



Space Syntax Analysis on a Nursing Home of Soelund Urban Nursing Home in Denmark

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Abstract

Deinstitutionalizing nursing homes requires effort from an architectural aspect to improve the quality of life for the elderly. One of the methods is to add social spaces and encourage community interaction with the elderly. In this paper, the logic of space is studied based on a case study using space syntax to analyze wayfinding and space permeability. The case study selected is Soelund Nursing Home in Denmark. It is a pioneering example of a city-integrated care center with community involvement. The results show that semi-public spaces are prepared and separated from the private spaces, which are the nursing home's residence units. Wayfinding for the public on amenities and interaction space is easy but hard to reach residential units. This approach helps to maintain the privacy of the residence. Therefore, the case study has shown a good layout for creating a non-institutional nursing home with local residence involvement.

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1 Introduction

A nursing home, also known as a long-term care facility, is a medical care facility that provides living space for the elderly and patients in need of medical care. In recent years, architecture has put its effort into improving nursing homes to less institutional and more "residential" environments by adding social spaces (Kaup, 2007; Keysor et al., 2005). The planning of spaces is essential to both the privacy of the elderly and successful public drawing to the nursing

home. Research in this aspect is also vital to ensure quality of life for the elderly and empower life's resilience.

This study identifies the logic of a nursing home's layout with community engagement using space syntax. The analysis is essential to understand the space with multiple users and functions. The quality of spatial configuration can be determined by the degree of permeability and wayfinding analysis (Evangelia, 2019). These elements are crucial for nursing homes because wayfinding difficulties in a healthcare facility may stress patients' and medical staff's efficiency. Besides, the healthcare residence's permeability may promote a sense of security and support the curing healing, and caring process through the physical environment (Scher,1996). The building's spatial formation and layout may also influence people's behavior to use it (Hassan, 2004).

The case study chooses Soelund Urban Nursing Home by C.F. Møller Architects in Copenhagen, Denmark. This hospital's long-term care facilities for the elderly adopted a completely new approach, providing a sense of living in terms of urban living, lights, views, and most importantly, encouraging interaction with community and nature. Due to its significant emphasis on creating a non-institutional expression, the project was selected, facilitating multi-faceted meetings between the public and residents without compromising the peace and security of the elderly and staff.

2 Literature Review

Space syntax is a method and technique that evaluates spaces' connectivity and integration performance in a building by analyzing spaces' relationships or networking. As the space syntax method was developed to understand spaces' social logic, it can be further utilized as an independent variable in investigating social, economic, and cultural attributes (Hillier & Hanson, 1984). In terms of architecture, space syntax presents as a language to think and talk about a space, a tool to understand the possible effects during the preliminary space planning stage, and an evaluation of spatial configuration with movement patterns and social meanings (Dursun & Pelin, 2007).

Space syntax is usually used to measure the permeability of space for the end-user and measure the level of wayfinding. Wayfinding is a building user process, solving spatial configuration problems while navigating from one point to another destination. This process often includes three mental operations: information processing, decision-making, and execution (Abu-Ghazze, 1996). According to Haq and Luo (2012), human navigation decisions and wayfinding performance are mainly influenced by the design and layout of the buildings and urban settings during an empirical study using space syntax. In architectural design, wayfinding gives people guidance to improve their understanding and experience of the physical environment and space (Mohd Yasin et al., 2017). The permeability of space, also known as the accessibility of space, is generally defined as public, semi-public, semi-private, and private spaces. People or vehicles are limited to specific spaces within the spaces in the building. Permeability of space can be achieved in terms of hierarchy order and spatial differential level. The potential effects of healthcare spatial

organization on movement, flow, and operation efficiency can be determined by analyzing the spatial orders and space flow (Zadeh et al., 2012).

A nursing home is a residential healthcare institution for care, aging, and rehabilitation for the elderly and people in need of medical care. Satisfaction of healthcare-built environment quality is usually determined by the patient perception (Andrade et al., 2013). Wayfinding, which is also known as space exploration, is essential in healthcare settings. Difficulties in finding the right direction for a patient due to the inefficiency of accessibility and circulation in the layout design (Abu-Obeid, 1998), might cause stress, anxiety, and frustration to patients and their families (Abu-Ghazze 1996). Commonly, the nursing home is institutional care that separates patients from mainstream community life. In recent years, the deinstitutionalization of healthcare services has been developing as community-based care provides a better-aging life and encourages life independence (Gibson, 2001). Hence, this case study was carried out to identify the spatial configuration and serve as a guide for designing long-term care facilities with community engagement in an urban setting. In this remarkable design scope of the nursing home, various public, semi-public, and semi-private spaces are designed based on the community, supporting medical staff and residence needs. A good design of circulations between public and private spaces allows public accessibility without interrupting private spaces (Lim et al., 2019).

