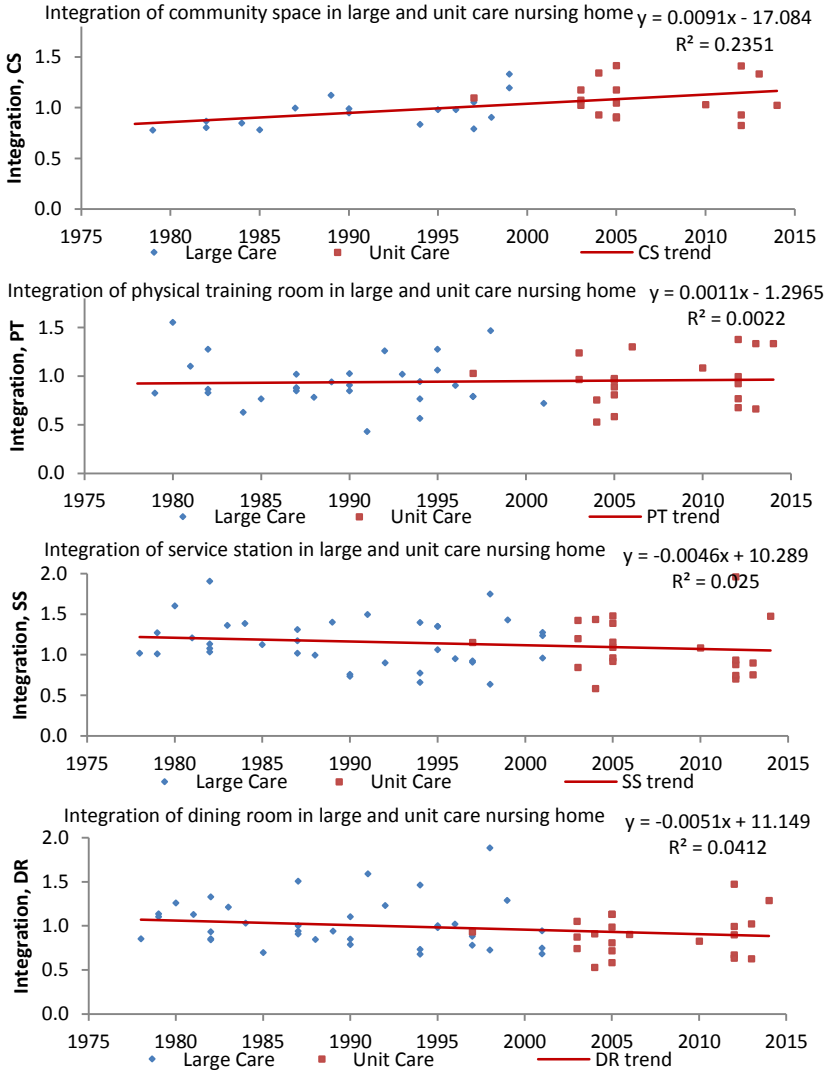

Figure 5: Common space integration overall changes in past 35 years(CS: community space, PT: physical training room, SS: service station, DR: dining room)
(Source: Created by the author)

5.0 Conclusion

Analysis of spatial characteristics of common space for 62 Japanese nursing homes by space syntax theory revealsthat in classical large-scale care nursing homes, the corridor along which the living and service facilities were distributed is the place with the highest spatial integration, and in modern unit care nursing homes the connection corridorwhich links different functional areas typically is the place with the highest spatial integration.

With the transition of Japanese nursing home from large-scale care to unit care, the spatial integration of community space is increased about 15%, but service station and dining room are reduced about 10% and 13%. Based on this transitionand to enrich resident social activity in the nursing home by easy access tocommon space, the flowing factors could be important in future Japanese nursing homesdesign.

1. The community space

Because the spatial integration has increased about 15% in modern unit care nursing homes,and the uptrend has shown up in the past 35 years, the community space in future nursing home can be expected to be allocated to a place with the spatial integration being higher than the current unit care nursing home average of 1.0998, to provide an easier access place for residents totake social activity.

2. The physical training room

The spatial integration of physical training room in modern unit care nursing home is slightly higher than classical large-scale care nursing home, and the transitionin the past 35 years also shows minor increase, soit can be expected to allocate physical training room in future nursing home to a place with spatial integration around the current unit care nursing home average of 0.9608, to keep the current spatial centrality of physical training room in modern nursing homes.

3. The service station and dining room

Because the spatial integration of service station and physical training room in modern unit care nursing home is about 10% and 13% lower than large-scale care nursing homes, and both of the two common facilities show the downtrend of spatial integration in the past 35 years, it may be expected to allocate the service station and dining room in future nursing home to the place with spatial integration of lower than the current unit care nursing home average of 1.0990 and 0.8979, which on the other hand is to assure the spatial centrality of other common facilities like community space in nursing homes.

Nevertheless, the conclusion in this article is based on Space Syntax theory, the theory provides a view of spatial layout but ignores some practical aspects in the real world likeprecise space location, size, decorations, and attractions. Besides, the study focus on four common facilities. This study will be improved by including living room to provide whole spatial structure in next phase.

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