3 Case Study: Soelund Urban Nursing Home

Soelund Urban Nursing Home is chosen as the case study for this paper. This city-integrated care center is located centrally in Copenhagen's Nørrebro district, Denmark next to the Sortedam Lake, designed by architects from C.F. Møller Architects. The concept of the project is integration with natural and urban contexts and social integration among generations. The development plays a role as an urban activity generator, encourages users and guests to meet at the central courtyard on the ground floor, and introduces activities along the streets and the lakeside (Moller, 2016). The planning of spaces provides a dignified, homely, and safe place for the elderly's everyday life.



Figure 1: Exterior Perspective of Soelund Urban Nursing Home

The Soelund Urban Nursing Home's primary design focus is a visionary long-term care design that creates an active environment where the elderly or patients will no longer be excluded from urban and community life and distanced from society. The residences are clustered around a communal kitchen, dining, and living room.

4 Method

The research design was conducted using qualitative analysis by using space syntax. By using this method, the connectivity of spaces can be easily identified to analyze wayfinding. In contrast, the depth of space can examine the space's permeability to understand the level of privacy. Firstly, the selected case study's layout plans were drawn with indications based on the space's function. Then, each space is coded with an alphanumeric. The alphabet stands for space use, followed by numbering. For example, staircases use the shortcode of "S", circulation corridors use the shortcode of "C" and "TC", life use the shortcode of "L" and residences unit use the shortcode of "R". If there are five staircases, the code used will be S, S2, S3, S4, and S5.

On top of that, S1A is defined as Staircase 1 on the ground floor while S1B will be defined as Staircase 1 on the typical floor. There will be only numerical labeling for the main usable spaces. The indications and labeling are done in the figure and shown in the legend. Next, spaces' indication is labeled with different colors based on different space functions for better visual presentation and reading. The indication of colors is shown in the legend on the respective justified graph.

The analysis second part will be to transfer all the labeled space to a justified graph. The purpose of a justified graph is to provide a mathematical and associated theoretical model to study the arrangement of the space in the building. It was the first analytical method developed from the theory of space syntax (Oswald, 2011). By using the justified graph, permeability, and wayfinding are analyzed. The depth of wayfinding and permeability will be analyzed using a Likert scale for space syntax as the measurement scale. The Likert scale numbering of 0 will be indicated for entrances. The Likert scale for this paper is defined in Table 1.

Table 1: Likert Scale for Analysis of Permeability and Wayfinding

Likert Scale Numbering	Level of Permeability	Level of Wayfinding
0	-	-
1-3	Public	Easy
4-5	Semi-Public	Moderate
6-11	Semi-Private	Moderate
12-15	Private	Hard

In the discussion, the spaces are identified according to the hierarchy of accessibility based on wayfinding and the degree of permeability. The spaces are also discussed based on the usage of different users of the building. All layout plans are redrawn. A justified graph is drawn using AutoCAD with different line weights and line types for space syntax analysis.

5 Result

The Soelund Nursing Home spaces analysis was drawn in a justified graph of three levels: the ground floor, the typical floor, and the top level to study the horizontal circulation. This nursing home's vertical circulation is direct as all staircases and lifts are accessible to all floors. Soelund nursing home adopted the concept of community engagement. Hence there are several users, which include the public, students, the elderly, and the caretakers. The analysis is done based on public users, including visitors, to study the space configuration with community engagement in a nursing home. With the result obtained from the justified graph, the result is analyzed using the depth of space indicated in the graph using a Likert scale as defined in Table 1.

5.1 Site Plan

The site of Soelund Nursing Home (Figure 2) is in an urban setting and next to the lake. Due to community involvement encouragement, all access points and access methods are straightforward from all directions and easy to access based on a Likert scale in Table 1. According to Figure 4, the depth level of entrance accessibility to the site is 0 to 2. With a depth level of 0-2, it is straightforward to easily access the building in terms of wayfinding and public. The results are so due to 5 access point entrances linking with the 11 entrances and urban landscape as shown in Figure 3 to the building's surroundings to encourage people to go through the building as a city street linking the street with a lake. The public permeability of the space has also created a community gathering space for local and the Soelund Nursing Home residents.

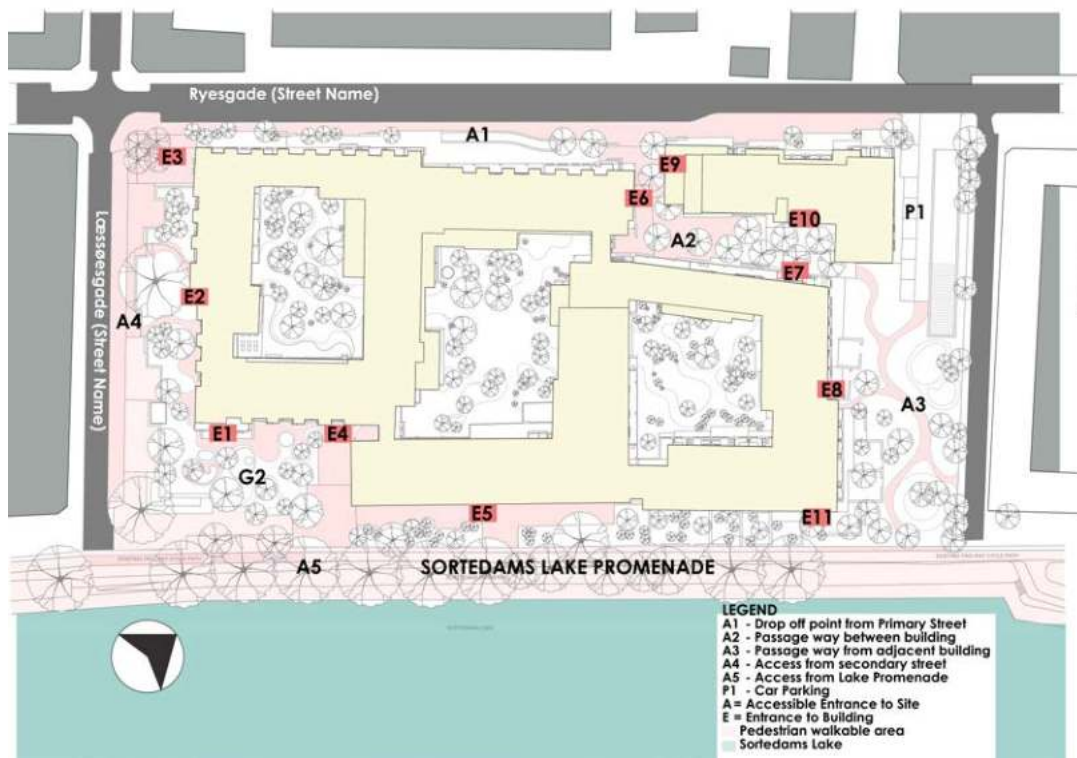


Figure 2: Site Plan of Soelund Nursing Home.

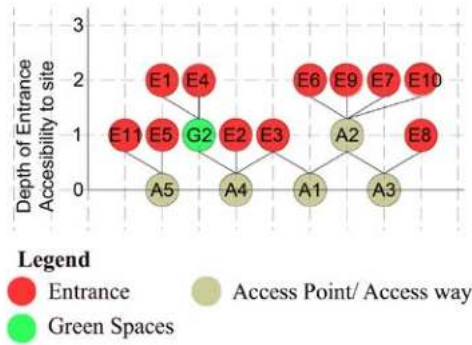


Figure 3: Justified Graph of Accessibility to Soelund Nursing Home

5.2 Analysis of Ground Floor

Figures 4 and 5 show the redrawn ground floor and the justified graph for Soelund Nursing Home's ground floor. According to the justified graph in Figure 5 and Table 2, there are eight depth levels for spaces on the ground floor plan.



Figure 4: Ground Floor Layout of Soelund Nursing Home

Most of the spaces are in-depth on the level of 5 and 7. Spaces with a depth level of 5, it is considered semi-public and easy to wayfinding. Spaces in these categories are mostly supporting facilities for the nursing home, such as rehabilitation gyms, therapy rooms for the elderly, and medical staff offices. However, there are spaces like the education kitchen and children's playground as well. The residents can access all these spaces to encourage intergenerational interaction with residents in the nursing home. Hence, these spaces are semi-private with a depth

level of 5. Next, the most spaces on the ground floor with 43.75% are with a depth level of 7. These spaces include residential units and communal spaces for the residents and their visitors linked to the circulation corridor. However, residents' circulation corridor is separated by public corridors (C1, C2, C3, C4, C5, C6), achieving semi-private spaces in permeability and medium-finding. In a larger picture, accessing spaces on the ground floor is relatively straightforward due to its tree branch-like circulation shape. However, there might be some confusion due to the connecting corridors in a loop.

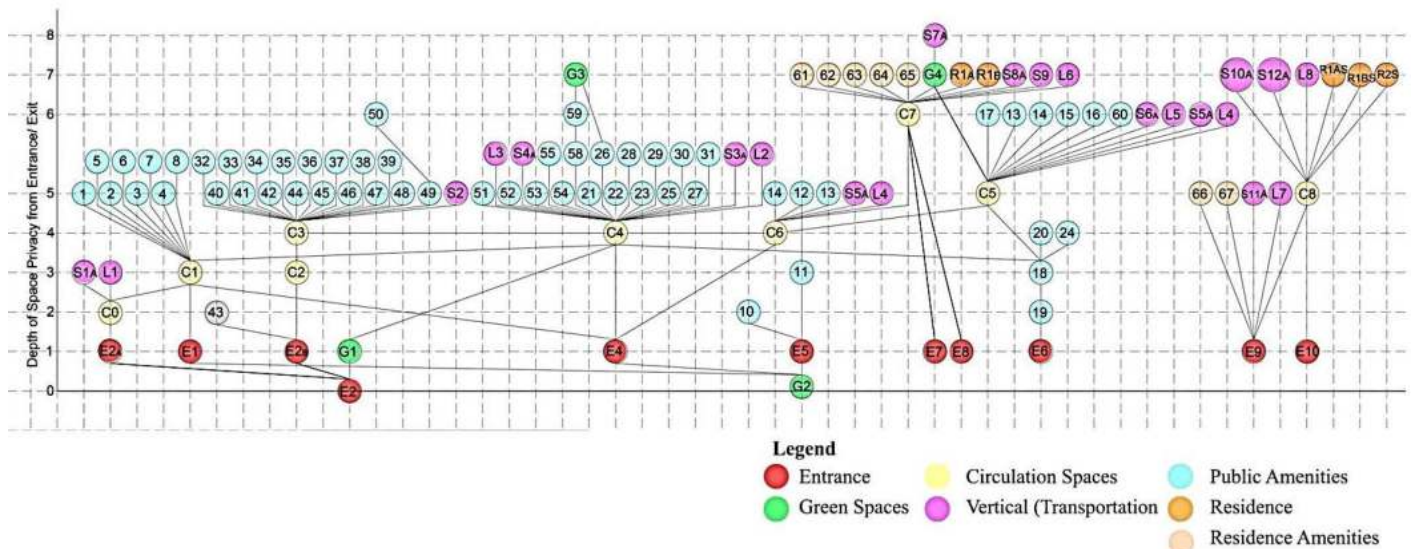


Figure 5: Justified Graph of spaces on the Ground Floor of Soelund Nursing Home

Table 2: Measurable Scale of Spaces on the Ground Floor

Depth of Space	Level of Permeability	Level of Wayfinding	Spaces in codes	Total number of spaces	Percentage (%)
0	-	-	E1, G2	1	0.89
1	Public	Easy	E2A, E2B, E1, G1, E4, E5, E6, E9, E10	1	0.89
2	Public	Easy	C0, 43, 10, 19	3	2.68
3	Public	Easy	S1A, L1, C1, C2, 11, 18	2	1.79
4	Semi-Public	Moderate	C3, C4, C6, 20, 24	2	1.79
5	Semi-Public	Moderate	1, 2, 3, 4, 5, 6, 7, 8, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 44, 45, 46, 47, 48, 49, 51, 52, 53, 54, 55, 58, 21, 22, 23, 25, 26, 27, 28, 29, 30, 31, 12, 13, 14, 66, 67, E7, E8, C5, C8, S2A, L3, S4A, S3A, L2, S5A, L4, S11A, L7	46	41.07
6	Semi-Private	Moderate	50, 59, C7, 17, 13, 14, 15, 16, 60, S5A, L5, S5A, L4	8	7.14
7	Semi-Private	Moderate	G3, 61, 62, 63, 63, 65, G4, S8A, S9, L9, S10A, S12A, L8, 18(R1AS), 3(R2S), 1(R1BS), 15(R1A), 5(R1B)	49	43.75
8	Semi-Private	Moderate	S7A	-	-
TOTAL				112	100

Note: Analysis of the total number of spaces does not include entrances and circulation spaces
**n(Rx)* represents *n* numbers of room for residence type *x*

5.3 Analysis of Typical Floor

Soelund Nursing Home consists of 3 typical floors which are the first, second, and third floors. Figures 5 and 6 show the redrawn typical floor plan and the justified graph of it, respectively. The depth of space on typical floors is 10-12.

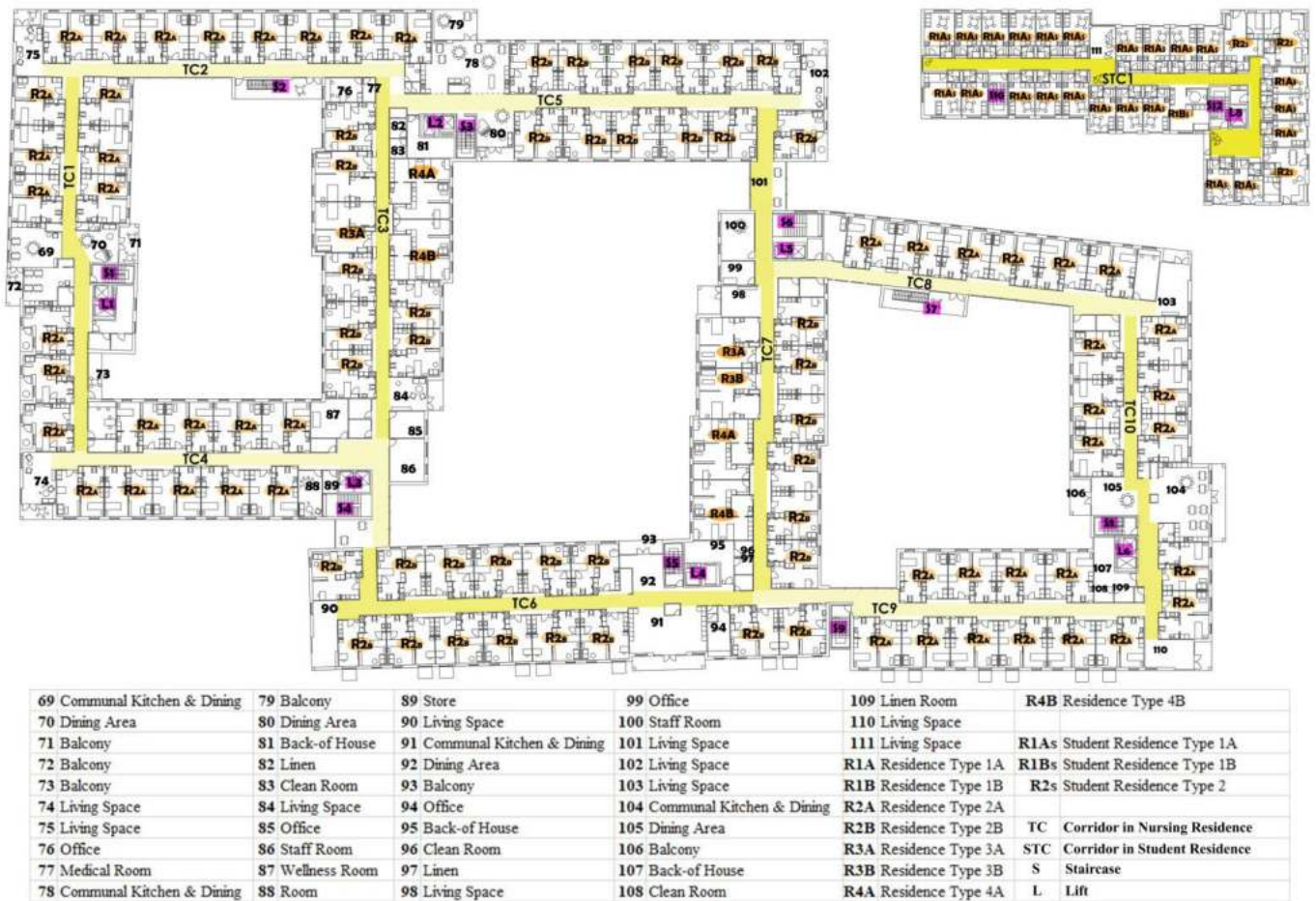


Figure 6: Typical Floor of Soelund Nursing Home.

Table 3: Measurable Scale Graph for Typical Floor Plan

Depth of Space	Level of Permeability	Level of Wayfinding	Spaces in codes	Total number of spaces	Percentage (%)
10	Semi-private	Moderate	TC1, TC2, TC3, TC4, TC5, TC6, TC7, TC8, TC9, TC10	-	-
11	Semi-private	Moderate	69, 70, 73, 74, 88, 87, 77, 89, 75, 76, 84, 85, 86, 90, 91, 92, 94, 95, 78, 80, 81, 102, 98, 99, 100, 101, 103, 104, 105, 107, 110, 111	32	19.39
12	Private	Hard	71, 72, 93, 96, 97, 79, 82, 83, 106, 108, 109, 50(R2A), 39(R2B), 1(R3A), 1(R3B), 2(R4A), 2(R4B), 23(R1AS), 1(R1BS), 3(R2S)	133	80.61
TOTAL				165	100

Note: Analysis of the total number of spaces does not include circulation spaces
 *n(Rx) represents n numbers of room for residence type x

Based on Table 3, 80.61% of the spaces on these floors are in-depth 12, comprising private space in terms of permeability and hard level on wayfinding for visitors or the public. Even so, wayfinding for nursing home residents is easy as most of the spaces in this depth are single-

connected to the circulation corridors. The only access to the typical floors is provided by eleven staircases and seven lifts, see Figure 6. It led to the common corridor linked to all semi-private communal spaces such as the living space and dining area (with level 11 in the depth of space) for social interaction among residents and visitors. The communal spaces are moderate in terms of wayfinding. The nursing home and student residence are in a separate building with no linkage among both.

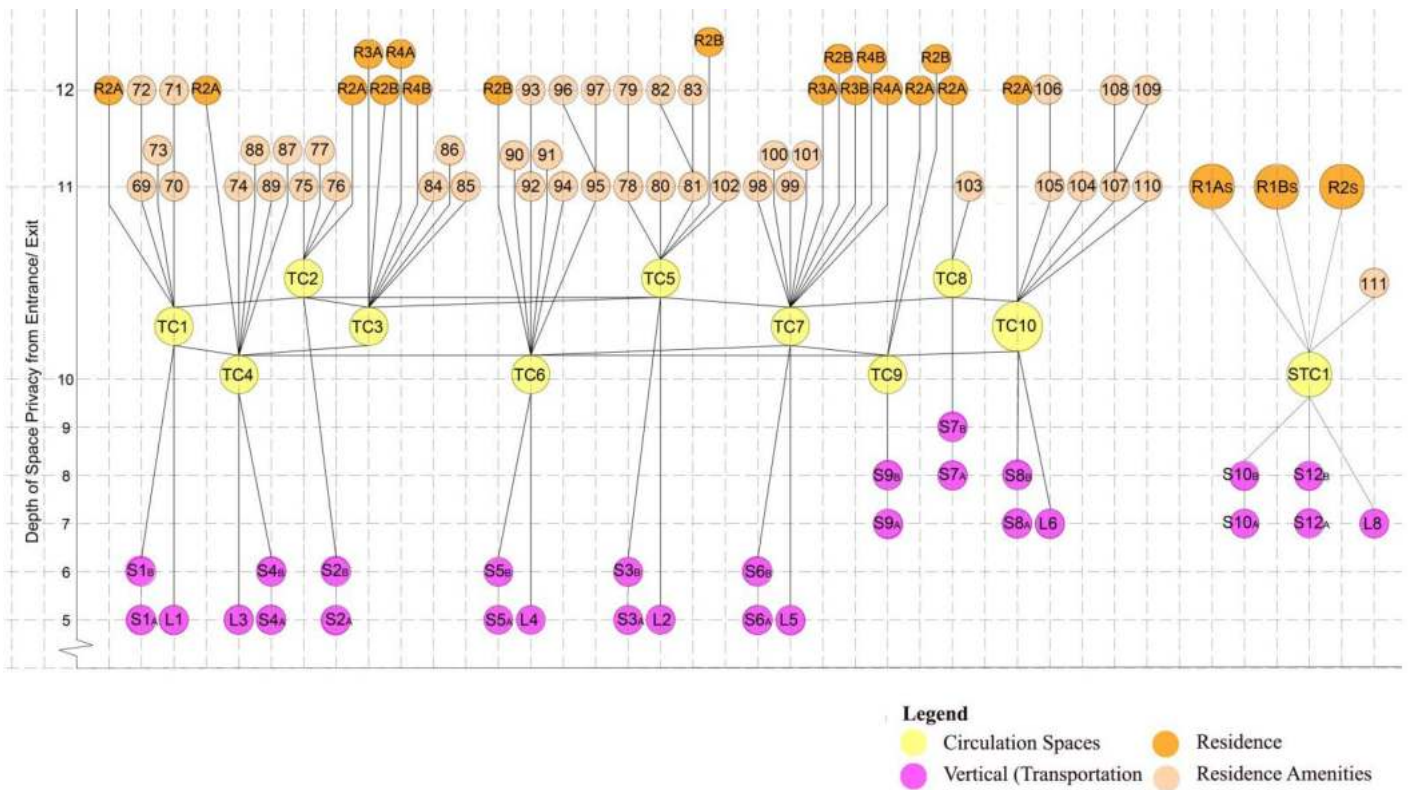
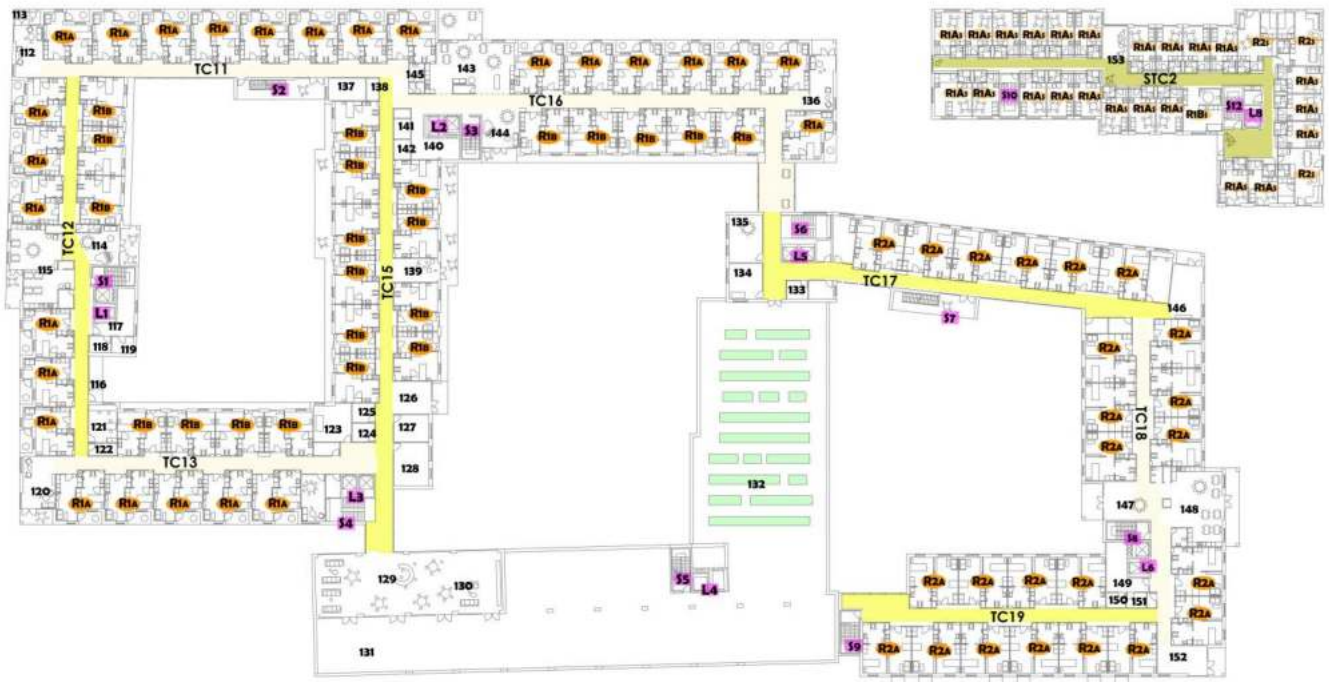


Figure 7: Justified Graph of Spaces in Typical Floor of Soelund Nursing Home

5.4 Analysis of Top Floor

Figures 8 & 9 show the layout plan of the top floor of Soelund Nursing Home and the result of analysis in the justified graph of spaces according to space depth. The top floor (fourth floor) adopted similar floor plans as the typical floor, as shown in Figure 8. Some additional facilities like sky lounge and farming green area. Due to staircases' usage to access the top floor, the top floor spaces are spaces with a depth of space of 11-15. Based on Table 4, 77.15% of spaces are private spaces with difficult wayfinding for visitors (Depth level of 13). These spaces mostly comprised residential units. On this level, all spaces except the corridor are the most private spaces in this building, and it's hardest in wayfinding.



112 Living Space	120 Living Space	128 Staff Room	136 Living Space	144 Dining Area	152 Living Space
113 Balcony	121 Office	129 Sky Bar	137 Office	145 Common Toilet	153 Living Space
114 Dining Area	122 Medical Room	130 Game Room	138 Medical Room	146 Living Space	R1A Residence Type 1A
115 Communal Kitchen & Dining	123 Wellness Room	131 Roof Terrace	139 Living Space	147 Dining Area	R1B Residence Type 1B
116 Balcony	124 Conversation Room	132 Roof Garden for Kitchen	140 Back-of Houses	148 Communal Kitchen & Dining	R2A Residence Type 2A
117 Back-of Houses	125 Store	133 Store	141 Linen	149 Back-of Houses	R2B Residence Type 2B
118 Linen	126 Living Space	134 Staff Room	142 Clean Room	150 Clean Room	TC Corridor in Nursing Residence
119 Clean Room	127 Office	135 Office	143 Communal Kitchen & Dining	151 Linen	STC Corridor in Student Residence
					S Staircase
					L Lift

Figure 8: Top Floor of Soelund Nursing Home

Table 4: Measurable Scale for Top Floor Plan

Depth of Space	Level of Permeability	Level of Wayfinding	Spaces in codes	Total number of spaces	Percentage (%)
11	Semi-private	Moderate	<i>TC11, TC12, TC13, TC15, TC16, TC17, TC18, TC19, STC2</i>	-	-
12	Private	Hard	114, 115, 116, 117, 121, 122, 123, 120, 124, 112, 137, 145, 138, 127, 128, 125, 126, 129, 144, 140, 143, 135, 146, 133, 134, 147, 148, 149, 152, 153	30	21.43
13	Private	Hard	118, 119, 113, 130, 142, 141, 150, 151, 27(R1A), 22(R1B), 24(R2A), 23(R1AS), 1(R1BS), 3(R2S)	108	77.15
14	Private	Hard	131	1	0.71
15	Private	Hard	132	1	0.71
TOTAL				140	100

Note: Analysis of the total number of spaces does not include circulation spaces
**n(Rx)* represents *n* numbers of room for residence type *x*

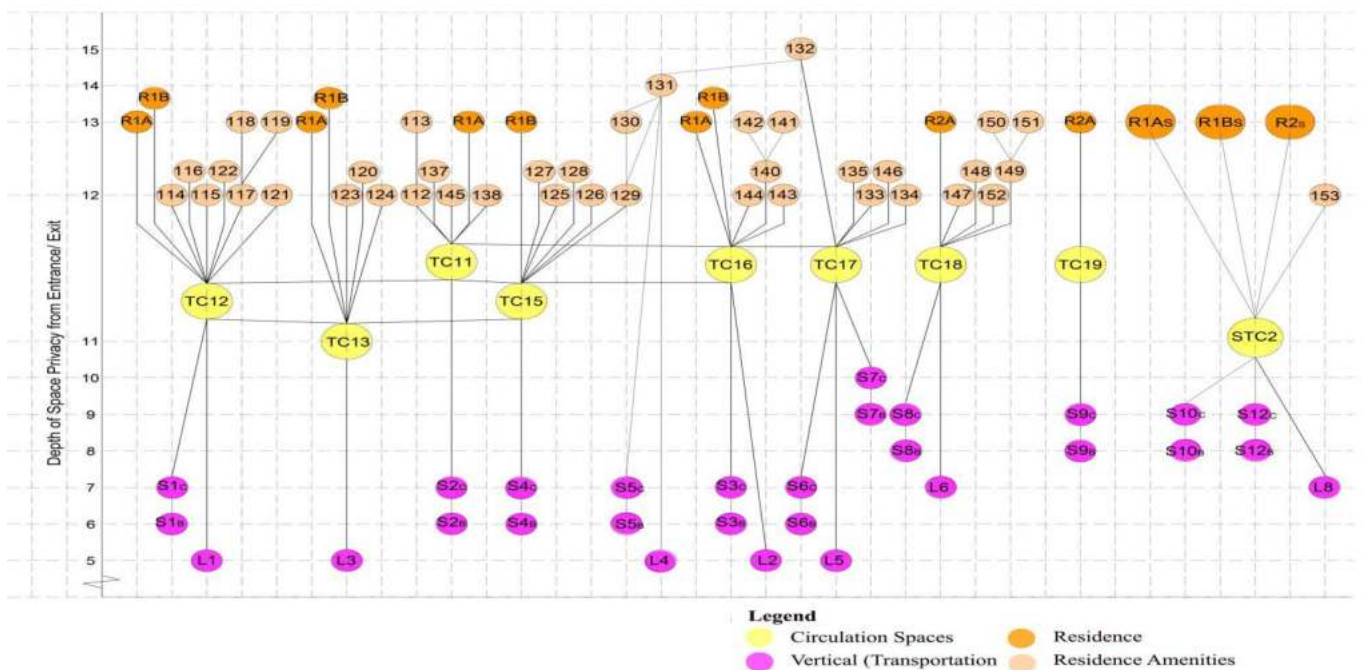


Figure 9: Justified Graph of Spaces on Top Floor of Soelund Nursing Home

6 Discussion

Based on the results from the justified graph in Figure 6,8,10, the spatial relation as shown in the graph is in tree formed model. Circulation corridors act as base spaces connecting with all other spaces with different functions and vertical circulation spaces (staircases and lifts). On the ground floor, residence use spaces and public amenities are distributed around the public courtyard and private residence courtyard. The spaces are designed with a long and straightforward corridor for easy navigation of spaces. Public spaces are located all on the ground floor, upper floors catering only to residential spaces, and communal living and dining spaces for visitors and residence use. The building allows the public to access high permeability to enter the building from all directions to encourage public engagement with the nursing home. A minimum depth and courtyard surrounding spatial configuration are used to achieve the building's purpose, facilitating interaction between the public and residents. However, for the public with no experience in the building, long and connected corridors might create confusion in finding the right room in the building and get lost in the corridors' loop.

Based on Figure 6 and Figure 7, typical floors are accessible through the ground floor's lifts and corridors. All residence units and sharing communal spaces such as living, and dining spaces relate to a continuous loop corridor with no dead ends to create a wandering loop for the elderly. The residences for the elderly and the student hostel are separated, and they are not connected. Hence, interaction is only encouraged on the ground floor, making the typical floors semi-private and private spaces for elderly residents and visitors. A similar spatial configuration is adopted on the top floor beside some common spaces such as the sky bar and urban farming. The minimal depth and similar spatial configuration have been implemented on the typical and top floors to assist the elderly with navigation and wayfinding.

Table 5 shows the summary of the level of permeability and wayfinding in Soelund Nursing. In terms of the level of permeability, the building spaces consist of 65.47% of private spaces, 21.34% of semi-private spaces, 11.51% of semi-public spaces, and 1.44% of public spaces. As the building is built for nursing home residents, most of the spaces are private spaces. There are semi-public and semi-private spaces with visitors and residents involved to cater spaces for multigeneration interaction. The wayfinding will be hard for a visitor; however, moderate wayfinding to common and sharing facilities on the ground floor.

Table 5: Summary of the level of permeability and wayfinding in Soelund Urban Nursing Home

Floors	Depth of Space	Number of spaces	Level of Permeability	Total Number of Spaces	Percentage (%)	Level of Way-finding	Total number of spaces	Percentage (%)
Ground Floor	0	1	-	1	0.24	-	1	0.24
	1	1	Public	6	1.44	Easy	6	1.44
	2	3						
	3	2						
	4	2	Semi-Public	48	11.51	Moderate	137	32.85
	5	46						
	6	8	Semi-Private	89	21.34			
	7	49						
8	-							
Typical Floor	9	-						
	10	-						
Typical	11	32						
Top		-						
Typical	12	133	Private	273	65.47	Hard	273	65.47
		30						
Top Floor	13	108						
		14	1					
		15	1					
TOTAL				417	100	TOTAL	417	100

7 Conclusion

The analysis case study of Soelund focuses on the spatial configuration of a nursing home with community engagement approaches using the space syntax method. As a nursing home, the overall space syntax performance is low permeability, resulting in mostly private spaces for the residence with hard wayfinding for the public. Moreover, the nursing home encourages multigenerational interaction with the elderly. Hence there are semi-public spaces on the ground floor with high and medium permeability for easier wayfinding. All supporting amenities and community spaces are single connecting spaces using the common corridor as a base. To ensure the peace and privacy of residences on the ground floors, gardens are separated into four, one for residence use and another three to encourage interactions with other generations.

However, too many spaces attached to the same corridor might lead to difficulty finding the right room and space on the ground floor, especially for the public, which is first-time users. The identity of spaces should be created with nodes at every junction to ease wayfinding. For the

residents part in the nursing home, most of the communal spaces shared among the residents are semi-private. The layout arrangement provides the nursing home's residential units with access to lights and views of the garden or lake and encourages interaction with the community.

Soelund Urban Nursing Home's design has a good layout for creating non-institutional expression with local residence engagement while providing personal spaces and security to the elderly. This study's limitation is that other factors will affect wayfinding; for example, the characteristics of spaces for differing visual characters, openings that provide views to ease wayfinding, and signage.

8 Availability of Data And Material

All data is included in this article.

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